University of Reading

Homo Mensor: Self – Quantification as an act of habitual resistance against neoliberal numbers

PhD in Management

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Sylvian Patrick Jesudoss

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Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

Sylvian Patrick Jesudoss

Abstract

Researchers and the mainstream media enquiry of self-quantification have either painted a techno-utopian society with self-governing users or an Orwellian world of surveillance governed by corporations and governments. On the other hand, more and more people (20% year-on-year increase in the market) are embracing self-quantification practices and technology, and they have started living their life in a quantified world where every aspect of their life is measured with or without technology. Some sociologists like Deborah Lupton posit that self-quantification is yet another neoliberal project that already imposes many numbers (including credit scores, grades, and social ratings) to govern the subjects. Informed by postphenomenology and based on 33 in-depth interviews of UK-based self-quantifying users and the exploration of devices, apps and secondary literature on the technology, the thesis studies everyday self-quantification practices.

Through a conceptual framework drawing from affordance theory and De Certeau's tactics of the weak, the thesis first unpacks the affordances offered by the self-quantification environment to the user and then identifies how the users actualise these affordances. Next, the thesis explains how users gain agency and control through the numbers produced by self-quantification and affordances. The control gained through numbers creates multiple micro resistances that are tacit, pre-reflective, situational, and embodied. The study theorises that self-quantification and the numbers produced through those practices are an act of habitual resistance against the neoliberal hegemony. The study presents an alternative narrative to the techno-deterministic viewpoint of the existing literature but agrees with the imposed surveillance theorisation of the sociological paradigm. However, it challenges that narrative and theorises how the users respond to the authorities' neoliberal and surveillance impositions. The study's theoretical, societal, and marketing implications are manifold, including the stance that self-quantification is not a singular practice but integrated and the noticeable resistance turn from the existing self-knowledge narrative. The thesis is subject to several limitations, including data generation complexities, and the study was conducted in a specific context of self-quantification. Finally, future research avenues are discussed and addressed in detail based on the implications of the findings.

Dedicated to my mom

(who couldn’t see my successes and failures)

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NHS - National Health Service

HCI - Human-Computer Interaction

BMI - Body Mass Index

QS - Quantified Self (represents the community of trackers started by Wired editors Gary and Wolf)

CAD - Canadian Dollar

GBP - British Pounds

GPS - Global Positioning Systems

PIM - Personal Informatics Model

ANT - Actor-Network Theory

NFC - Near-Field Communication

BMR - Basal Metabolic Rate

PMS - Premenstrual Syndrome

PCOS - PolyCystic Ovaries Syndrome

MRI - Magnetic Resonance Imaging

REM - Rapid Eye Movement

PSG - Polysomnography

RPG - Real-Playing Games

BHF - British Heart Foundation

1. Introduction

(Numbers) 'It is given to us to calculate, to weigh, to measure, to observe, this is natural philosophy; almost all the rest is chimera.' – Voltaire

Voltaire deemed anything that was not defined by numbers as an imaginary monster. However, he would not have imagined that numbers would rule the world and humans. Humans are governed through the quantification of various aspects of their lives, and they see numbers everywhere. For example, the health of a newborn is measured by their weight and height; as the child grows world also quantifies through school scores, sports ranking, the amount of money in one's bank and the matching score on a dating platform; even the love in a relationship is measured through the number of years a couple has been together. Quantification has seeped into our lives so much that humans involuntarily express themselves in numbers. To the authorities, a human is a social security number, a National Insurance Number or a mobile number. Humans express whether they are doing well or not through percentages; in hospitals, pain is expressed in numbers. The number of numbers humans encounter daily is unimaginable, and the quantification is so implicit that humans do not realise it exists. But, humans did not embrace numbers and quantification by choice or chance. Instead, the capitalistic world, and later, the neoliberal market imposed those numbers on the users. Neoliberalism is 'a hegemonic system of enhanced exploitation of the majority', as 'a global system of minority power, plunder of nations and despoilment of the environment' (Saad-Filho and Johnston, 2005, 2). The neoliberal construct uses numbers to govern its subjects, and in the world of 'governance through indicators', these numbers are the social currency (Mau, 2020). Humans have an innate cognitive ability to count, referred to as a 'number sense faculty', but some number theorists argue that counting large numbers is considered to be 'true' quantification (Gelman and Cordes, 2001, 279). Macro quantification or large numbers are used to control subjects, but self-quantification (or micro quantification) is another neoliberal project used to produce a self-optimising and self-governing individual who can be productive in the capitalistic world. The question arises whether consumers follow the self-knowledge decree imposed through the self-quantification paradigm by the neoliberal market.

The neoliberal market has introduced digital technology that has helped humans quantify and express different aspects of their lives through numbers. Self-quantification plays an important and increasing role in governing social life, and humans either self-quantify (through self-tracking technologies such as fitness, diet, sleep, heart rate, travel, finance, sex, etc.) or subject themselves to imposed self-quantification (health monitoring like insulin levels) in their daily life. Digital technology has enabled humans to quantify aspects of themselves in ways not possible in the past. The self-quantification of everyday habits and behaviours impacts humans' subjective experiences (Neff and Nafus, 2016). Increasingly, more people are embracing self-tracking and have started living their lives in a quantified world where every aspect of their lives is measured with or without technology.

Researchers and the mainstream media, in studying self-quantification, have either highlighted a neoliberal techno-utopian society with self-governing individuals (Lanks, 2015) or an Orwellian world of surveillance governed by corporations and governments (Mau, 2019). The market for self-tracking apps and wearables increased exponentially after the introduction of Fitbit in 2007, and since then, it has had a steady growth rate in adoption. According to Statista (2022), there were around 533 million wearable shipments in 2021, and the market is growing by 20% annually. The shipments almost doubled from 2018 to 2019 (Laricchia, 2022), and the statistics does not include app-only consumers who use mobile apps that are natively available on their mobile devices. According to Statista (2022), the penetration of digital health apps was at 20.87% in 2022, with an average revenue per user of 25 GBP (30.36 USD). Furthermore, the COVID-19 pandemic has affected this market in interesting ways. When a majority of countries were in lockdown, Fitbit reported that step activity reduced by 12% on average across the world (Fitbit, 2020), and at the same time, the number of fitness app downloads grew by 46% (WEF, 2020). According to the BBC, Strava added 73 million users worldwide in 2020, and UK-based Freeletics saw a 50% increase during May–June 2020 during the first lockdown in the UK (Criddle, 2020). During the same period, the National Health Service (NHS, 2020) reported that its 'Couch-to-5K' app was downloaded one million times, a 92% increase compared to 2019.

On the other hand, according to a Gartner (2016) study, wearables have an abandonment rate of 29–30%, and self-trackers who were consistently making 10,000 steps (the industry norm for optimum daily step levels) reduced to 18.5% within two weeks from the start of the tracking practice (Lee and Lee, 2017). According to Statista (2022) , the health and fitness category apps have a retention rate of 4% after 30 days of usage. This dichotomy beckons the question of how everyday users undertake these self-quantification practices and how the numbers produced by these practices impact their lives.

Academic scholarship interest boomed after the market for self-tracking wearables increased in 2014 due to the proliferation of low-cost wearables and the widespread adoption of mobile apps. 2014 is widely referred to as the 'year of wearable technology' due to the introduction of the Apple Watch, other smartwatch brands, and other activity trackers and apps (Mehdi and Alharby, 2018). The market-driven academic interest has pushed the studies into three major streams of research: human–computer interaction (HCI), sociology and psychology. Due to paradigm presuppositions, HCI researchers focus on technology and how it can improve the adoption of self-tracking devices; sociologists study the broader implication of self-tracking in society, politics and governance; and psychologists focus on individuals and their motivation to adopt quantified self practices.

Additionally, HCI researchers discount the impact of human agency in self-tracking; sociologists distance themselves the qualitative experiences like behavioural change, material engagement and playfulness of the individual; and psychologists discount the impact of social aspects on self-tracking practices and how they impact the family and society. Self-tracking practice needs a humanist enquiry that would encompass the consumer, the mediation of technology, the impact of society on the practice and the influence of quantification on the consumption practices of the user and society. The focus must move from the individual consumer, the technology and society to the practice itself.

The other important conundrum concerning quantification research is how numbers are produced. The numbers stemming from individual micro-quantification practices vastly differ from the accumulated numbers termed 'big data' produced through macro-quantification.

Berman and Hirschman (2018) discuss the complications of studying quantification and how the new 'quantified self' has made a paradigm shift in the subject. Self-tracking users are exposed to numbers that were not possible in the past. Due to this exposition, numbers play a larger role than mere self-knowledge in governing behavioural aspects and social life. Humans assign different meanings to the numbers produced through their activities than the big data numbers provided to them through various other means. It is important to study the nature of numbers produced by self-tracking users, how they affect their daily lives and how the users subvert the self-knowledge paradigm.

This research started with this premise and explored the different self-tracking practices of the users, how self-tracking and quantification produce the different numbers and how it affects the related consumption practices of the users. Based on the study, I have developed a theory of quantification that will explain how humans make sense of numbers and what it means to live in a quantified world in the digital age. To strip away the presupposition due to the paradigm choice, I employed postphenomenological tradition and drew from affordance theory and De Certeau's consumer resistance to theorise qualitative experiences of the self-quantification environment. The data was collected through in-depth interviews with 33 participants in the UK and subsequent interrogation of smartwatches, apps, media coverage and the self-tracking environment. Reflecting upon the findings, the thesis makes the following contributions to academic and broader marketing practice.

First, I theorise that consumers use self-quantification and the numbers produced through it to resist the numbers imposed by the neoliberal market on them. Numbers have been used as a way to control, regulate and govern users, but self-quantification, through their affordances, provides users with a way to create a space they can control.

Second, I argue that the self-knowledge interpretation of self-quantification has transformed into a form of resistance. This resistance does not stem from the self-knowledge or extensive data valorisation of self-tracking users but through the control of numbers produced by the self-quantification practice and the affordances they produce. Through this, I challenge the existing interpretation of self-quantification through the Foucauldian lens of self-governance, which observes that users voluntarily undertake data-driven lifestyles to become better

individuals. The transformation from self-quantification as self-knowledge to self-quantification as resistance also implicates the marketing practice, as it restricts itself to the self-knowledge and data analytics paradigm.

Third, the thesis provides a nuanced deviation from the dichotomous arguments of a techno-deterministic utopian society of self-optimising individuals and the surveillance world of governments and corporations. This thesis concurs with the latter argument that self-quantification is a tool to survey and control users, but it differs from the aspect that users are powerless and lack agency in self-quantification. The thesis argues that although users cannot control how their data can be used to survey and govern them, they regain agency by altering, playing and manipulating their self-tracking practices and data. Through this, they construct and control their own set of quantification practices.

Finally, the thesis establishes that self-quantification is an integration of multiple tracking practices and not a set of personalised, isolated aspects undertaken randomly by users. Users gradually create their own integrated self-tracking environment with a specific aspect they want to track, identify their own set of numbers that they want to control derived from their self-quantification and discard the other environments and numbers they cannot control. Thus, in short, instead of reproducing the existing narratives of self-optimisation, governance or the Orwellian narrative of surveillance, the thesis draws from affordance theory and DeCerteau's consumer resistance lens and provides an alternative nuanced narrative of consumers using numbers to resist the numbers imposed on them.

The thesis starts with an introduction to the academic perspective of the quantified self and an enquiry into taxonomy and definitions, which is followed by a detailed review of different paradigmatic perspectives on the quantified self. The discourse will further deliberate on the various limitations of the existing paradigm enquiries and argue for the need for interpretive consumer research in the quantified self. Next, the research questions are articulated, and the reasons for the need for ground-up theorisation and the motives for deviating from using an existing theoretical framework are discussed. Then, the detailed research methodology, data collection plan, and impact of COVID-19 on the data collection are discussed. I use affordance theory to unpack the affordances of the self-tracking environment in the findings

section. In the discussion, I theorise how these affordances provide an illusion of control to the human and how the numbers produced by the self-tracking environment have more agency than users do.

1.2. Thesis Structure

Chapter 2 elaborates on the extensive literature on self-quantification and self-tracking. The chapter starts with an enquiry into the quantification and production of numbers. I expand on the origins of quantification and how macro-quantification has been the centre of research enquiry while micro-level quantification has been discounted. Post that analysis, the definition of self-quantification and I explain how market-induced scholarly enquiry has restricted the definition to the 'self-knowledge' paradigm.

In the next part of the chapter, I expand on the literature based on the different paradigms of enquiry. The first set of studies was in the HCI paradigm and categorised them into three streams, behavioural change, the effectiveness of apps and reasons for engagement or disengagement. Next, I review the literature in the psychology paradigm that was in motivation research, self and identity construction through behavioural change and goal attainment. Post that, I analyse the literature in the sociological paradigm in two dichotomous streams – the Foucauldian self-optimisation and the Orwellian surveillance. I also elaborate on how quantification and self-quantification are part of the neoliberalism project.

I then list the limitations of the current discourses in the three paradigms and argue for the humanist consumer research-based enquiry. Consequently, I analyse the limited enquiry of self-quantification in the consumer research paradigm and explore the reasons for the nascent knowledge production in the stream. I also study the consumer resistance literature in the self-quantification stream, and finally, I end the chapter with the summary and the rationale for the research.

In Chapter 3, I proceed to reflect on my research philosophy that formed the basis for the research. I deliberate on the interpretative consume research paradigm and how postphenomenology is an apt philosophical approach to enquire about the complex self-quantification assemblage, but at the same time, the philosophy places the human at the centre of the enquiry instead of the technology.

I also critically assess the methodological considerations of postphenomenology and proceed to develop a conceptual framework combining affordance theory and De Certeau's tactics of the weak. I review the literature on affordance theory and how it can develop into an analytical framework for postphenomenological enquiry. Later, I elaborate on how the actualised affordances and the impact emerge as micro tactics as described by De Certeau. I also review the relevant literature to show how there is a precedence to such an enquiry. Based on the literature review and the conceptual framework, I contextualise the research questions that the research aims to study. In the second part of the chapter, I elucidate the research method for the study and how phenomenological interviews are a valid way of generating data for the research, and then, in detail, I explain the interview process, data generation and the various limitations that I had to encounter as the interviews took place during the peak of the COVID lockdown. I also explain the process of analysis and the ethical considerations of the research.

In Chapter 4, I introduce the findings section, contextualise the various aspects of self-quantification, and explain what a self-quantification environment entails. In the first part of the findings in Chapter 5, I use affordance theory to identify four different affordances offered by the self-tracking environment to the user. I then explain how the users actualise these affordances through their actions and how these actualisations lead to a perception of control for the user. In the second part of the findings, I explain how the affordance actualisations and the perception of control manifest into tact micro resistances through De Certeau's lens. I also explain how the numbers are at the centre of the affordances and tactics and theorise that the consumers use the numbers produced by themselves against the numbers that are being imposed on them.

In Chapters 6 and 7, I discuss the broader sociological impact of the findings, the contribution to literature in consumer research and the limitations of the research. I also present several avenues for future research, including a sociological perspective, methodological refinement and critical perspective.

2. The Research View

2.1. Numbers and quantification

There are three kinds of number assignments. Cardinal number assignments represent the cardinality of a set of numbers or simply identify a numerical quantity of things. The cardinality of numbers is also used to indicate arithmetic and measurements (Wiese, 2007). For example, in the self-tracking context, 10,000 steps are a cardinal number. Ordinal number assignments indicate the order or rank of an object in a sequence or set (Wiese, 2007). In the self-tracking context, if the user is tracking pain levels in menstrual tracking, providing a number to the pain level is an ordinal number assignment. Nominal numbers are those that identify a specific object or thing in a group or set. It does not represent a rank but only an identification (Wiese, 2007). Humans started using numbers when they started using language, and the earliest number system could have been in the Sumerian civilisation, as early as 3,500 BCE (McDonald-Ross, 1977). Laplace considered that the current Indo-Arabic positional value numerical system is the most important innovation of humankind (McDonald-Ross, 1977). Humans use numbers through a system-dependent linking pattern (i.e., numbers are always used concerning an object, or the meaning depends on the position of the number concerning the object). Contextuality acts as the basis for quantification.

Alain Desrosières, a historian of quantification, defines the term quantify as ‘to express in numbers what was previously expressed in words’ (2016, 184). Quantification in the social sciences does not create objects but gives them a new form that gives a different type of existence in comparison to the same object in words. For example, in sleep tracking, what was initially described as good or bad sleep is described as a form of a score based on quantification. The quantification of social sciences (what I term macro-quantification) was developed during the 19th and 20th centuries to give social sciences a scientific status compared to the natural sciences (Desrosières, 2016). Quantification has been adopted by various social science streams over the years through different means. Quantification of political science happens through interpretation based on territory and socio-demographics (e.g., election results) (Desrosières, 2016).

Quantification of economics occurred through economic statistics in the 1920s and econometrics in 1944, while the quantification of psychology occurred through psychometrics in the 1950s (Desrosières, 2016).

The historians of social science have documented the macro-quantification in detail, while they have vastly ignored the micro-level quantification (Sysling, 2020). The use of numbers was ubiquitous in scientific enquiry and society by the late 19th century. According to Ted Porter (1996), quantification created a common language to provide smooth communication across streams, social class, professions and nations, which in turn created trust among the various uncertainties. As quantification became popular, the ruling class started deciding on what could be quantified in society and started using numbers as means of social control (Sysling, 2020).

One of the reasons why personal quantification was vastly under-presented in social sciences was because it was used by the medical sciences. When mathematicians identified statistical averages, medical scholars started defining the ideal numbers (or normal numbers, as they define them) of blood sugar levels, blood pressure, Body Mass Index (BMI) etc. Psychiatry started defining normal behaviours, while external market forces like insurance companies and clothing companies initiated ideal body measurements (Sysling, 2020); for example, size zero is an ideal measurement created by the fashion industry. The market created these measurements because it enabled them to sell products around these ideal measurements; for example, insurance companies wanted to increase premiums, and the fashion industry wanted to sell more clothes. The ideal body measurements were one of the triggers for various means of measuring, tracking and quantifying the aspects of the body, and each of the tracking can be traced to market-induced triggers, as can be seen in the introduction of commercial thermometers linked to menstrual cycle tracking (Day, 2014) and weighing machines leading to weight tracking (Linde et al., 2005).

2.2. Self-Tracking, Self-Quantification and Quantified Self

Some researchers and news reports attribute the start of the quantified self phenomenon to Gary Wolf and Kevin Kelly, the editors of *Wired Magazine*, who wrote the article 'Know thyself: Tracking every facet of life, from sleep to mood to pain', which introduced the quantified self as a practice and the self-tracking group in 2009. Wolf and Kelly (2009) should be credited for the term 'Quantified Self (QS)' and also for the creation of a community around self-tracking. It was a meeting of 28 trackers from San Francisco at Kelly's home that kick-started a global network. The website, *quantifiedself.com*, is still run by the duo and connects geographically distributed self-tracking communities around the world (Barta and Neff, 2016). *Wired.com* has a vital role in the promotion of QS, and its articles review newly developed gadgets using carefully selected scientific findings with beautiful infographics to push the techno-deterministic agenda of the quantified self (Ruckenstein and Pantzar, 2017). Interestingly, *Wired* continued to push the Quantified Self agenda, even after Wolf and Kelly left the magazine. Wolf and Kelly (2009) also defined QS in their first article, which was adopted by researchers to define self-tracking.

This attribution to *Wired* editors is questionable because self-tracking has been practised since ancient times. For example, Foucault remarked that dietetics was used meticulously in ancient Greece to analyse and shape the body of Greek athletes. The tracking included exercises, food, drink, sleep and sexual relations (Selke, 2016). Leonardo da Vinci is credited with inventing the first mechanical step counter, which can be worn around the waist (Bassett et al., 2017). This was referred to as a 'perambulator' or 'odometer' and was used in cartography (Wernimont, 2019). The term pedometer made it to the *Encyclopedie* edited by Denis Diderot and Jean le Rond D'Alambert and published from 1751–1759 in France (Wernimont, 2019). Royal warrants from the British monarchs for making pedometers were given to George Adams (1765) and William Fraser (1777). Napoleon Bonaparte had one of the advanced pedometers of that time that could track his activity with annual and diurnal time (Wernimont, 2019).

In modern times, based on the ideas of Greek athletes, Benjamin Franklin further developed the practice by tracking his sins for 60 years to improve himself (Li et al., 2010), whilst Thomas Jefferson commissioned a step counter through a watchmaker in Paris and used it to track his steps. There are other instances, like Buckminster Fuller, who tracked every 15 minutes of his life in his 'Dymaxion Chronofile' scrapbook (Li et al., 2010). In the late 19th century, the introduction of commercial thermometers enabled non-doctors to use the device and changed how households interacted with doctors (Sysling, 2020). Deanna Day, in her thesis, elaborates on how women used temperature tracking to track their fertility and ovulation cycle, which was used especially by Catholic women throughout the 20th century until contraceptives came onto the market (Day, 2014). Modern menstrual tracking through digital technology could have originated from this practice. Analogue tracking of height and weight similarly exploded in the same period after the introduction of simplified weighing scales in the 1930s, while group tracking became familiar with organised tracking groups like Weight Watchers in the late 1960s (Linde et al., 2005).

Self-tracking and imposed monitoring through technology have been prevalent in the sports industry for decades, but these technologies did not make it to mainstream consumers, as they were expensive (Rapp and Tirabeni, 2018). The first commercial digital pedometer, Manpo-Kei (which translates into 10,000 measures), was introduced in 1965 by Yamasa, a Japanese watchmaking company. They advertised that 10,000 steps/day is essential for overall well-being. Interestingly, no substantial scientific studies proved the efficacy of 10,000 steps. Moreover, this has been adopted by many other brands to sell their fitness trackers and has influenced retroactive academic studies like the one by Schneider et al. (2006) and Tudor-Locke et al. (2011) , studying the effectiveness of 10,000 steps. The retroactive studies show that there is a strong focus on marketing the quantification practice as a health or self-governing practice. The ideal target of daily steps is a market-defined measure adopted by authorities such as the American Heart Foundation and charities (e.g., Heart UK) without investigation (Cox, 2018).

Ironically, in his article, Wolf (2009) mentioned the prevalence of self-tracking practices in the past. He also mentioned how Larson and Csikszentmihalyi (1983) introduced a line of research and sampling methods using the self-reporting of emotions. However, in hindsight,

humans have always quantified certain measurable things in their lives. They measured their children's height, weight and waist size, and even distance to a destination relative to a particular landmark (instead of steps). Thus, quantification is not a recent innovative practice. The quantification of life had already seeped into the consumers' lives as the market used it to control them through numbers, and self-quantification was a natural extension of an already metricised society. Even digital self-tracking has its roots in patient care with chronic diseases like adiposity, hypertension, diabetes, respiratory conditions, chronic heart disease, etc. (Gimpel et al., 2013). The expensive self-tracking technology was available to only a few, and this changed with the introduction of low-cost products and the advancement in mobile technology, such as gyroscopes and accelerometers, in combination with global positioning systems (GPS). Smartphones inherently track steps, calories spent and even mobile phone usage, but it is up to the user to access, track or measure that data. There are over 350,000 consumer-focused fitness apps on app stores, with over 90,000 apps added in 2020 (IQVIA, 2021), and according to a survey by GfK (2016) conducted in 16 countries, one in three people who have access to the internet track health or fitness with an app or device. This does not include other self-tracking practices such as alcohol tracking, finance tracking, etc.

The commercialisation of medical products and the introduction of tracking technology into mobile phones have exploded the digital self-tracking market. The market extended the tracking to other aspects that were difficult to track in the past. For example, recreational sexual intercourse tracking became possible because of gyrometer technology in mobile phones (Saunders, 2022). The market started operating with the idea that if anything could be tracked, it could be quantified. This has pushed the market into the tracking of poop (Poop Tracker, PCal), film and TV series (Letterboxd, Hobi), alcohol (DrinkControl, MyDrinkAware), sexual pleasure (Lioness, Sex Keeper), etc. The wearable market has also exploded from fitness trackers and smartwatches to much more detailed quantification devices, such as UBiome (tracks gut health), Lumen (analyses breath), Naked Labs Mirror (analyses body composition) and Inflow (analyses urine). At the same time, the market has expanded into aesthetically designed fitness trackers, such as Oura Ring and Bellabeat Leaf (a small brooch-like device). It is usual for market forces to exploit the technological embracement of the consumer and develop a market around that.

Technological advancements in self-tracking have given rise to the widespread adoption of self-quantification. The offshoot of this is the market-driven approach in academic research enquiry, and this approach to the subject has propelled the enquiry into a narrow stream of discourses. This narrow focus has limited the understanding of the quantified self as a behavioural change mechanism (Epstein et al., 2016; Guo, 2016; Attig and Franke, 2018) or as a big-data tool for self-govern and controlling human subjects (Degli Esposti, 2014; Van Dijck, 2014; Lupton, 2016; Sanders, 2017). It also indirectly led to a lack of consumer-based discourses in academia. Didziokaitë et al. (2018) argued that academic research enquiry should move away from the quantified self-metaphor created by Wolf, as the mundane experiences of the users are transforming the segment. This thesis concurs with Didziokaitë et al.'s (2018) argument and explores the experiences of everyday users. Consumers are already bombarded with many numbers and different forms of quantification in their daily lives but still have adopted self-quantification as part of their lives.

The upcoming section will also discuss the different ideological (psychology, sociology, etc.) enquiries and argue for the need for consumer research. Consumers are buying these devices, taking up the practice and using the technology to mediate their lives, so it is crucial to study how it affects their everyday life. It is impossible to understand self-quantification without studying the consumers who are practising it. Thus, it is essential to first define self-tracking and self-quantification and elaborate on how these terms are used interchangeably.

2.3. Self-Quantification Definitions

The taxonomy and definition of quantified self-practices are often contested. The term ‘quantified self’ has taken multiple forms, such as self-tracking (Lupton, 2014b), personal informatics (Li et al., 2010), lifelogging (Kamal et al., 2010), self-monitoring (Rapp and Cena, 2014) and personal analytics (Lupton, 2014b). Academics and mainstream articles use these terms alternatively to represent the quantified self. According to Boesel (2013), the term ‘quantified self’ is a capitonym that represents the broader practices of self-tracking when written in lowercase, while the ‘Quantified Self’, with uppercase letters, is used to represent the community created by Gary Wolf and Kevin Kelly.

There is no uniformly accepted taxonomy or definition among academics or the market. Most of the academic definitions of the quantified self use Wolf's (2009) simple tenet, ‘self-knowledge through numbers’ or definitions developed based on the tenet. For instance, Swan (2013, 85) defines self-tracking as ‘the regular collection of any data that can be measured about the self, such as biological, physical, behavioural or environmental information’, whilst Li et al. (2010, 406) define personal informatics systems as ‘helping people collect personally relevant information for self-reflection and gaining self-knowledge’. In the academic scholarship on the quantified self, there is a move to using an alternative taxonomy like personal informatics, self-quantification, lifelogging, etc. This could be because of a soft resistance against the market-dictated use of quantified self. However, all these taxonomical variations claim that those who use these devices use them for self-knowledge and self-reflection (Li et al., 2010; Almalki et al., 2016; Selke, 2016). This assumption has driven research studies on the quantified self in a specific direction, and this could be because of the early quantified self enthusiasts who started with the idea of gaining more information about themselves and their activities (Didžiokaitė et al., 2018).The other important issue to tackle is what entails tracking and quantification. The difference can be identified based on how the data are recorded and measured. Lupton (2014c) defines self-tracking as the systematic recording of one’s activities and physical functions to discover behavioural patterns, but mere recording cannot be categorised as quantification. For example, in mood tracking, users might record the data daily but not count to find the average mood levels weekly or monthly. Espeland and Stevens (2008) identify that a particular practice can be categorised as

quantification only if it is marked and commensurate. Marking involves identifying particular locations, objects and humans through numbers (Jersey numbers, Dewey Decimal System, etc.). Commensuration is the valuation or measurement of different things based on a common metric (Espeland and Stevens, 2008). Marking and commensuration are two opposite dimensions of the quantification spectrum. Self-tracking becomes quantification only when it is commensurate. However, self-tracking and self-quantification are alternately used in both research and market-oriented literature. The muddling of the two terms can also be seen in the consumers, as they use them alternately.

In the findings section, I have elaborated on how the participants have used the terms alternately. The various definitions of self-quantification are inadequate for producing a complete picture of the phenomenon. The definitions referred to above either overstate the impact of self-quantification or understate the associated practices. Researchers also use alternative taxonomies that are paradigm-based. For example, self-monitoring is used by medical researchers because 'imposed monitoring' was part of the medical community, as the technology was used to monitor patients. The fragmentation in the research paradigms concerning the quantified self is also the reason for alternative taxonomies. Each of the other taxonomies has some issues concerning the way they are worded as they eliminate one or more practices – for example, lifelogging does not include the idea of quantifying the tracked data. However, it is essential to understand that the concept is evolving rapidly. Even the 'quantified self' could be questioned because tracking apps have started tracking external aspects too, for example, finance.

Therefore, the existing definitions are inadequate in providing a complete explanation of the quantified self, and this thesis aims to define through an empirical enquiry. To have an operating definition, this study will conceptualise self-quantification as an **'integrated environment of multiple practices including (but not all-encompassing) tracking, measuring, quantifying, sharing and responding to one or more aspects of oneself'**. The discourse will not use the term quantified self to avoid comparisons to the QS movement and as a way to resist the market-induced definition; instead, it will use 'self-tracking' and 'self-quantification' alternatively for easier understanding.

2.4. Paradigms of academic enquiry in self-quantification

The market-driven approach to research had two significant impacts; the first was that the majority of the academic research was undertaken by HCI researchers and sociologists (Till, 2014). The other significant impact is that most empirical research has been undertaken on fitness tracking or activity tracking (Kamal et al., 2010; Epstein et al., 2016; H. Brinson, 2016; Hamari et al., 2018). Only a handful of studies have researched other self-tracking practices, such as mood tracking (Hollis et al., 2017), sleep and diet (Kim, 2014), etc.

2.4.1. Self-Quantification: A Human–Computer Interaction Perspective

HCI academics have been at the forefront of research on any new technology. Although early HCI research was linked to the liberal, human side of computer interaction, over the years, the dominant rhetoric has been that technological development has the power to transform society (Roedl et al., 2015). The HCI academic enquiry on self-quantification can be categorised into three different streams: 1) how new applications can persuade people to self-track, hence changing their behaviour, 2) the effectiveness of apps in promoting or positively reinforcing healthier behaviours or well-being and 3) why people (dis)engage from self-tracking practices.

First, prior work has explored the potential for new applications to persuade people to adopt self-tracking and, in turn, change behaviour. Historically, the studies started with the necessary frameworks of apps and social networks for the quantified self. For instance, Kamal et al. (2010) provided a framework for a social network to share self-tracking data and track behavioural change. Khovanskaya et al. (2013) proposed a critical design system that does not focus on an individual's behaviours but on how the data is collected and the infrastructure of self-tracking systems. The research questioned the 'know thyself' motto, arguing that there is an ethical burden of the data collection method and providing an alternative strategy where the user decides the level of data collection. After the introduction of commercial devices, the research moved to advanced frameworks that were built as solutions for health problems. For instance, Kang et al. (2017) developed a framework for an

application that tracks anxiety during sleep, with a potential solution for insomnia. Hollis et al. (2017) developed a design for a personal informatics tool targeted towards emotional well-being, showing how it can forecast the emotional issues of the person. This study did bring out critical issues through its empirical research – users' competence in understanding the data given to them and users' expectations of actionable behaviours based on the data provided to them. HCI research then moved into developing apps for specific tracking categories and more specialised aspects in a specific category. For example, Timar-Anton et al. (2021) have designed an app prototype that strengthens identity development in young people through personal goal tracking. The research has moved from a broader design of apps to specific features that can be added to the apps/tracking practices. This thesis acknowledges that the design of the app and the tool influences quantification and behavioural changes but intends to study how self-trackers use commercial applications available in the market. Furthermore, the thesis confers to Khovanskaya et al. (2013) argument that the self-knowledge motto should be questioned and explores how users use alternative data collection methods.

The second stream of studies explored the effectiveness of apps and how app-based interventions on patients are used to promote healthy behaviour using tracking data. Breton et al. (2011) reviewed 204 first-generation apps available on app stores to check whether they adhere to 13 evidence-informed practices of weight loss (like eating vegetables and fruits, tracking weight, etc.) as prescribed by US government health agencies and found that the majority of the apps adhere to only two of those practices. The study highlighted the shortcomings of these apps and how they are inadequate for aiding weight loss. The study also found that the apps did not incorporate methods to maximise social support in weight loss practice. There have been other efficacy studies like the one by Krebs and Duncan (2015) that conducted a national survey on the usage of health apps in the US, while Paré et al. (2018) provided a similar insight in Canada. Paré et al. (2018) provided a more comprehensive study that included users' demographics, usage and socio-economic status. The majority of the users were typically young or mature adults, university-educated, employed and healthy, with an annual family income of over CAD 80,000 (around 50,000 GBP). This directly links to the awareness and affordability of self-trackers. There have been more studies on how app-based interventions act as positive reinforcements. For instance,

Coughlin and Stewart (2016) did an extensive literature review of papers that studied consumer wearable devices promoting healthy behaviours and found that most of the studies have experimental designs, use smaller sample sizes and make unreasonable generalisations. In addition, MacLeod et al. (2013) studied how design can help create app interventions in managing chronic health diseases, while Bassett et al. (2017) found that using step counters can increase a person's physical activity by 2,500 steps. Chen et al. (2017) proposed the idea of including gamification techniques that can train 'novice users' to become 'expert users' of self-tracking devices, while Fenton et al. (2022) studied the efficacy of using football fandom to improve physical activity in fans through an app called 'Fanfit'. They studied fans of the Scottish football club Rangers and found a positive impact of using an app connected to the official football club app and programs. HCI researchers have therefore focused on suggesting design changes to improve app-based interventions and promote positive behavioural change (Epstein et al., 2016; Guo, 2016), and at the same time, studies like Austin and Kwapisz's (2017) identify that habit formation and motivational apps have a counterintuitive effect on the intended behavioural changes. The same effect can be seen in diet-tracking apps, as they make users resist unhealthy eating while encouraging them towards healthy eating (Honary et al., 2019). This thesis recognises that app and tool interventions have an impact on behavioural changes (positive or negative), but these interventions also produce numbers that impact the way users act. The thesis studies the impact of these interventions, how the numbers produced influence consumption, and how consumers make sense of these numbers.

The third set of studies has explored the motivations behind self-tracking practices and why people engage in or leave those practices. Li et al. (2011) identified two phases of self-tracking – discovery and maintenance – that are important for the motivation to start the quantification practice and engage with the practice. According to Li et al. (2011), the discovery phase is data intensive, and users explore the information provided to them. Users also identify the different factors that affect their behaviour. The visible results provided in the discovery phase make the users transition to the maintenance phase, which is important for sustaining the practice for a longer period. Li et al. (2011) have suggested design changes to move users from the discovery phase to the maintenance phase.

Rooksby et al. (2014) observed that people choose a device/app to solve a current issue, and the tracking device does not create the need. They studied 22 participants who were involved in fitness tracking and found that none of the participants started the practice after downloading the app or buying a wearable. For example, the users decided to lose weight and then downloaded the app to track their progress, not vice versa. Technology is being used to support the long-term interests and issues of self-trackers. They suggest a term called 'lived informatics' that underscores the idea that self-trackers are using the data and finding its meaning in their day-to-day lives. Rooksby et al.'s (2014) argument is that device manufacturers consider quantified self-practitioners to be rational decision-makers and categorise them as data scientists who enjoy analysing the data. The study also found that the self-trackers do not aspire towards the dispassionate analysis of their bodies, but they believe that they are undertaking a practice that is deeply emotional and often focused on the future.

The study provides a set of recommendations for device manufacturers and designers and suggests that companies need to design for interweaving and not just integration. They also contend that behaviour change cannot be induced by technology and that people achieve behavioural changes through interweaving various technologies. Rooksby et al. (2014) contradict other HCI studies and question the techno-deterministic agenda of the HCI paradigm.

While Li et al. (2011) and Rooksby et al. (2014) studied individual motivations, Senabre Hidalgo et al. (2022) studied how users' shared motivations help sustain self-quantification as a group. They identified that the goals and motivations widely follow the tenets of the citizen science field (i.e., a participatory scientific temper supported by a critical thought process and collaborative work). Senabre Hidalgo et al. (2022) posit that participant-induced personal science is an extreme form of citizen science.

There have been only a few attempts in the HCI paradigm to theorise about the phenomenon of the quantified self. The most popular model is the personal informatics model (PIM) proposed by Li, Dey and Forlizzi (2010). Researchers have used this model to highlight the issues in self-tracking practice (Rapp and Cena, 2014), identify methodologies to improve patient-healthcare provider interactions (Chung et al., 2016), explain the problems in a

specific context, such as in tracking women's menstrual cycles (Costa Figueiredo et al., 2017), and identify the reasons behind the abandonment of self-tracking (Epstein et al., 2016). Wannamaker et al. (2021) used the model to design a situated self-tracking device based on tactile inputs. Caldeira et al. (2017) reviewed 32 of the popular mood-tracking apps in the IOS App Store and Android Play Store using the same model. Li et al. (2010) used mixed methods research with an initial survey of 68 self-trackers through self-tracking websites and blogs to understand the different personal information they collect, their motivations and the problems they face. Eleven participants were shortlisted to participate in the follow-up interviews.

The PIM is a process-based model that exposits that there are five stages in any self-tracking practice. The first stage is the 'preparation' stage, in which the user decides what to track and how to track it. The second stage is the 'selection' stage, in which users collect personal information about themselves, interactions and the environment. 'Integration' is the third stage in which the user (with the aid of a tool) assimilates the data collected to reflect on. During the 'reflection' stage, users deliberate on their data either in the short-term or long-term. Their reflections might lead to actions based on the data provided to the user. The actions are undertaken in the final stage, called the 'action' stage, which might lead to behavioural change. The stages are iterative, as the users might change how they track, add new tools and change variables, etc., and these stages can be user- or system-driven depending on the technology used in self-tracking.

Li et al.'s (2010) PIM take a rational approach to theorising self-tracking. The model takes a techno-deterministic view of the issues in self-tracking and posits that technological tools are essential to starting the quantification. Moreover, the linear-stage model states that for a tracker to reflect and take action, the data needs to be collected and assimilated. These linear models are usually based on the economists' idea of rationality and the rational economic man (Simon, 1993). The rational view of Li et al.'s (2010) model cannot be entirely discarded, as it enables us to understand the process of self-tracking, but it is inadequate in explaining the underlying meaning of self-tracking and how the human–technology assemblage affects the behaviours associated with the action (sleeping, walking or running) that is being quantified.

One of the latest developments concerning frameworks in the HCI paradigm to design and evaluate self-tracking systems is the PAST SELF framework proposed by Yfantidou et al. (2021). Based on a systematic literature review of 129 research articles from 2008, and they developed the periodic table of self-tracking design (PAST), a tool to test the efficacy of the design in aiding human behaviour change, and the self-tracking evaluation framework (SELF), a standardised framework to evaluate self-tracking tools concerning sustained user experience. The periodic table consists of 32 different elements, including self-monitoring, personalisation, reminders, normative influence, etc. On the other hand, through the SELF framework for user experience, they have defined four different aspects: the physical self, the behavioural self, the perceived self and the environmental self. The PAST SELF framework is a comprehensive look at various design elements in the HCI and was specifically developed to make informed decisions during the design stages of a self-tracking system. The framework also (like PIM) takes the techno-deterministic view of the paradigm and considers the users as rational decision-makers with the data provided to them and who changes their behaviours based on that. But the model might help in designing comprehensive systems of self-quantification. The issue with such models is that it discounts the human experience and views from the design perspective.

HCI academics have identified and proved that app-based interventions have helped users and found that the tracking devices do not motivate them to start self-tracking; they get motivated by an existing problem they might have (Rooksby et al., 2014). HCI research has taken a pragmatic approach to self-quantification and presupposes the user as a rational human who is self-tracking to find more information about themselves and makes decisions to self-govern and improve their life. Most of the research is dedicated to designing changes to improve usage and motivation and modify feedback loops. This confers to the neoliberal project, which imposes self-responsibility on the users and provides new ways of motivation that will push the users to track more. Some growing voices in the HCI research call for a change in how designs are made and how the designs should challenge social inequalities (Sloane, 2019). HCI designs of self-quantification push the neoliberal paradigm by creating designs and frameworks that will manipulate users to change their behaviours for the "good".

Although HCI research has advanced the design aspect of self-tracking devices, the human in HCI has been discounted. It is essential to understand what the users think and feel about these apps, devices and self-tracking practices. HCI researchers in self-quantification have failed to place the 'user' in the forefront. Secondly, the HCI designs produce numbers that became the change agent for the self-quantification paradigm. The system uses these numbers to induce behavioural change in users that helps forward the neoliberal project of self-responsibilisation The thesis studies the quantification practice from a human–technology perspective. It will complement the existing HCI literature by unpacking different aspects of self-tracking but challenge the techno-deterministic agenda to explore how the users interact with the devices and how the technology mediates self-tracking practice. The thesis also confronts the neoliberal agenda of using numbers to govern users and how users, through affordances of technological design, resist those impositions.

2.4.2. Self-Quantification: A Psychological Perspective

The psychological enquiry of self-quantification is quite recent compared to HCI and sociological perspectives. Psychologists take a cognitive or socio-psychological approach that focuses on the individual's reciprocation to the quantified self-practice.

The first set of studies tried to identify the motivations behind the adoption of self-tracking. Gimpel et al. (2013) developed a self-tracking motivation model and identified five motivational factors: self-entertainment, self-association, self-design, self-discipline and self-healing; these factors can affect the increased tracking activity. Gimpel et al. (2013) did an exploratory survey and concluded that people are motivated to start a self-tracking practice for either self-entertainment or self-healing. The studies do provide insight into the psychological motivations behind the initiation of quantification, but they discount the impact of social motivations like friends and family. Attig and Franke (2018) found that people need intrinsic motivation to start and engage continuously with self-tracking. Based on a survey of 212 users, they concluded that there is a material agency, and the devices have a dependency effect on self-trackers.

Furthermore, the Big Five personality traits have been used by Maltseva and Lutz (2018) and Attig and Franke (2018) to understand the motivations behind self-quantification. The Big Five framework is the most commonly used model to explain personality traits (Maltseva and Lutz, 2018). The model has been developed by incorporating over 1,000 personality types, and there are five factors: extraversion, agreeableness, conscientiousness, emotional stability and openness. Extraversion is attributed to enthusiasm and assertiveness, while agreeableness is related to the trustworthiness and empathy of an users. Conscientiousness is the extent to which an user has self-discipline and responsibility, while emotional stability is the absence of negative traits like anxiety, neuroticism, etc. Finally, openness involves being curious and open to novel experiences (John and Srivastava, 1999).

Maltseva and Lutz (2018) conducted a survey of 475 respondents using Amazon Mechanical Turk. First, they found that self-quantification is a multi-faceted phenomenon and not restricted to data collection about oneself. The proposed thesis takes this perspective and considers self-quantification an integrative system, not personalised singular tracking system. Second, they found that self-quantification is associated with certain personality variables, such as emotional stability and conscientiousness. Third, they observed that users learn to self-disclose their personal information instantly and habitually to their devices and applications. This self-disclosure can be extended to situations not associated with quantification. In their study, Maltseva and Lutz (2018) hypothesised conscientiousness (self-discipline) to be positively associated with self-tracking, but there was no meaningful relationship between the two, and they found that the personality variables related to selfhood (openness and emotional stability) are more positively associated with self-quantification than interpersonal variables. Attig and Franke (2018) observed a similar finding in their study. Maltseva and Lutz (2018) suggested that device manufacturers should shift their focus from community-oriented self-tracking to selfhood-oriented quantification. This undermines the influence of family and friends in a self-tracking experience, but there is evidence in studies like Rooksby et al. (2014) and Nafus and Sherman (2014) that self-trackers view themselves as part of a community. The self-trackers consistently share their tracking data, attend meet-up conferences and participate in activities that are part of their quantification practice. Attig and Franke (2022) also used the Big Five framework and self-determination theory to study the reasons for abandoning activity-tracker devices. They surveyed 159 former users of activity trackers. They found that the abandonment happened because of various issues, including domain-specific personality traits, dependency effect and lack of trust in the device tracking capabilities. However, Attig and Franke (2022) view the activity tracker as a singular practice of a specific kind but discard the tracking through mobile devices or usage of shorter periods. This thesis will elaborate on how the activity tracker is just another means to track and quantify and how self-tracking happens without the use of digital technology too. Digital technology exposes new data but is an extension of existing motivations to undertake self-quantification.

The second set of psychology scholarship on self-quantification studied the effects of self-tracking on behaviours and how behavioural change affects users' self, identity and decisions.

Pettinico and Milne (2017) departed from the previous research to study whether there is a 'quantification effect', meaning a higher chance of behaviour modification in people who quantify compared to those who are not quantifying. The study compared a non-quantified fitness scenario with a technology-based quantified scenario through an online survey. They found that the adoption of self-tracking and positive behavioural change depends on three factors: feedback loop enhancer (granularity of data), self-improvement amplification (self and situational awareness) and goal-focus strengthener (greater meaning to the goal). Pettinico and Milne's (2017) study found evidence that quantification helps in behavioural change, but the study focused on fitness tracking with an assumption that people track to change behaviours.

Zhang et al. (2019) extended this study to other contexts, like calorie tracking, to reiterate that users are more motivated in quantified than non-quantified situations. The motivation to start and sustain the tracking depends on the individual, but Jang and Kim (2020) studied another important aspect of self-tracking, the concept of a perceived companion. Some apps and services in the market provide an Artificial Intelligence bot or a real-life person who nudges the user to act. Jang and Kim (2020) developed an Android application, ExMe, with a bot named Samantha, which delivers four different types of messages. They studied how the level of context and message type following the perceived companion might induce change in behaviours. They identified that the perceived companion acts as an extended self to the human, and the companion has a greater impact on behavioural change (Jang and Kim, 2020). Jang and Kim (2020) used an experimental design for a short period. The experimental methodology might unearth certain aspects of the self-tracking practice, but the question arises as to whether the users interact in a similar way to the commercially available apps. The experimental design does not recreate the same experience as a commercial app and tests only a specific aspect; in Jang and Kim's (2020) experiment, the aspect is messaging. Commercial devices have algorithms that learn the behavioural aspects of the human over some time and personalise messaging, timing and form.

Another assumption is that a specific aspect can be measured (for example, the impact of messaging or haptic nudges) independently of other aspects and the environment. Self-tracking and quantification occur in an integrated environment, and all the aspects are

interconnected and studying individual aspects discounts the other interconnected aspects. This became even more evident during my study, and it has been elaborated on in the findings and discussion sections. Furthermore, in the current studies in the psychological paradigm, there is an assumption that behavioural change is positive. There are instances of counterintuitive effects of self-tracking, as elucidated by Rooksby et al. (2014) and Austin and Kwapisz (2017).

Sjöklint et al. (2015) suggested that most users start self-tracking with a self-exploration curiosity, not with a target goal, as device manufacturers expect. Sjöklint et al. (2015) further argue that there is a tension between the rational self and the emotional self because self-tracking appeals to the emotional self, which, in turn, develops coping tactics that push away the intended behavioural changes. The devices that are available in the market have specific goals for users to achieve. When self-trackers could not achieve these goals, they used four coping tactics: disregard (rationalising failure), procrastination, selective attention and neglect (purposely overlooking). Due to this, Sjöklint et al. (2015) argue that there is no need to have explicit rational goals, instead allowing users to explore their data. They contended that the goal attainment process might affect the quantification practice itself. This is important because it questions the foundation of the very definition of self-quantification and the expectation that self-trackers are rational human beings who seek self-knowledge. This thesis conforms to the idea that self-trackers should not be seen as rational decision-makers, and they undertake self-quantification to change behaviours.

In another perspective of goal attainment, Eikey et al. (2021) introduce the concept of rumination. They define rumination as a position where users think and re-think about something but without any progress, and they have identified how self-tracking induces rumination and impedes the quantification itself. They posit that rumination could lead to the abandonment of self-trackers, too. The idea that users start with an idea to attain a goal is in itself an assumption concerning self-tracking and self-quantification. Some of the self-tracking undertaken by users is an extension of existing tracking, and some start because the device that they use enables it automatically. The goals might or might not form after the user understands the abilities of the technology used. For example, screen time tracking is enabled out of the box in some mobile devices, and the users are given the information without explicit consent to track. The user may or may not use the information to achieve goals. The

assumption that users start with an explicit goal comes from the same assumption that users are rational when they choose to quantify. As quantification results in numbers, and numbers are considered to be part of rational thinking, it is natural to assume that tracking practice is rational.

The psychological discourses of self-tracking are inadequate in explaining the self-quantification phenomenon thoroughly, as they focus on the individual and how the user responds to self-tracking devices, but they discount the broader social dimensions and impact of those devices on the self-tracking users' family and social groups. Most psychological research, like the HCI paradigm, follows the self-knowledge and self-optimisation discourse and stabilises the neoliberal project of using self-quantification. The numbers produced are yet another means of controlling humans. This thesis agrees with the argument that self-tracking induces behavioural change and does not discount the effects of numbers on human behaviours, as that discourse is well established. However, psychological discourses do not explain the broader societal impact of these changes. This discourse will uncover how self-quantification impacts the various consumption aspects of the users and how the numbers produced by the users impact the wider society.

2.4.3. Self-Quantification: A Sociological Perspective

The impact of technological innovation is complicated, and it affects the nature of daily life, social fabric and cultural practices (Wajcman, 2008). Standard sociological readings have seen technology as an external agent of social relations (Wajcman, 2008), but recent readings have studied 'social' and 'technology' as parallel spheres. Studies have shown how technologies have shaped new practices and created new social relationships (Wajcman, 2008). The sociological lens on self-quantification has given rise to diverse perspectives that can be broadly categorised into two major divisions; some sociologists see the self-tracking practice as a means of self-governance (Berg, 2017; Fotopoulou and O'Riordan, 2017), whilst others portray an Orwellian surveillance situation (Degli Esposti, 2014; Van Dijck, 2014; Lupton, 2016; Sanders, 2017). This section will describe these two perspectives and how Foucault's ideas were used as enabling theories in prior studies. Later in the section, I describe how neoliberalism uses quantification to govern and control users. The most widely discussed sociological perspective of the quantified self is self-optimisation and broader surveillance of self-tracking users through the lens of Foucault. Michel Foucault was one of the most influential philosophers of the 20th century, and his thoughts on power, knowledge, self, governance and technologies have influenced many researchers to explain or critique the various developments in society. Many sociologists have taken the Foucauldian perspective to analyse the rise and popularity of self-quantification. There are two main streams of thought used by researchers using Foucault. The first stream sees the self-tracker as an individual who undertakes self-quantification as a means of self-governance, and they collect and practice a voluntary data-driven lifestyle to be responsible citizens by taking care of their health and wellness (Lupton, 2012; Pantzar and Ruckenstein, 2015; Catlaw and Sandberg, 2018; Zakariah et al., 2021)

Catlaw and Sandberg (2018) studied 65 video logs of self-trackers on the quantifiedself.com website, and they theorised that the quantification of self had created a new form of info-liberal – someone who retains the neo-liberal focus of individualisation but for whom the data collection process has been liberalised. In a shift from the hard neo-liberal idea of surveillance and governmentality, the citizen is seen as a producer and user of data. They also posit that there is a 'different everyday making' in which the individual user's data is

exposed, which has not been previously accessible or visible to existing expertise. The users on the website can be considered early adopters of self-tracking, as they actively track, analyse and share the data that they collect on themselves.

The everyday use of such a self-tracker cannot be extended to someone who is a casual tracker who uses commercially available self-tracking apps with limited data visualisations. Zakariah (2021), using the Foucauldian view of self-surveillance, has theorised that there are two sets of dichotomies, 'health and indulgence' and 'labour and leisure', in the way users interact with the self-tracking technologies. They elaborate that four subjectivities emerge through these dichotomies: 'redemptive self', 'awardee', 'loyal' and 'innovator'; the users switch between these positions by reconfiguring their self.

The second stream concerns the ideas of governance, surveillance economy and biopolitics, in which corporations and governments use these technologies to track 'citizens' (Lupton, 2016) or 'workers' (Moore and Piwek, 2017; Moore, 2018) to control them. These discourses paint a dark picture of an Orwellian society, where every citizen's movement can be tracked using such technologies. Sociologists term this practice 'dataveillance' (Degli Esposti, 2014; Van Dijck, 2014; Lupton, 2016). One example is Lupton and Williamson's study (2017) analysing how children are datafied and how dataveillance is used to control children from 'in utero' up to 'school years'. In addition, Sanders (2017) talks about how biometric surveillance might help the fashion and beauty industry to push a woman to adopt normative beauty standards, explaining how women might have more surveillance than men in society and how a woman becomes the object of men's gaze. Charitsis et al. (2018) use Foucault to explain that there is a bio-political marketing environment that uses the data of consumers' lives to appropriate values, behaviours and cognitive capacities to make them prosumers by valorising and commodifying the data generated by the self-trackers and exploit their labour.

As self-tracking is becoming ubiquitous, sociologists allay fears about how any company or government can control various aspects of life, including food, fitness, emotions and even sex (Lupton, 2015). Foucault's idea of power, how power changes hands, and how power can be used efficiently to control the 'citizens' are used in these discourses. Foucault followed a Socratic view of self and argued that everyone needs to undertake certain mechanisms to self-

optimise and attain happiness and contentment in life. He posited that self-understanding is the basis for the moral rationality of humankind. The concept of surveillance assemblages and biopolitics is valid because of the introduction of self-tracking in various companies (Moore, 2018). China has brought in a social credit system that tracks people, and they are rewarded for good citizenship and penalised for spending more money, dangerous driving, buying too many video games, etc. (Ma, 2018).

Esmonde (2020), through a Foucauldian lens, identified four strategies of resistance against datafication. She posited that users resist labelling some data as excessive, avoiding tracking every day, classifying themselves as not perfect like machines and prioritising feelings over data. They also interpreted the 'data double' created on the device as a representation of the power of surveillant assemblage, and users resist this power through their practices. De Moya and Pallud (2020) studied the quantified self-community through interviews and Fitbit forum posts and analysed it through Foucault's panopticon perspective. Bentham introduced the panopticon metaphor to describe a circular prison designed to restrict any communication between the prisoners (Foucault et al., 1988). Foucault (1988) expanded this to describe modern societies that use domination techniques to control citizens through constant surveillance and restricting collective action against authorities. Zuboff (1988) adapted Foucault's view to describe a technological panopticon as a group of techniques and technologies employed to survey subjects continuously. Sociologists have used the panopticon metaphor to analyse the pervasiveness of technological surveillance in modern societies, and sociologists have identified self-tracking as another tool for controlling subjects through surveillance (Hepworth, 2019). Bode and Kristensen (2022) call self-tracking a personal panopticon, while De Moya and Pallud (2020) argue that the panopticon metaphor should be changed to the heautopticon, a consented surveillance that produces both beneficial and counterproductive effects on users. The panopticon metaphor creates a view that self-tracking technologies are imposed on the users, and even Zuboff's (1988) argument was about how the companies are using technologies against the employees. The imposed tracking technologies in offices and the implementation of self-tracking in motor insurance and health insurance can be explained through the panopticon metaphor. Furthermore, the panopticon metaphor does not explain consumer practices or how they react to the authorities' surveillance.

The research agrees with the argument of De Moya and Pallud (2020) that there is consented surveillance in self-quantification, but it explores how the users are resisting these impositions of surveillance. The consented surveillance views the consumer as a passive producer of numbers without any agency or control. Moya and Pallud (2020) create a narrative that the users do not control the production of numbers and the impact of those numbers. But, this thesis challenges the narrative and provides an alternative explanation that the consumers are not passive but resist these surveillance impositions through the numbers they produce through self-quantification.

While sociologists widely use the Foucauldian view, others, like Bode and Kristensen (2016), suggested that self-trackers create 'digital doppelgangers', online duplicates of one's self that are perceived to be better than the existing self. Haggerty and Ericson (2000) called them 'data doubles'. Sociologists have asserted that the gap between the online and offline selves is shrinking, and the human–technology relationship is continually shifting due to the changing contribution of non-human actors (Lupton, 2014a). They also studied the discriminatory nature of self-tracking devices. A Pew Research Centre study from 2013 suggests that self-tracking of health is likelier to be undertaken by upper-class white Americans than their black counterparts, and self-tracking devices are gendered, where certain aspects of women's health, like the menstrual cycle and childbirth, are ignored by the device manufacturers (Wernimont, 2019). Wernimont (2019) asserts that the gendering of self-tracking devices is entangled with race and class, as these technologies were created predominantly for white, affluent male bodies. These issues raised by sociologists are important and discussed in mainstream media, but it would be interesting to see how everyday self-trackers perceive their tracking practice.

The other important theoretical viewpoint used sporadically but important to this thesis is the sociology of quantification proposed by Espeland and Stevens (2008). They defined quantification as the 'production and communication of numbers' (Berman and Hirschman, 2018) and provided two dimensions of quantification: numbers that mark and numbers that commensurate. Marking refers to the categorical relationship between two objects, whereas commensuration refers to a metrical relationship. The central claim of this approach is that

social measures influence behaviours, affecting new experiences and the evaluation of society as a whole (Espeland and Sauder, 2007). Espeland and Stevens (2008) also posited that the influences are not unidirectional. While data influences social life, social factors also influence how data is collected, processed and analysed. The sociology of quantification calls for a more comprehensive critical analysis of how data influences social life and vice versa, but the majority of the studies have researched the broader political and economic context (Hayes, 2011; Centemeri, 2012; Vesty et al., 2015). Kneidinger-Müller (2018) briefly uses Espeland and Stevens' (2008) idea to study self-quantification but suggests that the theory is inadequate in explaining the quantification of the individual because sociologists are fascinated by the implications of broader contexts and safely ignore the impact of everyday data. The Foucauldian perspective presupposes that self-trackers are self-governing individuals who actively collect, measure and analyse the data. It does not account for the passive data collector or the playful data aggregator. Self-quantification is a complex environment unique to every user, and the motivations change due to various factors, but assuming that self-tracking is undertaken to improve oneself is problematic. For example, quantification provides two kinds of numbers - the big data used to impose surveillance on the users and the self-quantification numbers used for self-governance. In the next section, I elaborate on how neoliberalism uses quantification to impose control on the subjects.

2.4.4. Neoliberalism and Quantification

Neoliberalism has its roots in the works of Ludwig Von Mises and his criticism of socialist economic policies (Davies, 2014). Although the Ordoliberalism of Germany and the Chicago School played a role in the development of neoliberal policies, the problems of Keynesian macroeconomics and Fordist production provided leeway for a new economic paradigm (Davies, 2014). This was exploited by the pro-free-market leaders in the US and UK and was exported to other developing countries. Peck et al. (2018) trace the current definition of neoliberalism and the discussion regarding conceptualising the political-economic keyword to an *Antidote* workshop in 2001. Neoliberalism cannot be defined in precise terms because of the polymorphic ability of the system to construct and reconstruct itself based on the contextual situation. It could be described as a pro-market political-economic philosophy that extends from capitalism and is based on entrepreneurialism, privatisation and competition, or

it could be defined as an umbrella term for pro-corporate policies filled with deregulations, exemptions and liberalised tax reforms. It could also be defined as the rampant commodification of social life fuelled by extreme individualisation and responsibilisation that simultaneously leads to overconsumption while imposing fiscal discipline and personal development (Peck et al., 2018). At its core, neoliberalism is based on an idealised version of the market rule and liberal economics with strong, competitive individualism stimulated by the disdain for collectivism and social redistribution (Peck et al., 2018).

Neoliberalism is not a stable system or stringent policy structure that adheres to certain codified rules or policies but rather a process of social and spatial change. The strength of neoliberalism is its ability to morph, contextualise and localise based on environmental, economic and social factors. Neoliberalism has redefined the relationship between the economy and the various actors such as the state, society and the individual (Fine and Saad-Filho, 2017). As Neoliberalism has transformed social and economic aspects, it has begun to create material cultures with direct impacts on the everyday lives of humans. Neoliberal policies have dismantled the collectivist principles of the Post–Second World War society and have created a new neoliberal subject who must self-govern, self-optimise and take responsible decisions (Datta and Chakraborty, 2018). A neoliberal subject is expected to create their own financial plan, not expect help from public welfare policies, and to be an entrepreneurial subject and create opportunities for others. The neoliberal individual is subjected to an endless journey of self-improvement towards a perfect life that is non-existent. The neoliberal world accomplishes this objective through hegemonic ideas such as aggressive individualism (e.g. dating apps), market efficiency, gig economies, fierce competition (e.g. university admissions, job markets), a credit-based lifestyle, social capital and unrealistic ideals. In order to show progress and improvement in the neoliberal subject's life, the markets use numbers and quantification. Life is managed through numbers such as credit scores, competitive exam numbers, grades, numbers of 'likes' and 'shares', productivity hours, match scores in dating apps, customer approval ratings in gig economies and Uber ratings. The life of any individual is expressed through numbers, and in that path of self-improvement, quantifying one's own life is another way of imposing numbers upon the lives of neoliberal subjects.

In the sociological paradigm, Foucault contributed to the study of neoliberalism through his "A Birth of Biopolitics" series of lectures in 1979 (Dean, 2018). Neoliberalism was at the nascent stages when Foucault gave those lectures and the political leadership of US and UK were starting to implement the neoliberal policies based on Hayek's work (Dean, 2018). However, the English translations of Foucault's lectures were available only in 2008 and the contextual understanding of Foucault's views of Neoliberalism has changed (Dean, 2018). Due to this, Foucault and his relationship with neoliberalism have been a constant subject of debate in academic circles, and various interpretations have been drawn from his works (Dean, 2018). Foucault defined neoliberalism as a way that market analyses are used in non-market contexts and the labour power is not a commodity but an enterprise in itself (Foucault et al., 2008) Foucault theorised neoliberalism as an act of governance and both the branches (pro and against) of neoliberalism that have endorsed Foucault support their view point (Dean, 2018). There have been criticisms on Foucauldian Neoliberalism like the one by Lagasnerie (2020), who argued that Foucault adopted a subtler form of neoliberal dogmas and 'used neoliberalism as a test, as an instrument of critique of both thought and reality' (pp. 28–29). On the other hand, researchers like Newheiser (2016) have argued that although on the face of it, Foucault's "The Birth of Biopolitics" might suggest that he was drawn towards neoliberalism, it provides an insight into the systems of neoliberalism that forms the basis for resistance. Foucault's critique of neoliberalism does not denounce it but cautions the transient nature of the system that makes it dangerous (Newheiser, 2016).

However, in the self-tracking context, self-quantification has become a way to impose control on neoliberal subjects. The various interpretations of self-tracking through the Foucauldian lens by Charitsis (2018), Hepworth (2019), De Moya and Pallud (2020), and Bode and Kristensen (2022) have taken the neoliberal view of Foucauldian biopolitics and observed self-tracking practices as a personal development project. For instance, Hepworth (2019) argues that the big data visualisation of the self-quantification paradigm functions as the technologies of neoliberal governance. De Moya and Pallud (2020) proposed that self-quantification is a heautopticon (self surveillance) through the Foucauldian lens. I contend that self-tracking studies using the Foucauldian lens have taken the neoliberal agenda forward by viewing it as a self-improvement project. Foucault's exploration of neoliberalism

happened at the start of the Neoliberal agenda in the US and UK. Foucault was neither a proponent of neoliberal agenda nor a strong critique of the neoliberal agenda. The interpretations of Foucault have oscillated between the two branches of neoliberalism and it can be observed in the self-quantification studies too. Foucault moved from self-optimisation and pushed an agenda of self-stylisation that can be directly linked to the neoliberal marketisation of an individual's body (Green, 2010). Green (2010) argues that Foucault in his later works proposed that the technologies of self may even serve as the 'practices of liberation'. Foucault found some aspects of the neoliberal agenda attractive, especially the self-regulation concept that is outside the sovereign bio-political forms. He also agreed to the neoliberal criticism of the welfare state and accepted that state health systems are expensive and called for reforms (Dean, 2018). Foucault's perspective of neoliberalism is complex and it is impossible to ascertain how Foucault would have interpreted the current state of neoliberalism. However, the self-quantification studies using Focauldian view of neoliberalism have taken a more positive outlook and consider self-quantification aids in self-optimisation and self-governing of an individual.

Self-quantification produces numbers; and numbers are the centre of this phenomenon. As I explained in 2.1. Numbers and quantification, contextuality forms the basis for quantification and the numbers become neoliberal, based on the context with which they are imposed on the consumers. For example, a number becomes a credit score only when that number is used in the banking sector to analyse the financial position of a consumer. Neoliberal quantification provides a promise of managing the uncertainty through quantification (Mennicken and Espeland, 2019). Thus, a neoliberal number is something that stems out of neoliberal quantification of social, political and everyday life. The number is contextual and imposed on a subject to push them into the path of endless self-improvement. In this thesis, I use the term neoliberal number to refer to various numbers produced by neoliberal quantification that is used to control the consumers (for example, ideal BMI in weight tracking, credit score in financial tracking etc.,). It is also imperative to acknowledge that not all quantification are neoliberal in nature. According to (Espeland and Stevens, 2008), production and communication of numbers is quantification. They draw attention to the various fields where quantification is significant in discovering democracy (election quantification), merit (education), participation (social justice projects), accountability (measurements in

bureaucracy) and fairness (public policy measurements) (Espeland and Stevens, 2008). (Espeland and Yung, 2019) argue that there can be ethical quantification and it has three characteristics - the capacity to express or mediate power, focus attention, and shape opportunity structures. They explain how quantification can shape social relations and be harmful or beneficial to the social groups. The quantification becomes neoliberal only based on the context it is used on the consumer. Self-improvement need not be neoliberal in every context; for example, spiritual self-improvement of a person could be considered not neoliberal. If the same spiritual self-improvement is used in an organisation to increase the productivity of the employee, then it becomes neoliberal. In the self-tracking context, users undertake self-tracking to monitor heart rates, sleep and blood sugar levels to stay healthy. These self-tracking cannot be construed as neoliberal in nature. The second aspect that makes a number neoliberal is when they are associated with a market or the numbers produced are sold or used to sell something to the consumer. The numbers produced by the self-quantifying individuals are used to sell something to the individual or it becomes a number that informs the market to sell something. For example, the period and pregnancy apps have been found selling usage data to marketers (Ricapito, 2020).

The self tracking data has becomes the input data for insurance companies as some of them use that data as a business model (Olson, 2014). The self-tracking numbers have created the market of self-tracking apps, devices are being sold and there is an extended market of accessories that are based on those numbers. On the whole, the concept of self-tracking is being marketed as a tool of self-governance which makes it neoliberal. The market dictates what should be counted through apps/devices, how they are counted, what kind of data is shown to the users (and what is hidden), how they are presented to the users and how they can share that data with others. Thus the numbers produced by this environment becomes neoliberal.

The investigation of self-tracking through the lens of neoliberalism has been grossly under-investigated; the sociological perspectives, as elaborated above, have discussed its self-optimisation and self-knowledge aspects but have not discussed self-quantification as part of the neoliberal project. Lupton (2015) performed a critical analysis of sexual and reproductive apps in app stores and posited that these apps invite users towards participatory surveillance,

influencing them to valorise the idea of quantification to comply with the self-responsibilisation purported by neoliberal politics. Lupton (2015) discusses these issues from the perspective of data privacy and surveillance but also explains how these apps could aid in stigmatising users who are not 'responsible'. Sanders (2017) argues that self-tracking technologies are patriarchal and reinforce the gender-regulatory practices of the past. Sanders (2017) also expands on how advocating avoidance of these technologies is futile and agrees that rejecting such technologies will not remove consumers from disciplinary and normalisation projects (Sanders, 2017).

Elias and Gill (2018) studied beauty apps such as Golden Beauty Meter, which provides a score for a person's face and body. From this analysis, they argue that self-tracking apps aid in the biometricisation of surveillance and assist in individualising the knowledge of appearance. Elias and Gill (2018) also contend that self-tracking apps create a 'surveillant sisterhood', as these apps promise to help women to optimise beauty instantly. They discuss how self-tracking domesticates beauty procedures and creates a self-beautifying individual who does not have time to access a professional beauty salon. However, a stronger argument to connect self-tracking and neoliberalism comes from Reichardt (2018), who terms it as a tipping point in the impact of neoliberalism, as even the most intimate personal aspects of a human being, such as menstrual cycle, ovulation, sexual intercourse, heart rate and the like, are managed by agencies. The freedom-of-choice argument of neoliberalism has become invalid because authorities govern subjects through quantification technologies (Reichardt, 2018).

Research regarding the neoliberal enquiry of self-tracking, although sparse, has uncovered pertinent points of how neoliberalism uses self-tracking technology to govern, regulate and control consumers. This discourse accedes to the arguments made by researchers that these technologies are patriarchal and that they impose disciplinary mechanisms through surveillance. However, it also goes beyond that enquiry and identifies how users regain agency by using self-tracking technology and numbers produced through self-quantification.

Sociological academic enquiry involves a presupposition (such as HCI) that self-trackers undertake these practices to know themselves better but that they also see these technologies as predatory, discriminatory and surveillant. The neoliberal side of the argument has been explored less. Although the sociologists' views cannot be discounted because the fears they allay are a reality in China's social credit system (Ma, 2018), dataveillance of insurance companies (Giddens et al., 2017) and the recent fears of governments using menstrual data to regulate female bodies in the US through menstrual cycle apps (Morrison, 2022), the individual is at the centre of the practice and studying quantified self will not be complete if the lived experiences of individuals are discounted, making a study on how everyday tracking practices are important. The research takes the Reichardt (2018) point of view that the self-tracking technologies are the tipping point in the construction of the neoliberal subject by analysing how neoliberalism uses quantification to regulate the consumers but challenges the discourse to show how the consumers use quantification to resist neoliberal imposition.

2.4.5. Limitations of current discourses

The existing studies in quantified self have significant limitations in explaining the self-tracking practice. The first limitation is that most of the existing research in HCI paradigm assumes an active self-tracker who collects, analyses and takes decisions on the data. There is a presupposition that all self-tracking is undertaken for self-knowledge and making rational decisions based on the knowledge that they have gathered. This presumption discounts the lived experience of a day-to-day tracker who might actively track one aspect of their life and passively track other aspects. Also, most apps/tracking devices are goal-oriented (completion of 10,000 steps or reduction of screen time or tasting a new craft beer) rather than providing data about the aspect being tracked. It also discounts the playful applications of self-trackers like beer tracking or zombie run based fitness tracking, or raising a virtual plant by tracking water intake. Although not all apps are goal oriented, the HCI discourses of self-quantification focus on rational decision making and have studied the apps/devices that are goal-oriented (Almalki et al., 2016). The app designs that are developed using the HCI paradigm are also goal-oriented that pushes the users towards rational decision making and achieve goals (Nelson et al., 2016; Hamari et al., 2018; Timar-Anton et al., 2021). The widely used PIM model in HCI discourses proposed by Li et al. (2010) also takes a goal-oriented approach and the goals are decided by step-by-step rational process. The HCI discourse sees the self-tracker as a rational decision maker who look to achieve a goal through their tracking practice whereas the playful applications like beer tracking or apps like Plant Nanny are not taken into account.

Second, there is an inherent theoretical framework bias based on the paradigm chosen by researchers. The strong emphasis on Foucauldian biopolitics by sociologists, or Li et al.'s (2010) Personal Informatics Model (PIM) of HCI, has restrictions in explaining the phenomenon thoroughly. This is because of the presupposition that people undertake these practices for self-knowledge. The proposed research challenges such approaches by not taking a paradigm position or a predetermined theoretical framework but rather undertaking an exploratory viewpoint through the lens of postphenomenology.

Third, these studies consider self-tracking as an personalised isolated bunch of singular practice of a specific aspect (i.e., fitness, sleep or diet). Considering self-quantification as a personalised system could be problematic because the users construct their own set of complex tracking environment that involves not one but many tracking aspects combined into one single integrative system. Even the devices in the market track multiple aspects of self. However, the existing studies discount these self-tracking environments and how they undertake multiple self-tracking practices instead of one. There is a lack of research that studies the consumption activities surrounding this integrated self-quantification environment. As self-quantification changes the behaviours of an individual, it is bound to change the consumption undertaken by that individual too.

Fourthly, the majority of the empirical enquiry in quantified self use experimental designs. For example, a new app design is developed and given to a specific set of users to test the efficacy of the design (Purpura et al., 2011; Khovanskaya et al., 2013; Guo, 2016; Gross et al., 2017; Hollis et al., 2017; Pettinico and Milne, 2017; Shin and Biocca, 2017; Imschloss and Lorenz, 2018) , or a set of commercial devices are presented to a specific sample of users to test a specific hypothesis (Meng et al., 2017; Shin et al., 2017; Goodyear et al., 2019; Reychav et al., 2019). The aforementioned is apart from the studies that analysed the videos and presentations uploaded in the www.quantifiedself.com that are uploaded by active self-trackers who track, measure and analyse data extensively (Li et al., 2010; Sjöklint, 2014; Sharon and Zandbergen, 2017; De Moya and Pallud, 2020). Only a minuscule number of research works have studied existing self-trackers who use the data provided to them by their devices/apps and make daily life decisions based on them (Elsden et al., 2016; Lomborg and Frandsen, 2016; Didžiokaitė et al., 2018; Burbach et al., 2019; Esmonde, 2020; Zakariah et al., 2021) Experiment based studies with the controlled environment will help researchers to study the behavioural change, but the method will not be able to see determine how these practices are assembled in everyday life.

Fifth, each paradigm has its own ontological presuppositions; for example, the HCI takes the techno-deterministic viewpoint, emphasising the technology and how it impacts user behaviours. The psychological perspective puts the human in the forefront and argues that the human impetus to change behaviours pushes the adoption of self-tracking but it discounts the technological mediation, the impact of the technology on the user, the relationship between the user and the environment and also the broader sociological implications of the practice; in contrast, the sociological perspective has society as its prime focal point and theorises the wider impact of these technologies. Self-quantification is unlike other digital technological systems in which none of the actors in the system can be discounted. The self-quantification system consists of the human actor, the technology and environment in which the human -technology operates. Studying self-quantification from a single viewpoint will understate the impact of the various actors in the system.

Finally, people purchase self-trackers and consume various things around them, and the day-to-day lives of humans and the wider society are affected by self-tracking. Sociological enquiries restrict themselves between two dichotomous arguments of self-knowledge and surveillance; however, the lack of enquiry through the neoliberal lens and how users react to these technologies and imposition practices is under-theorised. The limitations in the various paradigms show that a lack of studies makes the consumer the centre of the investigation. Self-quantification is an act of consumption; consumers are quantifying, producing numbers and, more importantly, taking decisions that change their lives and impact the wider society. So, it is essential to understand how the consumer research paradigm has approached self-quantification.

2.5. Self-Quantification: A Consumer-Research Perspective

Consumer-research studies are disjointed because the field is nascent, and the fragmented discourse shows there is no consensus on how self-quantification should be studied from the consumer's point of view. Some investigators have studied the practices as singular (Crawford et al., 2015; Jauho et al., 2016; Cox et al., 2017), and a few others have studied technology mediation in the quantified self (Pink and Fors, 2017). Lomborg et al. (2018) have discussed how the concept of 'flow' can be used to create micro nudges that push the self-tracker into consistent data production. Lomborg et al. (2018) contend that this consistent data production plays a multi-faceted role and that each self-tracker perceives it differently. There are a few substantial studies in consumer research; Pantzar and Ruckenstein (2015) have taken markets as a practice approach to explaining the historical emergence of self-tracking and how these practices have expanded and strengthened the markets for self-tracking devices. These authors have provided three directions in which markets could expand by studying existing and new practices. The first extension could be the promotion of heart-rate monitoring and its use to create a new type of stress and recovery practice. This idea has come into reality through the introduction of Apple Health and through the use of commercial heart rate measurements in healthcare (Campbell, 2019). The second extension that Pantzar and Ruckenstein (2015) have proposed is that the measurement practice can become a teleo-affective practice in which visualised symbols and graphs are essential in creating engagement in the quantification practice. This is in contrast with the idea that users desire more data about themselves; the recent designs of commercial devices and apps have shown that people are engaging in gamification elements, abstracted data with goals and haptic cues rather than hard data. The third extension proposed by Pantzar and Ruckenstein (2015) is that the incorporation of self-tracking into daily practices and the initiation of these practices might not arise among medical and healthcare professionals; instead, self-tracking practices might be routinised and extend into normative behaviours. This particular dimension is where I have situated my research to study how these practices have been incorporated into consumers' everyday lives.

The emphasis on studying the impact of self-tracking technologies in users' everyday lives can be seen in the recent past. Pink et al. (2017a) studied the ‘mundane data’ produced by 18 cyclists in Australia through self-tracking technology and concluded that self-tracking could improve the affective engagement of the cycling practice itself. They found that self-trackers appropriated quantification and how it got embedded into their cycling routines. The mundane data became part of those routines, creating new meanings and processes in everyday life. Pink et al. (2017a) reconceptualised mundane data as a generative site and discard the idea that making data available to self-trackers can motivate them to change behaviour. Behavioural change might occur only when the data is embedded in the everyday practice itself. Both Pantzar and Ruckenstein (2015) and Pink et al. (2017a) conclude that self-tracking has become routinised and recommend studying the impact of self-tracking in everyday practices, routines, processes and consumption. Both discourses counter the HCI and psychological discourses of the undertaking of self-quantification by rational humans to change their behaviour. Behavioural change is an effect of self-quantification and not the motivation to undertake it. Vigren and Bergroth (2021) used collaborative auto-ethnography to study the impact of self-tracking technologies on daily life. Using Lefebvre's rhythm analysis, they theorised that humans adopt new rhythms of self-quantification, adapting to existing rhythms and falling in and out of rhythms. They suggest that self-tracking users perform acts of repetition and that this defines their relationship with themselves. The devices induce humans to engage in rituals of repetition through which they shape behaviours and self (Vigren and Bergroth, 2021). Similarly, Silverman and Barasch (2022) found that self-tracking users undertake practices in ‘streaks’ of behaviours and that these streaks are important for the continuity of the practice itself. They argue that meaningful goals are not the motivation to continue but rather that the repetition of behaviours (streaks) is a goal in itself. Both discourses indicate that the goals are not the motivation to undertake or continue self-quantification, and they restructure the definition of a goal within the context of self-tracking. Silverman and Barasch (2022) also studied multiple self-tracking aspects as a whole using cross-sectional samples, although each of the seven studies had separate hypotheses; they still studied each aspect as a singular personalised process and not as an integrated system.

Some consumer-research studies in the self-tracking domain have focussed on weight management and food logging, demonstrating the material agency and communal impact of self-tracking. For instance, Crawford et al. (2015) studied the comparison of weighing scales and wrist-wearable devices and how both technologies promise mediated self-knowledge. Crawford et al. (2015) claim that self-tracking data needs to be communal for it to make sense and that the makers of these devices are not transparent regarding the scientific, cultural and technological assumptions they made before developing the algorithms (or the changes they made after the analysis of data). Cox et al. (2017) have asserted that food loggers are more concerned about the accuracy of the data that they input than the effectiveness of the data. Jauho et al. (2016) used a practice-theory approach to weight management while studying 68 weight-loggers in Finland through eight focus group discussions; their findings suggest that the participants defined weight management through practices such as healthy eating, slimming, and other means. Their understanding, procedures and engagements overlapped with neighbouring practices to the extent that the research questioned the independence of weight management as a separate practice. The findings of Jauho et al. (2016) coincide with the assumption made in this thesis that the self-tracking practice itself cannot be studied as a singular practice; sub-practices are interrelated, and they influence other consumption behaviours. The findings of Pantzar and Ruckenstein (2015) and Pink et al. (2017a) have confirmed the assumption that there should be a widespread enquiry regarding the everyday quantification of self-trackers. Pink et al. (2017a) and Vigren and Bergroth (2021) have discussed the routinisation of self-quantification through technological mediation. Vigren and Bergroth (2021) and Silverman and Barasch (2022) have confirmed the assumptions that goal attainment is not a motivation for undertaking self-tracking; rather, the routinisation and repetition of quantification become the goal. But, it does not mean that self-tracking individuals do not have any goals, but it means that the goals are not the reasons to self-track. My thesis evaluates the integrative self-tracking environment of everyday users and goes beyond the current discourses in the literature to study how users react to the numbers produced by self-quantification. In the next section, I elaborate on a specific part of consumer research related to consumer resistance and the different streams of consumer resistance discourse. I also identify and review the studies that deal with consumer resistance and self-quantification.

2.5.1. Consumer Resistance and Self-Quantification

When consumption began, so did the rejection and evasion of products by consumers. Consumers might openly reject and oppose the companies but simultaneously resist silently, individually and sometimes perpetually. Although it may have been observed in the past, the theorisation of consumer resistance started with Poster's (1992) work of the agency through De Certeau's lens, in which he defined resistance as ‘the way individuals practice a strategy of appropriation in response to structures of domination’ (1992, 94). Advancing the discussion, Penaloza and Price (1993) introduced the term consumer resistance as an alternative to the consumer boycott theorisation and active, collective, organised actions against companies (Friedman, 1991). There are two significant streams of discussion in the consumer resistance paradigm – the manipulation and enslavement discourse that critiques the consumer culture and the agency and empowerment discourse that takes a celebratory approach to consumer culture (Izberk-Bilgin, 2010). The manipulation and enslavement discourse mainly discusses the commodification of individual lives, transformation of value and disruption of traditional identities. The primary proponents of this discourse, including Marx (exploitation), Horkheimer and Adorno (passivity), Ewen (imperialisation of the human psyche) and Baudrillard (entrapped consumer), observed the market as a place of domination, contending that consumerism is a manipulative ideology that keeps the consumers seduced by the attractiveness of consumer goods and that in turn there cannot be any resistance from the consumer side.

McEwen (2017) has analysed theories of digital labour and feminist theory through the Marxist lens, suggesting that self-tracking is another form of reproductive labour, that self-tracking individuals understand themselves as labourers and that self-tracking is an exploitation of life itself external to normal labour market relationships. Moore and Piwek (2017) have conceptualised that these technologies have created a neoliberal workspace that surveils and controls its employees. The surveillance-based studies in the sociological paradigm add to the manipulation and enslavement discourse, as governmentality controls users and creates a passive consumer who does not resist.

In contrast to the manipulation and enslavement, the agency and empowerment discourse sees consumption as a celebratory aspect that provides users with some agency to play and manipulate the cultural resources to reinterpret and restructure their everyday practices (Izberk-Bilgin, 2010). The emphasis is on micro-tactics (a subtle and skilful reworking of the status quo) against the macro-strategies (hegemonic dominance over the consumers).

According to Izberk-Bilgin (2010), there are three major works in this stream. Douglas and Isherwood have reconceptualised consumption to communicate individual taste, status, ambition and even protest. They see consumption as a ritualised practice that binds society together (Izberk-Bilgin, 2010). Bourdieu (1984) observed that social classes do not determine taste but that they exhibit different tastes; to explain these tastes, he introduced the concept of habitus, a combination of preconceived notions that guides an individual's choices and actions. Habitus is the lens that the consumers use to interpret objects, people and happenings. Consumers use their consumption to practice taste and habitus to maintain their positions in the social hierarchy. Similar to the enslavement discourse, there is a power struggle; however, in contrast, this struggle is between social classes to establish legitimate tastes and practices. Unlike the enslavement discourse, the consumer here is not a passive subject but instead has the agency to resist through various practices.

The third major discourse in the empowerment paradigm is De Certeau's (1984) argument that consumer resistance is inevitable and that consumers are not made to operate in the modern hegemonic markets. He contends that the market will try to control the users and that in the power struggle, users will find new ways of using the objects within the dominant system to resist it. The users will identify a myriad of micro-tactics in everyday practices to form an ‘antidiscipline’ against the strategies of the hegemonic market.

The resistance discourse with respect to numbers and quantification in the context of non-self-quantification is not extensive; however, some well-grounded discussions have occurred. Barnes (2012) has described how customer service agents in an organisation resist quantification-based managerial control through ingenious and aesthetic methods of subversion. Scott (2017) argues that the quantification of social processes by the state triggers resistance to quantification. He uses a historical example of crop quantification, in which

states preferred crops that grow above the ground because they could be easily quantified compared to root vegetables. The farmers openly resisted by growing root vegetables and resisting the quantification. Hutson (2019) has studied how pregnant women resist the medicalisation of pregnancy weight by reframing it as 'baby weight', allowing them to see it as a temporary condition. They also resist by not weighing themselves and by not observing the weight on the scales because seeing the number would make the weight real. This research also found that they engage in this behaviour with the help of medical professionals, as they do not reveal that information to the women. Hutson (2019) argues that this effect is due to the market construct of post-pregnancy obesity, the medicalisation of weight and body surveillance. The studies discussed above elaborated on different consumer resistance practices in non-self-quantification contexts against control by managers, the state and the market. However, the discourses are few with respect to user resistance against quantification and the numbers that are used to control them. The resistance discourse regarding self-tracking is nascent. Nafus and Sherman (2014) argue that the quantified self is a 'soft resistance' against Foucauldian bio-politics. By 'soft resistance', they mean that self-trackers assume the different roles of designers, data collectors and analysts. Data becomes fragmented through this process, creating a material resistance against traditional data collection methods. Nafus and Sherman (2014) describe softness as not the ineffectiveness to act but rather the ability to change over a period of time as the meanings of data evolve. Based on their findings, they contend that the quantified self is a valid alternative to the moral rationality of Foucault, as users resist by not fitting into a market category and as categories mutate into newer categories (e.g. sleep cycle becoming meditation). Self-trackers also resist working alongside and circumventing automation simultaneously by finding alternative modes of working with data and constructing their own set of quantification practices. The resistance here in self-tracking creates another 'productive' way of using self-tracking data.

Sharon and Zandbergen (2017) have explained self-quantification as a practice of mindfulness of data and have termed self-trackers as 'quantifying selves' through which they find new ways of navigating the world of big data and resist the socio-techno environments in which they operate. They posit that the QS movement is no longer a celebratory movement but is now a network of people who identify new meanings, navigate data and find new ways of claiming agency. Through these new ways, they resist the quantification practice itself.

My thesis concurs with Sharon and Zandbergen's (2017) view that users find new ways to enact agency, but they still term all self-quantification aspects as part of the QS movement. The QS movement is linked with the initial adopters of self-tracking, who valorised the data with wide-ranging analytical models and systems. The QS movement has dwindled in popularity over the years, and no formal meet ups are scheduled on the QS website. This does not mean that the extreme users have stopped tracking but rather that the proliferation of low-cost devices has changed the landscape of self-quantification. The QS movement has greatly impacted how self-quantification has been studied, and the data valorisation discourse can be linked to the movement. The resistance practices of a QS movement self-tracker would be utterly different from those of an everyday user who accesses mundane data. I detour from the QS movement discourse to study the users' mundane self-quantification and data production and how they resist the numbers produced by these practices. Consumer research studies in self-quantification are a growing paradigm, and existing research has studied individual self-quantification environments (like fitness, sleep, or calorie tracking). However, there is a lack of studies that views self-tracking as an integrative environment. Another under-explored area is the consumer resistance investigation of self-quantification practices. The users undertake these practices, produce numbers, and how the individuals use these numbers are important aspects to study. Based on the studies of Jauho et al. (2016), Pantzar and Ruckenstein (2015) and Pink et al. (2017a), the thesis will study the integrative quantification environment of a self-tracker. Based on the studies of Nafus and Sherman (2014) and Sharon and Zandbergen (2017) through the agency and empowerment lens, this thesis will study consumers' resistance.

2.6. Need for research

Numbers and quantification have always been part of human life since its inception, and they form the crux of administration, science and social life. Neoliberalism and markets have used quantification of big numbers (macro quantification) to control the subjects as a way to inculcate market-oriented individualism and responsibilisation. Self-quantification is yet another project of the neoliberal world that pushes people to self-optimise and self-govern so that they can become entrepreneurial subject who consumes more and simultaneously be productive to push market capitalism.

The market-oriented approach in the academic enquiry of self-quantification has pushed the different streams of research towards creating new forms of quantification, identifying ways to motivate users to adopt self-quantification, and developing new strategies to change behaviours and celebratory discourse of liberated self. The sociological enquiry has revealed the problematic issues of surveillance, data valorisation and how the market creates neoliberal workspaces and society through self-quantification. But the research on how users react to these neoliberal impositions is lacking. The current discourses observe the users as 1) active data gatherers and analysers who relentlessly collect data and try to make rational decisions around them 2) passive subjects who don't have any agency, manipulated by the market to be producers of data for the capitalist market 3) the liberated user who quantifies for self-knowledge, self-optimises and self-governs, changes behaviours for good and acts as a responsible citizen in the society to create overall well-being. This research acknowledges these discourses but identifies the lack of research on how users react to the imposition of self-governance. The self-quantification has become so ubiquitous, and the market is growing yearly with new devices being introduced. As the users are quantifying themselves and producing these numbers, it is important to study how they make sense of these numbers instead of discounting them as co-producers of big data. Users have resisted quantification and the neoliberal market in the past, as elaborated in the previous section, but these discourses are far and few.

On the other hand, the existing studies are researching from a paradigmatic presupposition with either the human or the technology or the society in the forefront. The need to study humans and technology as an assemblage, how they interact with the environment, and the implications of self-quantification in the broader society are imminent.

Thirdly, the discourses approach self-tracking as a personalised and separate act and study each tracking practice like fitness, food logging etc. Still, however, the different tracking methods are interconnected and should not be studied as separate components. As stated earlier in this section, studying self-quantification as an integrated environment is practically non-existent. Therefore, it is important to view self-quantification as an integrated act undertaken by a human–technology assemblage every day. The thesis takes the above conclusions from the literature review and studies how the human-device assemblage creates an integrated self-quantification practice and a resistance practice to the neoliberal imposition on consumers.

3. Research Methodology

This thesis explores self-quantification assemblages and examines how self-quantification is mediated by technology. Self-quantification produces numbers, and users interpret and construct new meanings for these numbers. This project studies how users interpret these numbers and use them against the numbers imposed on them by the neoliberal world. In the previous chapter, I have elaborated on the existing literature, the limitations of various discourses and the issues surrounding them. In this chapter, I discuss the research philosophy and how it eliminates the limitation of paradigm presuppositions. I present the aim, scope and research questions and describe how those can answer the issues discussed in the previous section. Later in the chapter, I elaborate on the enabling conceptual framework that I have drawn from affordance theory and De Certeau's tactics of the weak. Finally, I explain the research methods employed for data generation, analysis and interpretation.

3.1. Research Philosophy

Before discussing the research questions and aims, I explain here the research philosophy that informed the aims, the planning and the implementation of this thesis. The choice of research philosophy was informed by the ontological position (how one sees the reality of the phenomena), the epistemological position (how knowledge is constituted and how one can acquire it) and the methodology (how knowledge can be understood). In consumer research, realism, positivism and their variants have been the dominant ontological and epistemological positions (Shankar and Patterson, 2001). The counter-narrative to the positivist paradigm began in the late 1980s (Goulding, 1999). Although relativist philosophical approaches such as phenomenology, subjectivism and others were popular in other streams, they were not used in consumer research, as positivism dominated the discourse (Hirschman, 1986).

The interpretivist consumer research paradigm emerged after investigators shifted their image of consumers from ‘rational information processors’ to ‘pleasure seekers’ (Holbrook and Hirschman, 1982). Traditional positivists have severely criticised this perspective change, and

there has been a continuous debate with regard to paradigm choices in consumer research studies (Goulding, 1999). This can be seen in self-quantification research, as most of the enquiries have taken the positivist route and considered consumers rational decision-makers. Positivism has been the dominant epistemological paradigm in consumer research because marketing has been categorised as the way to deliver commodities to the consumer and has been measured based on profitability, resource utilisation and cost efficiency (Hirschman, 1986). The primary issue with studying consumer research through the positivist lens is that it views consumers in their fixed state and discounts the continuous changes and evolution in how consumers experience the world around them (Szmigin and Foxall, 2000). Interpretive research does not discount or reject the 'real world' but studies and establishes the constructed 'reality' of the consumers from their subjective experience. Both positivists and interpretivists have studied consumer behaviour, but the positivists have approached it with a contingency that there is a causation of consumption by an external variable; in contrast, the interpretivists have approached it with the idea that the human experience in the act of consumption is important (Ozanne and Hudson, 1989). Self-quantification through a technology-mediated environment cannot be studied through a positivist or a realist ontological position. As explained in the previous section, positivist methods can create biased presuppositions and are widely seen in every paradigm. The mere definition of self-quantification takes a deterministic view that consumers are rational beings who undertake the practice for knowledge of the self and the improvement of their well-being. It discounts all other possible experiences that a consumer might have through self-quantification. In order to study the lived experiences of the self-quantifying user mediated through technology and the means by which consumers interpret numbers, it is important to investigate through a relativist approach and an interpretivist epistemological paradigm. Consumer experience of self-quantification is bound by time and context; each consumer has their own integrated tracking practice. Neither behaviour nor technology can be removed from the discourse, and the self-tracking users construct their own environment where they undertake the quantification practice. An obvious extension to the interpretive consumer research paradigm that has moved beyond the humanist approach is acknowledging the impact of non-human actors. According to (Belk, 2014a) studying human-object relationships and how they co-construct meaning has been extended to many theories, including Actor-Network Theory (ANT), entanglement theory, assemblage theory and postphenomenology

3.1.1. Postphenomenology as a Research Philosophy

Husserl introduced phenomenology at the start of the 20th century. It derives its genealogy from the Greek word 'phenomenon', which means 'that which shows itself from itself' (Moran, 2002). Phenomenologists focus on the human experience and how they perceive it before it becomes reducted and rationalised (Aagaard, 2017). Phenomenology began as a philosophical approach and transformed into an empirical research method after the introductions of descriptive phenomenology by Mac Van Manen and descriptive phenomenology by Amedeo Giorgi (Aagaard, 2017).

Postphenomenology was conceived by Don Ihde (Herrmann, 1993) to explore the philosophy of technologies, but it has now expanded into other research fields (Jensen and Aagaard, 2018). It has gained momentum in the sphere of social sciences research in particular because of its strong focus on developing a philosophy of technology with a phenomenological basis. Classical phenomenology has approached technology more abstractly with a bit of romanticism. Phenomenologists have studied technology as an entire entity that affects the social and cultural aspects of humanity, focusing specifically on how technology alienates human beings (Rosenberger and Verbeek, 2015). They have discounted actual human experiences and the impact of technologies in mediating these experiences.

Postphenomenology differs from phenomenology in three different ways. First, it replaces Husserlian consciousness with an embodiment. Husserl's phenomenology is insensitive to the materiality of technologies, but Ihde (Ihde, 2008) argues that human interrelations with technologies affect the way in which they experience the environment. Second, it defies one of the basic tenets of phenomenology – the idea of essences or the essential use of any technology, artefact or material. Ihde contends that any artefact or technology has multistability and that there is no single essential use of material. The use of computers could be a good example of this concept. A computer could be a learning device, a gaming device, a television or a writing board. Hence, any technological device has been designed to incorporate multistability (Ihde, 2008). Third, it departs from the world as the focus of hermeneutic phenomenology to the bodily nature of perception (Aagaard, 2017).

Based on Merleau Ponty's (Ihde, 2008) work on phenomenology, Ihde contends that everyday human activity and habits are responses to how the body perceives the world around it. Postphenomenology owes the idea of embodiment to Merleau-Ponty's (1962) postphenomenology, which explains how perception is not a mental construction of a conscious subject but rather how the body interacts with the material world (Aagaard, 2017). Merleau-Ponty (1962) argued that embodiment creates habit structures that are sedimented over the years because of skilfully practised activities. Merleau-Ponty (1962) used the example of a blind man's stick; when it becomes transparent due to the embodiment, he does not feel the pressure of the stick; instead, his focus turns to the environment around him. Ihde (2008) used the example of how spectacles become part of the body to explain embodiment in postphenomenology. Spectacles become part of the body, the body pre-reflectively uses things, and the things, in turn, use the body. To understand the human experience, humans and technology should be studied together, along with the environment in which they operate.

3.1.2. Postphenomenology and Self-Quantification

Postphenomenology is a relatively new philosophical approach, and few empirical research studies have employed it. Van Den Eede (2015) performed a conceptual study and unpacked the self-tracking technologies through a postphenomenological lens, making a case for studying the relationship between self-tracking technology and humans. Van Den Eede contends that there are two reasons that self-tracking can be studied through postphenomenology. First, self-tracking involves the entanglement of bodies, technology and experiences that links directly to the philosophy of postphenomenology. Second, postphenomenology can provide an open-minded investigation of self-tracking by stripping away explicit and implicit cultural presuppositions. A conceptual study dwells on how self-tracking studies can benefit from postphenomenology and how self-tracking complements the concepts of postphenomenology. He asserts that studying self-quantification practices would be complex because of the practice's multiple stabilities intertwined with macro perceptions (notions of performance, body and fitness in Western postmodern culture) and micro perceptions (emotions, self-knowledge). The next observation that Van Den Eede (2015) makes is that self-tracking technologies might exhibit embodiment relations of an isomorphic nature (data visualisations, graphs) and hermeneutic relations of a non-isomorphic nature

(data doubles). Van Den Eede (2015) also contends that although self-tracking can be involved in biopolitical domination, cultural norms, social involvement and material agency, its focus, in the end, concerns the individual self and its practices.

There are two significant reasons to choose postphenomenology to study self-quantification. Postphenomenology's basic tenet is that technologies used by humans actively mediate their experiences of everyday life (Aagaard, 2017). The philosophy defies the instrumentalist view of technology that sees humans as active participants while technologies are passive and mute spectators. This is best explained by the statement, 'Guns do not kill people. People kill people' (Aagaard, 2017). Other perspectives can be used to study the interrelationship between humans and technology, including entanglement theory, alien phenomenology, assemblage theory and the most prominent one, Actor Network Theory (ANT) (Belk, 2014b). However, a significant issue with ANT is that it views both human and non-human actors on the same plane. This flat ontological approach discounts subjective human experiences. Postphenomenology, although a flat ontology, circumvents this issue by placing humans as the centrepiece of the theory instead of the artefact. In addition, ANT studies complex network relationships from a third-person perspective, while postphenomenology allows the researcher to explore human–technology relationships from the inside (Rosenberger and Verbeek, 2015). Rosenberger and Verbeek (2015) have argued that technologies not only transform human actions but also translate them, inviting or soliciting specific actions based on the human perception of technology. The second reason to choose postphenomenology is to mitigate presupposition. A significant limitation of existing studies of the quantified self is that there can be an ideological bias while studying the phenomenon. This ideological bias forces researchers to begin with a theoretical framework and 'apply' the framework to the phenomenon. Postphenomenology starts the philosophical inquiry by examining the multiple stabilities and how technology and its advancements mediate this practice instead of 'applying' theory to the phenomenon. Postphenomenology posits that material things and humans are entangled and cannot be studied in isolation. Although researchers have studied the semiotics of self-tracking technology, the necessary negotiations happen between humans and the tool or app. The relationship between materials and humans cannot occur in a social vacuum. Externalities, social contexts and practices are tightly linked to human–technology relationships. Converting postphenomenological ideas into methodological guidelines is

difficult, as with other philosophical perspectives. Because postphenomenology is a new idea, researchers are exploring different possibilities and different analytical approaches. Rosenberger and Verbeek (2015) have observed that postphenomenologists use micro case studies to investigate how technologies shape human experiences, but they have specified that there are no strict methodologies to follow.

Ihde (2008) has observed a few studies based on human experiences, such as a study of cell phone usage while driving by Rosenberger (2015) and Selinger's (2008) study of how cell phones used in micro-credit transfer have impacted the broader socio-political climate in Bangladesh. According to Ihde (2008), there is no single method to generate and analyse data in postphenomenology. He contends that any data generated through personal experiences should be corroborated through environmental inquiry, insight into the technologies used and other human interactions. Although postphenomenology is an 'empirical philosophy' that is not only conceptual but also derived from the study of technology and artefacts (Rosenberger and Verbeek, 2015), it has limitations in how it can be used to study human–technology mediation. First, postphenomenology, at its core, is a concept of technology mediation that is structured as a two-sided entity; it shows how humans are shaped in the technological lifeworld (Kiran, 2015). There are multiple dimensions in which the technological mediations are expressed: magnification–reduction in the epistemological dimension, revealing–concealing in the existential dimension, involving–alienating in the ethical dimension and enabling–constraining in the practical dimension (Kiran, 2015). This two-sidedness affects the methodological considerations in the postphenomenological philosophy. Technological mediation forms an integral part of the methodological nexus when the shaping of society by technology is investigated and analysed (Kiran, 2015). Two-sidedness does not imply the positive and negative impacts of technology but enables the researcher to understand how technology impacts humans in two different aspects. For instance, in self-quantification regarding menstrual tracking, women provide a considerable amount of data about their bodies; this data might have privacy issues, but at the same time, the tracker can predict the cycle only if the data is provided. The ethical challenge in technology mediation (in the above case) is the balance between the privacy and accuracy of data, and the ethical dimension exposes this ambivalence. Thus, to investigate technology mediation in the practical dimension and to understand how technology shapes behaviour and actions, the affordances

of the device can be used (Kiran, 2015). The second limitation with respect to analysing a technological artefact and its impact on humans is the aspect of multistability. Ihde states that 'technologies simply cannot be reduced to designed functions' (Ihde, 2008). Technologies are multistable, as they have different functions and meanings based on the social setting in which they operate. The multistability that postphenomenology advocates and discounts the environment in which the technology operates. There are two major methods that are used to analyse technology mediation in postphenomenology. The first is variational analysis, which searches for the various different stabilities of a technology. According to Ihde, all these stabilities are at the same level; therefore, it is impossible to determine which stability has emerged at the forefront (de Boer, 2021). The second method is to access the multistabilities based on how the technology forms the practices. The meaning of the technology changes based on how the practices are constructed by the user and, in turn, creates multiple stabilities for the technology involved, depending upon how the technologies have been appropriated (de Boer, 2021).

Investigators have used both methods to analyse the multistability of technology. Rosenberger (2020) used variational cross-examination to analyse how park benches have multiple stabilities and how authorities use a median to constrain some of the stabilities of the bench, such as sleeping on the bench affects the homeless. Moerenhout et al. (2020) studied the multistability of electronic health records in patient care and the loss of data in each of the stabilities. In the self-tracking context, Zheng (2021) studied self-quantification practices through a postphenomenological lens and concluded that users quantify not only from self-knowledge and behavioural change but also from other stabilities such as casual usage; Zheng calls for design changes based on the stabilities. The problem with these interpretations of multistabilities is that they discount the imaginative stabilities that the user might perceive. The methods used to perform analyses through the postphenomenological lens are inadequate in studying the perceived stabilities of the device (de Boer, 2021). There is a strong criticism that postphenomenologists are trapped in the technological mediation of individual human–device relationships and have discounted the impact of the environment on the human–technology world (Aydin et al., 2019; Romele, 2021). Romele (2021) argues that there are three different approaches that postphenomenologists can take while analysing the human–technology world: 1) standard postphenomenology that studies only one human–

technology relationship at any point in time; 2) a combination of postphenomenology and actor-network theory to provide a complex analysis of technology mediation; and 3) adoption of the original idea from Ihde (2008) to analyse technology mediation along with the environmental, social and cultural aspects that influence the human-technology world.

Romele (2021) has added Bourdieu's habitus and the approach to technology as a way to analyse human–technology relationships through a postphenomenological lens, while de Boer (2021) has advocated affordance theory as an interpretive framework to study the multistability of technology through phenomenology. This thesis takes the view that it is important to return to Ihde's (2008) original intention of studying the impact of technology on humans and the broader environmental, social and cultural aspects. I take inspiration from Romele's (2021) use of Bourdieu to study the social impact and de Boer's (2021) study to draw from affordance theory and analyse the human–technology–environment relationship in the self-quantification paradigm and De Certeau's tactics of the weak, to analyse the social impact of self-quantification. In the following section, I explain how affordance theory can assist in unpacking the self-quantification assemblage and how affordance theory is a valid interpretative framework for a postphenomenology philosophy.

3.2. Conceptual Framework

In the previous section, I elaborated on the research philosophy on which this thesis is situated and the reasons for choosing a postphenomenological lens to understand the relationship between humans and technology. I have also presented the methodological limitations of postphenomenology and the relevant additions (technological, environmental and social) that can be combined to form a holistic enquiry into self-quantification and how it impacts human life. In this section, I explain affordance theory and how affordances assist in studying technological mediation through the phenomenological lens. In the second part of the section, I elucidate DeCerteau's tactics of the weak and how they can be used along with affordances to study the social impact of self-quantification. A conceptual framework can be defined as a plane interlinked with diverse concepts to understand a phenomenon comprehensively (Jabareen, 2009). A conceptual framework is not a collection of concepts created for analytical purposes but a construct that aids in interpreting the social reality of the phenomenon. It provides an understanding of the phenomenon rather than applying a theory to a data set like in a positivist paradigm. As illustrated in the previous section, self-quantification is a complex phenomenon of technology mediation with human agency and, at the same time, has a societal impact. So, it is essential to understand how technology shapes humans and how the numbers produced by this technological assemblage impact society. Conceptual frameworks are not deterministic in nature and are not used to predict a specific outcome (Jabareen, 2009). In the following section, I will explain how affordance theory is an apt way to interpret multiple stabilities of self-quantification technology. Subsequently, the effect of the affordances leads to acts of micro resistances that can be explained by De Certeau's tactics of the weak.

3.2.1. Affordances

Researchers have studied consumer culture through social constructivism and post-structuralism (Arnould and Thompson, 2005). Through these methods, the impact of material (or technology) and how it shapes the world and society around it have been investigated. The move towards researching sociomateriality has been labelled as the ‘material

turn' (Fayard and Weeks, 2014). Social constructivist epistemology focuses on textuality and the importance of human agency. The material turn in social sciences advanced the development of flat ontologies (ANT, postphenomenology) that place objects and technology in the same plane as humans (Schneider-Kamp and Askegaard, 2022). Self-quantification is an example of sociomateriality, and it involves three important actors: the human, the technology and the environment in which the human–technology assemblage operates. Humans and technology are engaged in the practice, but the investigation into how this assemblage operates and the influence of technology on humans has been under-investigated.

Affordance theory provides a powerful lens to investigate the co-constitutive relationship between self-tracking devices, humans and the environment. Affordance theory traces its roots to ecological psychology, defined succinctly as 'what it [the environment] offers the animal, what it provides or furnishes, either for good or ill' (Gibson, 1977). Individual affordances can be positive or negative to the user depending on the environment in which they operate and the degree to which they operate. Gibson (1977) was cautious when he stated 'good or ill' in his definition, as it might be misconstrued. Instead of understanding the definition subjectively, it can be seen objectively, according to Gibson, (1977) when the affordances are approached as behavioural facts. For example, a stick might afford the user the ability to walk, but it can also afford hitting for the user when used in certain contexts. Gibson's (1978) original theorisation and examples (such as the surfaces used for sitting) are based on the physical properties of the objects in an environment but not on the object's functions. For instance, in the surface example, he indicates that if a surface is flat, horizontal, rigid and at the height of the knee, it could afford sitting for a human; however, the function of that surface could be something else. The following important characteristic of affordance is that it is a relative property between the human and the object, existing only in that environment. For example, with respect to climbing steps, an adult human can afford to climb, whereas a small child cannot because they do not have the ability to climb the stairs.

The third important characteristic is the perception of affordance; Gibson (1978) uses the idea of a 'niche' to explain how animals perceive affordance. He refers to a niche as '*how an animal lives than to where it lives*' (1978). It could be understood as the set of environmental properties that metaphorically allows the animal to fit into the setting. For example, humans

cannot afford the same thing as a bird or a horse, although they might live in the same environment. Air affords flying for the bird, while it does not afford flying for a human. However, affordances are not properties or characteristics of a human or the environment; they can exist only when humans and the environment reciprocate with each other. For example, air does not afford flying for the human, but it affords breathing, which can happen only if the human comes in contact with the air to breathe. According to Gibson (1978), the niche does not afford the same thing everywhere. The same air can afford combustion in a place in which the composition of the environment is different. For Gibson (1978), the place is not a location but rather a set of multiple relative stabilities that are found in them; it is the user's perception that changes with respect to those stabilities. For example, humans can use a pool for swimming, drinking water, paddling, kayaking, or simply viewing from the outside, as they might drown in the water. What the pool can afford depends on the user's perception.

There are three important aspects of Gibsonian affordances: physical property, relational property between the environment and the animal and, finally, its ability to perceive. Initial theorisations regarding Gibsonian affordances were sparse and primarily used in psychology. Smitsman et al. (1987) used them to analyse how children categorise objects based on the affordances given by them, and Riccio and Stoffregen (1988) used them to examine how the environment constrains the control of the stance.

Chong and Proctor (2020) have argued that the lack of research regarding Gibsonian affordances is due to its challenging perspective of cognitive psychology. Goldring (1991) extended the affordances to humans and how humans afford actions to other humans. The most important extension was that of Norman (1988), who appropriated the theory to design human–computer interaction studies. His interpretation emphasised the properties of artefacts designed by humans and stated that the action possibilities are restricted to the functions of the design. Norman (1988) overlooked the human–environment relational mutual reciprocity of humans and the environment of the Gibsonian affordances. Later, he (1999) distinguished between real and perceived affordances. Real affordances are the functions linked to an object and what it potentially affords to the user. In contrast, perceived affordances are features of the object that are evident to the user.

The difference between Gibson's (1978) and Norman's (1988) interpretations is that Gibson (1978) articulated that the species directly perceive the affordance; in contrast, Norman (1988) deviated from that idea and postulated that there must be a cognitive process to perceive the affordance. Norman theorised that affordances are dispositional and can be misinterpreted or missed by the user. Therefore, a strong design is one that shows the affordances to the users and reduces the gap between perceived and real affordances (Fayard and Weeks, 2014). Norman's view helped design studies, mainly because designers need users to think before perceiving an affordance; Maier and Fadel (2009) developed an affordance-based design framework based on Norman's work. Since its appropriation, affordance theory has been widely adopted in design studies and other streams, including management, sociology, psychology and anthropology. Li et al. (2003) studied the role of virtual experience in student learning, Blackwell (2006) analysed how metaphors are used in human computer research, Smock et al. (2011) studied the motivations behind Facebook through affordance, Selwyn (2012) conducted a sociological study of how students approach digital technology in education and, even in management, Nambisan et al. (2019) postulated how digitisation aids in innovation and entrepreneurship through the affordance lens.

Norman's conceptualisation spawned a slew of studies, but it oversimplified the initial theorisation of Gibson by adapting to the practical needs of the paradigms (Chong and Proctor, 2020). Gibson (1941) expressed concern regarding the generalisation and oversimplification of concepts as researchers started interpreting the concepts loosely. There have been other interpretations of affordance theory over the years. Hartson (2003) developed a classification system for affordances based on Norman's work. He described a four-way classification system of cognitive, physical (both based on Norman's perceived and real affordances), sensory and functional. Norman saw the affordances as dispositional, and Gibson saw the affordances as perceived; this created a dualism that Gibson had sought to avoid in the initial theorisation (Fayard and Weeks, 2014).

Figure 1: Artefact - user relationship adapted from Diver (2018)

Over time, there have been multiple attempts to reconcile the tension between Norman's interpretation and the initial Gibsonian affordances. Two of these attempts are prominent and also widely used in social sciences. Gaver (1996) contended that social researchers restrict themselves to sociological and anthropological interpretations of social behaviours instead of including the material shaping of the environment. He advocated a holistic investigation of the sociality of affordances instead of the study of individual affordances between humans and the material and the possible social interactions afforded by the physical environment (Gaver, 1996). Gaver used communication systems such as email and digital documents as examples. In the email example, he described how humans create new practices and subcultures that are different from the local culture and how the affordances provided by email can replace existing communication devices such as the telephone. Hutchby (2001) provided another deviation from the interpretations, grounding his theorisation on Gibson's (1978) original work. Hutchby (2001) contested that affordances are dual in nature – they are functional and relational. Functional indicates that the technology enables and constrains the user's actions and that the affordances are present even if the user does not perceive them. Relational means that the affordances are specific to the user and the object in a particular environmental context, and there can be multiple interpretations of the same technology. This relationality and multiple interpretations of technology are the same as the multistability principle in the postphenomenology paradigm. Postphenomenology helps understand the technology's normative role instead of viewing the technology as neutral or deterministic. The relationships can be split into two - those that can be perceived and those that can be acted on (Diver, 2018). These two relationships evolved and were constructed by the human and the artefact to create technology mediation, and in the postphenomenology paradigm, it is the co-constitution of reality (Diver, 2018).

Technology mediation and multistability can be derived as parallels between affordance and postphenomenology. Diver (2018) posits that affordances are individual building blocks that can be aggregated to construct the technology mediation between the user and the artefact. In other words, the stabilities the technology offers users can be construed as affordances.

But methodologically speaking, Fayard and Weeks (2014) have provided an integrated interpretation of affordances by building on the work of Hutchby (2001) and Gaver (1996). They postulate that the affordances of an environment are both dispositional and relational; that is, the affordances arise from the social construction of the use of technology and the physical properties of the technology simultaneously. In other words, affordances are relational, depending on the goals of the individual, the materiality of the technology and the context in which the technology is used. Fayard and Weeks (2014) provide the example of photocopier rooms; specifically, people use certain spaces in an office, such as photocopier rooms, rather than other places for informal conversations. They postulate that the affordance of informal interactions bears the three dimensions of privacy, social interaction and propinquity and that these are enabled through the materiality of the space and the social meanings constructed by the people who use the space.

Fayard and Weeks (2014) agree that as affordances are specific to a human and the environment, as Gaver (1996) suggested, there needs to be a way to understand the social affordances and how the social meanings impact the affordances of the environment. They propose that affordance theory should be supplemented with Bourdieu's habitus (1977), which can complement affordance by combining sociality of the practice with the acknowledgement of materiality of the practice. Due to the varied and frequent use of the concept, there has been confusion regarding how to use the theory as an analytical lens to study a specific phenomenon. Over the years, there have been attempts to introduce different conceptual frameworks; however, empirical studies have suffered from a crucial issue in that they take the approach that artefacts either possess affordance or lack it. In his original theorisation, Gibson (1977) mentioned the variations of affordances and the studies recognising this understanding that affordances operate on gradations rather than duality.

This thesis concurs with the theorisation of Fayard and Weeks (2014) and thus considers affordances as functional, perceived and relational, moving beyond Norman's dispositional argument. At the same time, it has rooted its analysis in Gibson's original idea of the properties of the device that the user perceives and acts. But Gibson did not delve into the aspect of how humans choose from the various affordances that are offered to them by the device. Researchers using affordance theory organisation research developed the concept called affordance actualisation to mitigate this issue.

3.2.2. Affordance Actualisation

The user's choice of affordance is one of the most significant conundrums that Gibson's (1978) original theorisation did not address. Any object or environment can have multiple action possibilities, and users perceive a specific affordance. Information systems researchers have worked on how users choose to perceive an affordance and have developed the concept of affordance actualisation. Affordance actualisation was introduced in organisation research; Strong et al.'s (2014) definition of the term reflects this. They defined affordance actualisation as the action that occurs when users take advantage of one or more perceived affordances to achieve organisational goals. The concept of affordance actualisation has also been adopted for other purposes, such as studying the affordances of augmented reality in offline retail (Teh et al., 2021) and analysing how consumers actualise the affordances they perceive in metaverse games (Shin, 2022). Individuals have goals that affordances can enable them to achieve.

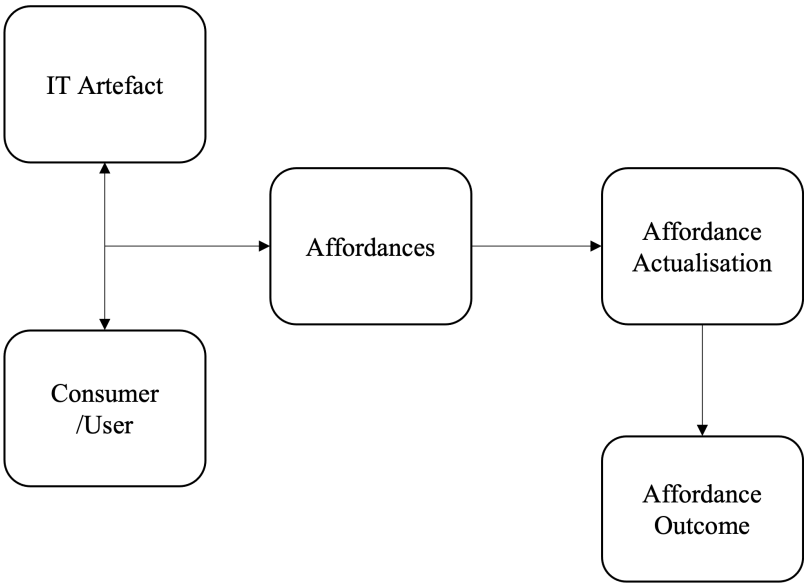

Figure 2: Affordance actualisation - adapted from Pozzi et al., (2014, 3)

Pozzi (2014) provides a conceptual outlook on how affordance actualisation works. The relational action possibilities between the user and the artefact lead to affordances. The decisions taken by the user on the affordances are affordance actualisations, and actualisations lead to the affordance outcomes. There are two reasons why users might not actualise the affordances offered by the environment. First, they might fail to perceive an affordance. According to Gibson (1978), an affordance is present irrespective of whether a user can perceive it. Therefore, at any point in time, the number of affordances that an environment presents will exceed the number of affordances that a user perceives. Second, there may be a disconnection between affordance and a user's goals.

In his original theorisation, Gibson (1978) asserted that affordance does not change along with a user's need. Affordances are not defined according to a goal. Instead, an affordance can be actualised only when it leads to a goal that the user undertakes. For example, a chair might afford standing, irrespective of whether a user perceives it. The affordance becomes actualised, however, only when a user wants to change a lightbulb (i.e., sets a goal), perceives that the chair can afford standing and actualises this affordance by standing on the chair.

Leonardi (2011) has addressed what happens if users are unable to achieve their goals using technologies that are currently available in their environment. In this case, users change their goals, the technology or the environment. According to Leonardi (2011), the decision to change a specific aspect depends on a user's perception of affordances and constraints. A user who perceives that technology is the constraint, for example, will change the technology, not the goals or routines. In short, affordance actualisation is conditioned by a user's perception of the affordance and its link to their goals. Along with the affordances actioned by self-tracking technology and the environment, this thesis will use affordance actualisation to consider the affordances that users perceive and how their perception and actualisation of these affordances leads to control and resistance.

3.2.3. Affordance Theory in Consumer Research and Self-Quantification

Consumer researchers have only recently begun to adopt the perspective of affordance theory. Their research concentrates on new technologies, the motive for adopting them and the creation of identities around them. Studies based on technology mediation are emerging in consumer research and self-tracking. One of the earliest studies in affordance-based self-quantification was conducted by Rapp and Cena (2015), who introduced a conceptual model with three levels. According to this model, reflective, behavioural and social affordances can be used to reframe the design of self-quantification systems. The first level, reflective affordance, denotes the potentialities of data, which can be revealed to users and thereby invite reflection. Behavioural affordance is the model's second level. It refers to the ability to demand and encourage users to undertake certain actions. The model's third level, social affordance, refers to the ability to adapt a device to different social contexts. Rapp and Cena's (2015) model was designed for self-tracking systems. A hierarchal model suits this paradigm, but affordances are not perceived and actioned in a hierarchy. Benbunan-Fich (2017, 2019) used Norman's (1988) dispositional affordances to study the usability of minimalist devices and combined them with activity theory to suggest that minimalist devices have affordance integration issues.

Like research on self-quantification, affordance theory has focused on HCI. Some studies have focused on other aspects within the HCI paradigm, including the design of instruments to measure self-quantification affordances (Rockmann and Gewald, 2018), prior motivation and motivational affordances (Jarrahi et al., 2018), behavioural outcomes of affordances from the perspective of self-quantification (Rieder et al., 2020) and the ways in which elderly people use self-quantification devices (Abouzahra and Ghasemaghaei, 2022). One challenge with respect to the current design of self-tracking devices and apps is the preconceived notion that users are tracking for self-knowledge and that they think rationally when approaching self-tracking systems. As discussed earlier, the techno-deterministic view of the HCI paradigm masks the qualitative experiences of the self-tracking users.

Following the same trajectory, researchers have also studied the psychological motivations behind the adoption of self-quantification devices and practices. Kappen et al. (2017) investigated how gamification can encourage the adoption of certain practices through motivational affordances and self-determination theory. Molina and Sundar (2018) used self-determination theory, a motivational model and technological affordances to understand whether mobile fitness-tracking apps can motivate users to undertake certain practices. Within a psychological paradigm, investigations of self-quantification through an affordance lens have followed the same outlook by focusing on individual users' motivations and discounting the social impact of practices and devices. Sociological enquiries into the self-quantification paradigm through an affordance lens are evolving. There are two streams in sociological research: the organisational perspective and the consumer perspective. This division exists because organisational research has used the affordance lens and because researchers have studied the broader societal impact of the self-quantification-based surveillance used in organisations. Elmholdt (2021) described how organisation-based sleep self-tracking provides affordances such as remote health management, body visibility and opacity. These affordances provide users with a sense of perceived self-control by making them think that they can control their bodily clocks. Nonetheless, control also shifts from users to organisations due to surveillance. Elmholdt (2021) found that there is an ambiguity in the ways in which an agency shifts from a user to an organisation and vice versa. This is an important study with respect to this thesis because it posits that users perceive a form of self-control to emerge from affordances.

On the consumer side of sociological enquiries, Lupton (2018) used the affordance lens to show how the body is a combination of human and non-human elements and how these elements produce different types of knowledge and data. Humans use their senses to engage with these data. Byrt and Dempsey (2020) studied five different apps targeting parents of premature infants. These apps enabled parents to track various aspects of their children's health. The researchers used the affordance lens to analyse the action possibilities that the apps offered, including journaling; understanding feeding cues; and planning for various activities, such as tracking a child's physical development. Using affordance theory and feminist theory, they argued that apps infantilise young mothers and reinforce the ideal description of motherhood that society forces upon them (Byrt and Dempsey, 2020). This study informs the current research, which uses critical social theory alongside affordance theory to analyse the data acquired from qualitative interviews and a walkthrough method. Bergroth (2019), who studied self-tracking among everyday users in Finland, combined affordance theory, Foucauldian biopolitics and Stiegler's theory of cinema (Stiegler, 2010). The study posited that self-quantification not only produces self-knowledge but also creates uncertainty: 'the self is constructed as a temporal object and ephemeral flux' (Bergroth, 2019, 203). Bergroth (2019) also encouraged social scientists to move away from the self-knowledge paradigm. Instead, they should investigate what kinds of affordances self-tracking systems provide users and how these affordances impact wider society. To study self-quantification systems, Bergroth (2019) drew theoretical views from three diverse paradigms. I conform with Bergroth's (2019) argument that it is important, and even inevitable, to look beyond the description of self-knowledge and also use a complex conceptual framework encompassing diverse theoretical perspectives.

In consumer research, affordance theory has been used to study the impact of digital technology, especially in terms of social media adoption and mediation. Nagy and Neff (2015) studied platforms such as Facebook to propose that imagined affordances, which are users' expectations about platforms and technology, might not be provided by technology itself. Users, however, still perceive that affordances exist based on their actions. The researchers cited the example of Facebook's News Feed, which users perceive as a genuine curation of their friends' posts, not as the product of an algorithm controlling what they see.

Freeman and Neff (2021) used imagined affordances to study the adoption of self-tracking devices by adolescents in the UK. They also studied the social control of the authorities and how the control affects the adoption. They postulate that the self-quantification practices of adolescents are different from those of adults as the social and cultural contexts of the two categories are different. Choi et al. (2020) studied self-representation in social media through the affordance lens and posited that the temporal affordance of ephemerality affects the concept of self. Southerton and Taylor (2020) studied how privacy violations in social media impact users' trust and how affordances create a habit of sharing on a platform. They argued that privacy violations break users' trust, that users remediate this trust, and that trust becomes routine again through everyday practices. Many other studies have used an affordance lens to analyse everyday consumer experiences, such as the privilege of receiving 'free' or 'zero-priced' goods (McClain and Mears, 2012), the adoption of algorithmic services (Shin and Park, 2019) and the way in which consumers behave when sorting plastic goods (Nemat et al., 2022).

Recently, Kozinets et al. (2021) analysed a Brazilian consumer review platform to identify whether the affordances of platforms empower or constrain users. They found that the platform in question disempowered consumers through its affordances. Another important study in consumer research was conducted by Borghini et al. (2021), who investigated how the affordances of retail spaces create a sense of attachment or detachment among users. Borghini et al. (2021) drew on Davis and Chouinard's (2016) mechanisms of affordance to unpack the spatial affordances offered by retail spaces. Davis and Chouinard (2016) posited that artefacts request, demand, encourage, discourage and refuse affordance to their users. Requests and demands are the bids that artefacts offer a subject. Encouragement, discouragement and refusal refer to how artefacts respond to a subject's actions. Allowance refers to the bids placed on both the artefact and the subject. Davis and Chouinard (2016) provide three conditions to identify whether a particular property is an affordance: the affordance must be perceived by the user, the user must have the dexterity to perceive and action it, and the affordance must possess cultural and institutional legitimacy.

As explained above, consumer research conducted through an affordance lens is in its nascent stages. Therefore, studies have limited themselves to evaluating how affordances constrain and enable certain actions when users actualise them. For example, a study of empowerment by Kozinets et al. (2021) considered various elements of consumer empowerment from different theoretical frameworks. That study analysed how platforms empower or disempower users through affordances; nonetheless, it discounted the broader social impact that a lack of consumer agency can have. The same trend can be observed in self-quantification enquiries that have used affordance theory. The sociological paradigm uses an affordance lens to understand technology mediation among users, but it does not investigate the impact of affordances. There are a few exceptions to this pattern, including work by Byrt and Dempsey (2020) and Bergroth (2019). Gibson's (1978) initial theorisation showed that the affordances which environments offer animal species shape their behaviour and thereby affect the environments themselves.

Affordance theory is popular in HCI, design studies and social sciences because it offers a way to study how technology mediation shapes human behaviour in everyday life. The primary reason to use affordance theory in design studies is to induce the behaviours that a designer wants users to adopt. One question arises: if affordances shape human behaviour, are humans bound to construct and reconstruct their environments to achieve their goals?

3.2.4. Resistance, De Certeau's Tactics and Affordances

Most scholarship on self-quantification focuses on who uses the technology, how they use it and how they can be motivated to use it more often. The opposite of this scholarship considers the non-use or abandonment of technologies. Within the HCI paradigm, there have been studies to understand the abandonment of self-quantification. Among these studies in the HCI paradigm, one by Clawson et al. (2015) posited that the design of devices and apps could be the reason for abandonment because the devices could not match the promises of health-improvement behaviours. Researchers also found that personality traits and a lack of trust can lead to abandonment (Attig and Franke, 2022). Clark et al. (2022) postulated that the abandonment of a device or practice is a myth and that embodiments change while users

disengage. Old practices are reconstructed and remediated, thereby morphing into new ones. For example, Clark et al. (2022) discussed how users continue to believe in the utilitarian aspect of walking even after they disengage with the practice of step-counting.

As the literature on technology resistance developed, researchers began to question the assumption that non-use is the only form of resistance. There could be other forms of resistance exhibited by the consumers that are not an explicit rejection of technology and associated practices. Recent research in self-tracking has observed that users engage in practices episodically instead of continuously self-tracking their behaviours. Gorm and Shklovski (2019) investigated how users episodically use fitness tracking. They asserted that, although users found tracking to be useful, episodic use is triggered by individual priorities and social changes rather than technological issues. Ultimately, they contested that episodic use is a feature, not a bug. In the broader literature on technology resistance, studies have observed momentary and irregular acts of resistance. For example, Lee et al. (2014) found that users employ small tactics to stop themselves from using smartphones; they might change their phone settings, physically separate themselves from their devices or install intervention software to temporarily prevent themselves from accessing their phones.

The literature on technology resistance has now begun to identify alternative forms of resistance, including those involved in usage as well as abandonment. Users are caught in an inescapable web of technological mediation, market-enforced discipline and consumption. They are forced to find alternative ways to resist both the market and technological discipline. To study how users create resistance practices through affordances, I borrow Michel De Certeau's tactics of resistance as part of my research's conceptual framework.

As elaborated in the literature on consumer resistance, the tactics of the weak, as described by De Certeau, form part of the agency and empowerment paradigm. De Certeau was a contemporary of Foucault and Bourdieu, who studied the power structures that impact consumers in everyday life. Whereas Foucault (1988) and Bourdieu (1977) studied how everyday life reproduces processes through structural power, De Certeau (1984) considered how people traverse their lives despite the hegemonic powers that control them. He argued that users are already tangled in the nets of discipline and that they cannot escape the clutches

of power. According to De Certeau (1984), the force-relationships of certain powers (e.g., authority, an institution, an organisation or an individual) are ‘strategies’ around which political, economic and scientific rationality are constructed. He calls these strategies ‘proper’ because they are formed, strategised and created as a model (De Certeau et al., 1984). There is a specific, designated place of authority that provides longevity for these strategies. In contrast, the acts of the weak against the powers are termed ‘tactics’. Unlike strategies, they are not proper; instead, they are time-bound and temporal (De Certeau et al., 1984). The weak must consistently manipulate and transform tactics into ‘opportunities’.

Tactics do not need to have a structure. Instead, they combine heterogeneous moments into an act of resistance. De Certeau (1984) postulated that many everyday practices – including walking, reading, sleeping, shopping and cooking – are tactical in character. The weak use *metis* (derived from the Greek term for ways of operating) such as ‘hunter's cunning, manoeuvres, polymorphic simulations, joyful discoveries, poetic as well as warlike’ (De Certeau et al., 1984, xix).

De Certeau (1984) claims that social stability has broken down because the system is too large for consumers, who are immigrants, to own it. At the same time, the system is so tightly constructed that consumers cannot escape. He asserts that tactics create a ‘Brownian movement’ in the system and that this movement provides leeway for users to regain a certain degree of agency which, in turn, allows them to execute acts of resistance that are opportunistic and disintegrated. De Certeau uses various metaphors to explain the tactics of the weak. One of them is the metaphor of war, through which he describes how tactics are akin to guerrilla combat. The weak have few resources to use against authority, so their tactics are closely related to resistance. Resistance practices include unrelated acts that are undertaken to reclaim control. Consumers often employ creative ways to exploit moments for resistance. The second metaphor that De Certeau uses is important to my research. It departs from the war motif by framing consumption as a tactic. De Certeau (1984, 31) observes that the world is comprised of ‘systems of production’ that create ‘rationalised, expansionist, centralised, spectacular and clamorous production’, which is countered by another form of production called ‘consumption’. He argues that consumption, through its ruses, continuously creates personal meanings and rituals that act as resistance against the products which the

dominant economic order imposes. De Certeau (1984) identifies something called ‘poaching’, which allows consumers to develop their own interpretations as they work within the very system that they resist. Consumers do not abandon the system because they cannot do so. Instead, they resist disciplinary power through ‘antidiscipline’ by making use of the resources and moments that the system permits.

The word ‘tactic’ might be misconstrued as a strategic structure motivated by a stable cognitive process to resist. In fact, it is more akin to an embodied practice that becomes part of consumption itself. The example that De Certeau (1984) uses is that of walking in the city. Instead of taking the paths and directions that urban planners and authorities want them to take, walkers create their own trajectories when they wander, pause, use shortcuts and write their own ways of accessing the city. Here, walking is a bodily process, not a calculated cognitive one. The body improvises the walking and appropriates the environment to resist the authority that forces them to use the city in a particular way. Another misinterpretation of the word ‘tactic’ interprets it as a visible opposition to the dominant power structures. However, De Certeau's (1984) description of everyday tactics depicts evasion rather than open opposition. Open opposition to the strategies of the strong might result in the suppression of defiance. Therefore, tactics are a kind of inertia that evades the dominant structures; they are invisible acts of defiance. In scholarship on technology resistance, Selwyn (2003) used De Certeau's tactics to reimagine the non-use of communication technologies as an act of resistance whenever non-use was pathologised as a lack of access or an inability to understand technology. Selwyn (2003) theorised that the non-use of technology is a way for users to regain control of their lives.

Through the examples of walking and the non-use of technology, it becomes possible to understand that tactics are unplanned, instinctive, invisible, habitual and relatively unconscious processes. The other mundane examples that De Certeau (1984) in his text – such as cooking and reading – are habitual and instinctive as well, but there is logic to them. Users consciously create their own logic at the time of enactment. In De Certeau's words, ‘it (logic) surmounts the very institution of consciousness’ (1984, 40).

The affordances offered by technology and the environment can help users create tactics of resistance. Michael and Still (1992) provided a theoretical argument about how affordance can become a resource for resistance. They compared and contrasted Gibson's affordances with Foucault's power-knowledge discourse and De Certeau's tactics of the weak (Michael and Still, 1992). According to their interpretation, affordances are neutral – 'they provide a resource and not a source of resistance' (Michael and Still, 1992, 883) – and the environment's physical properties can become a resource of resistance. Affordances can encourage or constrain action possibilities, and users actualise affordances into an action. Actualisation can take the form of mediation, as Michael and Still (1992) described. The affordance actualisation was not developed when their paper was published.

In communication studies research, Mannell (2017) identified 'butler lying' as an affordance provided by text message technology. A butler lie is something used in text messages to avoid possible interactions or face-to-face meetings. Mannell (2017) posits that the practice of butler lying exploits the technological affordances provided by the device and the communication app; for example, users might keep their device on airplane mode or do-not-disturb mode to avoid seeing texts, then lie about it later. Although Mannell (2017) did not describe this practice as an actualisation, it can be considered as such because it is an action taken based on an affordance that the device provides. Shirtcliff (2019) conducted a phenomenological study through an affordance lens. That study analysed urban spaces where young adolescents play and employed the ideas of three urban theorists: De Certeau, Walter Benjamin and Gaston Bachelard. Using De Certeau's (1984) walking metaphor, Shirtcliff found that institutionalising play spaces were unsuccessful in turning US adolescents into good citizens. Although the public spaces in question were designed to afford play, adolescents resisted the institution that was trying to control and discipline them. Here, the act of play actualises the affordance; it is not the affordance itself. The problem was that these play spaces were structured and aestheticised, pushing adolescents to use other public spaces, such as malls and roads, which afford risky practices. Like walkers who take unnamed routes and shortcuts, adolescents take risky routes to play. Shirtcliff (2019) suggested that urban planners must rethink whether they desire to encourage adolescents to use these play spaces.

As explained above, affordances are neutral. They are based on action possibilities that encourage or constrain users. Users actualise affordances by making decisions based on their goals. These affordance actualisations give users agency and control. In turn, affordance actualisations and control become micro-tactics that resist the hegemonic power that pushes a self-optimisation agenda onto the consumer. Resistance is invisible, habitual and instinctive.

3.2.5. Conceptual Framework: Summary

A self-quantification and self-tracking environment is a complex system comprised of various actors. It includes a human actor who uses various apps and devices to undertake a certain practice in a contextual environment. Self-quantification is an integrated process involving multiple quantification aspects that may be either interconnected or independent. I draw from affordance theory to unpack its complex assemblage and the stabilities associated with it. Technology and the environment offer certain affordances to human actors. These actors perceive affordances, have the dexterity to afford them and actualise them by making decisions.

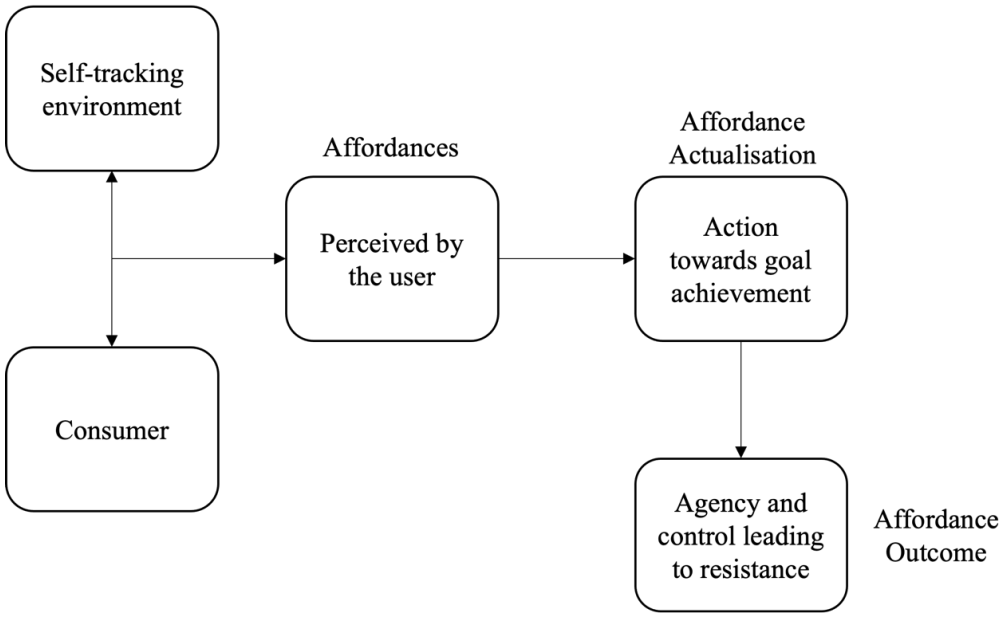

Figure 3: Conceptual framework for studying affordances of self-quantification adapted from (Pozzi et al., 2014, 3)

Users' affordance actualisations act as clever tactics that resist the powers that impose control. These actualisations help users to regain the agency that they lost to hegemonic powers. In turn, the regained agency and perceived control that arise from actualisation become a set of micro-tactics. Interpreting these micro-tactics through the lens of De Certeau's tactics of the weak provides a better understanding of the broader social impact that self-quantification practices can have.

3.3. Aim, Scope and Research Questions

The conceptual framework, literature review and discussion of existing paradigms' limitations reveal the aim and questions of this study. This thesis will contribute to consumer research by exploring users' self-quantification environments. As explained earlier, this thesis views self-quantification as an integrated act; it does not focus on separate aspects of tracking. In this way, it diverges from the majority of studies in the self-quantification field, but it remains consistent with some recent studies, including those of Jauho et al. (2016) and Maltseva and Lutz (2018).

It is important to define the scope of this project's research. First, it does not attempt to provide an all-encompassing theory of quantification. Instead, it theorises the micro-quantification of numbers. Existing studies on quantification tend to focus on macro-quantification or big statistics (Espeland and Stevens, 2008). Existing theories of micro-quantification postulate that the numbers produced through self-quantification are a part of big data production (Degli Esposti, 2014; Van Dijck, 2014; Lupton, 2016; Sanders, 2017; Sharon and Zandbergen, 2017). Moreover, they consider humans to be passive data producers or co-creators of big data. This thesis deviates from that approach. It understands humans have their own agency in producing these numbers; humans create their own self-tracking environment as they navigate the process of self-quantification. At the same time, this thesis recognises that self-tracking devices shape how humans behave in everyday life. The second important aspect of this project's scope is the attention that it pays to mundane quantification. This thesis limits its scope to mundane aspects because there is a dearth of studies focused on them. The study's paradigm presuppositions are the third important aspect of its scope. The study's choice of a postphenomenological research philosophy and an affordance lens perspective mitigates the issues of presupposition, human agency and technology mediation that is lacking in existing research. Although this project's findings fit the sociological frame, the research does not start with the sociological presupposition of self-optimisation and Orwellian surveillance. The study aims to answer three research questions to theorise self-quantification.

First, the thesis responds to Pantzar and Ruckenstein (2015), who proposed that markets will push everyday analytics and mundane quantification practices. It also responds to Pink et al.'s (2017a) enquiry into the day-to-day aspects of self-quantification and how self-quantification is impacted by technology. As explained above, there is a lack of prior scholarship in this area; most of the research has been undertaken in experimental settings or with data based on quantified self-movement. The proliferation and widespread adoption of low-cost devices has enabled everyday tracking to become more ubiquitous. A consumer research study is imminent. This thesis diverges from the active user and data valorisation perspective by studying the everyday practices of casual users. RQ1 addresses the first limitation discussed in 2.4.5. Limitations of current discourses, and studies the every day lived experience of the trackers who use commercial devices that are available in the market. This also addresses the fourth limitation as discussed in the above mentioned section, discards the experimental design and studies the everyday tracking by the users. It also addresses the third limitation of existing studies that sees different self-quantification practices as isolated practice not as integrated. This research views the self-quantification as an integrated environment that has the human, device, various quantification practices and the surroundings.

RQ1: How do consumers undertake everyday quantification through an integrated quantification environment they construct?

Secondly, this thesis engages with the consumer research studies of Vigren and Bergroth (2021) and Silverman and Barasch (2022), as well as with studies on the shaping of self-quantification and the production of numbers through technology mediation. In doing so, this thesis diverges from the behavioural change perspective of the HCI and psychology paradigms. The research also takes an exploratory approach and uses post-phenomenology to study technology mediation. This addresses the second limitation of the existing paradigms that have an inherent theoretical framework bias. The exploratory approach also helps in studying self-quantification without any ontological presuppositions and through that, addresses the fifth limitation.

RQ2: How does technology shape self-quantification and, in turn, the production of numbers?

Thirdly, this thesis seeks to discover an intermediary view between techno-determinism and Orwellian surveillance discourse. The impact of technology on behaviour is well established, and the fear of Orwellian control cannot be discounted. Both techno-determinism and Orwellian surveillance discourse, however, see consumers as passive onlookers without any agency. There is a lack of research on how users react to quantification and the numbers that it produces. Self-quantification is yet another neoliberal imposition of numbers, but the viewpoint that users are succumbing to this project is problematic. As a result, the third research question that this thesis aims to answer is as follows which in turn addresses the sixth and final limitation discussed in the previous chapter. The research goes beyond the dichotomous arguments of self-knowledge and surveillance and also studies self-quantification through neoliberal lens.

RQ3: How do users react to neoliberal quantification and the numbers they produce through self-quantification?

Rather than reproducing existing narratives of self-quantification, this thesis uses a postphenomenological lens, draws from affordance theory to study technology mediation and engages with De Certeau's tactics of the weak to show how humans react to the imposition of numbers.

3.4. Research Method: Generating, Analysing and Interpreting Data

3.4.1. Data Collection Methods in Quantified Self Research

Academic scholarship on self-quantification began with studies of the videos and presentations available on the quantifiedself.com website (Choe et al., 2014). The studies' participants were recruited from Quantified Self (QS) meetups (Gimpel et al., 2013). Nafus and Sherman (2014) conducted an ethnographic study on QS meetups to identify 'soft resistance' among users. Because QS community members were the first set of users who undertook the self-tracking practice, using them as respondents in a study was a valid approach. Nonetheless, studies have been restricted to self-tracking; they have not explored the practice being tracked. For example, the tracking of steps has been studied, but studies have not explored how this practice changes running or fitness.

Mass surveys (Li et al., 2010; Krebs and Duncan, 2015; Chatzigeorgakidis et al., 2016; Epstein et al., 2016; Karapanos et al., 2016; Nelson et al., 2016; Stragier et al., 2016; Pettinico and Milne, 2017) and interviews (Khovanskaya et al., 2013; Rooksby et al., 2014; Renfree et al., 2016) have been preferred methods in self-tracking studies. Researchers have also used laboratory-based experimental studies to evaluate cognitive behavioural change (Etkin, 2016; Baumgart, 2017; Lee and Lee, 2017; Schembre et al., 2018; Stiglbauer et al., 2019). These methods have explained certain aspects of self-tracking, including behavioural changes and the motives behind self-quantification. These methods, however, are inadequate to explain how quantification shapes other aspects of life. Such an explanation would require a comprehensive study of the self-tracker, context and material agency.

Some scholars have used innovative methods such as diary study (Rapp and Cena, 2016) and auto-ethnography (Roberts, 2012) to analyse different aspects of self-tracking. Consumer researchers who have studied the quantified self have used in-depth interviews (Niva, 2017; Didžiokaitė et al., 2018; Régnier and Chauvel, 2018) and focused group discussions on researching consumer behaviours. Cox et al. (2017) and Jauho et al. (2016) used focus group discussions, while Pink et al. (2017b) and Lupton et al. (2018) used digital sensory

ethnography to explore different self-tracking practices among cyclists in Australia. These studies have explored how people produce, experience and interpret self-tracking data. Nevertheless, they did not address how practices and data affect other aspects of everyday life.

3.4.2. In-depth Interviews as a Data Generation Method

The philosophical approach to this thesis maintains that there is no single 'reality' to study through a definitive method. Rosenberger and Verbeek (2015) observed that postphenomenologists use micro-case studies to investigate how technologies shape human experiences, but they specified that there are no strict methodologies for researchers to follow. Ihde (2008) noticed that most postphenomenological researchers engage in experimental design and what he calls the 'research and development' stage of technologies. HCI researchers use experimental design and research when creating methods to investigate technologies through a postphenomenological lens (Hauser et al., 2018). Although the experimental design could help to uncover the impact of technology and design on humans, it is inadequate to provide insights into human experience. Ihde (2008) observed that there are only a few studies based on human experience, including one on the use of cell phones while driving (Rosenberger and Verbeek, 2015) and another on how the use of cell phones in micro-credit transfers has impacted the broader socio-political climate in Bangladesh (Selinger, 2008). According to Ihde (2008), there is no single method to collect and analyse data in postphenomenology. He has argued that any data collected through personal experiences should be corroborated through environmental inquiry, insight into the technologies used and analysis of other human interactions. Based on this argument, Aagaard and Matthiesen (2016) suggested that postphenomenology's focus on materiality positions it to engage with ethnography and participant observation. In-depth interviews about life-worlds can be used to collect users' personal experiences. These interviews can be supplemented with 'interview' of the devices and the environment, as Ihde (2008) has proposed.

My research study aimed to explore users' self-quantification practices without relying on any preconceptions. In-depth interviews are one of the few ways to capture users' personal experiences as perfectly as possible (Groenewald, 2004). I used unstructured, in-depth interviews that allowed participants to share their life experiences. The interviews began with questions about the participants' lifeworlds and the different self-tracking devices and apps that they use. Based on their responses, I developed thoughts, opinions and beliefs about the participants' various self-quantification environments in which they operate. The interviews were not restricted to specific topics or specific quantification aspects. Instead, they focused more on how the participants traversed various self-quantification acts in their lives.

Contrary to the claims of the positivist paradigm, it is not possible to keep a researcher's predispositions out of interviews (Crabtree and Miller, 1992). I used a 'bracketing' technique to disengage myself from my own presuppositions about self-quantification. According to Crabtree and Miller (1992, 24) '[a] researcher must 'bracket' her/his own preconceptions and enter into the individual's life world and use the self as an experiencing interpreter'. I interviewed 33 participants from June 2020 to September 2021. Each interview included a minimum of one and a maximum of three interactions. The research was not designed to be a longitudinal study, but partaking in multiple interactions with participants enabled me to discuss more of their life experiences. The study was conducted during the peak of the pandemic lockdown in the UK. In-person interactions were not allowed during that period. Therefore, interviews were conducted over Microsoft Teams, meaning that users could connect from home. Conducting multiple interviews with each participant also helped to make them feel more comfortable; some of them took time to explore the various aspects of their lives. Some participants shared their data on a screen, showed apps over video or shared data related to their social media use during the interactions. Revisiting the participants over the course of multiple interviews helped me to analyse the changes that occurred in their tracking practices over a period of time. Some participants changed or abandoned their practices. Others did not make any changes, but they revealed new information during the second interview.

Ihde (2008) proposed that researchers should investigate the environment in which participants operate. Therefore, I asked questions about participants' apps, whether they share data on social media and how they traverse their self-tracking environments. The participants also shared details regarding how they undertake their practices, including information about the accessories or devices they use to track and quantify their behaviours. To study self-quantification through a postphenomenological lens, it was imperative to investigate non-human actors and environments. I used the "interviewing objects" method developed by Adams and Thompson (2011) to investigate how the apps and devices are used by the self-tracking individuals. Adams and Thompson (2011) studied how students and educators use Microsoft PowerPoint in Higher Education classrooms. They could uncover materialities like how PowerPoint stages dissemination of knowledge through templates and bullet points. Adams and Thompson (2011) provide eight important heuristics including listening to invitational quality of things and interviewing objects that would help the researchers to study technology mediation. The other approach suggested by Rosenberger (2020) is variational cross-examination to identify multiple stabilities of an artefact and it helps to uncover the perception of the users about the various stabilities that the artefact provides.

In the case of this study, to build the lifeworlds of the participants, I interviewed objects and collected environmental information the surrounds the artefact and the human. The non-human actors included mobile phones, apps, fitness watches and social networks. These objects cannot be 'interviewed' in the traditional sense. Instead, the data were gathered from participant data, publicly available social media shares from consenting participants, data about apps, smart watches, fitness trackers, review websites, news articles and images publicly available on various websites. I used all of these to study the overall environment and explore the different aspects of self-quantification.

Studying the environment and the devices helped my research to move beyond consumer experiences. One limitation of online interviews is the loss of materiality that they involve. The interview process mitigated this limitation by acquiring first-person accounts of users' devices and finding the connection between humans, devices and environments. Although conducting in-person interviews would have helped me understand how users actually 'did' their practices, I made sure to ask them questions like 'What is the first thing that you do in

the morning', 'How do you run or walk', 'In which hand do you wear the device' and 'Do you hold the mobile phone while walking, or do you keep it in your pocket?' Questions like these enabled me to understand how users engaged with their devices and what kinds of action possibilities self-quantification offers. These questions became the starting point of my analysis; the mundane action possibilities led me to choose affordance theory as the analytical lens for this thesis. The study adopted an emerging design instead of maintaining a fixed number of interviews and interactions. It engaged in an iterative process of data generation, analysis and interpretation, which led the research's focus to emerge naturally. Iteration, furthermore, helped in the selection of participants and emergent themes. It also refined ideas that enabled in-depth exploration of the subject at hand. Data generation was concluded once theoretical saturation was reached; at this point, acquiring more data would not have drastically changed my interpretations. In the next section, I will detail the process of generating, analysing and interpreting data.

3.4.3. Participant Recruitment

This study explores consumers' self-quantification practices, the impact of technological mediation, how consumers react to quantification, and the numbers it produces. Because the study is based on postphenomenology and interpretative consumer research paradigms, it believes that reality exists even if one participant has experienced it. Therefore, there can be multiple realities in relation to the same phenomenon. The purpose of this research is not to develop a generalised theory of self-quantification by choosing a representative sample. Instead, it is to generate rich data through in-depth unstructured interviews. As elaborated in the research questions above, this study aimed not to examine isolated acts of self-quantification but to analyse the integration of multiple aspects that users undertake. There were no prior studies from which to derive the plan for participant recruitment. Therefore, I determined that participants should currently be self-tracking or quantifying some aspect of their lives, whether with or without technology. During the initial recruitment, most participants said that they only partook in limited tracking. During the interviews, however, they discussed various other quantification activities that they were undertaking.

Interestingly, regardless of whether they used technology-based or non-technology-based self-tracking, every participant integrated two or more quantifications. For example, diet tracking was supplemented with heart rate tracking and step counting. The study's only exclusionary criterion was that users must not be part of the QS movement. Almost no participants even knew that something like QS existed. They were, however, often part of local fitness groups, NHS-based app groups or their own small group of trackers. Participants were recruited through a poster circulated on social-media-based fitness groups; forums like Mumsnet; personal networks; and general social media sites, including Twitter, Facebook and Instagram. I also used the snowballing technique to recruit more participants through participants I had already interviewed. If a participant had a partner, I asked whether I could interview that person, too. I interviewed four couples. Three of these were independent interviews; one pair gave the interview together. There was a group of three friends who belonged to an informal 'weight loss'' group. Each monitored the others' MyFitnessPal, but they all had self-tracking environments. The screening was conducted through email exchanges, WhatsApp chats, and voice notes, allowing participants to provide information about their quantification practices. These materials helped me purposively choose the participants.

Table 1: List of participants (anonymised)

S.No	Pseudonym	Age Range	Occupation	Tracking practices	Apps and Devices Used
1.	Spark	30-35	Digital Marketing Manager	Steps, Fitness (Sports, Swimming, Running, Cycling), Heart rate, Weight, Finance	Apple Watch, Strava, MS Excel and Manual
2.	Ivy	30-35	Social Media Manager	Steps, Fitness (Cycling), Weight, Menstrual Cycle	Apple iPhone (Health App), Strava, Clue and Manual

3.	Jole	25-30	PhD Researcher	Steps, Fitness (Gym, running), Calorie counting, Menstrual cycle and Finance	Nike Training App (on Phone), MyFitnessPal, Clue and Microsoft Excel
4.	Cleon	25-30	Armed Forces (exact job anonymised for privacy)	Fitness (activities, gym and outdoor workouts), Heart Rate, Sleep, VO2 Max	Samsung Gear
5.	Rashelle	25-30	Professional athlete, Ex-Olympian and Personal trainer	Fitness (Running and Gym activities), Sports training for ultramarathon, Heart rate, VO2 Max	Garmin Forerunner 735XT
6.	Harla	20-25	Not working	Fitness (Steps, Running), Food purchase tracking, Mood Tracking and Menstrual Cycle	Apple iPhone (Health App), Yuka, Clue and manual Bullet Journal
7.	Hari and his wife	45-50	Cardiologist	Fitness (Steps, Sports), Location, Finance, Electricity (Solar Panels) and Screen time (for Kids),	Apple Watch, Bank App, Proprietary App for solar panels and Apple Analytics
8.	Dors	35-40	Lecturer	Steps, Fitness (Yoga and Exercises), Water intake, caffeine intake, Sleep, Heart Rate, Movies, Menstrual Cycle and Mood Tracking	Samsung Health App (Phone), Clue, Microsoft Excel and Dailyo

9.	Jasper	25-30	Engineer and Entrepreneur	Fitness (Running and Cycling), Sports tracking (Sailing), Heart rate and weight	Garmin watch and trackers, Velocitek & Go Pro, Strava and MS Excel
10.	Cinda	30-35	PhD Researcher	Fitness (Running and Gym), Finance, Menstrual Cycle, Weight and Waist size	Apple iPhone Health, Map my Tracks, M Cycles and manual tracking
11.	Wanda	35-40	High-School Teacher	Mood Tracking, Habit Tracking, Water Tracking and Student Activity tracking	Manual, Bullet Journals and Memrise
12.	Emer	35-40	Sales Manager	Calorie and Diet Tracking, Steps, Menstrual Cycle, Finance and Books	Second Nature, Samsung Health (Phone), Clue, Emma/Plum and Goodreads
13.	Azak	25-30	Bio-medical Scientist	Steps, Fitness (Gym and running), Menstrual Cycle, Screen time, Weight, Sleep and Calorie Tracking	Fitibit Charge HR2, Flo, Apple iPhone Health, Slimming World and Strava
14.	Elvett	25-30	Climate Scientist	Steps, Fitness (Gym), Sleep, Finance and Calorie Tracking	Fitbit Charge HR2, MS Excel & MyFitnessPal
15.	Golan	60+	Retired techie	Steps, Fitness (Outdoor workouts), Heart rate Sleep, Calorie Counting and Diet Tracking, Weight	Samsung Gear, MyFitnessPal & Manual

16.	Fara	30-35	PhD Researcher	Steps, Fitness (running, cycling), Menstrual Cycle, Weight, Calorie Tracking, Weight, Location & GPS, Sleep & Body Battery (proprietary Garmin number)	Garmin Vivoactive, Reflexio, MyFitnessPal, Strava, Google Timeline
17.	Gladia	25-30	Clinical Scientist - NHS	Steps, Fitness (Running), Calorie Tracking, Menstrual Cycle	Garmin Vivofit, MyFitnessPal & My Calendar
18.	Duby	30-35	Systems Engineer - Rail	Steps, Heart Rate, Sleep, Menstrual Cycle, Moods & Water	Fitbit, Clue and Manual
19.	Jaim	30-35	Software Engineer	Steps, Sports (Climbing), Hear Rate, Sleep, Finance, Media (Games), Screen Time	Fitbit, Monzo, Paraglider Pitch, Steam and Screen Time App
20.	Azver	25-30	Post Doc Researcher	Steps, Fitness (Running and Cycling), Heart rate & Sleep	VeryFitPro
21.	Vasilia	35-40	Data Scientist - NHS	Steps, Calorie Counting, Sleep, Fitness (Running), Location (Kids)	Fitbit, MyFitnessPal and FitBit Ace, Couch to 5K
22.	Callia	40-45	Mental Health Nurse	Steps, Calorie Counting, Menstrual Cycle, Locations, Outdoor Exercise	Fitbit, Slimming World, MC, Google Timeline

23.	Yate	35-40	Nurse	Steps, Calorie Tracking, Menstrual Cycle, Location Tracking	Samsung Health App, Samsung Gear, Google Timeline and MyFitnessPal
24	Bliss	25-30	Entrepreneur	Steps, Menstrual cycle, Fitness (Yoga), Calorie Counting, Meditation	Apple Watch, Clue, MyFitnessPal, Calm
25.	Rowan	60+	Family Business Owner	Steps, Calorie Counting, Weight, Sleep	Fitbit Versa
26.	Arcadia	20-25	UG Student	Steps, Fitness (running and outdoor workouts), Heart Rate, Calorie and Diet Tracking, Water Tracking	VeryFit Pro, Huawei Health App, MyFitnesspal, Surrey Moves
27.	Gaal	25-30	Sports Marketer	Steps, Fitness (Running & gym), Screen Time, Sleep	Garmin, Sleep Cycle, ScreenTime App & Strava
28.	Azura	35-40	Archeologist	Steps, Habit Tracking, Water Intake, Fitness (Running)	VeryFitPro and Samsung App, Habitica, Plant Nanny
29.	Gia	20-25	PG Student	Fitness (Running), Calorie tracking, Weight, Sleep	Huawei Fitness band, MyFitnessPal, Strava
30.	Veena	50-55	Restaurateur	Steps, Sleep, Weight	Apple Watch
31.	Bayta	35-40	New Mother	Steps, Sleep, Weight, Child tracking	Apple Watch, Huckleberry

32.	Mari	20-25	Care Assistant	Steps, Menstrual Cycle, Mood Tracking	Samsung Health App, Manual and Clue
33.	Amai	35-40	Librarian	Habits, Moods, Weight, Menstrual Cycle	Journals and Diaries

Table 2: List of apps investigated

Tracking Practice	Devices/Apps Investigated (Secondary Sources and Investigated by downloading the app)
Steps	Apple Watch, Garmin, Fitbit, Apple Health App, Samsung Health App, Huawei Health App, Surrey Moves
Calorie Tracking	MyFitnessPal, Second Nature
Habit Tracking	Habitica
Menstrual Cycle Tracking	Clue, Flo
Fitness Tracking	Apple Watch, Garmin, Fitbit, Apple Health App, Samsung Health App, Nike App, Huwaei Health App
Heart Rate	Apple Health, Garmin
Sleep	Apple Watch, Garmin, Sleep cycle
Location Tracking	Google Timeline
Water Intake	Plant Nanny
Mood Tracking	Dailyo

I recruited and interviewed 33 participants from the UK. My goal was to choose participants exclusively from the UK because it would ensure that participants' societal conditions were similar. Some apps are available only in the UK, and also certain self-tracking and quantification practices are linked to health; the NHS suggests apps and practices for individuals to use. Consequently, some participants began self-tracking after their GPs asked them to do so. Apart from the above conditions, no other exclusionary criteria were used. Participants spanned age groups (from 20–65 years old), family status (single, married, partnered, with children and without children), an education level (from high school to PhD) and occupation (full-time and part-time students, managerial, self-employed, part-time employed, health care professionals and even a past Olympian). The study was not designed to be comparative in any form, so there was no care taken to recruit specific genders or professions. Although I sought to study everyday practices rather than the behaviour of active data valorisers with extensive analytic habits, I did not make this an exclusionary criterion. One of the 33 participants had extensive analytic practice – he monitored his heart rate – but I only used the data that he generated through everyday cycling and running.

Although self-tracking involves digital technology, I did not create a demarcation with respect to IT usage. One subject that the interviews explored was how users traverse digital technology. Two participants used limited digital technology or none at all, but they maintained extensive manual quantification using journals. Other participants described a wide range of self-quantification activities, including step counting, heart rate tracking, menstrual tracking, calorie tracking, financial tracking, mood journaling, alcohol tracking, car mileage and speed tracking, habit tracking, water intake, movie tracking and even daily photograph tracking. Despite this wide variety of tracking practices, I discovered common themes during the data generation and analysis stage.

3.4.4. Data Generation: Human, Device and Environment

Each interview lasted 1–2.5 hours. The participants discussed various aspects of their self-quantification practices, lifeworlds, thoughts about numbers and quantification in general. In total, I accumulated 60 hours of interview data from 33 participants. Unfortunately, not every participant accepted my request for a second interview. Due to the COVID-19 pandemic, some were unable to accommodate me.

During the first part of each interview, participants usually discussed the various quantification activities they undertook through devices, apps and manuals. Some recalled all the quantification that they had engaged in, throughout their lives. The interviews were not only about their experiences; participants were also prompted to talk about how they undertake quantification. For example, one participant was counting her steps. She was encouraged to explain how she uses the quantification device, where she walks and what kind of app settings she uses. These questions allowed her to share her experience of the practice and information regarding her device and her environment. Once participants described what they did, they usually moved on to the next question. Nonetheless, I did not interrupt them during the flow. I later asked questions such as, ‘Can you elaborate on the specific quantification?’ or ‘Can you talk more about the privacy issue that you mentioned?’. I also used a considerable amount of nonverbal cues because the interviews were conducted via Microsoft Teams. Because cross-talking affected the transcription process, I used more nonverbal cues in the later interviews. As mentioned earlier, all interviews took place online. Therefore, it was impossible for me to track how participants used the devices in person. Nevertheless, I asked them about the process of using their devices. One participant had hers on a charge while she talked to me. She said it was her idle time; she was recharging her fitness tracker because she was sitting at her work table at home. Some users showed their apps and devices on the screen. The active data valorising participant shared his analytic system on Strava. Other participants showed me their social media posts. All of these became part of my data. I used these observations to supplement each participant's narrative. Doing so helped me analyse how they built their self-quantification environments.

After completing the interviews, I transcribed the video recordings verbatim and added my supplementary notes. Based on the transcripts, I collected data about the apps. For example, one participant talked about Plant Nanny, an app that uses a virtual plant to track water intake. The participant discussed the aesthetics of the app and the plant. I collected pictures of Plant Nanny as a form of supplemental data. Similarly, several female participants talked about the prediction of their menstrual cycles. I collected articles published by the menstrual tracking app company, which discussed the question of accuracy. I also traced the authorities to which participants responded. For example, one participant was a student who was tracking her steps with an app provided by her student union. Although she was tracking her steps through the app, she was responding to the student union and to university authorities, who provided her with perks. The tracking was possible only because I tracked the origin of the apps and the various modalities that they adopted.

Because the data generation process was iterative, I transcribed the interviews and analysed the broader themes that emerged from them. If I conducted a second interview with a participant, I would begin with a simple question about what had changed since we last spoke, then move on to discuss specific aspects that I wanted them to elaborate on. The interviews were still unstructured, but we discussed broader themes in depth. Certain interviews also informed others. For example, one of the earlier interviews considered the difference between wearing a manual watch and a fitness tracker. I began to enquire about this specific issue when I spoke with users who wore watches. One participant wore two watches on either hand because she had a sentimental attachment to a manual device. My interviews also dealt with the minute details of certain processes. For example, I asked participants when they charge their devices or what they do first after waking up. Although these questions concerned small details, they enabled me to create a picture of the environment in which each user was operating. For example, one participant told me that the first thing she does when her menstrual cycle begins is not to get a sanitary napkin or some medicine but rather to record it. If users did not broach the broader issue of what they felt about gathering numbers, I prompted them by asking what they thought about quantification and the numbers it produces. This question enabled me to understand their views about broader quantification practices, big data and the imposition of numbers.

As a whole, the interviews generated data about users' experiences and their devices. They enabled me to understand the relationship between humans and technology and the broader social impact of quantification practices.

3.4.5. Analysis and Interpretation

In interpretivist consumer research, the choice of methodology and the process of analysis and interpretation have always been subject to discussion due to the creative mix of methodologies researchers use (Goulding, 1999). Goulding (1999) argued that an account of one's methodology should begin with one's research philosophy and that one's choice of analytic technique should be informed by the same. To analyse the interviews, I followed the process outlined by Colaizzi (1978) and Thompson (1997). First, I read the complete transcripts and assimilated the ideas to understand them. Second, I extracted significant quotes and identified critical statements related to the subject of the study. Third, I interpreted the meaning of the interviews and developed a cluster of themes around them. There were multiple themes emerged during this process. Finally, I chose the dominant meaning to create a detailed description of the study. I observed that the devices offered multiple stabilities and that users perceived these stabilities based on action possibilities. I clustered the stabilities into affordances and found that users actualised these affordances in different ways. Through the actualisations, I theorised the phenomenon of self-quantification. I identified the stabilities by analysing non-human actors and derived the actualisations from users' experiences.

Goulding (2005) observes that phenomenologists (in this post-phenomenologists) are not theorists in a strict sense. Rather, they connect existing theories with data through constant reflection, producing alternative interpretations. After creating a coherent narrative, I linked it to the theoretical underpinnings that I discussed in the literature review (Chapter 2). The process of analysis and interpretation was iterative. As I switched between stages, I immersed myself in narrative ideas and theorised based on my reflections on the data.

3.4.6. Ethical Considerations

I conducted my research under the ethical code prescribed by the University of Reading. Because I had to change my research method due to the COVID-19 pandemic (see impact statement), I drafted two different ethics applications and received approval. After the initial screening, I sent participants the consent form and participant information sheet. Participants sent their consent via email. I also explicitly asked for consent at the beginning of every interview. The participants were informed that the interviews would be recorded and used only for the context of this research project.

The interviews were conducted over video calls, but I always ensured that participants were in a comfortable place to talk. We mutually agreed on the timing of each interview. Due to the lockdown, the participants gave their interviews from their homes, which made it easy to ensure their comfort. After the interviews, I debriefed the participants, assured them that the interview had no hidden criteria or agenda, reminded them that all interviews were unstructured and explained other matters if they were new to the unstructured interviewing technique. This process helped participants understand the purpose of the interview and the prompts that I made. I also explained that no two interviews would be the same. Anonymity was assured to encourage participants to share their information freely. All data were anonymised. Any identifiable data were left out of the final analysis. I used pseudonyms (courtesy of Isaac Asimov) in the participant descriptions. To ensure data protection, all interviews were conducted through Microsoft Teams, which was a part of the University of Reading's servers. Interview recordings were auto-uploaded to a private, password-protected Microsoft Stream account that was part of the university's data servers. No interview was downloaded to a local computer. All videos were accessed through a OneDrive account provided by the university. Through this process, I ensured complete data security and the protection of participant information. Because the self-quantification paradigm is inherently linked to the health paradigm, participants shared some of their health data, including heart rate, weight and ailments (though I did not explicitly ask about them). Nonetheless, data that might identify the participants were not used in the final analysis. Any data relevant to self-quantification practices were used anonymously. Steps were taken to ensure that information did not directly identify any participant.

4. Introduction to Findings

This chapter introduces certain concepts that emerged during the interviews to contextualise the findings and discussion section. These concepts contrast with existing studies on self-tracking. This chapter explains the use of terms like 'tracking' and 'quantification' and the way in which users construct a self-tracking environment.

4.1. Self-Tracking and Self-Quantification

In the context of self-quantification, the terms 'tracking' and 'quantification' are used interchangeably. The literature discussed in the previous sections has defined self-quantification as the result of either self-tracking or quantifying any type of physiological, behavioural or environmental information (Swan, 2013). There is, however, a slight difference between tracking and quantification. Tracking can be defined as recording information about a specific practice (Lupton, 2014c). That practice becomes an act of quantification only when it is '*measured'* and '*compared'* (Espeland and Stevens, 2008). Practices are undertaken either manually or with the help of digital technologies.

The interview participants commonly used the term 'tracking' to express the various aspects of self-tracking and quantification. They did not explicitly mention the differences between tracking and quantification; instead, the terms were used alternatively in the interviews. This shows the muddling of terms in the market, as it is pretty common for companies to use the terms alternatively. 'Tracker' is a common word for fitness trackers, smart watches and apps on mobile phones. This standardisation shows that quantification has become so synonymous that it is no longer seen as a different practice from tracking. The muddling of two practices and consumer perception shows that the consumers cannot track without quantifying an aspect of it. Quantification has become so habitual in our lives, and the neoliberal society has imposed various numbers on the consumers that it is impossible to ascertain the value of something without quantifying it.

4.2. Wearable Devices and Mobile Phones

The participants used a range and combination of devices to track and quantify themselves. Wearable tracking devices are worn on the body and include biosensors – for example, fitness trackers, smart watches and smart shoes or t-shirts (Lupton, 2019). Fitness trackers are wearable devices that enable step counting, activity tracking, heart rate tracking and calorie tracking. Smartwatches do more than track fitness measurements; they call, send text messages and make Near-Field Communication (NFC) payments (Jin et al., 2022). The gap between fitness trackers and smartwatches is closing due to the proliferation of low-cost devices on the market. Both kinds of devices have their own accompanying apps or connect to a common app provided by an ecosystem. The Apple ecosystem has Apple Health, for example. Google has Google Fit, and Fitbit has its own free app and a premium service that provides comprehensive data analysis tools. The devices can be used on their own, but users download and sync data in response to companies' data valorisation promises. Some participants termed their device a 'Fitbit' although they were using another brand of fitness tracker, and it showed that Fitbit has become synonymous with fitness trackers. But the users who had a smartwatch mentioned it as a 'watch' or 'tracker'. Spark, a digital marketing manager in his mid-30s, started tracking the various aspects of his life when his girlfriend bought him an Apple Watch as a gift. When I inquired about how he starts each day, he said the first thing he likes to see is the watch. He even said that he feels naked when he does not wear it:

> *So, the first thing is, like, I'm not wearing my watch while I'm sleeping. So, the first thing that I'm gonna do in the morning is, like, maybe have a big glass of water and put on my watch [...] I feel a bit – how can I put it? When I'm not wearing my watch, I feel a bit naked. Like, I have to put my watch on second. It can track these calories [spent].*

The word naked shows that Spark is not ready for the day without wearing the Apple Watch. He gets a sense of control simply by wearing the watch in the morning. Spark is a manager in a digital marketing agency, and he deals with numbers every day. The numbers that he might be able to control or not control. But, the Apple watch and the environment around the watch

are something that he can control. If he was not tracking in his sleep, the first thing that Spark did in the morning was put on his fitness tracker. He compared the importance of a smartwatch to that of clothing or glasses. This comparison shows that the device has become part of his extended self and that the existence of his watch is tacit. He also talked about manual watches and how he would have bought a chronograph if he had not received the Apple Watch as a gift:

> *Again, if I want to buy a watch, I will buy different watch. Maybe not an electronic one but a more manual. Yeah, yeah, one with a chronograph or something. Yeah. But I'll tell you what, these kinds of watches, like, the tracking device are interesting.*

Although some participants had a manual watch, they used it only for special occasions and events. In contrast, they consistently wore a smartwatch or a fitness tracker, which had become part of their everyday lives. Apart from the generic apps that each ecosystem provides, participants also used specific apps for specific tracking needs. Some used a mobile device as their primary tracker. They carried a mobile phone on hand while tracking activities like running, or they wore a strap to tie the phone to their bodies. With few exceptions, female participants tracked their menstrual cycles on a specific app even if they owned a fitness tracker or smartwatch) due to continuity, privacy and similarities to their old tracking practice (calendar-like apps). Although the use of mobile phones and allied apps is less tacit than the wearable trackers, the participants consistently carry their phones not just for tracking but also for other functions. In the everyday life of self-tracking consumers, they use a combination of devices and practices, and studying them separately discounts the multitude and complexity of the tracking. Participants have different apps and devices to track the various things in their life. They also demarcate the boundaries of those devices. The limits are what I term self-tracking environments.

4.3. Self-tracking environment

Self-tracking activities are assumed to be separate practices without interconnection with each other. This can be seen in how self-tracking and self-quantification were studied in the past as researchers studied them in isolation (Li et al., 2011; Rooksby et al., 2014 ; Attig and Franke, 2022). The findings in this research show that the participants have multiple tracking, and even the devices are equipped to quantify different aspects of oneself. The self-tracking aspects are interconnected, and the numbers produced by one impact another. For example, the sleep score is based on heart rate number, and the step counting impacts the calorie spent by the user. But each self-tracking act has distinct properties and can operate in separate self-tracking environments. They can be self-contained or integrated with other tracking activities of the user. For example, water intake tracking can be part of calorie tracking. Users can have a separate app that tracks and quantifies water intake without integrating it into any other app. The self-tracking users create their own self-tracking environments with or without empirical goals. One participant, Bliss, was an entrepreneur in her early 30s. She had multiple tracking activities that she adopted, abandoned and readopted based on the needs of each situation, like a weight loss regime or being competitive with her boyfriend. She remembered a time when she was meticulously tracking her calories with the specific goal of losing weight. Her calorie tracking had a specific goal, but simultaneously, she was counting her steps with a different goal of having a competition with her boyfriend.

> *It was a time that I was very much worried and obsessed with, with my weight and my body age and, you know, how many calories I was always consuming per day. And, for me, it was fascinating to see that there was this app (Myfitnesspal) that I could easily, you know, scan the barcode, especially here in the UK. It gave me a sense of control over what I was consuming...I think that I started using that (step counting) when I finished my Master's here, and I had a bit of time to explore London. And at the time, I had a boyfriend with whom I was very competitive in terms of who walked more. And we used that too, in a way, brag about how much we walked when we were exploring the city. And that's what we're trying to do, to be honest.*

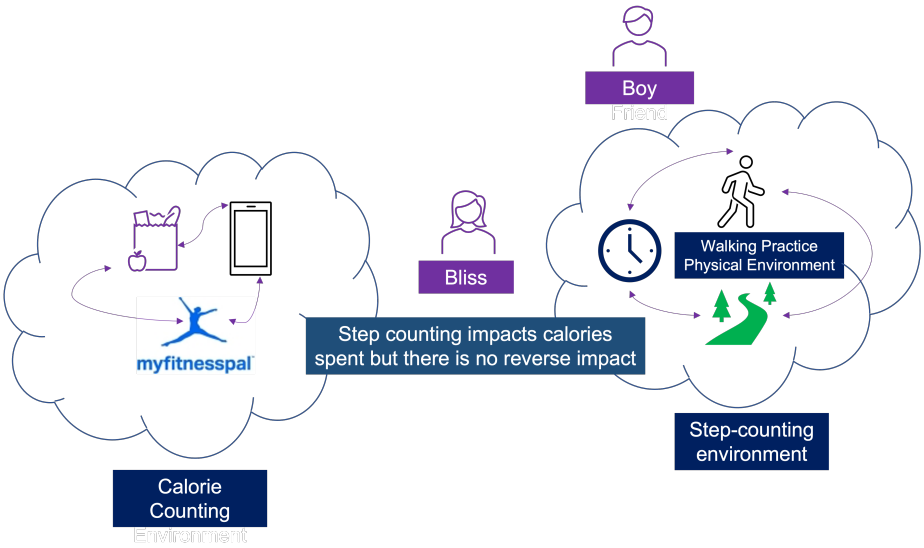

Figure 4: Self-Tracking environment - Example

Self-tracking apps and devices are fragmented, but ecosystems like Apple (Health) and Google (Fit) have comprehensive systems that link all the data from different apps and trackers to provide an integrated look at the data. Garmin's Body Battery is one system that gives a single number connecting multiple tracking numbers. The participants also use Strava, which gathers data from different sources to comprehensively analyse the self-tracking data. The apps, devices and tracking form part of the self-tracking environment constructed by the users. The users create a self-tracking environment with a specific goal in mind. But the goal need not be a rational idea of self-improvement or changing behaviours. Instead, the goal could be playful (like a competition with the boyfriend). So the self-tracking environment is a controllable environment that they have constructed with the specific self-quantification aspect. The construction of the self-tracking environment is an act of resistance to the numbers imposed on the user. They tend to circumvent these numbers by creating an environment around them that might not be rational. As the data revealed that the users are co-constructing the self-quantification practices with the self-tracking environment and not just the device, it was appropriate to examine the phenomenon using affordance theory.

4.4. Findings Section Structure

I have structured the findings section into two parts. In the first part, I identify four affordances that arise between humans and their self-tracking environments. The affordances are not features of the artefact or the environment but the relational property created through the human's interaction with the device and the environment. For each affordance, I elaborate on how it surfaces between the user and the device, how the user actualises that affordance, how the actualised affordances give the user a sense of control over the self-tracking practice, and the numbers produced by the practice and the tracked activity. The affordances are neutral, so they cannot be construed as resistances. As Michael and Still (1992) posit, they can become the resources for resistance but not resistance itself. The actualisation of the affordances only can manifest into resistance. So, in the first part, I discuss only the affordances, then show how affordance actualisations form part of the resistances.

In the second part of the findings, I elaborate on how the perception of control manifests as tacit micro-resistances exhibited by the users against the market forces and authorities, unpacking those micro-resistances through the lens of De Certeau's tactics of the weak against the strategies of the strong. I also explain how numbers and quantification are the centres of the practices and affordances that create these micro-resistances.

5. Findings

5.1. Affordances of self-tracking and self-quantification

In the previous section, I discussed the difference between self-tracking and quantification and how these practices are extensions of existing practices. Still, digital technology exposes data that self-trackers were unaware of before, which changes the way self-trackers approach the data, device and practice. In this section, I elaborate on the affordances of the self-tracking environment, how the users perceive them and how they actualise them. Self-tracking and self-quantification practices involve three important actors – the human, the technology and the environment in which the human-technology assemblage operates. Humans and technology are engaged as an assemblage in practice, but the operation of this assemblage and the influence of technology on humans have not been thoroughly researched.

I apply affordance theory (Gibson, 1977; Chemero, 2003; Davis and Chouinard, 2016) to unpack the relations between technology, humans and the environment. One issue with the analytical use of the theory is the ambiguity of identifying affordance. The fundamental mistake a researcher might make while identifying a feature of the device as affordance. Only relational property between the user and the environment can be considered an affordance (Volkoff and Strong, 2017). Affordances are not the user's mental representations of what a device can do. Davis and Chouinard (2016) have provided three essential conditions for affordances – perception, dexterity, and cultural and institutional legitimacy. Perception is the subject's awareness of affordance and its functions, while dexterity is the skill and ability needed to undertake the function. The affordance also needs social support to execute the function, which is categorised as cultural and institutional legitimacy (Davis and Chouinard, 2016). I use the same conditions to confirm each affordance. The third issue while analysing affordance is misconstruing the action taken by the user based on the affordance as the affordance itself. For example, if a chair affords standing on it, a user can stand on it, dance or grab something from a height.

The standing is the affordance, and the subsequent action is not. The actions and decisions taken by the actor through the technology to achieve immediate concrete outcomes are termed affordance actualisation (Strong et al., 2014). Therefore, I explain how each affordance is perceived as an affordance, how it impacts the user, how users actualise the affordance and the effects of actualisation.

5.1.1. Counting

Counting is the first affordance I identified as part of the self-tracking environment. A user can afford different types of counting during self-quantification of specific aspects. Each tracking environment might entail some form of counting, such as steps or calorie counting. The devices, whether mobile or smartwatches have technologies like accelerometers and gyroscopes to identify the user's movement and record the number of steps. After recording, it provides the number of steps on a real-time basis. The device can count the steps only if the user wears the smartwatch or carries their mobile phone when they walk or run. With respect to counting food calories, the user has to scan the barcode of the package, and the app on the mobile phone identifies the food item.

The user must choose the specific food item that they want to count the calories for. The user is much more involved in calorie counting since sometimes they have to guess the calories or type of food because most apps rely on user-generated content. The most popular calorie-tracking app, MyFitnessPal, prevalent during my interviews, uses market data and user-generated content (Maringer et al., 2019). Counting calories or steps can be afforded by the user through the device only when the user and device come together. Calorie counting and the granularity of nutrients are new quantification abilities that are possible because of technology. Gia had the most elaborate calorie-counting environment among the participants I interviewed. A young woman in her mid-20s, she elaborated on her two primary tracking environments. One is counting her steps through Strava and Wii Fit watch, and the second is counting her calories through MyFitnessPal.

Well, usually, it's just a case of when I go on a run, I have, like, my running armband with my phone. So, I set Strava on my watch. And sometimes, like, because it's just GPS problems, one of them will track and one of them won't. So, it's mostly just so I have a backup. I guess I use them for slightly different purposes as well because Strava provides more in-depth data on my actual running. It gives me a nice map of where I've run, and it's more of a sharing platform as well. But my watch, I guess, because it can read my heart rate and stuff like that. It also tells me about calories and stuff like that….like two years ago, I've been quite good, but I think it beeped, and it vibrated, and it stopped tracking my run. And it was like, "Stop. Stop what you're doing". Yeah, it wasn't great. It wasn't even a really long run, but I think it was just quite hilly.

For an affordance to exist, the user should first perceive that the device and the environment can afford it, as it is a relational property between the user and the environment. The fitness tracker requests that Gia count, but she also uses the smartphone to count her steps. The smartphone has features for counting, but it is the prerogative of the user using the device to count. The smartphone's primary feature is not to count the steps, but Gia perceives that the device can count her steps. At the same time, she does not trust either of the devices to count them due to GPS issues. The physical and technological environment enables and constrains counting. Gia wanted to be certain about the numbers she was tracking, so she adopted the practice of strapping her phone to her hand with an armband. In order to count, the device must always be held in her hand, which limits her speed, so the armband becomes an extra appendage in the body to hold the phone. When strapped onto the arm, the phone is on equal footing with the smartwatch.

Second, the user should have the dexterity to undertake the act of counting. Gia has used two devices to count and produce a more detailed analysis through Strava. The Strava analysis provides a detailed account of her runs. Again, the device requests that she conduct the analysis through the app accompanying the device. Gia has chosen to ignore it and uses another app to obtain a detailed analysis. Gia has constructed a self-tracking environment of

step counting through two devices with two different self-quantification action possibilities. The mobile phone and fitness watch act as two extensions of herself. It can be observed from the way she thought the watch had alerted her to stop running when her heart rate increased beyond a certain level. The device refused to count the steps because the device had decided that the user had an abnormal heart rate. Gia actualised certainty of moving, her spending of calories, heart rate calculations and, in turn, the state of her physical health through counting. The certainty is perceived since the data she derived from the practice were not actual health stats but only provided a glimpse. Gia stopped running because the device stopped counting and not because her heart rate was abnormal. She still thought she was fine that day but stopped because the device told her to do so. Therefore, the device brought certainty through the numbers that it produced.

Gia also afforded counting through her meticulous calorie counting.

> *So, there have been a few different steps in my life. I hardly ever use it anymore. I used it when I was losing weight. So, I put on quite a lot of weight. And I was using it to lose weight. And I really struggled with it for a while; I had to get used to remembering to put things in, and you know, when you just pour a load of pasta in a pot, and then you're like, I have no idea how much pasta, and so I didn't want to put any in. So, it was a lot of getting used to weighing things out and measuring everything I was eating. But once I got in the habit, it was okay. And then, I did that sort of without really changing what I was doing for maybe two or three weeks, just to see where I was at. And then I started making adjustments after saying, "Okay, well, clearly, portions of rice are massive. So, I need to calm down on that or, I mean, you know, half a packet of biscuits today". I should stop doing that. And then it kind of got to the point where I've been tracking for so long now that I sort of do it in my head. Like, I know how many calories are in a slice of bread.*

Again, here it can be seen how Gia perceived that the app counts the calories of each ingredient in her food, which is possible only if the user intends to afford the division of the

calorific value of each ingredient. Second, Gia also specified that she must learn how to use and change how she cooks her food. The app requested that she count the calories by providing the input options, and Gia acknowledged the request by counting her calories through the app.

The affordance of counting changed the way Gia cooked her food since she now measures and adapts to the calories instead of going with the original recipe. It impacted not only her calorie-tracking activity but also the way she consumed food. Through counting, Gia actualised the certainty of the calorie quantification, the kind of food she consumes and her body. Counting calories helped Gia ascertain that her food has a specific calorific value. She perceived that she was taking in the number of calories in comparison to the target calorie that the app had decided for her. Overall, the counting made her certain about her body because she was counting calories to lose weight. The certainty became so ingrained and tacit that she could count in her head without the help of a measuring scale. Gia also actualised planning through the affordance of counting.

> *I have on occasion because I also got into the habit of logging things before I ate them rather than after, which was quite a big thing...I found it especially difficult to order curry because I had a huge curry phase. I'm pretty sure the delivery guy knew my name by the end of the month. We found this one really good place that did a really good mushroom masala, and I was obsessed with it every week. So, it's like when you want a Pizza Hut or something; you know how many calories each slice is. It's really tricky (to find the calories of a curry). It's impossible. I think I ended up stopping the Indian takeaways, but I was like, this is not conducive to weight loss. If I had any idea what's in this, I can't track it, and I'm pretty sure it's something like 6,000 calories in one meal.*

Gia plans her daily food intake based on the counter she uses through MyFitnessPal. She logs in before eating, which discourages her from eating certain things because she cannot count those numbers. She explained how she stopped ordering curry because she could not count

the calories; at the same time, she could count the calories of a pizza slice because the restaurants provided calorific information. The affordance of counting from MyFitnessPal competed with the food delivery app, and eventually, MyFitnessPal won – not because of a desire for healthy eating but because Gia could not count the calories. Gia suppressed her urge to order something she loved and instead ordered something she could count. The certainty and planning give Gia a sense of control over her body.

> *I guess it held me accountable. It definitely held me accountable. Because it's very easy to lie to yourself and say, "Oh, I didn't eat that much, or I didn't drink that much". But once you're actually tracking it, you can see the numbers in front of you. I did actually eat a whole pizza (in the past). That was me. I'm the person who did that. And it was like, I did have to do some weird, like, mega reduction in calories and then a mega rise in calories. It was like some weird thing that's meant to, like, sort your metabolism out again. I had to do something like that when I hit the plateau. And I was like, I'm doing everything right. I'm doing everything I've been doing, and now it has stopped working. But then it also led to me doing some more research, and I learnt now that this is something that happens when people lose weight. They generally hit a plateau. And that's how you fix it. And then when the numbers start going down again, you go okay, that's good. It's working. Carry on.*

Gia used the word “accountable” when it came to her relationship with the app. A person is accountable when they see something as a responsibility or an obligation and are accountable to authority. For example, citizens are accountable to the government for paying taxes. MyFitnessPal acts as the authority that calculates the calories that Gia can eat everyday. MyFitnessPal calculates an ideal calorie spend based on gender, weight and height and it also invites Gia to update her weight at regular intervals (OptimistMinds, 2023) MyFitnessPal controls the way Gia would intake calories on a daily basis. Gia sees MyFitnesspal as an authority on managing her calorie intake, and it stops her from lying to herself about the food she eats. The authority provides her with the number of calories she can consume daily, and she sticks to those numbers to achieve her goals. She believes that

sticking to the numbers allows her to plan and be certain. The number of calories counted gave her a form of control, and she became flustered when she lost control after the graph hit the plateau. She made changes to break the logjam and regained control again. Nevertheless, the control is only perceived; Gia opened up about what made her feel accountable and how she had planned her life around these numbers. She said she was not angry at a specific person but at the market in general.

> *I don't think the anger was directed at, I don't really know, just the universe. I guess. Just that general. That general anger...Why isn't this working? Why did I put on weight in the first place? Why is the scale not telling me what I want it to tell me? It's just that general anger. It wasn't at the tracking. I did get annoyed a couple of times when, you know, everyone just wants to eat their food and I'm like, 'Okay, wait, I've got like, measure this out' or I've been at work all day and studying and stuff. And I just, I really just want to eat an endless amount of pasta.*

Although she specified that she felt a general sense of anger, her follow-up statements provided insights into where her anger was directed. MyFitnessPal consistently tells her that she is consuming way too much calories if she eats a pasta or a pizza. When investigating the app, it can be seen that there are multiple calorie levels that are given for pasta (210 - 440 for a 2 Oz portion). Gia has to measure everything to keep her calorie counting at a specific level. MyFitnessPal persuades to record the calorie count and the remaining calories that an user can spend through notifications. At the same time, the delivery apps are providing notifications with discounts that might persuade her to order. Her anger was directed at the marketplace, which wanted her to order and devour an entire pizza. At the same time, it also wants her to adhere to unrealistic beauty standards constructed by the same marketplace. Corporations and marketplace have consistently defined the ideal beauty standards and ideal weight, shapes of women over the years (Johnston and Taylor, 2008). Now, the neoliberal marketplace uses feminist ideals to define the body standards for women. Neoliberal market forces women to manage their weight in comparison to the ideal standards and the market provides these apps to self-track and self-quantify (Elias and Gill, 2018). Furthermore, it has devised a new way to track calories so that they can lose weight. The market has also

invented devices to count the number of steps and devised programs like Couch to 5K (which Gia was doing) to help shed calories. The market still wants Gia to order the pizza or eat that full bowl of pasta, but it wants her to track her food intake using the app. Gia confirmed that it was not about healthy eating but tracking calories. The market does not help Gia develop healthy eating, but it wants her to manage her weight through counting. She feels angry and guilty for gaining weight, and at the same time, she wants to become responsible for her self-improvement and adhere to their standards.

Counting calories is a way to impose those rules on the self-tracking user. MyFitnessPal and similar calorie counting apps use the basal metabolic rate (BMR) based on height, weight, age and activity to calculate the number of calories. However, researchers have found that this method is flawed and does not provide an accurate level of calories (Lim, 2005). MyFitnessPal provides an inaccurate number yet holds authority over calorie-counting consumers like Gia. Gia feels both accountable for and angry about that number. She has started using the same numbers as a way to take control of her life through planning and certainty. The anger transforms into control, which she then uses to resist the impositions of the market. Numbers become a negotiating factor in the practice. Gia has resisted the numbers by trying to avoid them and making the calculations tacit and inherent to the practice itself. She carefully manoeuvres the counting and switches to a different number than the calories given by the app. She has started tracking her weight at regular intervals to counter the calorie-counting numbers.

> *I weigh myself at least once a week, if not most days, just to keep an eye on things because it was not weighing myself that made me put on those 15 kilos in the first place. So I keep regular track of my weight. And I log that in MyFitnessPal as well. So, if it stays around the same, I won't log it. And I won't give too much concern to what I'm eating because clearly, I'm doing okay. It's when it starts to creep up a bit. And if, over the course of maybe two weeks, it's gone up and not dropped again, then I'll start tracking again for a couple of days, and if I'm going a bit crazy with my source or something, I will calm it down again.*

Her method of avoiding the calorie numbers is to do mental math instead of counting calories, and she also changes the tracking period to avoid tracking calories. She has replaced consistent tracking with occasional counting so that the numbers do not control her, and she takes control by being certain about her weight. Whenever she feels she is losing control, Gia regains it through the certainty provided by the counting. The act of consumption becomes an act of resistance, which is clever manoeuvring on the user's part. There are multiple numbers that Gia was tracking initially (calories, weight, heart rate and running stats), and at the same time, the market has imposed numbers on her (ideal weight, BMI). Through the affordance of counting, she actualises certainty and achieves control through various other numbers she produces. The calorie counting done by the app is moved to mental math as it becomes habitual for her. She switches the tracking period of her weight. She continues to run and is certain about the numbers produced by running, and the running environment gives her much more control of her life. Gia carefully manoeuvres the numbers she is producing to counter the numbers imposed on her. The manoeuvring is a micro-tactic, as De Certeau posits.

The affordance of counting can also be seen in other self-tracking categories, and the users actualise it as certainty and planning. Dors is a single woman in her late 30s. She lives alone in the UK and talked about how she has to be conscious of her vital stats because of her health problems.

> *When I moved here (the town), I bought a new phone. And that was a Samsung S10. And that phone had a feature for tracking health. It's called Samsung Health. And initially, I didn't think much of it because my previous phones didn't have those features. And so, I didn't really think about it. But this time, actually, because it was really there on my phone, I started tracking. I tried the usual stuff.*

Dors started counting her steps because it was available on the phone. The device affords counting various things, including steps, menstrual cycle, activities and many more. Dors could perceive that the device could count steps for her. Dors also carries the phone while walking, which allows the device to count the steps, confirming the dexterity condition

needed to consider it an affordance. Counting has received institutional legitimacy from NHS since it widely promotes these apps and has its own Active 10 app that tracks and quantifies steps (NHS, n.d.). Without the device, she cannot accurately count the number of steps, activity time or many other aspects that the device allows her. The mobile device encouraged her to track and count various aspects. The mobile device also requested that Dors choose the unit of counting. Dors explained that the app provides the option for counting either the active time spent or the number of steps. It also gives the different aspects of the data like average pace, the outside temperature and many other aspects related to the walk.

> *It gives options for both, actually, so I can choose that I want to work out for 60 minutes every day. And during those 60 minutes, I can also choose what target I have for steps. So, for instance, if I have 6,000 steps and 60 minutes, it will tell me that I walked for 61 minutes, but I only managed 5,900 steps. What was my average pace? What was my highest pace? What was the weather like at that time? I mean, what was the environmental temperature at that point in time, blah, blah, blah...*

The language (*blah, blah, blah*) that Dors used about other aspects of the data (apart from counting steps or active time) showed that it did not matter to her much. Nevertheless, she specifically elaborated on how the counting differs based on where her mobile phone is located.

> *I might add that it depends on where I'm actually keeping the phone. If I'm keeping it in my hand, then it actually records only longer strides. And if it is just firmly in my pocket, then it's more realistic.*

The device here enables and constrains the counting based on its use. Dors understood this over a period of counting her steps rather than instantaneously upon first using the device for tracking. The device constrains the user when it comes to counting steps accurately. Although on the surface, it might seem that Dors was counting steps and active time spent, the counting actualised certainty about the various activities that she was undertaking for her health. She

claimed she was not a fitness-conscious person and that tracking did not change much about her, but she agreed that it made her track more.

> *I wouldn't say it made a very huge difference to my choices. The fact that I would be able to track it might make me want to track it more regularly.*

It also gives certainty about her health since she has a thyroid problem. Although she did not elaborate on her problem, there was an underlying assertion in her conversation that she needed to stay active because of her thyroid issue. She consistently brought it up during the interview and stated that it affects her food and activities. She also takes medication for the condition daily.

> *I had a very simple understanding, like, if I do it four times a week, and I do it for a month, I will be at a certain level of fitness, irrespective of what I eat, you know. If I were not doing it four times a week, if I were doing it three times a week, it would be different. And then what I am eating will also matter, more like an observational kind of a thing.*

Only specific thyroid issues have permanent treatment methods. Doctors and health authorities prescribe management through diet and exercise for most problems (Foundation, n.d.). Dors has been coping with her health problem for ten years. The counting did not drastically change her behaviour before and after tracking, but it did give certainty to the actions that she was taking. The numbers confirm that her activities work the way she wants them to.

Dors also tracked her moods through another app called Daylio, which was not connected to Samsung Health. Daylio is an emoji-driven mood journaling app. It has five emojis for five mood statuses (rad, happy, meh, sad and awful), and the user is allowed to choose one status for how they feel on that day. At the end of the week and month, it tallies the average mood and provides a set of numbers to the user. The user can also choose to write activities related to the mood and custom notes for the day.

It just tracks five emotions. What do you feel? And whatever you choose for that emotion, you have to choose the associated activities that happened that day, or there's an option for leaving a personal note as well – you know, what happened on Monday. It gives me the weekly analysis. But it gives me the quantified idea of, you know, what was my average mood for the week or, you know, which week was happier than another week and things like that.

Again, here the self-tracking environment affords the counting to the user. Although at a superficial level, it can be observed that Dors counts her steps and her mood, the counting actualises something else for her. The step counting actualises the certainty about her health, and the mood counting gives certainty to her feelings. However, the device does not improve her health, nor does it better her mood. It counts Dors' feelings and provides an average. Whether the user is happy or sad, it does not matter to the apps. Tracking their moods creates an illusion that users can change their mental health. Users buy into that idea, and as seen in Dors's case, she makes a note of associated activities and tries to go back and recreate them. She perceives that there is some kind of certainty of emotions in the uncertain world that she is living. This perception gives her a sense of control. It is the same with counting her steps. It provides certainty that she is moving enough and allow her to feel as if she is in control of her thyroid issues even though she is not. Dors started her mood tracking when she moved from marketing and joined a new job in sales. But unfortunately, people were entering and leaving her, which gave her uncertainty in life.

Everything was just going crazy. People were joining and leaving, and I didn't know. So every day, no matter what my mood or what the weather was, I just clicked a picture. And I would look back, and I still look back sometimes at those pictures to see what they said about me, my head, shape and my mood. Does it give away what was going on in my life? So I don't know if it kind of helps for what you're trying to see. That was a kind of weird photo journaling.

Along with her mood tracking, she also started taking a picture of herself every day for eight months to be certain about herself. The weird photo journaling (as she terms it) and her mood tracking were the most certain things in her life that enabled her to gain a sense of control. The market created uncertainty for her, as she did not know if she would lose her job like her colleagues, and the market also invented these apps to manage her moods through numbers. If Dors felt happy, on average, for more days in a month, she was certain about the mood of the month.

> *But, for instance, if certain days, I listened to a lot of music, or I had a lot of water, or if I did a good deed, so we can choose the activities we really want to put on it. So I'll put an activity for say, good deed, I did a good deed today. And if I did it over a lot of days, it's something that may correlate to me having felt positive that day or a day when gratefulness did not feel like an activity. But I've put something like that as a thing.*

She has also started manipulating the data to show that she is happy for most of the month. She has added gratefulness as an activity, even though it is not an option on the app. Nevertheless, being grateful for something helps her to feel happy. If that is the case, it is important for her to manipulate the data to show what she wants the apps to show. Dors uses the only thing she can control in her life (i.e. the self-tracking environment) to resist the neoliberal imposition that wants her to work hard and be productive in a sales job while living in a constant state of uncertainty of job loss and, at the same time, self-tracking to improve her moods. Dors was provided with an app to manage her average mood (number) rather than gain job security. When she only has the app, she starts manipulating herself to resist the forces that make her track her moods. Mood tracking and manipulation become acts of resistance. However, this resistance is not overt but tacit and becomes an inherent part of the tracking practice. While Dors is not explicitly resisting, she has created a habitual response to the uncertainties surrounding her life. Compared to Gia, Dors co-constructs a different set of self-tracking environments in her life world. Dors' account should be observed from a historical perspective. The mood tracking was in the past, and the step counting started recently. The step counting numbers provide her certainty about her health and body,

while mood counting gives certainty about her mind. Although mood counting was in the past, she revealed that she continued even now as she could control her feeling and average mood. When the average mood is happy, it informs her that she is in control, and when she achieves a set of step counting numbers, she feels in control of her health. But to ensure that she has an average happy mood counting, she manipulates the recording of her feelings. The clever manipulation to get certainty about her moods is yet another micro-tactic shown by the users.

Similar kinds of responses can be observed with Gia, who has created a habitual response of mental math to resist the numbers the app imposes on her. The resistance is not automatic, though. It is a response to the issues she cannot control outside the purview of self-tracking. Thus through the production of alternative numbers that is effectuated by the clever tactics of manipulation, the users resist the numbers that are imposed on them, which creates uncertainties. Counting is an affordance, and as elaborated, it is neutral. However, the actualisation of affordances and the numbers produced around them create micro-tactics of resistance. In this section, I have only highlighted the affordance perceived by the user and how they are actualised. I have also signposted how they form into micro-tactics of resistance. In the next part of the findings, I collate all the micro-resistances and how affordances are actualised by the users and the numbers produced around them.

5.1.2. Predicting

The second affordance I have identified in the self-tracking environment is predicting future events based on the provided data. There is confusion between the terms' prediction and forecasting. Although the terms are used interchangeably, there is a difference between them. Prediction can be defined as the estimation of the outcomes of unseen data, while forecasting is a form of prediction based on time-series data (Doring, 2018). Self-tracking, such as menstrual tracking, could be called forecasting because the prediction is based on time-series data. Still, some apps predict future outcomes without an extensive series of data. Furthermore, as I am discussing the influence of the market, the apps use the term "predicting" instead of forecasting (Johnson et al., 2018). Therefore, I use “predicting” as the umbrella term for estimating future events in the self-tracking environment in this section. Users can predict future outcomes while manually tracking a specific aspect. When it is a time series, the users can predict a broader timeline of events based on past data. The exact prediction of data can be observed in menstrual tracking, which has been historical. Ivy is in her early 30s and lives with her boyfriend in London. They have been living together for the past six years. I also interviewed her boyfriend, Spark. Ivy works as a digital marketing manager in a fashion company. She tracks her steps, cycling, weight and her menstrual cycle. She started tracking manually because her doctor asked her to. Menstrual tracking was the longest tracking and quantifying aspect that she had undertaken.

> *I started tracking it like I did when I was in school. Because I remember I went to the doctor one day, and they asked me, "Oh, when was your last period?". And I didn't really know the answer to that. When I started tracking, it was literally in my calendar. I would just open my phone. And at the time, I was, like, a uni student. I didn't really need to put anything else in my calendar, you know. And then the whole calendar was empty, and I just had, like, a little dot and the specific day. But then, I started to want to put more stuff in the calendar than just some period data. So there were, like, more dots. And I was too lazy to go, like, through everything.*

While tracking the phone calendar through the dots, she was not quantifying her period or predicting the next one. She needed to know the date of her last cycle because her doctor had asked for it. She was using manual tracking as a historical reading of her menstrual cycle. One of her friends suggested another app (which she did not remember), and as she did not like the user experience, she expanded the search and found Flo. She could use the manual input of data to predict the cycle, but the app affords the prediction. Technology becomes an important artefact for the affordance of prediction to exist, and the prediction can be afforded only with the app present in the environment.

> *And she was like, "Oh, I just track it on the app". And I was like, "Oh, I didn't even know that there's an app for that", which is weird. But yeah, and I asked her, "Why?" And she was like, "Yeah, yeah, I'll just do it on the app". And then I remembered I downloaded the app. I didn't like the UX design and experience within the app. So I was like, "No, scrap that. Now I will go back to my usual calendar". And then I was like, well, maybe I just need to search a little bit more for a more appropriate app for me. So I just did like digging, and then I found Flo.*

Ivy used the word "weird" because she did not think there could be an app for tracking her menstrual cycle. Like Ivy, the other women participants who tracked their menstrual cycle started with an app after an extensive search or after the app's functions were recommended by their friends. There is a strong aspect of sharing and belonging when it comes to tracking menstrual cycles. Additionally, the tracking demands much more involvement, because of the problems associated with the menstrual cycle. If a person misses a cycle, there are multiple possibilities, such as pregnancy, period complications or serious ailments. Ivy articulated the same, which was one of the reasons she started tracking her cycles, specifically with respect to her pain symptoms, as she experiences massive pain during her period.

> *Because, like, if I was missing some periods or something like that, maybe something was wrong. And I was like, I would like to test it or like, get tested about something that's, like, different. So that's how I start tracking it....You can set, like, specific things you can track, like your pills (contraceptive) and stuff and the duration. You can track pain symptoms, which for me is really important because I do have a lot of, like, pain issues.*

Ivy was more enthusiastic about the prediction that the app afforded her. Although, on the surface, prediction might seem like a feature of the app, the app cannot make predictions without the intervention of the user. First, the app can predict only if the user inputs the data for several months and if the inputted data is precise. The dexterity of the user to input and assess the correct data is essential for the prediction to work. Second, the user has to perceive that the app can predict their cycle.

> *When I started using the app, obviously, the first time I used it, it didn't have any data on it. So, what I did was I backtracked seven, I think, seven months because I wanted the predictor to work better. So I did the backtracking myself for like seven months when I first logged into the app. There was just, like, the first like seven months, so it can give me, like, good predictions.*

The perception of prediction from the user started even before the app was downloaded. The user understood they needed to provide specific data before the app could predict. The app also encouraged the user to provide more data when they started tracking in the app. The app predicts two important things for the user, which may have different effects based on the intention of the goal. One predicts the future menstruation cycles, and the second predicts the ovulation cycle. Although both are related, the user might perceive the two differently. The cultural and institutional legitimacy of these apps comes from the historical importance of menstrual tracking itself. Women have been tracking this bodily function through various means. Ivy was keener on the menstrual cycle prediction, and she actualised it in two different ways.

Like, now I plan, like, kind of my life based on that calendar. I plan when I go on holiday depending on our calendar. And, like, all these things, you know, it's more than tracking now. Yeah, it's more of a planner for me because obviously, like for a woman, it has lots of difference if you're on holiday, you know. So, it has changed my life completely. I do like a lot of long-distance trips and stuff, which you usually plan, like, six months in advance....So, I used the predictor for six months. And I'm like, "Okay, where should I go on holiday then?" And then just plan based on that.

Ivy, in this case, plans different things in her life based on the predictions that the device affords her. The device only predicts rather than overtly emphasise on the planning. Ivy perceives and actualises that she could plan her life through the predicted data. However, she suffers from significant pain, especially on the first day of her cycle, and she was hospitalised several times. She understands that she cannot take a pleasurable trip at the same time, so she tries to avoid it by planning her schedule.

I'm a person who gets horrific pain on my first day. After the horrific pain, like, I had to be hospitalised a few times for that.

However, the prediction is not just about the trips. She plans her life around the prediction. As she works in digital marketing for a fashion company, she has to attend shoots and tries to avoid those dates when she will experience pain (especially the first day). She controls her work schedules and pain symptoms or even takes a compassionate holiday on those days. The prediction helps her to plan and buy medication during that period. The planning provides a perceived sense of control over what she can do during that period since she can neither control her bodily functions nor the external things that might have an impact. Women have used manual methods to plan their menstrual cycle but they also use oral contraception to suppress the menstrual cycle (Gunson, 2012) Although, women say that they suppress menstrual cycle as a free choice, the choice is influenced by market

considerations such as productivity at work, social events and heterosexual relationships (Woods, 2013). Menstrual suppression is marketed through the rhetoric of choice and it is positioned as a tool for women empowerment, which is indeed a neoliberal market view (Woods, 2013). The menstrual apps on the other hand are not positioned as apps to suppress the menstrual cycle but to manage it. Apps like Flo and Clue, promise tracking of the menstrual cycle, predict them and also track allied health issues. The planning based on menstruation cycle is not new, but the these menstrual apps enable detailed planning due to the prediction and also the technology mediated environment.

Ivy does not plan in isolation. The app also becomes a shared planner with her women friends. They plan their holidays together through the app, check the predicted dates and avoid those days.

It's just moved to a whole different level. Like, I'm not even joking when I go on holiday with my best friends. Before we plan on the day, we all open these calendars, and we're like, "Okay". Yeah, we'll try to find, like, common days that everyone will be okay.

The prediction allows them to plan together, and at the same time, it acts as a connection between them. A sense of more profound friendship will enable them to discuss these things and plan around them. Each one might have different externalities they cannot control, but this prediction helps them have perceived control over a specific aspect of their lives through planning. The second thing that Ivy actualises through prediction is a certainty. The app does not explicitly provide a sense of certainty, but Ivy perceives it through the predicted dates. According to various polls, majority of the women would be happy without menstruation or have it less frequent (Ferrero et al., 2006). Women are also anxious if they do not have the cycle at the right time and they consider it as abnormal (Andrist et al., 2004). Based on the menstrual cycle, women choose to be part of social and personal activities like sports, work, sexual intercourse and non-sporting events (Ferrero et al., 2006). Although the degree might change, the choice of clothes are influenced by the menstrual cycle (Ferrero et al., 2006).

Like, you know what, like, no jokes. If I know I'm going to be on my period on New Year's Eve, I'm gonna try to find that dress that will sort out those needs. Yeah, like, if I have, like, my period on my birthday. I will track this to see what I'll buy to wear on my birthday....It helps me to understand my body when I'm not feeling well. For example, when I felt, like, down, and then I get back to the calendar and am like, "Oh, is this connected?" So I cross-check my feelings and, like, how my body works with that calendar, even if I'm not on my period. Make sure that, yeah, everything I feel is kind of explained best.

The prediction of the menstrual cycle provides a sense of certainty that was not possible in the past. Women choose their clothes with extra care during the cycle in order to avoid staining or any other discomfort based on the product that they use to manage the bleeding. The Apps provide consistent notifications and reminders to provide a certainty to the decisions made by the user, based on the data.

The certainty of the prediction for Ivy leads to her wearing the right dress or clothes during her periods. The way she has constructed her world, she believes that it is inevitable that she will skip her New Year's Eve party and that world wants her to be outside and enjoy the party while managing her periods. Therefore, she is forced to choose clothes that might help during the menstrual cycle. However, whether choosing the right dress is enough to help her to be certain that she would not have any discomfort. Although it is a false sense of certainty, she feels certain because it is something that she can control, but she cannot control herself from going to a party on New Year's Eve because she is expected to have fun that night. The market wants her to be a productive consumer instead of resting at home.

The second type of certainty that is actualised here is the certainty of her feelings. She cross-checks with the app to be certain about how she feels and the impact of her body on her mental health. Researchers have asserted that premenstrual syndrome (PMS) is real, and some feminist researchers have argued that it should be called "symptoms" instead of "syndrome" (Figert, 2005). Nevertheless, the construction around a real bodily problem that

impacts a woman's mental health is far from reality. Terms like "crazy", "witch", or "raging hormones" are consistently used in popular culture and even in marketing materials (Figert, 2005). According to researchers, only 5–8% of women have the premenstrual dysphoric disorder, an extreme form of PMS, but every woman is characterised as if they have the disorder (Ewens, 2015). Pharmaceutical companies and popular culture have medicalised a bodily function and constructed it as a "mental illness" (Pugliesi, 1992). These constructions over the years have manifested in women, which leads them to find ways to be certain about their feelings. It should be noted that the medicalisation is not about the physical pain that women go through during the cycle but the mood changes that may or may not happen before the cycle starts. The prediction from the app is yet another way for the market to tell women that they are feeling "crazy" because of PMS. The menstrual cycle apps re-establish the same discourses from the past, and the apps and the tracking practice are not as "empowering" as the apps claim. Regardless, Ivy and other women participants during the interviews consistently claimed that these apps are empowering and revelatory. The neoliberal world's success is how it has made women think that they are "normal" and that these apps can help them be "normal".

Ivy kept insisting on being "normal" or "feeling right" during the interview. Moreover, she was pretty keen on tracking the start of her cycle; when the cycle starts, the first thing she does is record it on the app. It was more critical for her to record the starting time of the cycle than take a pill for the pain because she believed that timing impacts the prediction.

> *So, imagine me having that pain first thing and not grabbing some drugs. But being able to open the app and just make sure I log it because it's more important than the pill. Because, like, and I need to make sure I do it right. And I don't know. Maybe this isn't like an imposition in my head. I don't know if it matters, what time you insert the detail, but something tells me that it might not be. They might just track the day and not the time. But for me, I convinced my mind that time plays a role.*

The Flo app does not indicate that the precise time matters with respect to the accuracy of the

calculation, but Ivy thinks it does matter. For her, the planning and certainty will not be actualised if the prediction is wrong. However, when I enquired whether the prediction was accurate, she said it was not.

> *I will say 90% of the time. How does my cycle work? Is it steady? Yeah, for three weeks? Yeah. To a month, and then each change. One week, more or less on the fourth week, like that. The only issue I find is when the cycle changes slightly. This is when it can't accurately predict it. But, it has never given me an estimation of fewer than five days.*

The app cannot predict the cycle accurately for someone like Ivy, who even marks the cycle time. The app constrains the affordance of prediction and, in turn, the actualisation of the user too. Notably, on its Frequently Asked Questions page, the Flo app has said that its accuracy has a mean absolute error of 1.29 days, even if the user meticulously tracks each symptom (Flo, n.d.). The company uses macro-quantification numbers to explain its accuracy and acknowledges that they are off by 5-6 days on average (Flo, n.d.).

The predicted days are what Ivy uses to be certain about her mental health and plan her life. The actual prediction is inaccurate, and the certainty that is actualised from the affordance is uncertain. Thus, the question emerges why she feels that the prediction helps her maintain control of her life, her trips and her mental health and makes her think that it is the most critical data in her life. She has been tracking the data on the app since 2017, and she equated the menstrual data to her photos and memories. The menstrual data was the most important artefact of her self-tracking. Ivy actualises planning and certainty through the prediction numbers produced through the menstrual cycle tracking. Although the planning might seem like she is adhering to the neoliberal imposition of a productive female body, she uses the same prediction numbers to resist that. The prediction numbers provide certainty of when the cycle will occur. She uses that to manoeuvre the aspects of her life, holidays, clothes, taking compassionate leave of absence, buying medicines and ensuring that she is in control of that environment. While she assigned the utmost importance to the prediction of the menstrual cycles, she joked about the prediction of her ovulation cycle.

Me and my girlfriends are not looking to get pregnant at the moment. But we always make jokes about that. Like, for example, "Oh, my God, I shouldn't have sex today". And they were like a laugh, but, you know, they're like jokes. I'd have this calendar as well. So yeah, it's like funny, or like, it's information that my friend will share with me just for laughs.

The affordance of prediction helps friends connect with each other, but more importantly, it prevents them from having unprotected sex or encourages them to take contraceptive pills to be safe. The prediction affordance might differ for different people based on their life stages. It might act as a constraint for one person but encourage another user to have sex.

Callia is a mother of two and works as a mental health nurse at the NHS. When we started talking about tracking, she began with steps and activities. However, she always said, "let me jog my mind", and came up with more tracking instances. When she started talking about menstrual tracking, which she was continuing still, she spoke about how she used the menstrual tracking app to get pregnant. Callia was in a position to know more about menstrual cycles because she is a nurse.

So, the first one that I used around five years ago was something called just a menstrual cycle. It's called MC. So, in that, I just tracked, and it kind of helped me because, at that time, I was trying to get pregnant. So it gave you more than just, you know, being prepared for your period. And it gave your ovulation cycle. So you knew all of that. And then also because I have polycystic ovaries. So it kind of helped me, if I ever had to go to the doctors, it was easy for me to tell them that, you know, this month I was this late on my period.

The app predicts the ovulation cycle of Callia, which helped her get pregnant, but the pregnancy was more complicated because she suffers from polycystic ovaries syndrome (PCOS). The app encouraged her to provide more information about her cycles, which it

pushed with a promise that it would help improve its predictions. Research has shown that patients with PCOS have issues with ovulation, and an app can help track the same (Hoeger et al., 2014). Callia has actualised the prediction data into planning and certainty. The pleasurable experience of having sexual intercourse becomes a planned affair in order to get pregnant. At the same time, the prediction of the ovulation cycle provides certainty about her cycles. If she has irregular cycles (a side effect of PCOS), she can be certain that it is because of her PCOS. She asserted that she becomes anxious about the menstrual tracker if the days are off.

> *And I guess, with my menstrual tracker, I think that, again, is probably a little bit overwhelming because then you realise, you know, actually, that might be an issue. So maybe a little bit anxious about that.*

Callia was consistently anxious about the regularity of her periods because irregularity is directly related to PCOS. At the same time, Callia was also trying to lose weight, which is the longest tracking she has been doing. She records weekly and was following the Paleo diet when I interviewed her for the first time. However, she had abandoned the Paleo diet by the second interview. The weight, PCOS and irregular menstrual cycle are all connected in Callia's self-tracking universe. Health authorities suggest reducing PCOS complications by reducing weight and lifestyle changes to one’s diet (NHS, 2019).

> *So, right now, I use Fitbit only to do two things. One is to count my steps. And the other one is to track my weight because I have a goal that I set for myself that I'd lose two kilos every month, and I started in March. It is a great motivator to lose weight.*

Callia's situation and goals are entirely in contrast to Ivy's. The app provides the same set of predicted data (i.e. menstrual and ovulation cycle), and they use that to plan and be certain about different aspects of their life. Planning and certainty become a form of control in their life. Women have always been induced to "manage" their menstrual and ovulation cycles to work more productively. Menstruation is inevitable, and the stages of their lives, internal

body hormones, lifestyle and other external factors, like work-life balance, affect the cycles. The manual tracking and predicting of menstrual cycles have been in vogue for ages, and ovulation cycle tracking became popular after the introduction of commercial thermometers in the late 1800s (Day, 2014). The digital apps are an extension of that manual self-tracking through thermometers. The research says that women adopt these digital technologies to have more self-knowledge about their menstrual cycles (Epstein et al., 2017) or find the data uninteresting and unproblematic (Hohmann-Marriott, 2021). Nevertheless, my findings show that there is something more nuanced than these dichotomous arguments. The predicted data actualises planning and certainty, giving a perception of control in their lives. Women have possessed self-knowledge about their bodily cycles for a long time, and, ironically, menstrual tracking apps claim to help women have self-knowledge about their bodily functions. The apps only predict dates and identify specific medical issues based on algorithms that might not be accurate. The inevitable uncertainty of the menstrual cycle, the external pressure from the market to be productive, the medicalisation of mental health by the pharmaceutical companies and the continuous lack of research in this area push women to take control of their menstrual cycle. The validation comes from the market itself, where some of the apps associated with menstrual tracking advertise themselves as a form of control. For example, Flo asks the users to plan their life through the cycle, while Natural Cycles asks people to take control of their bodies. The control they perceive through planning and certainty is more important than the actual prediction of dates. The women cannot control the externalities, and through the control of self-tracking, they resist that external world. They cannot have compassionate holidays, but they can change the meeting dates. Women are not allowed to decide about whether to borne children or not, but can decide when and how. They cannot discuss these things with their peers or friends but can joke about them. Their resistance to external forces has become habitual with the cycle itself.

The prediction is not just afforded by the menstrual tracking environment but also the financial tracking environment. Menstrual tracking and finance tracking are two different things because the former is a bodily function while the latter is an external act. The difference also shows up because most participants were not keen on tracking or sticking to the staple bank apps that sent notifications on specific spending and did not quantify or predict the future. However, at the same time, when the user wants to track, they use

spreadsheets, especially Excel. The spreadsheets are sometimes classified as manual tracking because they require the manual input of data instead of automatic tracking. However, there is a certain level of interactivity in all the digital apps used in the self-tracking environment, and the calculations in the spreadsheets happen through digital technology. Therefore, I consider the spreadsheet to be a digital artefact. There are a few types of finance tracking practices that the users undertake. First, are the standard banking apps (e.g. Barclays and Lloyds) send notifications when a payment is made and quantifies certain aspects such as monthly spending. The second set of apps are money management apps (e.g. Emma, Plum and Moneybox) that connect with one's bank account to appropriate money as savings at regular intervals automatically, categorise the spending and help with investing. The third set of users are those who use the standard banking apps for notifications, create their own model on a spreadsheet and track their finances. The users who use a spreadsheet have a prediction model for managing their finances. When I interviewed Ivy, she also discussed her boyfriend Spark's obsession with his finances. He spends time with his laptop and an Excel sheet every other week. Spark is a manager in a digital marketing agency and lives with Ivy in London. Although they share expenses, Spark takes care of the household accounts, and he shared how his family, childhood and culture pushed him towards financial tracking:

> *So, I have always been trying to save money. I think it's because my parents passed this on to me. My parents would not normally buy things that they would not need, and they would do a lot of frugal living, but they would be conscious about the stuff that they would buy.*

Spark started saving money when he began working as an intern after completing his master's. He earned 1,000 GBP per month and was forced to save some for the future, even though he earned little.

> *But so, even when I was in doing an internship, and I was making, you know, 1,000 pounds per month, while living in London, I was trying to save a little bit, just to be happy with myself and feel that I'm saving for a rainy day in the future.*

Spark did not save much, but the idea of saving for the future gave him a sense of certainty about his financial position. Spark further expanded on his tracking and quantification by describing his process in detail:

> *So, once a month, I sit down, and I have my different—obviously, I'm trying to diversify my portfolio now. It's like, it's like a ritual for me, like for financial well-being, do it at least once a month, sit down, think about what I'm doing. So, at the beginning, it was just savings; now, it's also investing money. Yes. So, I have, like, I set up targets for myself for, like, my, for my pension fund. And […], how much money I would save in the different accounts they have. So, let's say, have one for a rainy day, one just for saving cash to spend it to buy presents, or like go on holidays, buy tickets, and so on. I have, like, some fixed-rate accounts that I cannot move money in and out of. I am buying stocks, different kinds of stuff. And they just have like these Excel [sheets] that I've been updating every month for the past five years, I can see how much money I've been saving month in, month out. And when I'm saving good, I know that, you know, I can buy a present for myself.*

The first point to observe here is the dexterity of the user in affording the prediction. Human agency in this environment is stronger because the ability to afford prediction is based on how well the user can assimilate the functions available in Excel. On the other hand, though, Excel also affords prediction through procedures to handle those numbers and calculations. The second aspect is the user's perception of whether Excel can predict financial numbers based on the inputs provided to the app. Spark explained why he does not use apps to make predictions:

> *Actually, there are a lot of apps nowadays. I use one of the apps. They actually do these for you. But I mean, again, like, no one is gonna give me the customisation that I want. Obviously, none of these apps is gonna suggest that you make good decisions for yourself. Because basically, they can't. Yeah, so they cannot tell you buy that stock if that doesn't work. So, I'm quite happy with that set-up that I've got.*

Spark actualises planning and the certainty of the present and the future through the affordance of prediction. In the present, this creates a sense of certainty about his financial situation so that he can spend money on what he perceives to be non-essential items, such as holidays or tickets to events. He rewards himself for being in control of his present. At the same time, he plans to control an uncertain future. Spark described a period in which he broke his leg and had to have an MRI scan. He had to have a private scan because of longer waiting times through the NHS, and he could pay for it through his company's employee insurance:

> *And I mean, you know, things in life and growing up, I have learned that things in life can happen that you wouldn't expect to happen a few years ago, so I wouldn't expect to break my foot two years ago, but they were broken. And I am lucky enough that my company provided me with health insurance and I didn't have to pay anything there. But when I saw how much money it costs to do an MRI in London, it's like 800 pounds. So, for a photo, you know, [what an] amazing photograph of your life. It is not just that, but also, my parents are growing old. So, I have to, if something bad happens, like, I have to take care of them and my brother, as well, and you know, I feel that I'm responsible for them.*

Spark cynically noted that he spent almost 800 GBP on a photo of his life. The cynicism reveals his anger about privatised testing and how people are forced to wait weeks for an MRI through the NHS. According to a report by the NHS (2021), the average waiting time for non-emergency tests was 3.1 weeks. Spark plans for uncertainty and therefore creates a perceived certainty about the future; he does so because of the uncertainties in his present life. His parents' ageing, the uncertain future of a job, and the insurance needed for healthcare that he cannot afford to motivate him to predict and plan for the future.

A drastic event, such as a leg fracture, reinforced his decisions. Planning and certainty seem to give him control of his life:

> *I would say, the quantification of my finances, I do feel in charge when I am in control, when I write everything down.*

He discussed control only during his second interview, after some reflection. He planned to climb seven summits and had started training, which also requires long-term planning regarding his finances and life. He feels he is in charge of his life when he quantifies his finances. The perceived sense of control comes from actualising predictions into planning and certainty. Spark can plan manually without the help of a spreadsheet, but he cannot afford the prediction as illustrated. At the same time, apps do not provide a comprehensive solution that links multiple aspects of personal financial tracking and planning.

Governments, financial institutions, authorities, and many people's friends and family consistently promote personal financial planning. On the one hand, the market bombards people with marketing communication that encourages saving; on the other, the market wants people to spend more. Spark saves and predicts his finances not only for future ailments, but also to spend on holidays, purchase tickets or presents for his girlfriend (he mentioned buying her an Apple watch for her upcoming birthday but ultimately bought an even more expensive handbag) and plans for his climbing expeditions. The planning and certainty about his finances, in turn, give the perception of control, which acts as a response to market forces. Spark assumed the financial planner role, and he worried about the economic well-being of his partner, parents and brother, leading him to track and predict his finances. Neoliberalism encourages its subjects to be responsible financial planners and entrepreneurial subjects; they must be the "investors" of their financial futures. Through the affordances of predicting the future and being certain about finances, consumers such as Spark create a tacit resistance. Buying a gift for themselves or their partners is an act of micro-resistance. The resistance here is habitual, ingrained in the consumption itself. Consumers are forced to plan their finances, and not a voluntary deed like Spark describes. Spark rationalises the choice by pointing to culture and his parents. But the reality, he has to plan for the future to consume more. He is saving to buy a gift for his partner or take that seven summit holiday. But the numbers provide him with that certainty. He discovers new numbers every week because of

the planning, and the joyful discovery of those numbers is the act of resistance from Spark.

Prediction, like counting, is an affordance that is neutral. Prediction is actualised as planning and certainty by the users. The planning and certainty provide a sense of control over their lives (Ivy on menstrual health and feelings, Callia on her ovulation period and menstrual health and finance for Spark). Prediction produces numbers that are used as a way to resist the numbers imposed by the neoliberal institutions (credit score for Spark, productivity for Ivy and ideal pregnancy age for Callia)

5.1.3. Visibility

The third affordance that I discuss is visibility. Two types of visibility emerge from the self-tracking environment: first, the visibility of data the device exposes to the user, and second, the visibility of the user's body in the data, that is, the perception of the extended body on the device. The two visibilities are not mutually exclusive, and users can observe them separately.

The visibility of data is evident in the exposure of new data in an already existing manual tracking, such as counting the number of steps in contrast to the distance in kilometres or miles. It can also be seen in new tracking aspects, such as sleep tracking, which was impossible in the past. Sleep-tracking devices and apps provide information regarding sleep duration; waking periods during sleep; different stages of sleep, such as light, deep, or rapid eye movement (REM); heart rate; and oxygen levels (Liang and Ploderer, 2020). The analysis depends on the kind of device used. The first set of sleep trackers on phones (for example, Sleep App on Android or Prime Nap) collected data via sound and movement when the device was placed on or near the bed. The second set is worn on the wrist (e.g., Sleep Cycle, Pillow) and tracks sleep through optical heart rate sensors. Users must wear such devices while sleeping. The third set of trackers are special wearable devices that are worn on the face or eyes (e.g., Neuroon) and contain electroencephalography technology to assess advanced sleep statistics and medical issues regarding sleep. For the last two types, users need an affiliated app on a mobile device or a computer to access detailed data regarding sleep. The apps native to wrist-worn devices provide only a short summary of sleep, and these devices calculate something called a sleep score. The visibility of the data is limited to a sleep score, and users must specifically check detailed statistics on the associated app.

During the interviews, when participants discussed sleep tracking, they referred to wrist-based tracking. Users' dexterity in affording the visibility of data in sleep tracking is needed even before the tracking practice starts. First, users understand that they need a wrist-worn device, constantly wear it during sleep, and must access detailed data on a mobile device. Some participants did not track their sleep because they were uncomfortable wearing the

device while sleeping. The next level is having access to an app that provides data on sleep patterns; different apps give different levels of detail. Azver and Elvett are a couple who track several things, and they share two types of tracking with each other: the steps that they walk together and their sleep data. Both are in their late 20s; Elvett works in meteorology as a scientist, while Azver is completing her PhD. I interviewed them separately to identify their self-tracking environments. Azver said that she avoided the gym and preferred running and long walks. Elvett, on the other hand, preferred going to the gym and tracked his activities there, including cardiovascular exercises and weight training. Elvett told me he joined Azver for long walks during the first COVID-related lockdown because the gyms were closed then. It was also an activity they shared as a couple that helped them bond after work. Sleep tracking emerged in both of their interviews because it concerned the visibility of data for them. However, they used the same type of tracking device (Fitbit Charge HR), and their perceptions of the sleep data differed substantially. Elvett questioned the data's accuracy because the sleep app deemed him a "light sleeper" and Azak a "heavy sleeper". Azak, meanwhile, did not question the accuracy of the data because it confirmed her perceptions about her sleep tracking:

> ***Elvett:*** *I like that it breaks it down into, like, how much REM or deep sleep you get. And it's sort of interesting how much it gives me, whether it's accurate or not. I'm not sure, but, like, I know, you can set, like, bedtime and wake up times, none of that ever helped. [I'm quite curious about, like, what my sleeping was like, is it consistent? I don't get a lot of deep sleep. I'm a light sleeper, whereas my girlfriend has a lot more sleep. Well, that was interesting. And, like, we both go to bed at the same time. So, it's the total sleep. It was similar, but the type of sleep was different at different times.*
>
> ***Azak:*** *And so, it tells you how long you've been asleep, and then the quality of sleep that you've had. So, I've got mine set to, I think it's about seven and a half hours of sleep every night. And then it tells you basically if you've hit that target, and the thing for me is, so, I—last night, I had loads of, like, really weird dreams. And then I can go on, and I can see massive pages of like my sleep data and REM, so yeah, it's like, oh, yeah, okay, so I was having weird dreams for quite a lot of the night. I think it's more—I think it's more like, oh, I'm tired. Now, look how much sleep I've had in six hours.*

First, Azak and Elvett perceive that the self-tracking environment can provide visibility of the data they want to access. Second, as Elvett explains, the data is granulated into different stages of sleep. Humans have continuously tracked the subjective quality of their sleep based on how they feel the next day (Liang and Ploderer, 2020), but objective tracking of sleep started after the Pittsburgh Sleep Quality Index was introduced by researchers from the University of Pittsburgh (Buysse et al., 1989). Health authorities use polysomnography (PSG) to track sleep structure and sleep-based breathing disorders in clinical settings (Liang and Ploderer, 2020). PSG involves the concurrent monitoring of oxygen levels, brain waves, breathing and many other aspects in order to create a visual graph of one's sleep. The wrist-based wearable devices are accessible, less intrusive devices that use a technique called actigraphy, which gives a score based on limb movements and heart rate. The institutional legitimacy of such sleep tracking comes from sleep researchers who use these devices to track and monitor subjects and health authorities who suggest them as a treatment for sleep disorders (Donnelly, 2022).

Azak and Elvett see the same sleep data but perceive it differently. Elvett was annoyed that the app designated him as a "light sleeper". He bought the same Fitbit device because Azver talked about her sleep every day:

> *And I could see, like, every morning, she would look at the sleeping pattern, how much she slept in the house. I was curious about what mine would be and say; I think it was very sleep orientated. I did search a bit, but I just bought what she had.*

Elvett was persuaded by the idea of having more data visibility about his sleep; some minor competition with his girlfriend also led him to buy the same device. The device encourages him to wear it while sleeping to track and obtain more information regarding his sleep patterns. Some sleep-tracking apps give additional notifications to recharge the device if the battery level is insufficient to track a whole night's sleep.

Azak also discussed meeting her sleep goals. When sleep data is invisible, users sleep and wake without any specific targets. Some users may have an alarm to wake up, but the idea of a goal related to the duration of sleep has evolved because of sleep tracking and the visibility of this data. Elvett and Azak actualise the affordance to be certain about their sleeping patterns. Although annoyed about its accuracy, Elvett is certain about the data that is visible to him and described changing his sleep patterns:

> ***Elvett:*** *[On numbers] I think they're good to monitor in terms of, like, oh, if you need to change anything, okay, I'm not getting enough sleep. I need to think about that.*
>
> ***Azak:*** *It's more, it does come up with things, like, for more, for a better night's sleep, you should try to go to sleep at the same time and then wake up at the same time, but that doesn't really fit in with my life. So, I don't.*

On the other hand, Azak was certain that her sleep was satisfactory, as she hit her targets and did not make changes to her sleep patterns. She was certain that she slept well enough because of the same visibility of the data. Elvett did not aim to control his sleep patterns; instead, through sleep, he sought to control other aspects of his health:

> ***Elvett:*** *Like, even before I met my girlfriend, like, I was quite a health-conscious person. I didn't—I sort of took the resting heart rate is, like, I guess, the threshold for a good health sign, like, it should be under 60, [that] sort of thing. But nowadays, not so much. But, yeah, that's quite curious about, like, some people's I've seen, like, in the day, it's like 100 or something, and I'm like, you can see it when they get to sleep, and in their deep sleep, it's, like, gone up to 50.*

Elvett wanted to have his heart rate under control because he considered it a sign of good health. Sufficient deep sleep helps control the resting heart rate, and this aspect annoyed him with respect to accuracy. He considered himself a health-conscious person with a decent gym regime, but the data gave him a different impression. He, therefore, tried to negotiate regarding the device's accuracy. The certainty that he actualised from the visibility of sleep

data led him to control his resting heart rate by changing sleep patterns; in this way, he sought to reinforce the idea that he was health conscious.

Azak, on the other hand, was quite certain about her sleep, weight, health and menstrual cycle. When I asked her what she thought about general tracking, numbers and quantification, she metaphorised the device and self-tracking environment, comparing them to the idea of a diary:

> ***Azak:*** *I think it's kind of like a diary. Yeah, definitely more of a diary. It's more like, this is what I've done today.*

Azak felt confident about her health; she thought of it as a diary of her life, and she had already internalised her perceived control through her tracking. For example, she said she stopped tracking her weight after she achieved her goal weight, and she did not actively track her menstrual cycle because she had a contraceptive device. Recording these events gave Azak a sense of control. While Elvett and Azak actualised the visibility of the data as certainty, Fara afforded the visibility of her body on the device through data. Fara is a Marine scientist completing her PhD. She is in her early 30s and talked extensively about her sleep tracking during the interview. Fara plays field hockey at the club level, and she also cycles, runs, climbs (she had already scaled Kilimanjaro), swims, boulders and enjoys long walks. She asserted that she was a reasonably active person, and she tracked all her activities (except hockey and bouldering, for safety reasons) through her Garmin Fitness Watch. She described making adjustments to track her sleep:

> *Because I'm quite interested in my sleep patterns. Whether how much I deep sleep or, you know, how many hours it would classify me as sleeping. When I first got it, it was weird, because I'm not used to sleeping with—I don't like to wear anything when I go to bed. I don't like wearing my watch, or I don't like anything quite that I don't like to wear to bed. So that was an adjustment. And so, I think in the first week, I found it quite a big adjustment.*

Fara had to adjust to a new sleeping pattern to obtain her sleep data because the fitness tracker had to be worn continuously to track sleep. Fara linked every aspect of her tracking, including sleep, to something called the Body Battery, which Garmin calculates. Garmin's Body Battery is a percentage that Garmin says is calculated based on activity, stress levels (based on the heart rate) and the restoration of energy through sleep (Garmin, n.d.). Garmin calls it a measure of energy resources and gives a philosophical answer to a question about whether a low Body Battery should be cause for concern (Garmin, n.d.). The other parts of the FAQ page examine rational calculations about how various aspects affect the Body Battery. For example, Garmin tells users that working out with a low Body Battery is acceptable. The device encourages the user to visualise the body and creates a virtual picture through a number; a datafied version of the body is visible on the device.

Fara gave the impression that she accepted the idea of a Body Battery. The Body Battery became the centrepiece of the conversation, and her activities, running, sleep, and even her menstrual cycle were connected to that number. The device became an extension of her body, and the Body Battery percentage became the charging level of the battery.

> *I'd go and go and connect [to the computer] and be like, Oh, this is what all my body stats look like and various things.*

Garmin views the body as a human-machine assemblage with a charge percentage attached to it. Sleep "recharges" the body and improves the Body Battery score. Fara saw the Body Battery in the same way, and she reiterated that she analysed the numbers even while relaxed. The consistent updating of numbers and notifications made her body visible in the data. Her perception was that she could see her body on the data the device produced. Further, Fara had the skills and opportunity to track, quantify and see her body on the device:

> *I've just been, like, sitting at my desk, like, wondering what my resting heart rate is, or when I wake up in the morning, I want to know what my sleep quality was like or what my resting heart rate is. And if I've had a stressful night's sleep. And so one of the functions on here is it tells your Body Battery by saying how restful you are. [...] Because I had long days, and I've been*

cycling, and then I sleep and because my sleep is really stressful. And I didn't sleep properly, [so] I wake up with the same Body Battery I went to bed with. So, sometimes I've woken up with a 5% Body Battery. And I've gone to sleep at 5% and woken up with 5% or 6%. Like with very, very little change, which means to me that I might need to take more care and be more relaxed during the following day.

When she does not recharge after a night's sleep, Fara realises that she has to take steps to recharge her battery. Fara internalises the human-technology assemblage, and when she finds that the Body Battery is low, she seeks ways to put the assemblage back in order. For Fara, three aspects are actualised because of the affordance of body visibility. First, it provides certainty about her bodily statistics, and the data is the extension of her body. The certainty not only concerns the body, but also her feelings about her body, such as stress and sleep quality. Fara sees her body as an assemblage that can feel, and the data about her body provides confirmation. The second actualisation is planning. Fara changes her activities based on this body visibility. If her Body Battery is low, she plans a quieter day with more rest and less of the usual activity:

So, because I put everything in my calendar, I can then see, like, how busy my calendar is and my time management, and, like, [I've] identified times in the week, I would be stressed because I've got back-to-back meetings, and I've got them, got social activities that day. Or I will know when my sporting activities were in my calendar. So, I would argue, I definitely need a rest day here. So, I would, in that sense, I would try and plan for it. Plan for the day. So, I'm tired. But I guess now that I've got the device, it's now, I can actually see the days I might potentially be more tired actually on the day.

Fara marks everything on a calendar and tries to adhere to schedules. The visibility of the body in the device and the Body Battery determines her daily schedule. The planned activities also allow proactive planning based on prior Body Battery data. If Fara has a long cycling session planned for a weekend, she knows that she will be tired the next day. This data provides a cycle of planning for her.

The third aspect that Fara actualises through her body visibility is progress. In the self-tracking context, progress can be identified as an personalised project of moving forward with one's goals. Users define progress in different ways:

> *So, if I can get it [heart rate] below 50, I must be super fit. So, I mean, it sounds stupid. But I'm like, okay, my heart rate is going up. It was like last week, it was super high. Like, I haven't been running long distances. It's not long distance. It's 10K. I've not been doing regular running. I've been doing exercises instead. And I'm like, it's interesting for me to know whether the HIIT exercises, what type of exercise kind of has an impact on my overall resting heart rate. And I know it's a progressive thing. Like, it's not something that changes directly overnight.*

Fara sees heart rate as a marker of fitness. Garmin uses resting heart rate as part of its Body Battery measurement. For Fara, progress means keeping her heart rate as low as possible, and she actualises this through the visibility of her body—in this case, the heart—on the device. Here, Fara defines progress, as a personal project influenced by the device and the self-tracking environment. The idea of progress comes from the visibility of the data and the body on the device, and the user decides what type of data is considered progress.

Through the visibility of the body, Fara actualises certainty, planning and progress, through which she aims to control aspects related to self-tracking. She says that she becomes obsessed with tracking an aspect when she wants to control it:

> *I know when I'm feeling a little bit low, and then I'm trying to control something, then I would check it a lot more. [....] I like it on the days I feel good or I like it. Because it also gives the days where it's low, gives me positive reinforcement. The days I see a lot of stress on the days where it's a negative reinforcement, which means I am, like, shit, what's happening? I'm okay. Is everything okay? Why am I stressed? Like, what is it? What do I need to change? Because I'm stressed about being stressed. You know, there are a lot of things going on. But then I'm trying to control the situation.*

Fara explains something many participants addressed when they can plan, be certain about their life and see progress; this acts as a positive reinforcement. When it does not, however, it becomes negative reinforcement. Her anxiety about being stressed reveals the extent to which the numbers can affect a person's daily life. She equates the Body Battery with her life, and when the numbers are low, she believes she is slowly losing her life. The negative reinforcement sometimes even leads users to abandon the tracking practice. In the second interview, Fara said that she stopped wearing the watch for a brief period because she was overly concerned about tracking her heart rate:

> *But also, because I felt that at one point, I was getting quite obsessed with looking at the heart rate on it. And using heart rate is an indication of how fast I was getting obsessed. I wonder what my heart rate is right now, then I'll check and see what the resting heart rate was for the day. And if it was high, then I try. And I don't know why. I guess I don't think that something might be wrong. So, I was like, you know what, I'm just gonna take a break from wearing the watch.*

She could not control her heart rate, and thus she temporarily stopped the practice. However, she later resumed tracking. Users tend to abandon tracking practices that they cannot control and continue with those they can. Sometimes like Fara, who still thinks she can get back to controlling the resting heart rate and Body Battery, readopts the tracking practice. Other participants also abandoned their practices because they could not control certain metrics. Fara sought to control her heart rate because of externalities in her life:

> *And the thing is just kind of using it as an avoidance mechanism because I was getting a bit stressed at work. And like, I guess it wasn't really clear what was going on with work, and that obviously, PhD loves uncertainty, you have to deal with confusion.*

Fara said that the tracking was her avoidance mechanism, and she was one of many underpaid PhD students worried about finishing studies on time while facing an uncertain future. Fara was anxious due to the pressure of productivity and the uncertainty of her graduate studies, which she cannot control. This led her to try to control other aspects through self-tracking and quantification. According to a study, one in two PhD students have mental health issues, and 32% of PhD students have mental health disorders (Levecque et al., 2017). However, the neoliberal university demands academic subjects who are self-improving, competitive, always ready to work, productive and who do not complain about their salary or stipend (Thwaites and Pressland, 2016). Someone who has recently completed a PhD is considered an early-career researcher, and the system demands collaboration, conference participation, external grants, publications and teaching experience, all at a competitive pace (Caretta et al., 2018). After finishing the PhD, securing a job is difficult, and if a student does not obtain a lectureship, they must pursue a series of casual, part-time employment and post-doctoral fellowships—which are also competitive—and confront an uncertain future. Fara knows her future is uncertain; at the same time, she must be productive and active and show continuous improvement in her health, job and life. The numbers that she could manipulate through her self-tracking made her avoid the numbers she saw in her PhD data. She compensated for external factors she could not control through the self-tracking. It was unsettling for her when she could not control her heart rate, which produced anxiety about her anxiety. The control that Fara perceives in the numbers helps her avoid external pressures and stress. However, it is also a way to create an alternative reality through the self-tracking assemblage. She could see that her body on the device performed better than her body in the outside world. The alternate body that Fara created in her device was a way of resisting external pressures she encountered. For Fara, resistance is embodied in the device and is implicit such that it became habitual. Visibility is a two-fold affordance, the visibility of data and the visibility of the body in the device. The visibility actualises into planning, certainty and progress for the users. The numbers (Sleep score, body battery) created around affordance and affordance actualisation helps the users to create micro tactics that manipulate, manoeuvre and switch. In this section, I have only unpacked the affordance of visibility and its actualisation.

5.1.4. Sense-ability

The fourth affordance that I discuss is the sense-ability, which can be defined as the way users interact with the device or the environment through their senses (touch, smell, taste, sight and hearing). In self-tracking environment, the devices show notifications, vibrate and provide visual and auditory confirmation of achievements (through, for example, displays of fireworks on the screen or via a celebratory voice confirmation). Sense-ability affordance refers to users' ability to perceive the visual and auditory confirmation through the senses and also actualise them into certainty and progress.

Ember is an archaeologist who tracked her steps, and walking was her primary fitness activity. She walked long distances and used a device a friend gave her. It was an old VeryFitPro with a broken strap, and she was waiting to replace it. Ember also used her mobile phone to track her steps through the Google Fit app, and her mobile phone was her primary tracking device. In the first interview, Ember said that she wanted to track her water intake through her tracker, but she did not like receiving too many notifications:

> *I tried to track my water intake. And so many notifications reminded me of water. I was like, nope! They were just—they were just really pestering me!*

She did not like the notifications, and the affordance of sense-ability acted as a constraint on her in practice. However, during the second interview, she had started water tracking. She had already experimented with several apps and found one called Plant Nanny. She discussed it enthusiastically:

> *It is very, very, very cute. It's something like growing a plant, which I literally do grow plants. I have plants kind of cartoonish, almost kind of poke him on plant kind of thing. So, you get to grow plants to, like, watch how much you're drinking water, because I wasn't doing that much. [...] You put your height and your weight and your age, I think it tells you how much water you should have. And you have a little plant, and you should water it. Every time you drink, you are watering the plant.*

First, Ember perceives that she can genuinely sense the plant, and the app allows haptic touches that let her poke it. Ember can thus perceive the sense-ability. The plant seems real to her when she touches, pokes and plays with it. Second, Ember's ability to sense the plant is real, which also stems from the same haptic cues and the ability to touch and feel the plant on the device screen. Through sense-ability, the device encourages her to track her water intake:

> *I do think it really works because, the plant, if you don't drink water, the plant looks really unhealthy. And it starts looking sad and sick. So, you go like, "Oh, gosh, I should drink". And then you've got to input the drink. And they said, Well, you know, I said, I want the plant to live, and I should really drink water.*

Ember perceives the plant to be real and acts as if it would die if she did not drink water. Through sense-ability, the device demands that she drink water. Ember has replaced her body's natural thirst with an app that reminds her to drink. What was previously a bodily function has become something a device manages, and she perceives the plant as an extended version of her body on the device, which is apparent in the use of words such as *"unhealthy"* and *"sick"*. The app decides the amount of water that she should drink after providing her weight and height. The app also provides the same perception to Ember because it equates the plant to her body. It notifies her when the plant is weak and sick. While Ember was frustrated about VeryFitPro's notifications to drink water, she welcomes notifications from Plant Nanny about the health of the plant. She feels prompted to action and drinks water when it notifies her. This is achieved via the sense-ability the device affords, which makes her perceive the plant as her body. Ember actualises certainty about her bodily function and water intake through the sense-ability affordance of the device. She also actualises progress when she can see and feel that the plant is growing. The progress and goals are short-term; a specific number of glasses of water must be drunk per day to keep it healthy.

However, the plant does not become fully grown in a single day; it takes several days for it to grow, and the app transforms short-term goals into long-term ones through its mechanics:

> *Once it's fully grown, you have a little bit of, you move on to the next plant. You start collecting them. It's a greenhouse. And my plants are super cute. I have my second plant. And it's like the mid-level, I mean, the mid-level of my second plant. I've heard that there are some plants are more difficult, but I'm just starting using it. So I wouldn't know. [...] Also, they have an in-game currency. Which if you, you know, you enter every day, you get some currency, things like that, coins. But yeah. knots or just knots or something like that. It's a currency. But it is easy to use them. Or at least for me, it is easy to use it without, you know, spending actual money.*

The app tries to create an illusion of progress, although there is no actual progress in the amount of water Ember consumes. Ember must drink a specific amount of water, approximately the eight glasses per day that health authorities suggest. Although there are controversies surrounding this advice, which lacks scientific proof, the mainstream media and authorities have consistently promoted it (Valtin, 2002). Ember tracks her water intake and seems to enjoy the process. She also collects the plants and says she has a healthy greenhouse; she also wants to grow "difficult" plants. If she sees the plants as an extension of herself, they resemble clones that are healthy and happy. The difficult plant is a metaphor for solving her external issues.

The app also provides an in-game currency that she can collect to buy seeds for new plants. To grow a new, potentially difficult plant and create another clone of herself, Ember must drink water, grow plants and gain currency. The app has created a virtual world of extended selves with its own monetary system, and users adopt that world through sense-ability (touch and vision). Ember actualises progress and certainty in this virtual world, and through these, she perceives control over her life.

Ember elaborated on her past use of an app called Habitica. Habitica is a game-like habit-tracker modelled after role-playing games (RPGs) in which users can create an avatar in a virtual world:

> *I used to have an app called Habitica. Okay, which I got really into, I got too much into, a little bit too much into the gaming component [...] In Habitica, you are creating your character. And then you can use it for quests, and a whole, a role game. So, I have a beautiful, super-pixelated wizard with a health level of four million, but I never actually went on a quest than a roleplay. I imagine a lot of people do that, then it becomes a distraction, rather than a way of getting focused. You lose control because you're, you are getting into the game more than into whatever you're doing.*

Ember immersed herself in a virtual world of an RPG, and the avatar was her extended self. Ember loves game elements, and she described different games that she downloaded; she also plays Candy Crush. The virtual world provided certainty and progress to control her avatar. She spoke in the third person during her interview, and she acknowledged that she abused the game and she used it continuously:

> *And one of the activities that I had daily was doing exercise. And then also, I still do exercise, even without the tech. But there was a point that it was something that I did. I didn't have to check the app to do that, if felt unnecessary, and I was abusing it. And it was actually good for me to stop using it because I was getting a bit too much into the gaming part.*

She had to stop because she felt she was losing control, which contradicted her aim of controlling her life on the app. Users abandon self-tracking activities when they lose their perception of control. Ember replaced the avatar in Habitica with the plant in Plant Nanny because she could control her extended self via the plants by drinking water every day. Users track and quantify aspects that they can control and abandon or avoid practices they cannot control. One form of a virtual body is replaced with another.

Ember controls her virtual extended self because of the uncertainties of her outside world. She described constantly being surrounded by numbers:

> *I am surrounded by numbers, and I am considered in numbers all the time. If you know it, or you don't know it, there's quantification of everything you do. I do not like the tendency of [the] quantification of life, in sentences like, if you've ever met a personal injury lawyer, you will know that then there's a value of life. So, if you go that route, no. Particularly algorithms that will reduce my personality to point ABC.*

Ember described how the numbers that is imposed on her by the neoliberal society control various aspects of her life and the impossibility of controlling them. She resisted the control of the outside numbers through control of her plants; the related certainty and progress actualised this control. She did not specify what numbers she meant, but the example she provided of a personal injury lawyer was interesting. Solicitors have calculated the value of life, and online services can calculate these numbers. As Ember noted, algorithms reduce humans to mere numbers that lack meaning but nonetheless control our lives. Ember demonstrated resistance to the numbers in general, and she expressed this using the same quantification.

Sense-ability can be afforded not only through the haptic cues users perceive but also through those users sense on their devices. Mobile devices and wearables use vibration as a cue when a specific goal is achieved. Arcadia is in her mid-20s and lives in Surrey, where she is in her final year as an undergraduate. She tracked her steps, sleep, gym activities, calories and menstrual cycle. She initially tracked her steps through her mobile phone and later bought a fitness tracking device, a VeryFitPro. She said she had not enabled notifications for the app on her mobile phone:

> *It does have the option. I just have not enabled them to do that. I don't know for what reason, to be honest, they have not been enabled.*

When I probed further, she discussed how the haptic cues differ from the textual notifications the app gives on the phone:

> *And even on the watch itself, you can still see your progress throughout the day. And for example, it gives you, like, badges, different badges for like 10,000 steps. It kind of vibrates while randomly walking in the shop and sometimes when I just feel it vibrating on my hand like, "Okay, my phone is in my hand". And I just realised, "Oh, I hit 10,000 steps".*
>
> *I quite like it when my watch goes off with those fireworks. But I do quite like it when I hit that. And it's got a thing to aim for, five bits, of five bits of exercise a week.*

First, Arcadia can perceive sense-ability through the device's vibrations, and the device provides the sense-ability affordance through the vibrations. Here, sense-ability provides certainty about the device itself because Arcadia does not even realise that she is holding the phone while walking, and the sense-ability provides the certainty of completing 10000 steps through vibration. She also actualises the certainty of walking and completing the 10,000 steps that she wanted to achieve for the day. Second, she further actualises progress through the sense-ability affordance, as the watch shows badges that represent the specific number of steps, kilometres or miles she has completed.

Arcadia mentioned hitting a target, which means that she sought to achieve those numbers with significant force and conviction. Through celebratory fireworks, the sense-ability affordance actualises the conviction to achieve those goals. The celebratory fireworks guarantee for Arcadia that she has achieved a goal that she set out to reach. They also actualise as progress for her, and that progress and certainty manifest as control of something external.

Arcadia discussed how she started tracking her steps; an app from her university union provided perks if she completed a specific number of steps every week.

> *And they do, it's, like, an online campaign in which you see, but basically, you're supervising your application that is tracking your steps with their own application. And you get points from steps, and then if you've gotten enough points, then you can go and get yourself a hoodie with the university logo, like some basic merchandise, like hats or water bottles and, like, free coffee, something like that, as well. That was, like, what actually got me into it in the first place.*

Arcadia explained that she started tracking for this reason; later, she disclosed that she even bought a fitness tracking device to have an accurate step count so that she could acquire more points. Through certainty and progress, Arcadia tried to control external rewards she desired from the app. The celebratory fireworks were for the coffee or the hoodie she received through the app, not for an overall goal she had.

> *I have not thought about that. It's definitely a delight when you get a badge. You've accomplished something. It's definitely a delight when you get the free hoodie, for example, because, you know, I worked my ass off to get that, even though it's like, I just walked from point A to point B.*

Long-term goals and health monitoring were a secondary concern. Arcadia replaced them with short-term, extrinsic rewards. Arcadia was quite clear that she worked for the hoodie and not to improve her health or self-knowledge. Although the steps helped her with long-term health goals, this was a secondary concern. The student union app's intentions did not concern nurturing the student’s health goals, but rather sought to reward students for "moving".

Across UK universities, such unions have become consumerist spaces, which has happened alongside the marketisation of higher education (Brooks et al., 2016). A comparison study of student union leaders from six countries by Brooks (2022) found that UK representatives acknowledged that students are consumers; even the government sees them this way. Student unions must market themselves with cafes, events and parties in order to sustain themselves or receive financial support from the university.

Universities also widely publicise the consumerist spaces of student unions, and, as representatives of the student voice, consumerism has become more important than unions. The student unions have become powerless to change the political and economic structures around them (Brooks et al., 2016).

> *As I started university, obviously, I was working a part-time job. And alongside my studies, and, like, I was getting money just to pay my rent and have, like, a basic amount of money for food. And that's when I really needed to keep track of my money. And, like, we needed to plan. How much on that, how much on that, and so on, so forth.*

The growing fees for education and student loans force students to fend for themselves through part-time jobs; similarly, they also seek free goods through various means. Self-tracking apps and data have become a way monetise students' physical labour. These apps are a market-based solution to a problem the marketplace creates.

Through a form of control that stems from numbers produced by self-tracking practices, users resist market practices. Arcadia demonstrates resistance to two authorities in two ways. First, Arcadia has disregarded the marketplace, neoliberal ideology of self-improvement through self-knowledge, as she is more worried about the perks that she receives. Further, she receives perks from the University, which wants her to be productive and active and to improve every day. She does not fight the system but works through it, and the resistance is implicit.

5.1.5. Chapter Summary

In this first chapter of findings, I have identified four different affordances for users in self-tracking environments (Fig 5). Users actualise counting, prediction, visibility (data and body) and sense-ability as planning, certainty and progress. Users perceive the affordances and might actualise them in different ways. In these observations that I have made, the participants actualise their affordance.

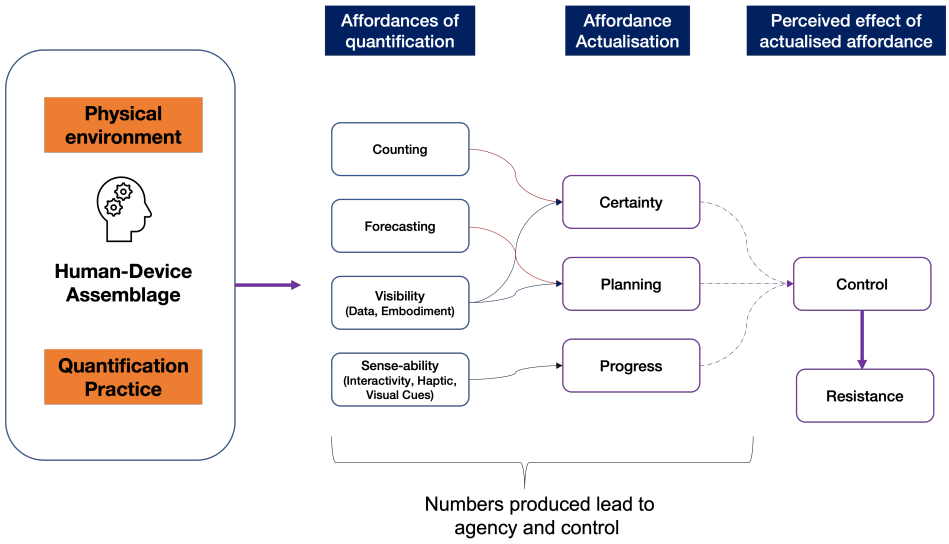

Figure 5: How affordances lead to resistance - adapted from Fig 4

Through the actualisations of affordance, the participants exert control over the self-tracking environments and the associated practices. The user perceives this control, whose purpose is to resist external uncertainties that create the initial motivation to track. Neoliberal institutions want a subject who can self-improve by tracking various aspects of their lives, but what emerges is a tacit and inherent resistance to the world. In the next section, I collate various micro-tactics exhibited by the users through the affordances, affordance actualisations and the perceived control they show.

5.2. Numbers, Control and Resistance

In the previous section, I identified several affordances that produce numerical data and the numbers that form the basis for control. The affordance of counting produces numerals, and numbers are forecasted through the affordance of prediction. The affordance of visibility is how users see numbers and how they see themselves in numbers, while the affordance of sense-ability translates numbers into haptic cues. Numbers are produced through self-quantification undertaken by the users. Through numbers, users actualise the affordances into planning, certainty and progress. The perception of control manifests as the effect of planning their lives, being certain of their tracking and environment and perceiving progress in life through self-tracking. Numbers and quantification provide a perception of control, but market forces effectuate users to control the numbers about their body and life. The perception of control is how users resist market forces.

In this section, I argue that numbers form the centre of self-tracking practices, and the affordances are indeed effectuated by the numbers. In addition, I examine how the marketplace uses numbers to exert control and how users use those same numbers to resist the market. Drawing on the work of De Certeau, I theorise how consumers use the control of numbers to create resistance to external market forces. De Certeau says that consumers are "poachers" armed with "clever tricks, knowing how to get away with things, hunter's cunning, manoeuvre, polymorphic simulations, joyful discoveries" (De Certeau et al., 1984), through which they resist, re-negotiate, re-align and appropriate the dominant meanings that the strong (e.g., organisations, the city, and authorities) impose on them. I explain how, through control, consumers become "poachers".

5.2.1. Numbers and Self-Tracking

Self-tracking produce numbers of different forms. In the examples from the last section, it can be observed that there are various numbers like the predicted dates, body battery, heart rates, calorie numbers, step count, money forecast, sleep score and many more. Neoliberal institutions have created these numbers as a way for the users to self-manage. For example,

the BMI score impacts calorie count, the credit score pushes for money forecasting, and many more such linkages can be found. As discussed in the literature review section, self-quantification is a neoliberal institutional project. The origin of the modern self-quantification movement was triggered by the neoliberal corporate leaders of silicon valley.

The numbers produced by self-quantification form the basis for affordances. Through the affordances, the users produce and manipulate the numbers to actualise the affordances to achieve their goals. For example, Arcadia's goal is to get the perks, so she actualises progress. Ivy's goal is to plan for her holidays, and she should be certain about her predicted dates. The numbers produced by the users through affordances help them to actualise certainty, progress and planning. The actualised affordances allow them to regain the agency and control they want in their lives. So, in short, the numbers produced by the users give the users control through the affordance and their actualisations. Through their perceived control, they create resistance tactics against the neoliberal institutions that impose the numbers on them. Self-quantification users resist the imposed numbers through the numbers they produce.

5.2.2. Manoeuvring by switching

Fitness tracking devices (mobile or tracker) have multiple tracking abilities in one device, and they encourage users to start tracking. Some tracking mechanisms are default on many phones, such as step-counting and screen time. Notifications are sent to the user whom the device encourages to start tracking. Users thus sometimes start tracking for this reason, or they download apps to track specific aspects, such as sleep or calorie counting. Users might start tracking certain aspects, and, in addition to devices, other externalities may induce them to start a tracking practice. Fara, who described herself as being obsessed with her Body Battery, later described the start of another tracking practice: calorie counting. She was in the US for several years, and during that period, she tracked her calorie count:

So, back in the day [eight years before the interview], I used to do MyFitnessPal. I used to track my calories, like, I think I had it up to only wanting to ingest 1,200 calories or something. And then, I would also drink beer at the same time, and beers give empty calories. And then, I wasn't getting enough nutrition because I was, like, wow, I'm now drinking beer, which adds calories on, and actually I'm exercising a lot. I actually—I liked it in the sense that I could track at that point in time, I think, I could track my nutritional intake. Yes, I think it's a premium feature. I liked it, because I was living in the US and was eating a lot of processed food. And I wanted to make sure I was getting enough of my nutrients. And, again, liking my health status. So, if I was, because I have been vitamin D deficient and calcium deficient before, and actually iron deficient, that it was just a way for me to keep on top of it a little.

Fara started tracking calories because she drank beer and ate processed food while she was in the US. She decided not to stop eating or drinking but rather to track and manage. The market forces here offered the food that she wanted to eat and offered an app to manage it. The affordances of counting and the visibility of data were in play here; they provided certainty and planning through the granularity of data. Through these affordances, Fara perceived the control she wanted. She exercised consistently and felt that she was a healthy person; as discussed above, she was an athlete and strong in sports. However, feeling healthy did not matter; the nutrition information on MyFitnessPal mattered more. Again, the constant struggle between the self-tracking environment and the user's control is evident. I probed further about why she abandoned calorie counting after almost six years of the practice:

I think I got tired of tracking every morning. I got really tired. It was tiring keeping up with it. And I think I—at that point in time, with My Fitness Pal, I just got to the point where I was like, I'm not enjoying life. I told you, I can only go on the Garmin Connect website now. It tells me I can link it up with MyFitnessPal. And I was like, "Oh, I do have an account for that. Maybe I should start doing that". And then I was like, "No, no, this is not—you don't

need to eat less. Because if you're monitoring it"—then I'm going to, I know what I'm like. I just need to, as long as I keep exercising and keep doing, like, the good self-care routine that actually for me, doesn't really matter what you eat because I do a lot of vegetables. I eat pretty healthily. Most of the time, honestly, everybody has cheat days and eats at McDonald's. But yeah, if I actually tracked like how much pizza I ate and stuff a week, I'll probably feel really sad about it. And I really enjoy pizza.

Fara paused before answering this question and said that tracking food in general was tiring. Several tracking environments, such as calorie-tracking, demand much more dexterity from users, who must input the information (another example of this tracking environment is menstrual tracking). The calories cannot be counted without the user's involvement. The act of inputting the food makes users feel guilty and experience a lack of control. Fara cannot control what she eats. She loves pizza and cheat days with McDonald's; at the same time, she also eats healthy food and is an active person, and her Garmin praises her resting heart rate and Body Battery, which she considers a sign of good health. Still, counting calories made her feel that she was not in control. The perceived control of tracking her activity conflicted with the perceived lack of control related to calorie counting. She therefore chose a quantification she could control and abandoned one she could not control. I also investigated Garmin's body battery by investigating their methodology of calculation and the Garmin App. The Body Battery is calculated based on physical activity, stress, sleep and heart rate but Garmin doesn't provide an exact calculation formula for body battery. The lack of transparency in the calculation actually helps Fara because she does not have a specific thing like calorie to count. By continuing with her normal activities of exercise and sport along with managing a good night sleep, she can keep the body battery at the desired levels.

The controllability of the Body Battery comes from the non-specificity of the calculation. There was a negotiation between two apps that tracked different things, and the one which gave her an illusion of agency won. Of the two self-tracking environments, the one with the higher agency, which provided a greater perception of control, triumphed. She switched from calorie counting to body battery.

Secondly, there was a conflict between the calorie-tracking environment and the other consumption environments, such as food delivery apps in Fara's case. Food delivery prevailed in that negotiation because she loved eating pizza. Hierarchically, though, the Garmin's Body Battery wins, as the number provided the perception of control Fara wanted. Fara could not control what she ate or the temptations from external forces, but she could control what she did with her body, and as along as the Body Battery was in check, she had the illusion of agency. Through that number, she resists the market forces that are trying to bombard her with offers of food. What was processed food and beers has become one-off cheat days with McDonalds or Pizza. Fara, through the illusion of agency, cleverly manoeuvres through the self-tracking environment, drops calorie counting that she cannot control and embraces Body Battery that she can control. Consumption here becomes a form of resistance against the calorie tracking that restricts Fara and makes her feel bad. It is also a form of resistance against the fast food companies that want to make her eat more.

Several other participants similarly started certain self-tracking practices, but abandoned them because they felt a lack of control in the quantification. For example, Elvett was using calorie tracking for a different reason than Fara. He wanted to gain weight, and the app provided minimum calories that the user should consume every day.

> *I think the biggest thing was I actually found it quite hard to gain weight and hit those numbers. And then eventually like I just got bored of doing it [...] me and my girlfriend care a bit less about foods and how you look.*

Elvett was not able to achieve the recommended calorie numbers and in turn did not achieve a sense of control. This lack of control induced him to abandon the self-tracking practice. Elvett also mentioned that he and his girlfriend started caring less about how they look. The body image issues of men, especially with respect to partners, are not extensively discussed in the mainstream. However, researchers have found that men are also subjected to unrealistic physical expectations by their romantic partners, aided through objectifying media consumption (Zurbriggen et al., 2011). Although Elvett was going to the gym and exercising, he was still conscious about his body and the expectations of his girlfriend. Men face external

pressures to manage beauty standards, diet and exercise geared towards having a toned body. Although Elvett did not explicitly explain that he was working out for this reason, he noted that, as a couple, he and his girlfriend started thinking less about how they look, which suggests that they were thinking about appearances in the past. Elvett, through abandoning, resisted the external pressure to manage his calorie intake. Nevertheless, he could not escape the pressure, so he switched to tracking other aspects that he can control - resting heart rate. As discussed in the previous section, Elvett considered resting heart rate as the marker for good health. A lousy sleep day affects the resting heart rate and Elvett was angry about it because his sleep score was not exhibiting that although his resting heart rates were in control. Elvett switched from calorie counting numbers to heart rate numbers that he can control.

Gia started tracking her menstrual cycle. However, her cycle was irregular and she could not control it.

> *I have a highly irregular cycle. So I used to track it, and I completely gave it up. It never met up in any kind of pattern. So I was like, there's no point. I've got the implant now as well. So that has changed even more. But I think if I was planning on having children, which I'm not anytime soon, or if I came off contraception, I would probably track it.*

Gia could not find any pattern and did not have a sense of control with respect to menstrual tracking. Therefore, she abandoned menstrual tracking, and contraception helped her not to think about it as much. Although contraception does not resolve the lack of control in menstrual tracking, it offers a way to alleviate the irregularity problem. Other participants also discussed using a menstrual cup to counter irregular cycles.

Elvett and Gia manoeuvred through self-tracking and regained control by abandoning tracking activities that they could not control. Instead, they replaced them with tracking that could help them achieve the same goals or completely changing the way the practice is undertaken (e.g., using contraceptives instead of trying to manage the cycle).

The above findings indicate that consumers switch tracking practices because of control (or the lack of it). The switching of practices is effectuated by the affordance of numbers. Only when users actualise the control, they can resist. They cannot completely abandon self-tracking or avoid external pressures, but they can manoeuvre by switching practices. The practices here are temporal, and there are multiple means to the ends they seek. However, users may also realise that a tracking practice will not lead them to the goals that they want or their goals may shift because of market influences. For example, if a person finishes a 5K race, next might be 10K; if a person builds a toned body, he or she will have to maintain it. The drive for self-improvement does not end. Furthermore, the switching is not overt; the participants in this research often did not realise that they were switching from one to another. They used words like "tiring", "obsessed" or "bored" to describe the tracking practices that they abandoned. The switch is tacit and a demonstration of resistance. The manoeuvring is also habitual, because the integrated self-tracking environment helps them to do so. The participants reported manoeuvring through different self-tracking environments whenever they felt a lack of control. The market provides them with new numbers and the cycle continues.

5.2.3. Manoeuvring and manipulation by altering

There are two types of numbers that self-quantification environments provide users. The first is numbers that are created as goals for (or by) the user (e.g., target calories or steps) and the second is calculated numbers that can later become goals. The numbers are either personalised or arbitrary, and these numbers become goals or create goals for the user through quantification. Devices and associated algorithms convert targets, goals and achievements into numbers. For instance, when a user provides his or her current weight and height and goal weight, MyFitnessPal calculates a number of calories that the user should consume per day. The user trusts these numbers and tries to achieve them.

Callia, who has PCOS, previously predicted her menstrual cycle. She sought to lose weight to keep her PCOS-based issues under control, as suggested by the NHS. PCOS also affects her menstrual cycle and in turn her ovulation cycle. When I interviewed Callia, she was not trying to get pregnant, but she wanted to manage her PCOS. She also reported that it made her anxious when her cycle is delayed. For Callia, step tracking and menstrual tracking were interconnected. She had a walking target of 10,000 steps. As previously established, 10,000 was an arbitrary number created for an advertisement campaign and became a gold standard for steps per day without any scientific basis. Callia repeatedly reiterated that she was targeting 10,000 steps because the British Heart Foundation recommended it.

> *And it says a gold standard is to do 10,000 steps a day. And then the British Heart Foundation says that you have to do it, you have to walk certain amount of kilometres a month in order to get fit.*

Callia's statement that walking a certain number of kilometres in a month (or 10,000 steps a day) would help her lose weight relies on the legitimisation of this target by the British Heart Foundation (I was not able to find any instances of the BHF promoting this target, but HeartUK, a charity, widely promotes it).

However, Callia could not achieve this target on an everyday basis, which negatively affected her.

> *The fact that see, my goal is to do 10,000 steps a day. So, even if I don't do 10,000 steps a day, I make it up on other days, you know, some I do 14, on another day, or 15 on the day. So for me that that is kind of realistic. And you know, I guess that's what the National Heart Foundation says that you need to have 10,000 steps a day or something like that. So yes, goals are important. It does make you feel bad though (not achieving).*

Callia perceives a sense of control over her walking because she cannot control other bodily related issues. At the same time, she cannot achieve her target number of steps every day because of her work (mental health nurse). She cannot control that aspect of her life too. Therefore, she alters her walking practice. She walks 14,000 steps or 15,000 steps on one day to compensate for slow days. Thus, as a whole, she achieves the target numbers on a monthly basis. The target given to her is per day, but she changes the time period of quantification so that she can achieve the target at the end of the month (and feel in control). In this way, Callia manoeuvres the target imposed by the app (market force) and the external agency (BHF). Callia strives to fulfil the target numbers imposed on her by the authorities because it enables a sense control of her exercise, body weight and menstrual cycle. She also shared that she was trying to follow diets, but she could not effectively control this area. The one number that she could control was the number of her steps, which was important for her. She therefore alters the time period of quantification, which becomes an act of resistance.

These target numbers are given legitimacy by the health authorities, charities and the NHS, which until the end of 2021 had a separate page recommending apps that can be used to self-track and quantify. Now, the NHS has integrated these apps into the website on different pages. For example, the weight loss page has a list of apps that are recommended by the organisation. Another number promoted by the NHS is 5K (5 kms). Couch to 5K is widely promoted by the NHS on their website, and the NHS have their own app (2020b), which many participants in this research reported using.

The app had more than a million downloads within three months at the peak of the lockdown in 2020 (NHS, 2020a). Although there is research that has studied the efficiency of the program (Mailey and Hsu, 2019), there is no explanation of why and how the NHS decided to recommend the program. The program was developed by an independent runner, Josh Clark, to help his mother (NHS, 2020b), but users are attracted to it because the app has been promoted by the NHS since 2010. There is an accompanying app, podcast and fitness devices which support the program.

> *I don't really run to lose weight; I run because I like I usually like to have a set goal. So, like my friends were suggesting, "hey, let's all do a 5k together". I was like "Okay, so that's more of why I run" and that's why I track my running and share that. But yeah, I did also lock the calories from the runs as well but I'd usually do low ballers so if my watch said it was a 350 calorie run, I'd usually put in like maybe 300. Because I know they're not very accurate and and then I don't want to get stuff in my face because I've done great today.*

Gia obsessively tracks her calories to lose weight, but claimed that she is not running to lose weight. If running aids in weight loss, it is an added perk for her, but she started a 5K program with her friends. External authorities publish target numbers and at the same time, apps and devices provide numbers that develop into goals. Gia reported that she does not follow the numbers that the app tells her and also does not record the exact calorie count that the device tells her. She trusts neither the device nor the app for accuracy. Running is leisure for her, and she seeks control with calorie tracking.

Although target numbers are imposed on users by apps or authorities, through affordances provided by the numbers, users try to control their self-tracking environment and reclaim their agency. Arcadia, for example, shared how she manipulates the numbers, because devices allow users to change the target number of steps. She chooses her targets based on what she can achieve.

At the beginning, when I started doing it, I think like around 6 or 7k steps per day. Sometimes I managed not to fulfil it, sometimes I will fulfil it. But it kind of depends on where I live, and how I was going about my day-to-day stuff. I need to hit 7k. For the sake of getting the points. But now it's just me being frustrated of not hitting a specific step count.

The default numbers provided by a device are not sacrosanct, and the user can change the targets. It might therefore seem that the user has agency to change the targets based on what can do but the device's algorithm recalibrates itself to the target and regains agency. Based on the users activities, it again suggests the user to change to new numbers. The user can stick to the numbers they can achieve or the consistent achievement of goals encourages the user to change the goals based on the suggestion from the device. There is a constant tussle between the user and the self-tracking environment for control as the agency shifts between the two. It is evident that numbers form the centre of this tussle and have more agency than the environment and the user. Number affords counting, visibility, predicting and sense-ability through quantification environment and the user. The human-device assemblage is in negotiation with the numbers they produce and the numbers have stronger agency in shaping how the assemblage works. Arcadia articulated about how as a self-tracker she was dependant on numbers.

You kind of may be dependent on these numbers in these statistics that come out of these applications. So, I think it's kind of you're in control. But are you really in control? So yeah, I think, yeah, it's um, it's somewhere in the middle. I think differently boosts your confidence and you're like, "Oh, yes, I hit 10k today, so might as well just keep going or have read 10 books for the past month", and you're like, satisfied with yourself. But it also can have its negative side like everything. Because you just like I mentioned, you kind of gonna be dependent on numbers. And at some point, you're not going to track your steps for yourself, where you're going to track them for the sake of getting that badge or I don't know boasting to your friends.

One of the things that happened with all the participants they switched from first person conversation to third person conversation when they talked about dependency and manipulation of numbers. Arcadia is ambivalent about the dependency on numbers. The ambivalence might have arose from the fact that she feels confident when the numbers are achieved and when they make her feel bad then she claims that they are negative and she is dependent on numbers. Irrespective of how the numbers make her feel and what the impact is, she is dependent on numbers. There are certain numbers that her external rewards system wants her to achieve but she uses the numbers produced by her self-tracking system to game the system. The external rewards system is a representative of the university system for her. The system that makes her to study, to work part-time and at the same time wants her to go to parties and events, and consume things with the money that they save, at the same time. The university system terms this as "student experience" and "student engagement" (Brooks et al., 2016). The app that Arcadia's university union uses has been adopted by 8 different universities in the UK including University of Bristol, University of Edinburgh and King's College London. The phenomenon is not isolated and various students are using the app in different universities. Universities have become neoliberal spaces in which the competitive and rational individualism has replaced collective good. Universities use numbers to govern students, who are powerless to external uncertainties, such as future job placement, and the value of education is determined by the fees that they pay. Universities see students as consumers, and the students realise it too. The one thing that they can control is the numbers that can be produced through their body, and they use those numbers as a way to resist against the hegemonic authority (in this case, the university). The dependency on numbers helps users to resist and and thus does not bother them, leading to ambivalence. In other words, the students are dependent on numbers, but this dependence allows them to perceive control over their bodies and to earn perks from a system that sees them as consumers (not as students); they use the same numbers to resist the system. Arcadia uses manipulation that is enabled by the perceived control of her body on the app to manoeuvre through the practice and exhibit resistance.

5.2.4. Joyful discovery of numbers

Fara, at one point in time, obsessively tracked her calorie count and food intake through MyFitnessPal. She reflected on how the image of a woman is constructed by the market and how society is conditioned to link self-worth with body image.

> *I would like with MyFitnessPal, often I'd be like, oh, I've done so much exercise, I'm only gonna keep eating the same amount I'm eating. It just annoys me the way the world is a lot of people's self-worth associated with their body image, including my own. And I'm very aware of that. And, I try not to be, but it still happened, because it's so conditioned into me and so conditioned into the society. Not something I'm happy about. But it's something I know happens. So me, I had to really think about like, over the last six, seven years and like why am I counting my calories? Like why am I doing this much exercise? And I had to really like think about the reason why I'm doing as much exercise as I'm doing.*

Fara is aware that neoliberal individualistic society imposes unrealistic beauty norms on women. She also understands how much these norms affect the way she eats and exercises, and she therefore switched from controlling what she eats to enjoying controlling exercise and heart rate. Professional and semi-professional athletes understand the impact of heart rate because they have access to medical-grade devices. Polar, a company known for its wearable sports technology, brought heart rate monitoring to endurance sports in the 1980s (Stahl et al., 2016). Polar was also the first company to introduce wrist-based continuous heart rate monitoring devices in the 1990s (Stahl et al., 2016) Although there were devices before Fitbit Charge HR, the device was one of the prime reasons why heart rate monitoring became ubiquitous and sparked the conversations around heart rate zones and how they impact fitness.

I've always had a relatively low resting heart rate, or about low 50s. Um, I guess it's something I guess it is an indicator of fitness to some extent. So I'm like, well, the fitter I am the no beat, right? So if I can get it below 50, I must be super fit. I try and control it to bring it to its lowest it can be which is probably the time I need to take the device off. Because at that point in time, I'm obsessed with trying to get my heart rate down and it's actually taking focus or whatever I need to do. And so it is nice to see the fluctuations of my heart rate, for example, and my stress, my sleep and you can basically pile them all on top of each other [...] I want to shift focus, because I can you know, that my self-compassion, self-worth, and self-esteem fluctuate. It's like, is a more refined routine, or other subtle differences in my body that if I pick up on this [fluctuations in heart rate], then I can either implement a self-care routine.

The participants all talked about heart rate monitoring, but the level of knowledge varied. While some participants centre their self-tracking practice around heart rate, others, like Fara, talked mainly about resting heart rates. Fara's target for her heart rate was inspired by the data visible to her. She thinks that the lower her resting heart rate, the better her fitness. Heart rate was a joyful discovery for her because she wanted to abandon calorie tracking, which made her question her self-worth. When she got a device (first her phone and then her Garmin) that could track heart rate, she slowly phased out calorie tracking. Heart rate tracking along with body battery (whose major component is heart rate tracking) became central to her self-quantification, and she links her stress levels, sleep and exercise to those numbers. She feels a sense of control over her heart rate, and through that control, demonstrates her resistance towards a society that is judging her self-worth through body image. She has not stopped her hockey, cycling or hiking. Fara also noted how to reduce her heart rate if she feels anxious or stressed.

> *I was laying in the hammock (outside) more before I got the device. And I was actually really happy and really relaxed because I was just like lying in a hammock, reading a book. But, now I've noticed that if I want to decrease my stress levels, the best ways for me are just to lie on my hammock and think about maybe not think about work or watch something that actually really helps.*

For Fara, lying in a hammock without being stressed about work or tracking is a form of resistance against external forces that want her to work hard, play hard and track hard. Fara shared that she used to feel relaxed when she was in the hammock, and because of her self-tracking, she lied less on her hammock. Self-tracking pushed her to run or drink water or do other activities to reduce her stress and anxiety, but through her heart rate tracking, she learned that leisure best reduces her stress. This was again a joyful discovery that she used to resist the self-tracking practice. In addition, Fara gained a better understanding of her body image, which led her to resist.

5.2.5. Polymorphic simulations of consumers

The control that users perceive helps them to switch to different types of self-trackers. Each of these simulations that they show through this perception creates resistance against a hegemonic authority.

Gia becomes a *meticulous planner* when she uses MyFitnessPal to carefully count what she eats. This self-tracking practice gives her control of her meals. At the same time, this need for control comes from anger that she has toward the market that is inducing her to eat unhealthy food and society that imposes unrealistic body image expectations. Gia becomes an *angry activist* in that regard, but she is unable to demonstrate anger in any other way than planning her meals. Gia runs for leisure and she deliberately underplays the impact of running on her weight loss because she wants to keep this practice as something she loves to do instead of part of her planning environment. Gia wants to escape from the controlled environments that she has created and therefore becomes a *leisure seeker*. Gia morphs into different forms in

her self-tracking environments based on the context, and these self-tracking environments are created by her relationships with the same device or different devices. Each of her quantification is a form of resistance against a hegemonic authority. While her calorie counting is a form of resistance against the delivery apps and fast food environment that wants her to eat more, it is also an expression of anger against societal pressures on a woman.

The running environment is a form of deliberate resistance against calorie tracking, although it aids in her weight loss. The different quantifications are expressions of resistance in different forms. Through counting her steps, Dors achieves certainty about her health (regarding her thyroid condition) and through her certainty, she can feel a sense of control of her health issues. In this way, she assumes the role of a *self-carer*. She also alters her mood tracker to add activities that she wants to track so that the app gives an overall good average mood for the week or the month. She therefore assumes the role of *mood manipulator* of her own moods. She does both to take control of her body and mind at the same time. One practice gives a perception of control of her body while the other gives a perception of control of her mind, both actualised by the affordances of numbers. She demonstrates resistance to the lack of control she has in her personal life, because of her health, and in her professional life, because people are leaving around her, through self-quantification.

Ivy plans her life through menstrual quantification and adopts the role of a *meticulous planner* for herself and her friends. They share their predicted data with each other and try to plan their holidays accordingly. Menstrual prediction also gives certainty to Ivy's feelings and emotions. In this way, she assumes the role of *mental self-care specialist*. She also jokes about her ovulation cycle to her friends, assuming the role of *playful jester*. The perception of control of her menstrual cycle allows Ivy to assume various roles in the same self-tracking environment. Ivy expresses multiple levels of resistance through her self-quantification.

Firstly, planning happens against the societal taboo that surrounds menstruation and the perception of women as impure during menstruation. Although conversations have progressed over the years, menstruation is still not discussed openly in public and among partners. Tracking and quantification provide a way to discuss these topics openly and even joke about it to friends. Women use these discussions to resist the norms imposed on them.

Secondly, compassionate holidays for period days are still not common, and women are expected to manage their lives around period pain and complications. Women resist by planning their lives around their cycles, and the inaccuracy does not matter because all they need is a ball park date to plan. They plan clothes, medicines, sanitary tools (menstrual cup, sanitary pads) and their sex life. Thirdly, all of the women participants identified their menstrual cycle tracking app through recommendations from friends or colleagues. Before this point, there were conversations among family members, but quantification by an app makes it easier to converse with friends. The jokes that accompany the sharing represent a way to resist taboos that stem from a patriarchal mindset. Fourthly, the patriarchal mindset suggests that women are responsible for the contraception in a relationship. This notion was treated as a matter of fact in the interviews, and it was implied that it is a woman's responsibility to have contraceptives. There were also participants, like Callia, who had to take responsibility for getting pregnant.

The romanticisation of motherhood forces women to adopt ovulation tracking. While society has made contraception and conception women's responsibilities, women have used the same planning tools to reclaim their agency. The tracking, quantification and prediction of ovulation are all new tools of resistance against the pressure levied on women by society. The tools were developed to help women to manage and adhere to gendered expectations, but through self-tracking practices, women fight by planning around their uncertainties. Similar polymorphic simulations can be seen in other participants. Spark, for example, becomes a *master planner* of his future through meticulous financial planning and becomes a *leisure seeker* when he wants to buy gifts and take up mountaineering as a hobby. Both roles are enabled by the planning actualised by affordance of prediction that is an effect of self-quantification practices. Spark uses the prediction as a way to resist the societal pressures that force him into a position of primary financial provider for the family. Consumers employ multiple tricks – such as manoeuvring, manipulation, joyful discoveries and polymorphic simulations – to resist against the hegemonic external pressures in their lives. These tricks are enabled by the perception of control that is effectuated by planning, certainty and progress actualised by affordances of counting, predicting, visibility and sense-ability from the self-tracking environment and the numbers that are produced in these environments.

6. Discussion

The previous chapter explored the gamut of self-quantification activities by users. The self-tracking environment provides four different affordances – counting, prediction, visibility and sense-ability. Consumers actualise these affordances as planning, certainty and progress. The actualised affordances provide a perception of control in their lives. Through the perception of control, consumers resist the external hegemonic neoliberalism that tries to control them. While the markets try to control them with numbers, consumers resist with the numbers that give them the perception of control.

In this chapter, I discuss the theoretical significance of the findings and demonstrate how self-quantification practices represent an act of resistance through De Certeau's tactics of the weak. In addition, I provide an alternative explanation to the existing assumptions about self-quantification. I also compare and contrast the findings with different theorisations and discuss the theoretical and managerial implications.

6.1. Neoliberalism and Quantification

David Harvey (2005), in his book *A Brief History of Neoliberalism*, argued that neoliberalism has become "hegemonic as a mode of discourse". Neoliberalism is so pervasive that it has become part of everyday life, incorporated into the common sense way of interpreting, living and understanding the world (Harvey, 2005). At the core of neoliberalism is a preference for private interests over collective public goals.

Once merely an economic and political ideology, neoliberalism has seeped into everyday life and defined a successful individual (Datta and Chakraborty, 2018). The neoliberal individual is subjected to an endless journey of self-improvement towards a perfect life that is, in truth, non-existent. The neoliberal world does imposition of responsibilisation through hegemonic ideas like aggressive individualism (e.g., dating apps), market efficiency, the gig economy, fierce competition (e.g., university admissions, job market), credit-based life style, social

capital and unrealistic ideals. In order to show progress and improvement in the neoliberal subject's life, the markets use numbers and quantification. Life is managed through numbers like credit scores, competitive exam numbers, university grades, number of likes and shares, productivity hours, match scores in dating apps, customer approval ratings in gig economies and Uber rating. The life of any individual is expressed through numbers, and in the path of self-improvement, quantifying one's own life is another way imposing numbers into the life of neoliberal subjects. The promise of self-quantification is self-knowledge, and through self-knowledge, consumers are expected to improve their health stats; manage their sleep, menstrual cycle and productivity and achieve a happy mental state so they can work and consume in the market. Self-quantification technologies and practices are employed by neoliberal forces to push focus towards the personal behaviour and self-responsibility of citizens. In parallel, governments are reducing funds for social welfare and health care across the world (Lupton, 2015). In this research, the participants consistently discussed improvement of their self and individual progress. Self-quantifying users are influenced by the neoliberal hegemony in the market through various sources. In the findings, I elaborated on how women are subjected to ideal beauty standards that are determined by numbers such as weight, proportions and dress sizes. They are also imbibed from a young age to "manage" their menstrual cycle through tracking and using sanitary pads or menstrual cups so that they can be productive at work and school. In addition, society has constructed a taboo around the subject and constrains women from discussing their cycle with peers, partners and even friends. On the one hand, women should be productive for the market, and on the other, the discussion should be curbed so that they collectively fight for compassionate holidays at work and school. Women are also expected to manage their ovulation cycle because they have been taught by patriarchal society that contraception is their responsibility. At the same time, motherhood is romanticised by society, where mothers have to be perfect in their jobs, families, fitness and social relations. Women alone are given the responsibility to become pregnant. The neoliberal outlook of gender equality is about keeping women individualised and keeping them away from solidarity and collective empowerment (Kabeer, 1999).

Men, like women, are subjected to unrealistic body standards, according to which they are expected to have a perfect body, specific looks and masculine image. Men are expected to participate in sports and keep themselves fit across all ages and health conditions.

Irrespective of gender, a neoliberal subject is forced to conduct financial planning, save and have a good credit score and yet consistently needs to also spend on leisure consumption activities like food, travel and entertainment. Due to the lack of social welfare, personal financial planning has become a private responsibility of consumers, who have to take care of their own financial wellbeing in case of emergencies. Among the couples I interviewed, the responsibility of household financial planning is invariably assumed by the men, although both men and women take care of the spending. Neoliberal gender equality norms suggest that women should be successful and financially viable but also absolve them of financial responsibility.

6.2. How neoliberalism uses quantification

Quantification and numbers have always been a part of modern societies in administration, science and markets despite a deeply problematic history of counting enslaved people and deaths (Wernimont, 2019). The core of neoliberalism as an economic principle is individualisation, deregulation and decentralisation. The social practice of neoliberalism thrives on individualisation and competition. Researchers have established that European imperialism was successful because of the paradigm switch from a qualitative worldview to a quantitative worldview (Lea, 2016). Quantification thus predates neoliberalism and has been expanded by market forces for use as a control mechanism over consumers. Neoliberalism has used macro quantification and statistics in administration, economics and democracy to exhibit power over citizens (Mennicken and Espeland, 2019). Even the numbers that are used on the consumer, (e.g., test benchmarks) are derivatives of statistical data. Self-quantification numbers are produced by the consumer as a result of micro quantification of their bodies and activities. There is a fundamental difference between the way the numbers are produced. Although self-quantification is not new, the market forces saw an opportunity to bring medical-grade devices to the hands of consumers due to the popularity of smartphones. The technology exposed new data that were not possible before and opened up new possibilities of quantification. Self-quantification of one's life is yet another way that neoliberal actors found to push self-improvement on the consumer. Self-knowledge through numbers was the starting point of quantified self movement.

The neoliberal thought process of individualisation forms the basis for self-quantification. Tirapani and Willmott (2022) disaggregated individualisation into responsibilisation and quantification. Under responsibilisation, they identified the social, legal and managerial practices that make the individual responsible for their success, self-improvement and welfare (Tirapani and Willmott, 2022). Responsibilisation is advanced through self-quantification, where each aspect of life is tracked, measured and compared. The self-referential feedback system discounts broader issues that impact tracked practices. For example, broader issues about women's health and unrealistic expectations are muddled by menstrual cycle tracking.

Market forces use both macro and micro quantification to impose the idea of self-improvement on consumers. Each self-quantification practice is linked to one or more macro-quantification numbers. Calorie counting, for instance, is linked to BMI and ideal weight measurements, menstrual cycle prediction is linked to the productivity of women, and step counting and activity tracking are linked to insurance premiums. Sharing all of these data with friends increases competition. Self-quantification practices have been adopted by companies to improve the well-being of workers and thereby improve productivity. Healthy, self-improving employees mean more work can be extracted from employees for the same salary. Companies also award perks to employees when they achieve goals and show progress in their personal self-improvement.

Neoliberalism reduces the human effort to numbers and ascribes meaning to numbers that are meaningless. Take, for instance, the number of steps. This number does not have any meaning unless it is linked with a contextual purpose of losing weight. The contextual purpose is created by the self-improvement discourse, and consumers share the meaning and start the self-quantification practice. The discourse makes users think they are inadequate and they have to improve to become complete. The goals for completion are shifted every time a goal is completed, and the inadequacy is kept alive. The constant inadequacy is what pushes the weak consumer to resist. In the findings section, I explained how self-quantification users perceive specific affordances through the numbers they produce and actualise certainty, planning and progress through those numbers. These affordances are multiple stabilities of the human-device assemblage and are embodied in the assemblage. The users actualise the

embodied affordances, and that leads to control. The control produces tacit and under-hood resistance tactics. For example, switching quantification of one aspect to another is invisible and not a conscious decision to change. The switching happens instantaneously when the users cannot actualise that affordance. In another example, the polymorphic simulations of users are tacit, pre-reflective and situational. The resistances are embodied in how users have made self-quantification an everyday habitual practice. The number production of self-quantification has also become cyclical and never-ending. In the next section, I explain how resistance is a habitual resistance through numbers and is an embodied everyday aspect created through self-quantification.

6.3. Self-quantification – An Act of Habitual Resistance

The findings in the last chapter suggest that the resistance exhibited by self-tracking consumers is a tactic of the weak against the strategies of the strong. I theorise that self-quantification is an act of habitual resistance that consistently pushes against hegemonic neo-liberal practices. I derive the definition of habit from Merleau-Ponty (1962), who describes a habit as neither a form of knowledge nor an involuntary action, but rather a form of knowledge that emerges only when the body makes an effort and cannot be detached from the effort. Merleau-Ponty (1962) stated that habits emerge from the interactions of the body with other actors and the environment. Ihde's (2008) theorisation of postphenomenology derives the concept of habit and embodiment from Merleau Ponty's (1962) theorisation. Merleau-Ponty (1962) defined the body as sediments of past experiences whose layers manifest and structure human perceptions and meanings. He defined the body as a habit and habituation as part of human nature. "Habit is a power to conserve structures of perception, communication and action which prove useful to us, thereby enhancing agency. Moreover, it lends our lives continuity" (Crossley, 2013, 146). The continuity of life helps humans to restart what they started yesterday, and this continuity manifests in history and culture. Merleau-Ponty argued that sight is also a motor habit, like the blind man's cane, because it is embodied and tacit. Researchers have studied and theorised tacit habits through this lens, including the gendered body experiences of women while running (Allen-Collinson, 2013), racist perception as a habit (Ngo, 2016) and how self-trackers feel data through haptic cues.

I define habitual resistance as a pre-reflective, non-automatic, embodied situational response to neoliberal authority. Resistance is formed by the user because of the accumulation of tactics over a period of time and becomes an underlying part of the practice itself. Resistance is not pronounced and is habituated by the human-device assemblage as it becomes part of the assemblage itself. Resistance is not a separate entity, but it is irregular and situational, so it is not a mechanical habit of the assemblage. In this section, I elaborate on the various characteristics of resistance enacted by users.

6.3.1. Pre-reflective and non-automatic

Resistance is a response to an action and does not evolve independently. Users respond to the lack of control in their external lives, and through self-quantification, they regain the perception of control. The responses that stem out of that perception manifest as resistance. Users do not explicitly understand that they are resisting an act of enforcement. Thus, the resistance that is observed is a first-order response and not an explicit, self-conscious decision. The resistance is pre-reflective, tacit and non-automatic. Pre-reflective does not mean that resistance is immediate as a response to stimuli but rather an accumulation of past experiences. Pre-reflective means that self-consciousness is already existing in the user, and resistance is a result of the pre-existing underlying sedimentation of experiences. Resistance is tacit, as it is not expressed or understood by the assemblage itself. Pre-reflective can be misconstrued as self-knowledge. Self-knowledge is a reflective practice and decisions are taken based on the data provided by the self-tracking. For example, Fara explained how she gradually got tired of tracking and switched from calorie counting to the body battery number. This switch happened when she bought the Garmin watch as it had a new number to track, which she could control. The decision to buy the new device was not influenced by a desire to switch. The switching was implicit and influenced by the device, not the other way around. The body battery is measured by Garmin, but Fara would likely have switched to another number (e.g., heart rate) depending on the device she purchased. The assemblage of the user (Fara) and the device (Garmin) produces a number (Body battery) that creates an act of resistance. If Fara has switched after reflection of data provided by her previous device and knowledge acquired by that, then it could be termed as a decision based on self-knowledge. But the switching happens based on a pre-reflective response initiated by the

device and not the human. Fara's decision to track body battery is not a conscious reflective decision based on a rational process but a habitual response to the tiredness that occurred because of calorie counting. Resistance and self-quantification are not automatic responses to an imposition. Here, non-automatic does not mean that it is a rational decision; instead, there is a human action to resist. Resistance is enacted by the human subject and induced by the numbers. It was also observed that counting, prediction, visibility and sense-ability are relational properties between humans and the environment. Fara's change in practice was a response to the lack of control in calorie counting and the societal imposition of body image. The switch also happened because of her joyful discovery of heart rate, which again is a non-automatic response to something she cannot control. Fara switched practices as a form of resistance but did not understand her action as resistance.

Nevertheless, even when Garmin wanted her to link to MyFitnessPal, she decided not to connect the apps. The switching and rejecting are the ways she resists, and the resistance becomes part of the self-quantification practice itself.

6.3.2. Embodied

Embodiment can be defined as how humans live and experience the world through their bodies through perception, movement, emotion, language and sensory features. Embodiment allows humans to perceive and experience things that are hidden in everyday life, which manifests into habits. Embodiment is affected by the physical and technological environment. Humanist and post-humanist theories have taken "digital dualist" positions which neglect the embodiment of the virtual self. Virtual bodies cannot be completely divorced from the physical body and are subjected to the same social realities of the physical world (Matich et al., 2019).

Self-quantification creates an extended human body on a device, as observed in various accounts of participants, who reported that they can see, feel and experience their bodies through self-tracking. Users control and manipulate their digital bodies because of the lack of control in the physical world. Resistance is exhibited through the manipulation of numbers

and polymorphic simulations. One's digital body represents the ideal version of the physical body – for Gia, by achieving the ideal calorie count; for Fara, by achieving the ideal heart rate; for Arcadia, by completing the daily step count; for Ember, by raising her plants healthily and for Spark, by having better financial success. These ideal digital selves are resistance responses to external pressures imposed on users.

Self-quantification is unique because of the entanglement of the device and the user's physical body. The numbers produced by the device impact the physical body. The body reacts to the numbers, and some of these reactions become an act of resistance embodied by the user. For example, Gia achieved her target calorie count on an everyday basis, and after a period of time, she absorbed the numbers and calculated her own targets through mental math. Gia demonstrated her resistance by avoiding calorie numbers provided by the app. The practice remained, but the resistance is towards the authority of the app and the societal body image issues she is angry about. Thus, resistance becomes an underlying response and is gradually habituated by the user and the device.

6.3.3. Situational and irregular

Although resistance is embodied and habituated, it is also irregular and situational. Users are not continuously resisting their quantification. This can be observed even with the affordance actualisations, like planning, where users plan based on situational requirements. Devices constantly collect data, but the users do not access the data all the time. Self-quantification happens from the user side only when users view and access the data. Thus, self-quantification is irregular and situational. Only when a situation arises does the user respond to the act, which manifests into resistance.

During the interactions, the users hinted at a consistent practice of keeping notifications off for the tracking apps that they do not consider important. For example, Ember shared that she is happy to get notifications from Plant Nanny but not from other apps. Instead, users wanted to access the data occasionally and only from the apps they deemed necessary. For example, Callia sees her data when she wants to and manipulates the time period. Ivy accesses

menstrual cycle predictions only when there is a need for planning. The prediction is consistently produced by the device, but it is actualised only when Ivy accesses and uses it for planning. The perceived control that stems from the actualisation is also irregular and situational, as is the resistance from the assemblage. The resistance can be observed only when the situation arises. For example, Arcadia manipulates the step count only when she wants to complete the goals. Dors becomes a mood manipulator when she wants to feel good about the day and when she wants her average mood to be positive.

Habitual resistance is ingrained in the human-device assemblage and enacted intermittently whenever the user is in a situation to actualise it through the accumulation of tactics. As noted in the previous section, the polymorphic simulations demonstrate that there are multiple levels of resistance enacted by the user in different self-tracking environments.

6.4. Habitual Resistance vis-a-vis Other Resistance Discourses

Habitual resistance is situated in the agency and empowerment discourse of consumer culture that provides more autonomy to the user against the enslaving strategies of authoritarian industries (Izberk-Bilgin, 2010). In this discourse, I have elaborated on the everyday micro-practices in self-quantification that resist neoliberal strategies. Resistance is habituated by the user through the embodiment of the device. De Certeau (1984) stated that resistance is inevitable, and consumers are immigrants in a system they can escape from; therefore, they find ways to resist against the dominant system. There are multiple dominant systems that are being resisted in the self-quantification realm because of the variations in practice. Every self-tracking environment resists a different system.

I concur with the arguments of Sharon and Zandbergen (2017) that the quantified self and self-tracking do not represent a celebratory or reactionary practice but a nuanced combination of self-tracking activities that provide different meanings to the user. However, I disagree regarding the way they view the data and consider all users as part of the quantified self movement. The quantified self phenomenon is ubiquitous, and the proliferation of low-cost devices and apps has expanded the population of users. Indeed, calling it a movement would

be a disservice. Furthermore, Sharon and Zandbergen (2017) consider self-quantification as part of big data and refer to self-quantifiers as producers of big data. Although the data that they produce is part of the big data for companies and governmental agencies, individual users do not consider themselves as big data producers, nor do they have extensive data analysis practice. The findings demonstrate how users are specific about certain numbers that they consider important and track them relentlessly. The other data provided by the environment becomes peripheral data with relatively less importance. Users are not data-obsessed individuals who constantly track, analyse and quantify data, but the numbers have become part of their everyday lives. Consumers are already governed by numbers (including self-quantification) in their daily life. The numbers produced by self-quantification are added to their existing array of numbers to which users are exposed.

Sharon and Zandbergen (2017) also elaborated on the various forms of agency enacted by users and how they resist through recalibrating social norms. They posited that the QS movement is a counterculture movement based on the digital resistance practices of the technological culture of Silicon valley exhibited by companies like Google and Apple against the norms of society at large. The argument fits the QS movement, as the majority of early self-trackers were techies working in such companies. However, the theorisation does not conform to the users who act based on the data that is exposed to them. Self-quantification as elaborated in this discourse, show that it is a form of micro-resistance against neoliberal strategies, not a form of organised activism or counterculture movement against society.

6.5. Habitual Resistance vis-a-vis Foucauldian Self-Governance and Resistance

There are two streams of sociological discourse through a Foucauldian lens. The first stream of research sees the self-tracking individual as someone who undertakes the practice for self-knowledge in order to lead a data-driven lifestyle to self-govern themselves and be responsible citizens (Lupton, 2012; Pantzar and Ruckenstein, 2015; Catlaw and Sandberg, 2018; Zakariah et al., 2021).

Catlaw and Sandberg (2018) theorised that self-quantification had created a new form of info-liberal subject, as the consumers adhere to the individualisation project of neoliberalism, but data collection is democratised as users are co-creating the data along with the device and the environment. The authors defined the co-creation of data as self-government according to the Foucauldian definition of government. Zakariah et al. (2021) drew from Catlaw and Sandberg's (2018) research and concluded that users had created their own self-identities and switched between them to achieve their goals. The authors acknowledged the fact that self-trackers fail in the process of achieving the goals of self-discipline.

Through the findings in my research, I problematise the idea of self-discipline. I argue that users are not looking to achieve goals because they want to see better versions of their self. The better version is instead defined by market forces and external authorities. Agencies like the NHS stipulate health numbers, and users follow them without question. Thus, self-discipline is not actually self-induced, but rather market-induced, and self-quantification is another method of external forces imposing biopower over humans. The self-knowledge discourse of self-tracking is not viable. Quantification offers data, and users have to make sense of the numbers to create knowledge. However, users are not actively seeking knowledge about their self, as evident in the selective tracking by users. Integrated self-quantification allows users to choose the aspects they want to track and control. The numbers produced by self-quantification provide the control. The findings also demonstrate that users are manipulating the goals and that self-quantification is irregular and situational. When users lose control of a goal, they either alter the goal or switch the practice itself. Users often continue to self-track, but the perception of control is more critical than self-knowledge because of the general lack of control in their lives. The perception leads to various forms of micro-resistance tactics against self-quantification and the market that induced the self-quantification.

The second stream of Foucauldian-based research is the idea of imposed surveillance and the biopolitics of governments and corporations which use self-tracking technologies for control. Sanders (2017), for example, elaborated on how these technologies help the beauty industry to push normative beauty standards, and Charitsis et al. (2018) posited that self-tracking practices are used by corporations to exploit labour and commodify the data. Goodyear et al.

(2019) explored how self-tracking individuals resist self-quantification when they are imposed by an authority, but this resistance is not tacit, as self-trackers completely reject the practice through a lack of engagement.

Researchers who study self-tracking have consistently linked Foucault's theory of biopower to self-tracking (Lupton, 2012) and affirm that people are forced to adhere to the norms of governments through self-responsibilisation. The other side of the argument is the panopticon metaphor of surveillance proposed by Foucault (1995), which elaborates on how the scrutiny of the powerful can force consumers to undertake self-optimisation activities. According to Foucault (1995), where there is power, there will be resistance. Foucault proposed that humans articulate their freedom through resistance that is creative and productive (1995). Scholars who have studied self-quantification through a Foucauldian lens of resistance and power have suggested resistance mechanisms, like the delinking of self-tracking devices from corporate surveillance systems (Whitson, 2015) and reimagining systems to create "micro-politics of resistance" (Fox, 2017). Although researchers call these mechanisms practical solutions, with the power of self-tracking with corporate systems, these solutions are unviable. The Foucauldian lens has been used to observe the surveillance power of self-quantification practices, but the discussion on larger neoliberal forces is nearly non-existent.

I concur with the argument that self-quantification practices are used as surveillance systems to impose biopolitical power on subjects, but the reality is that users cannot escape the self-optimisation promulgation. Self-quantification is yet another tool in the arsenal of the neoliberal world to control its subjects, and that was evident in the interactions with users, and the inevitability was evident. Users have started using the tool (self-quantification) against the hegemonic practices of neoliberalism. Esmonde (2020) arrived at similar findings when they studied the gendered practices of fitness tracking and how women are resisting self-tracking imposition through the Foucauldian lens of resistance. The users demonstrate resistance in various ways, including labelling data as excessive, choosing not to track every day and making feelings more important than numbers. Esmonde theorised that these behaviours are forms of push and pull resistance and are explicit decisions of the users. In contrast, I identified that these micro-tactics are under the hood, implicit, embodied and habitual.

As explained above, the majority of the existing studies observe consumer resistance to self-tracking through specific practices, which neglects the impact of external market forces. In this research, I have conceptualised self-quantification as an act of habitual resistance against the neoliberalism project of individualisation and responsibilisation.

6.6. Implications of Habitual Resistance

Self-tracking is ubiquitous, and more and more people are adopting quantification practices. The market is growing at an average of 20%, and there is a proliferation of low-cost apps. The market is providing new ways of using tracking devices. For example, Apple is poised to introduce a temperature sensor in the upcoming Apple Watch 8 (Rogerson, 2022), while the latest Fitbit focuses on holistic wellness and stress (Ellis, 2022). The former is trying to replace physicians (similar to the introduction of commercial thermometers), and latter is pushing the neoliberal productivity project by asking users to manage their stress. After the overturning of *Roe v. Wade* by the U.S. Supreme court, women have started deleting their pregnancy tracking and menstrual tracking apps as social researchers allay fears that the data could be used to persecute women who want to abort their pregnancies (Morrison, 2022). Meanwhile, insurance companies are using tracking devices for health and vehicle insurance (Olson, 2014), while the NHS has been advertising these apps for self-improvement.

The self-optimisation project is inescapable, and most users undertake at least one form of tracking, even if it is manual. One of the participants, Gaal, had an extensive manual practice of tracking her moods and meticulous diaries that extended for years. Although technology provides its own affordances, there are users who perform manual tracking. The findings reveal that many users have some form of manual tracking before starting with technology. The self-optimisation project predates technology, and so do the micro-tactics of resistance. De Certeau (1984) stated that the tactics of the weak do not provide any gains or transformational effect. They provide only temporary reappropriation in a system that is physically and symbolically imposed on the users. Thus, the question emerges whether these micro forms of resistance are meaningless.

Studying self-quantification through De Certeau has brought out new forms of resistance and shows that users are resisting hegemonic practices not by abandoning the practices, but by thriving and finding alternative ways to live within the system. Users have more agency and are more empowered compared to being considered as mere data points in the big data realm. The habitual resistance exhibited by users is intermittent and disparate and may seem meaningless in a broader societal context. However, these practices are widespread across self-tracking users. As there are multiple tracking devices and different apps, resistance practices also morph based on what users are tracking and quantifying. Self-tracking users are fundamentally, yet gradually, changing how they eat, travel, exercise, sleep and have sex using quantification. Through menstrual cycle apps, women are changing how they travel, exercise and dress. They use these apps as a way to regain agency over their bodies. Self-tracking users also use calorie tracking apps to change how they consume food delivery apps. Meanwhile, sleep tracking apps change how users consume their media, food and alcohol. As a whole, small, disparate micro-resistance through self-quantification is helping users to regain control of their bodies and lives. This control creates resistance, and resistance helps in regaining more control.

My discourse does not exemplify how self-tracking users can resist (nor does it give a toolkit for resistance like activism), but it demonstrates how users resist. The users that I talked to use self-quantification on different devices, ranging from enthusiastic tracking to mundane access to data and even outright rejection of certain tracking aspects (calorie tracking being an universal candidate for rejection). This multitude of attitudes can be seen in a single user. Resistance leaves the overriding neoliberal system intact but helps users to thrive in the system. The same form of resistance can be seen in other technological systems, like the World Wide Web, where users constructing their own set of practices to use the system to their advantage is inevitable.

My thesis alludes to the idea that there is human agency to resist the neoliberal project and the empowerment is enabled by the technological mediation. Human agency is understood as the matter of individualised choices and private concerns rather than emphasising on the influence of societal and external market forces (Esposito and Perez, 2014). For majority of the users, human agency means consumer choice of purchasing and neoliberal market forces

use this to enforce their ideals of self-optimisation and individualised consumerism (Esposito and Perez, 2014). The immediate critical response to the agency and empowerment discourse would be that whether neoliberal agenda would use that against the consumers. Habitual resistance is exhibited by the self-quantifying consumers not purely by choice or only through their actions. The resistance cannot be exhibited without the technology or the environment it operates. The enactment of resistance changes based on the the tracking practice and the environment of the practice. For example, the same type of tracking practice provides two different forms of resistance for different users depending on the affordance they perceive and how they actualise it. The habitual resistance cannot be enacted purely through human agency and through my discourse I am arguing that self-tracking devices and apps should be studied as a complex assemblage along with the environment instead of studying them in isolation. When it is studied in isolation, the discourse gets limited to certain limited paradigm presuppositions.

Habitual resistance can also be used against consumers, as observed in the pregnancy tracking apps issue in the United States. There have been complaints about how these apps use data for commercial purposes. For example, the Mozilla Foundation found that 18 out of 25 popular pregnancy tracker apps share data in one form or another (Hardcastle, 2022). The concern is not about sharing data only with governmental agencies but also with employers and advertising platforms, and there are reports of certain apps knowing that users were pregnant before they knew (Ricapito, 2020). What if companies determine that women are using menstrual apps for travel and social events planning and start using the tracking data for personalised advertising? This idea is a plausible stark reality, but resistance against such impositions is also inevitable. Neoliberal society wants consumers to self-optimise and self-govern so that they can form an individualised and productive society. Neoliberalism detests collectivist ideals. Habitual resistance is a surreptitious protest against neoliberalist institutions that may lead to a more ethical approach of self-tracking practices from authorities and market forces.

After Roe vs Wade was overturned in the US, the focus has turned towards the privacy of self-quantification apps and devices. Although there were calls for deletion of the menstrual cycling apps, women are using the apps to monitor their pregnancy. The companies were forced to respond and the most popular app in the US, Flo, introduced anonymous profiles (Ostwal, 2022) while Clue provided a statement that they adhere to GDPR regulations of Europe (Ricapito, 2020). Users will find ways to traverse these issues and create new ways to exhibit habitual resistances. The micro resistances will force the companies and regulatory authorities to change ways. At the same time, these micro-resistances provide the necessary resistance against neoliberalism. While the neoliberal market wants to optimise an individual through self-quantification mechanisms, self-trackers flip those practices to resist against the same neoliberal practices. Although these are individual resistances, they can be observed across the board in different ways and in various quantification practices. Collectively these resistances accumulate and fundamentally change the way the practice that is being tracked. As elaborated earlier, the habitual resistances exhibited by the self-tracking consumers have altered the way people eat, sleep, run, exercise and walk. Like how people have found ways to traverse the Internet practices, it is inevitable in self-tracking practices too. The companies will take note of these resistances and services that serve these resistances will find its way. For example, MyFitnessPal did not interest in tech giants when it was sold by Under Armour in 2020 and they sold it to an investment fund at a loss (Curry, 2023). MyFitnessPal is using tactics like making their most important feature of barcode scanning as a premium feature to increase their subscriptions. If they understood how diet tracking practices have changed and how users are resisting, diet tracking apps would change their strategy.

Habitual resistance poses a different challenge politically as the existing discourse on political implications of self-quantification have discounted the human agency and characterised the users as powerless (Lupton, 2016). Although, the technologically savvy users have formulated their own self-quantification regimes to take back control of the data (dataveillance), majority of the users rely on commercially available self-tracking technologies and they have zero control on how the data is being used (Lupton, 2016). Habitual resistance shows that users are creating their own integrated self-quantification environment and through that they choose to share the data that they want to share. For instance, multiple respondents have illustrated how to they restrict location data to protect

their privacy. The research shows that humans are regaining certain level of agency through micro-resistances and there was a general realisation that their data can be used in many other ways by the company. The existing regulations of data privacy and data protection like GDPR and Data Protection Act provide some level protection but self-quantification is complex assemblage where the users voluntarily part data to the companies and external agencies. There is also confusion with respect to health related data and how health data regulations would safeguard such data (Addonizio, 2016). Alhajri et al., (2022) identified four privacy issues with respect to self-quantification devices and apps, lack of system transparency, lack of privacy policy legibility, concerns regarding one-time consent, and issues of noncompliance regarding consent management. Apart from that, hidden data is collected by the apps and devices that are not exposed to the users and this creates an power inequality between the user and the market. Zuboff (2019) calls this "surveillance exceptionalism" and she brings in the idea of counter declaration and synthetic declaration. Habitual resistance is a form of counter-declaration from the users that resists through tactics but there needs to be synthetic declaration through regulations and legal. While the industry is providing solutions like blockchain encryption and self-regulation (Kacmaz), it doesn't provide the power to the users to understand the data that is being collected and control how the data can be shared. Users will find new micro-resistances or completely abandon practices but it will not solve the issue. As the users through their micro-resistances are showing intent to take back control of the data, it is imminent to provide legal protection to the users and dismantle surveillance exceptionalism.

Another significant implication of this research is that self-quantification is part of an integrated environment and not an personalised, isolated environment of a specific aspect. Users do not track just one aspect of their lives, and everything is interconnected, including goals and impact. Users have created their own self-tracking environment(s) where they assign different levels of importance to each of their self-tracking numbers. The importance is chosen based on the level of control that they perceive in each of their chosen self-quantification activities. The next important implication is the self-knowledge-based marketing is no longer viable because users do not consider the numbers and implications to be knowledge. The numbers give visibility to specific data that were not exposed in the past, but users do not valorise this data or make rational decisions around it. Terming self-

quantification as knowledge itself gives an impression that users are rational human beings with rational thought process trying to make informed decisions. However, this research reveals that the actions are implicit, emotional and gradual.

Further, I observed that users are exhibiting resistance to the practices that are imposed on them. Users buy into the self-optimisation paradigm and start related practices, but they recalibrate. The market should acknowledge this resistance and its effects. While governmental agencies are widely pushing the self-tracking agenda, they need to consider the wider ethical, emotional and physical impacts that these practices are creating and how users are manoeuvring these issues through their resistance.

The final implication is that marketers should abandon the QS metaphor and treating all self-trackers as individuals who continuously quantify and analyse data. The QS movement has been dismantled; the groups have stopped their meetings and devolved into smaller affairs. The media have also moved on from the QS movement metaphor to talk about everyday tracking practices. The question is whether marketers will now move on from the data paradigm.

7. Conclusion

The thesis started with an idea to explore the plethora of ubiquitous self-quantification activities and the impact of self-quantification on broader social life. However, an extensive literature review showed that the studies either take the techno-deterministic self-knowledge and self-improvement or the Orwellian surveillance route. The primary reason for such dichotomous readings of the phenomenon is the paradigm presuppositions and ontological issues of keeping one actant above the other. In order to mitigate that, I chose a flat ontological philosophy of postphenomenology while keeping the human in the forefront to ensure that the subjective experiences of humans are not lost. Furthermore, due to the nascent nature of postphenomenology and as multistability is the central concept of the philosophy, I brought in affordance theory as the enabling theory to analyse the data. Postphenomenology also dictates that I study the broader social impact of the practice and not just the technological exploration. To enable that, I drew from De Certeau's tactics of the weak to study the impact of the affordances perceived by the user through the self-tracking environment. In doing so, I have advanced the understanding of self-quantification as a resistance mechanism of the users and carved out a niche in-between techno determinism and Orwellian surveillance. I also show how the existing assumptions of self-knowledge and personalised individual practices are outdated, and the users have moved on to complex integrated practices.

In this section, I will summarise the theoretical contributions of the study to consumer research and also delve into the limitations of the study.

7.1. Theoretical Contributions

I have adopted postphenomenology as the research philosophy and created a methodological assemblage of affordance theory and De Certeau's tactics of the weak. This complex assemblage provides five crucial theoretical contributions to consumer research.

Firstly, the study theorises self-quantification as an act of habitual resistance. Doing so provides an alternative meaning to how numbers are perceived in the consumer research

paradigm. Consumer research always studied the big numbers or macro-quantification and the impact of statistics on the social life of individuals . The self-quantification numbers and the humans were seen as co-producers of big data (Degli Esposti, 2014; Van Dijck, 2014; Lupton, 2016; Sanders, 2017; Sharon and Zandbergen, 2017). In contrast, I theorise that the users have an agency in this context and exert the agency by showing an underlying, tacit, and implicit habitual resistance against the market-enforced numbers. The numbers produced by the users can be part of big data but users do not exhibit any kind of understanding that they are part of statistical reproduction. Their individual numbers mean more than the understanding of macro quantification.

Secondly, I add to the empower-agency discourse of the consumer resistance stream as I identify that the self-quantification and the numbers produced through them are a way of regaining human agency and control. In the consumer resistance stream, self-quantifying consumers were seen as passive data collectors and were enslaved by the capitalist hegemonic forces (Izberk-Bilgin, 2010; McEwen, 2017). However, I observe that the consumers are using self-quantification to regain their agency, and this agency is gradual and evolutes over a period of time. The resistances get sedimented over time, creating their own self-tracking environments they can control.

Thirdly, I add to the nascent self-quantification literature and posit that the researchers should abandon the market-oriented self-knowledge-based inquiry and start analysing the phenomenon through a different lens. The consumers have moved to an integrated self-tracking environment while the studies still consider them in silos. The implications are broader for other paradigms too. The HCI researchers can adopt the study to evaluate the self-quantification as an integrated practice and develop new forms of designs to accommodate the integrated aspect.

Fourthly, I offer a critique of the neoliberal world and show how the users are oppressed through numbers. The surveillance viewpoint is well-researched in the sociological paradigm, but they discounted the reactionary measure of the consumers. The consumers are reacting by creating complex self-quantification environments through which they produce habitual resistance that challenges the neoliberal market. Neoliberal authorities adopted and tacitly

imposed self-quantification to create a self-optimised individual. However, unlike the big numbers, numbers produced through self-quantification have democratised the space, and the users have taken advantage of it to control their life worlds and resist the neoliberal imposition.

Finally, I contribute to the postphenomenological research and provide an alternative conceptual framework that can be used to study through a postphenomenological lens. Similar to Romele (2021), through affordance theory, I studied technological mediation and De Certeau's tactics of the weak to study the broader social impact of the phenomenon.

Thus, rather than reproducing the existing narratives in self-quantification, my thesis provides an alternative theorisation that did not surface before through the phenomenon. By doing so, I move beyond existing theorisations like behavioural change (Epstein et al., 2016; Guo, 2016; Attig and Franke, 2018), a big-data tool to self-govern (Degli Esposti, 2014; Van Dijck, 2014; Lupton, 2016; Sanders, 2017) and Foucauldian view of self-optimisation (Lupton, 2012; Pantzar and Ruckenstein, 2015; Catlaw and Sandberg, 2018; Zakariah et al., 2021). Above all, it critically questions the initial theorisation of self-knowledge through numbers and is more like resistance through numbers.

7.2. Limitations of the research and future research

This thesis does not claim that this is an all-encompassing theorisation of self-quantification. Instead, the thesis aimed to explore self-quantification practices without paradigm presuppositions and to bring the consumer viewpoint to the forefront. I shall now critically assess the study's limitations and discuss how future research can explore the self-quantification phenomenon through marketing, sociological and public policy lenses.

Firstly, this study did not focus on single quantification silo and instead observed the quantification as an integrated environment. Although it helped observe the phenomenon through a bird's eye lens, it had its limitations. The participants were not quantifying every aspect available to them. Instead, they carved out a complex self-tracking environment that is

only meaningful to them. Some activities have natural integration, like calorie counting, fitness and heart rate. The exploration in this regard will help study the motivations behind these integrative environments and how the users are traversing this complexity.

Secondly, the initial data generation method involved undertaking a short-term ethnography of families. The aim was to study how these self-quantification technologies affect families and their consumption practices inspired by Daniel Miller's study of shopping (1998), but COVID thwarted those plans. As a result, the impact of these devices on families is uncharted, and I found glimpses of that when I interviewed couples (and how these devices create a disciplinary regime on the users. A detailed exploration of this aspect will provide new insights into how families operate the complex self-quantification aspects at home and how it affects related consumption like food, clothes, leisure and many more.

Thirdly, the study was grossly limited due to the online interviews, as I could not observe the users and how they were operating the device. The explanation and experiential accounts cannot match the richness of in-person observation. Observational data would have helped a much more nuanced analysis of the physical affordances of the device and how users perceive them. It would have also enabled me to observe how the resistances manifest physically in the user. In-depth interview of lifeworlds and exploration of apps is an effective tool for understanding the users, but combining it with observational data would have enriched the study further.

Fourthly, I have briefly highlighted the societal implications in the last section. Although the primary implication was in consumer research, there is a broader scope for public policy research in the self-quantification subject. Authorities like NHS and BHF are recommending these apps and have developed these apps. A broader exploration of the impact of these technologies on public health, existing regulations and user data privacy are imminent. As mentioned in the introduction to the thesis, insurance companies are using the data to regulate premiums. The recent cancellation of Roe Vs Wade legislation has raised new questions about privacy in the paradigm. A deeper analysis of users traversing such privacy can inform public health policy and regulatory legislation.

Fifthly, I have deliberately avoided gender, cultural and class-based reading of the phenomenon. Although I touched upon a few of the issues from the resistance perspective, an in-depth exploration of gendered quantification practices through a Marxist-Feminist lens or Judith Butler's theory of performativity (1988) would provide a critical thought process on how these technologies are gender discriminative and non-inclusive. On the same wavelength, the self-tracking practices and the way people access might change based on the culture as the physical environment and societal aspects change. Furthermore, as Wernimont (2019) suggested, the self-quantification technologies were created for white male privileged bodies, so it is essential to study the class issues and how the self-quantification practices are adapted in different settings and broader social impact. In summary, this thesis provides an alternative theorisation of self-quantification in the consumer research context, but the opportunities to explore are limitless. It is crucial that self-quantification researchers shed the self-knowledge paradigm and move beyond. The lyrics of the heavy metal song "System Idle" by 3rd Machine from their album *Quantified Self* perfectly capture this conundrum.

This path I take is forced, sensing false opportunities

Pain of change I feel

No securities

Attempts to rebound failed, miserable me

Trapped inside a system, idle

Me

The lyrics perfectly capture the neoliberal imposition of self-improvement and how consumers react to the false promises. Consumers are bombarded with numbers every day, minute and second. The problem is that these numbers are not produced by the consumers themselves, and the macro-quantification treats them like data points. The neoliberal world identified that there is a way to make a productive workforce through self-governance. However, the democratisation of data also favours the weak, as consumers have started resisting against these practices through their own construction of self-tracking practices. This research is an attempt to uncover such resistance practices and to provide an alternate to the techno-deterministic viewpoint of the world. Self-quantification is an act of habitual resistance by consumers against neoliberal hegemony.

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9. Appendices

9.1. Appendix A – Consent Form & Information Sheet

The title of the research project: The everyday practices of self-trackers

Invitation paragraph

You are being invited to take part in a research project because you are a self-tracker who tracks one or more aspects of yourself and tracking every day. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information.

What is the purpose of the project?

The purpose of the project is to study how self-trackers are undertaking the practice in daily life and how this practice influences the related consumption like shopping, food practices etc.,

Why have I been chosen?

You have been chosen because you are a self-tracker, part of an household, who tracks one or more aspects of yourself.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep (and be asked to sign a consent form). You can withdraw at any point until the end of the interview. You do not have to give a reason in the case of a withdrawal. You can contact the researcher at any time to ask questions about participation. All the data you provide will be held securely and treated confidentially (see below).

What do I have to do?

1. An informal chat about your tracking and explain the different aspects of tracking. You can talk about anything regarding your daily life, tracking practice and different types of tracking you do.
2. If you are comfortable, you can share the social media and online community updates of your tracking practice for the purpose of analysis.

3. If you are comfortable and if your family members are willing talk to me, it would be great to talk to them. The children will not be part of the study but if they are above 14 years old and if they are comfortable being part of the study, you can allow them to talk to me with your presence.
4. There will be two interactions so that after the first chat you have time to reflect on your tracking practice and the discussions we have during the chat. Interviews will be recorded only for use by the research team, and transcription and will be kept in a secure place and deleted once the project is completed. Privacy and confidentiality will be rigorously maintained and you will not be named in any research outputs, including any information that might reveal your identity (see below).

Will I be recorded, and how will the recorded media be used?

With your permission, interviews will be recorded and then transcribed, only as a way to accurately present findings and main themes that emerge from our conversation. Material collected will only be used for the purpose of transcribing, summarising and making sense of the data by the research team. Data collected will be destroyed within five years of the project's end. The audio recordings of your activities made during this research will be used only for analysis, with transcribed direct quotes used for illustration in the research project. No other use will be made of data without your written permission, and no one outside the research team involved in the project will be allowed access to the original recordings.

What are the possible disadvantages and risks of taking part?

There are no reasonably foreseeable discomforts, disadvantages, or risks to participation.

What are the possible benefits of taking part?

You will play an important part in creating an understanding of how people are undertaking self-tracking practice in their daily life. As there is a limited research around this topic, you will be part of a pioneering research project.

Will my taking part in this project be kept confidential?

All the information that we collect about you during the course of the research will be kept strictly confidential. You will not be able to be identified in any reports or publications.

What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

The information needed will be about the tracking practice, lifestyle and how the tracking practices help you to take decisions in your daily life.

The data collected is important in achieving the research objectives as it offers the possibility to understand your experience and understanding of self-tracking and quantification practice in detail. This project has been reviewed by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct. You will be given a copy of the information sheet and a signed consent form to keep.

Thank you for taking the time to read through the information.

Contact for further information

…….

Sylvian Patrick Jesudoss
s.jesudoss@pgr.reading.ac.uk

Henley Business School
UNIVERSITY OF READING

Consent Form

1. I have read and had explained to me by

   Sylvian Patrick Jesudoss

   ……
   ……
   the accompanying Information Sheet relating to the project on:

   The everyday practices of self-trackers

   ……
   ……

1. I have had explained to me the purposes of the project and what will be required of me, and any questions I have had have been answered to my satisfaction. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.

1. I understand that participation is entirely voluntary and that I have the right to withdraw from the project any time, and that this will be without detriment.

1. This project has been reviewed by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

1. I have received a copy of this Consent Form and the accompanying Information Sheet.

Name:

Date of birth:

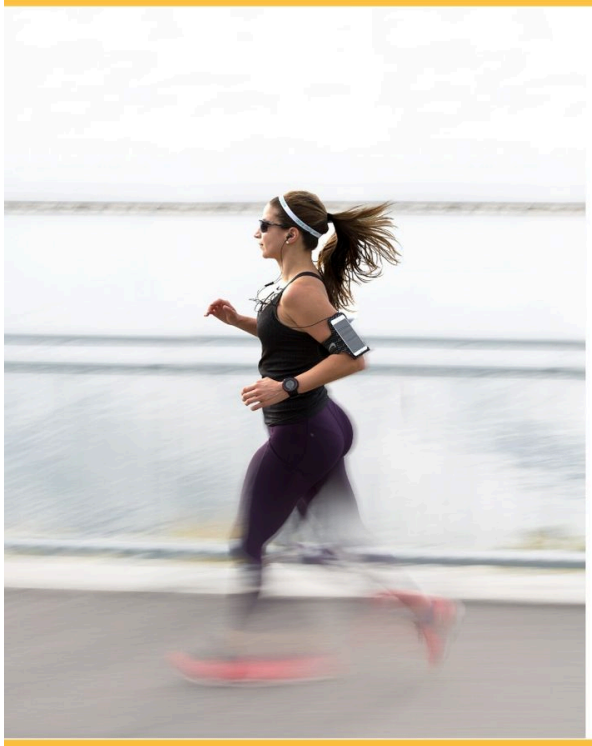
Signed:

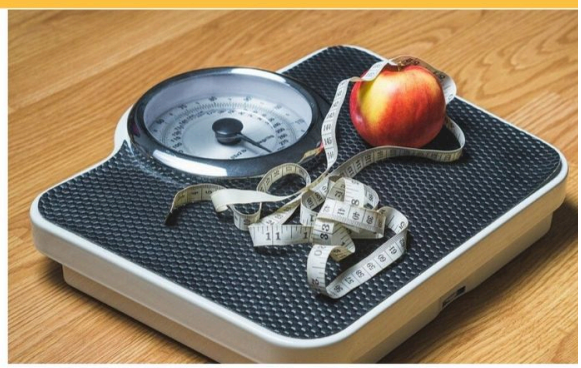
Date:

9.2. Appendix B – Example Interview – Participant Name: Gia

9.3. Appendix C - Call for participation Poster

CALL FOR PARTICIPANTS





DO YOU TRACK YOURSELF?

Are you using Apple Watch, FitBit or apps like MyFitnessPal, to track different aspects of your life like fitness, steps, diet, sleep, heart rate, travel, finance, media etc.,? If so, I would like to talk to you.

NO EXPERIMENTS. NO HEALTH DATA. JUST SHARE YOUR EXPERIENCE.

Online interviews only. We practice social distancing. The study is part of my PhD research on quantification and self-tracking.

For further details, contact

sylvian - s.jesudoss@pgr.reading.ac.uk

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