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A dual lens on self-tracking: exploring general ethics and feminist concerns

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Zusammenfassung

Seit geraumer Zeit leben wir in einer Welt des technischen Fortschritts, in der das Sammeln von Daten über den eigenen Körper nicht mehr den gleichen Aufwand erfordert wie früher. Das Thema des Self-Trackings in seiner digitalen Form entstand mit dem Aufkommen der Quantified-Self-Bewegung und hat sich seitdem weiterentwickelt und ist auch in der breiten Öffentlichkeit zu einer Praxis geworden. Allerdings Selbstverfolgung zunehmend in die Kritik geraten, und zwar aufgrund verschiedener Bedenken, die von den psychologischen Auswirkungen bis hin zum möglichen Missbrauch der gesammelten Daten durch Unternehmen. Diese Arbeit konzentriert sich auf eine der am meisten gefährdeten Kategorien von Self-Tracker - Frauen, die ihre weibliche Gesundheit überwachen. Sie untersucht das Thema aus einer feministischen Perspektive und verwendet das konkrete Beispiel einer "bewussten" Self-Tracking-App, Flo, um die Herausforderungen aufzuzeigen, die die die die Branche noch bewältigen muss.

Abstract

Since quite some time, we have lived in a world of technological advancement where collecting data about one's body no longer requires the effort it once did. The topic of self-tracking in its digital form emerged with the appearance of the Quantified Self movement and has since evolved, becoming a practice even among the general public. However, self-tracking has increasingly faced criticism due to various concerns, ranging from its psychological impact to potential misuse of collected data by corporations. This thesis focuses on one of the most vulnerable category of self-trackers – women tracking their female health. It examines the subject from a feminist perspective and uses the concrete example of a more "aware" self-tracking app, Flo, to highlight challenges that the industry still needs to address.

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Chapter 1 – Introduction

Motivation

The topic of self-tracking has gained significant popularity in recent years. With self-tracking apps becoming ubiquitous and no longer being the exclusive domain of technologically educated geeks and pioneers, it's imperative to examine the subject from various perspectives, not just the technological one, but also the ethical. While self-tracking practices appear to benefit our society in certain ways, like all technologies, they come with the risk of being misused, either intentionally or unintentionally, by both users and technology providers. Earlier research on self-tracking, as well as industry pioneers, seemed to focus predominantly on the positive aspects. However, as the usage of self-tracking expanded, the calls from experts for a more balanced discussion grew louder. Self-tracking can introduce specific adverse effects, and for the responsible utilization of this technology, we need to understand its potential pitfalls and how to circumvent them.

Self-tracking involves collecting and analyzing a wealth of personal and sensitive data, often not by the users themselves, but by an often opaque algorithm, a product provided by corporations. While these algorithms are sophisticated, they can still be based on erroneous or damaging assumptions, or simply be designed by providers lacking adequate expertise. The construction of self-tracking apps, from their design to the interpretation of the data they produce, can profoundly influence our health, well-being and even safety.

Today, various segments of the population engage in self-tracking, with some groups being more vulnerable than others. We are particularly interested in the feminist perspective on self-tracking, leading us to discuss femtech apps. Given recent political and societal shifts in the US and certain European countries, which have resulted in the curtailment of female rights (e.g., abortion bans), there's a concerning trend of women's rights regressing. As such, tracking apps that gather extensive data about women warrant careful scrutiny. It's crucial to comprehend the pitfalls associated with their use and, as a society, to pinpoint areas of focus to prevent the misuse of such technologies, potentially exacerbating the erosion of women's rights in the future.

Limitations

This study adopts a multidisciplinary approach, implying that we consider the problem from various perspectives, not just from a technical standpoint. The scope of our interdisciplinary research extends beyond the technical limitations of self-tracking. We aim to delve into the ethical dilemmas arising from self-tracking activities. We contend that understanding these ethical ramifications is equally vital as technical proficiency in forging a comprehensive perspective.

While acknowledging the advantages of self-tracking, our focus will predominantly be on its downsides. We will not dwell in detail on its merits since they have been adequately addressed in previous research by others. Our discussion will encompass the feminist perspective on self-tracking at large and on femtech apps, emphasizing the negatives that were glossed over in general self-tracking discussions.

Turning to the Flo app, which we've selected for a more detailed examination, we intend to conduct a meticulous analysis of both its overt features and the processes that operate behind the scenes. The Flo app was the sole subject of our investigation; we did not compare it to any other apps. Therefore, we are unable to say with certainty whether it is superior to others in its category. Our evaluation was limited to Flo as a distinct individual. We will exclusively evaluate the European version of the Flo app, concentrating on the menstruation tracking features. Our objective is to unearth any concealed objectives potentially lurking behind its polished exterior. However, we will abstain from conducting a deep technical probe into aspects like network traffic, internet security, or other intricate technological elements, as these areas have already been covered in prior academic investigations.

Certain facets of Flo's functionality and impact remain outside our analytical reach. Specifically, achieving an in-depth understanding of their proprietary AI and algorithmic processes would demand specialized technical expertise and firsthand access to their operational specifics, which we lack. Similarly, any financial transactions stemming from data exchanges, should they exist, are proprietary to the company, making it arduous to address them definitively. Assessing the accuracy of the app's period prediction feature is another area that's beyond our current scope, given the significant duration and expansive user data that would be essential for such an evaluation. Finally, gauging the app's impact on mental health presents a convoluted challenge that would call for an extended psychological study with a varied user base. Although such an investigation is pivotal, it exceeds our present resources and lies beyond the ambit of this particular study.

Structure

The thesis is structured into four principal sections. Chapter 2 offers a broad overview of self-tracking, exploring its applications and purposes. Chapter 3 delves into the potential drawbacks and challenges of self-tracking. Chapter 4 advances the discourse by examining the subject through a feminist lens, shedding light on vital considerations and introducing the realm of femtech applications. Chapter 5 conducts a comprehensive analysis of the Flo app, considering perspectives and insights highlighted in Chapters 3 and 4.

Chapter 2 - the basics of self-tracking

Emerging of self-tracking

Self-tracking is not a novel concept, emerging solely with advancements in technology. Instead, it has historical roots extending to practices like journaling and diary-keeping, used traditionally for self-reflection and personal growth (Lupton, 2014). These traditional methods were predominantly qualitative (Wieczorek, 2023). Yet, there were pioneers who delved into the quantitative realm of self-tracking. Benjamin Franklin, for instance, meticulously maintained a log tracking his practice of 13 virtues over six decades (Li, Dey, & Forlizzi, 2010). Similarly, Buckminster Fuller created the "Dymaxion Chronofile," a detailed scrapbook logging his activities every 15 minutes (Li, Dey, & Forlizzi, 2010). Furthermore, self-tracking has been intrinsic to athletes who have long documented their performance, diet, and physical activities. Women, too, have practiced self-tracking for generations, using menstrual cycle tracking as a method of family planning and contraception (Ajana, 2017). Thus, the current trend of self-tracking apps and devices builds on this long-standing tradition, enriching it with technology's precision and convenience.

In fact, this historical foundation of self-tracking has paved the way for more sophisticated methods. Among these, a significant development is the emergence of the Quantified Self community. This movement, as explained by Pharabod et al. (Pharabod, 2013), emphasizes the idea of enhancing self-awareness and knowledge through quantifiable data, thus creating a link between past practices and modern technological approaches to self-monitoring and self-improvement (Ajana, 2020).

The community was founded in the USA in 2007 by Wired magazine editors Kevin Kelly and Gary Wolf as a small gathering in San Francisco to discuss self-experimentation with sensor technology. Since its start, QS has grown internationally, now having more than 200 groups with 20,000 participants in 30 different countries (Nafus & Sherman, 2014).

The QS community operates with a flexible structure, lacking any formal leadership, spokesperson, or trademarked identity. Local groups are self-organized, and their gatherings, known as "show & tell" meetings or "meet up groups," prioritize active participation. During these events, individuals share brief presentations that center around their accomplishments, methodologies, and insights gained from their experiences (Bode & Kristensen, 2015). QS meetups usually consist of talks about personal experiments in self-tracking. "Presenters are asked to talk about what they did, how they did it, and what they learned" (Nafus & Sherman, 2014).

Their approach encourages data collection and analysis about one's body and vital aspects to derive meaningful insights for self-enhancement. Members of the Quantified Self movement collect their

data in critical and resistant ways, "seeking to exert greater control over the ways in which their personal data are collected, archived and used" (Lupton, 2014). On the Quantified Self website, during their meetups, and during their conferences, the topic of "controlling my data" is frequently brought up for discussion. Therefore, practices of the Quantified Self community could be viewed as an instance of a "biopolitics of the self," in which the body turns accessible to management tactics that comply with a set of established norms (Ajana, 2017).

"Quantified-Selfers" are mostly highly motivated enthusiasts - "life hackers, data analysts, computer scientists, early adopters, health enthusiasts, productivity gurus, and patients" (Choe, 2014). One might think that the desire to establish control over their bodies with the help of data collection is a specific interest of a relatively small group of admirers, however, nowadays the expanding self-tracking metric culture extends beyond the Quantified Self community's scope.

The term "self-tracking" now encompasses nearly all forms of self-tracking, but it is crucial to understand that not all self-trackers identify as Quantified Self members. According to the survey conducted by Ajana (Ajana, 2020), despite self-tracking being a widespread and mainstream activity, the Quantified Self remains a niche movement, as most interviewed participants were unfamiliar with the term. Deborah Lupton (Lupton, 2021) conducted interviews with self-trackers and discovered that despite the considerable attention to the Quantified Self movement in the media and academic research, none of her study participants claimed affiliation with this community or made any mention of participating in "self-quantification". Moreover, these individuals didn't conform to the usual caricature of the "self-obsessed self-tracker who is narcissistic and overly enthusiastic about communicating personal details of their lives with others as a form of self-promotion and aggrandizement".

A lot of the self-trackers nowadays are regular people that perform self-tracking on a routine everyday level. The sharing of self-tracking data and experiences extends beyond specific biosocial communities, occurring through various networks, online platforms, and offline interactions. Some research predicts that in the future the trend will intensify as trackers "will become more diverse, addressing different health concerns, as tracking technologies become more affordable and internet and smartphone infrastructures more widely available" (Hardey, 2022). Many more trackers are not restricted to formal health movements or attracted to the aesthetic of online health groups.

Engagement with self-tracking

In recent years, there has been a swift advancement in digital tracking tools, applications, and platforms, accompanied by the rise of health movements like the Quantified Self and the endorsement of data-centric approaches to self-observation and analysis (Ajana, 2020).

The rapid development of technology has made self-tracking accessible to everyday users. The qualitative ways to measure oneself were overshadowed by quantified ways (Wieczorek, 2023). The average person, especially in Western nations, can easily generate different types of large statistical data and use quantitative methods of analysis comparable to those found in science and business thanks to the accessibility and reasonably low prices of self-tracking devices and apps (Ajana, 2017).

The equipment for self-tracking consists of a combination of hardware (devices) and software (applications). There are 350,000 mHealth applications available in various app stores (Global mhealth Apps Market Size & Trends Report, 2022). The Fitbit Charge, Garmin Vivosport, Amazfit Bip, and Apple Watch are wearable devices made to record different biometric data and fitness indicators and deliver feedback on activity and health in the form of graphs and pictures (Ajana, 2020), which makes self-tracking more convenient than ever.

Since there are no statistics available, it is difficult to estimate the total number of users of the various self-tracking tools. Some are supported by millions of athletes worldwide (Nike+, etc.) and some are fully confidential (Quantter, 42goals, Fitbit 5, etc.) (Pharabod, 2013).

Deborah Lupton (Lupton, 2014) predicts that as humans become more connected to the Internet of Things, self-tracking practices are becoming increasingly prevalent. Whether adopted willingly or forced upon individuals, the use of self-tracking is expanding. This is driven by the growing recognition of the valuable data generated through these practices, leading to its adoption by various agencies and organizations.

One research provides an overview of the classification of tools that can be used for self-tracking (Pharabod, 2013). They could be divided into the following categories:

- Specialized tools: These are used to quantify a specific state or activity, such as sleep (e.g., Zeo) or eating habits (e.g., DailyBurn).
- General tools: These can record any activity and include platforms like Daytum, Quantter, 42goals, and Daily Deeds.
- Mid-spectrum tools: These focus on a particular type of activity and/or physical parameters, such as various sports (e.g., Runkeeper, Nike Running, Garmin Connect) or a healthy lifestyle (e.g., Fitbit for walking, sleep, weight).

Additionally, tools can be sorted by data recording mode:

- Sensor-based: Data is recorded by a sensor, either on a specific device (e.g., Fitbit step recorder, Wii) or embedded in a smartphone, and then transmitted to the interface.

- Declarative mode: Data are entered manually, as seen with general tools like Quantter, Daytum, and 42goals.
- Mixed systems: Some tools, such as Runkeeper, combine both sensor-based data capture and manual data entry.

(Bode & Kristensen, 2015) offers a similar classification of types of tracking: automatic data recording, also known as "passive tracking," where data is collected without user input, and manual data input, referred to as "active tracking," where users actively record information such as their current mood or food consumption using text or visual methods. However, many users find the manual data-gathering method to be unnecessarily complicated, even if it may allow one to gain a deeper understanding of the practices they are monitoring (Lee, 2021).

Self-tracking tools can offer broad functionality to the users:

- Historical activity tracking: Users can review their past activities over different periods, enabling them to establish trends or detect patterns, growth, or inconsistencies.
- Real-time engagement: Some sensor-based tools feature elements like virtual trainers (e.g., Runkeeper), reminder systems (e.g., RescueTime, Sleep Cycle), or instant support through "likes" (e.g., Nike+).
- Future goal visualization: Occasionally, tools enable users to see measurements concerning future objectives, regardless of a set date, such as weight goals (e.g., TargetWeight).
- Adaptable data visualization: Tools may present data in simple or more intricate ways, including numerical measures of goal deviation, calendar-based activity frequency or duration displays, or various data analysis charts (e.g., curves, diagrams, pie charts).
- Data sharing: Users can decide on the degree of sharing their data with others - the data can be either private or shared with the community.

What people track

A wide range of aspects can be monitored with all the existing self-tracking technology. Technology has many different meanings for people in various situations. "Users inscribe technologies with their scripts for appropriate use" (Loe, 2010).

People can track and measure various aspects of daily life, including their physical well-being (body temperature, heart rate, weight), mental states (emotions, alertness, anxiety, creativity, spirituality, happiness), and activities (sleeping, moving, running, eating, writing). They also consider factors like the situation, social interactions, environment, and relationships (day of the week, weather, location, noise, and group status). "The ultimate goal, however, is to establish a ubiquitous tracking of the totality of materials of daily life that can impact life quality" (Bode & Kristensen, 2015).

The areas for quantification and tracking extend from personal physiological factors and individual mental states to active behavior components and situational, social, and environmental aspects (Bode & Kristensen, 2015).

A survey conducted as a part of the study by Ajana (Ajana, 2020) aimed to identify the major patterns of use of self-tracking technologies. Step counting remains the most tracked aspect, despite the recent advancements in biometric and wearable sensor technology that allow measuring more complex biometric data. Other tracked factors were calories, speed, heart rate, hours slept, and food intake.

Another research states that the activities that users track can be divided into three main categories: sports activities, activities related to health and lifestyle (including weight, sleep, moods, migraines, and blood pressure), and balancing work and leisure (Pharabod, 2013).

Moreover, the concept of self-tracking is not focused on one individual anymore. Modern sensor-based technologies allow people not only to keep an eye on their bodies but also their friends, children, and pets (Lupton, 2014). Nowadays, there is a broad range of "smart" objects that also make it possible to track the context outside the human body for example environmental factors like air temperature, humidity, light levels, gases, pollution levels, and energy consumption at home.

Why people track

On a more abstract level, there is a broad spectrum of reasons for engaging in self-tracking practices. There is a category of people who have "techno-utopian hopes for scientific breakthroughs via the aggregation of shared self-tracking data" (Bode & Kristensen, 2015). On the other side, these beliefs are resisted by another category of users, who believe that self-tracking involves more than just gathering data. It also can be seen as using controlled data to learn more about oneself, think through how to use this information, interpret it appropriately, and consider its implications on individuals' current well-being, identities, and prospects for future success (Lupton, 2015). As the user interviewed by Lupton & Smith (Lupton & Smith, 2018) says: "I think self-tracking has helped me to be a much better person".

Several studies aim to understand why users engage in self-tracking activities by conducting interviews with them. (Grace Shin, 2013) concludes that using wearable devices such as Fitbit promotes awareness about daily practices and provides motivation for exercising. An interview by Ajana (Ajana, 2020), found that the primary incentive for adopting self-tracking activities is the desire to raise motivation, track progress, and gather data. Users of personal ST tend to prioritize three main areas: enhancing their health, increasing their work productivity or cognitive abilities, and seeking new life experiences (Choe, 2014). The study gathered specific information about each of these areas, which is presented in the table below:

Motivations	Sub-categories	Tracking example
To improve health	To cure or manage a condition	Track blood glucose to hit the target range [P37]
	To achieve a goal	Track weight to get back to the ideal weight of 135 pounds [P39]
	To find triggers	Log triggers that cause atrial fibrillation [P55]
	To answer a specific question	Track niacin intake dosage and sleep to identify how much niacin to take for treating symptoms [P76]
	To identify relationships	Track exercise, weight, muscle mass, and body fat to see the relationships among the factors [P31]
	To execute a treatment plan	Log food, exercise, and panic as a recovery plan for panic attack [P35]
	To make better health decisions	Record ideas of things that thought were healthy and unhealthy to make better decisions [P18]
	To find balance	Log sleep, exercise, and time to get back from erratic lifestyle [P23, P42, P54]
To improve other aspects of life	To maximize work performance	Track time to know the current use of time and ways to be more efficient [P43, P63]
	To be mindful	Take a self-portrait shot everyday for 365 days to capture each day's state of mind [P26]
To find new life experiences	To satisfy curiosity and have fun	Log the frequency of "puns" to see how often these puns happened and what triggered them [P12]
	To explore new things	Track every street walked in Manhattan to explore as much of the city as possible [P34]
	To learn something interesting	Track heart rate for as long as possible and see what can be learned from it [P62]

Figure 1: Quantified-Selfers' tracking motivations and examples for each category
Source: (Choe, 2014)

Respondents interviewed by Pharabod et al. (Pharabod, 2013) did not prove the motivation of exploring oneself as relevant, more important seemed the practices of archiving oneself and a "search for a knowledge-of-oneself effect". One of the primary reasons that motivate members of the shared household to self-track is "making sense of and maintaining health change". "Traditionally, I've been the one to shop and cook all meals, and now we're sharing a lot about healthy recipes and planning special occasions so that we can maintain a healthy lifestyle" (Hardey, 2022).

Sometimes selt-tracking can become a common activity that families discuss or even do together, which is known as "co-tracking". "We have a daily routine where I get up and the first thing I'm out of the house on a run while my family sleeps […] My son is interested in whether I am top of Strava's leaderboard that week. I share jokes about 'mummy's results' with my son" (Hardey, 2022).

There is a category of people who use self-tracking tools for managing their everyday routines that are not directly connected to health, which involves for example "keeping a close eye on their calendar appointments and ensuring that they met their deadlines and obligations and attended meetings on time, had their car serviced, attended medical appointments, or paid bills by the due date" (Lupton & Smith, 2018). One of the further appeals of self-tracking is the gamification of the process. Gamification is the process of integrating game mechanics into non-game contexts, such as digital points, badges, and leaderboards (Ajana, 2020). In general, the idea of numerical competition is often presented as having a recreational pleasure (Pharabod, 2013). It is growing in popularity as a way to boost motivation, introduce competition, and recognize excellence. The gamification of health and the instrumentalization of exercise hold the promise of improving the enjoyment and manageability of physical activity through self-tracking technologies.

A further reason for using self-tracking is the alluring and easy way to see quick results and progress, that may not be as obvious in other spheres of life, such as employment or social relations (Zheng, 2021). Users can rapidly recognize their development through the measurement of activities like

workouts, which enhances their sense of accomplishment. This measurable development offers a clear indication of success and a guarantee of personal development and productivity.

One of the more surprising and not well-studied audiences of self-tracking technology is elderly people. Very few scholars are exploring how contemporary elders utilize and ascribe meaning to technologies in their day-to-day lives. Existing gerontology literature tends to focus on evaluation instead of ethnography. It explores "how technology may be used to accomplish goals, rather than exploring the meanings elders attach to technology in their everyday lives" (Loe, 2010). As Loe discovers in her study dedicated to this audience, these elderly women employ their accumulated knowledge of lifelong care practices to navigate and adapt to emerging technologies, including self-tracking, to meet their daily needs related to mobility, communication, nutrition, physical well-being, and fostering mental growth.

In recent years, there has been increased interest in implementing workplace wellness schemes using fitness tracking devices and apps resulting in these programs becoming an 8$ billion industry. Companies like Target, BP, Bloomberg, Barclays, and Google have introduced programs to promote healthier and more active lifestyles (Ajana, 2020). The purpose of these corporate wellness programs, which are based on the two imperatives of "better health outcomes" and "lower health costs," is to cut healthcare and insurance costs while increasing employees' capacity for productivity (Ajana, 2017). Some self-tracking devices are even created exclusively for corporate wellness initiatives. Some survey participants (10.50%) seem to be motivated by getting the monetary benefit from sharing their data with such programs. These programs offered bonuses to employees who achieved goals like walking 10,000 steps a day using company pedometers or awarded prizes like electronics to top performers. The argument for implementing such programs is reducing healthcare and insurance costs. However, in some countries where companies do not emphasize the importance of well-being at work, people start using self-tracking privately to combat burnout. For example, interviews with Chinese workers conducted by Zheng (Zheng, 2021) have shown that people who experience the negative effects of overworking culture, "have regularly used at least one type of self-tracking device/application to monitor health".

How people track

Self-tracking is primarily a very private act that rarely develops into a habit (Pharabod, 2013). In certain instances, the procedure is ad hoc since it is comparable to a diagnosis in that quantification is no longer necessary once the evaluation has been done. The argument is supported by numerous quotes from the interviewed users:

- «I **sometimes** wrote down my weight, I had a sheet of paper...»

- «**at one point** I counted the cigarettes I smoked...»

Collecting data over an extended time is a huge challenge for the users also because "devices used to capture QS-data often become obsolete or abandoned by their owners within a couple of months" (Selke, 2016). The author mentions a study of US adults around 50% of whom confessed to not using their activity trackers anymore.

According to (Pharabod, 2013), tracking can also be classified based on how exactly a user puts themselves in numbers. Here three main types of measurements can be defined - monitoring (when tracking is not oriented towards actions but serves the purpose of observation), routinization (routine measurement, which is not directly connected to improving or increasing the numbers), and performance (monitoring the effectiveness of a specific effort).

The interviews with self-trackers also reveal that ordinary person tends to underutilize the statistical analyses of their data and the visual representations offered by the tracking tools. Regular self-tracking turns out not to be a deep dive into the analysis of the data, but rather a keeping track of oneself (Pharabod, 2013). Sometimes the analysis of data happens in combination with other software that was not produced aiming to help with self-tracking. A user interviewed by Lupton & Smith (Lupton & Smith, 2018) describes her self-tracking habits in the following way: "Fitbit for sleeping and for exercise. Internet monitors expenses and banking and putting it into Excel and working on a graph and things like that. I do lists for work and productivity."

Self-trackers also seek peers on online platforms to exchange numerical data, aiming to find others with similar progress and commitment levels. By examining others' data, they attempt to determine shared dedication to the practice, performance, goals, time investment, and relatability (Pharabod, 2013). When sharing information on social media, users add further meaning to self-tracking. They are motivated by a longing to join communities, engage and share experiences with others. This openness, revealing private information about oneself, is driven by a sense of altruism, the desire to establish social connections, and contribute to the accumulation of new knowledge (Lupton, 2015). An edge case of exchanging personal data with others was the period of the recent coronavirus pandemic, where people proved to be way more involved with the social side of self-tracking. One of the users of MapMyRun app explained her motivation the following way: "it's just kind of something to talk about and then kind of during lockdown we couldn't play tennis so that was just like another sport" (Fletcher, 2022).

However, sharing data with others is not a desire that is shared by 100% of the self-trackers. According to the interviews conducted by Lupton (Lupton, 2021), some people see self-tracking as a

private matter: "I think it's just a personal thing. It's like a motivation thing for me really to be healthy, so I don't really want to share that with other people".

One research (Choe, 2014) reveals what tools a special subset of self-trackers, the members of the Quantified Self community, use to track various aspects of their lives, health, and well-being. The most common among these are commercial hardware devices, such as health monitors like Fitbit, ZEO, WIFI-scale, and heart rate monitors, used by 56% of the community. Spreadsheets, including Excel or Google Docs, follow closely, serving as the tool for 40% of the users. A subset of this community, approximately 21%, have adopted a more tailored approach, creating custom software such as apps for monitoring snoring, mood, stress, location, and productivity. Standalone commercial software, including mobile apps specifically designed for tracking sleep, productivity, or dietary habits, is used by 19% of the community. Lastly, a small percentage of participants have engineered custom hardware solutions and wearable sensors.

There are several reasons for building custom self-tracking tools. Firstly, commercial tools often lack the capacity for single-platform data tracking and personal experimentation, leading technically skilled users to create their solutions. Moreover, some prefer a centralized tool for various tracking activities, reducing the need for multiple apps. Another factor of motivation is that many users are willing to achieve personalized data presentations. On top of that, the absence of existing tools for specific tracking needs also drives the development of custom tools, like software for managing a clothing inventory. And lastly, users desire goal configurability which essentially means that the technology that allows them to customize the process of tracking to their own goals (Lee, 2021).

When it comes to choosing the tracking tool available on the market, the study by Lee et al. (Lee, 2021) identified seven factors that people base their decisions on: "data collected, feedback provided, goal-setting capabilities, privacy, social opportunities, style, and convenience".

The design interfaces also play a significant role for a lot of self-trackers. As one of the users pointed out (Lee, 2021): "I sometimes just download an app because I think it looks pretty because I like pretty things so I'll just look through photos first". The interviews conducted by Zheng (Zheng, 2021)showed that the designs in various self-tracking apps and devices that provide rewards are generally and predominantly embraced by the users.

Modes of self-tracking

Deborah Lupton has created a classification of self-tracking modes that includes private, pushed, communal, imposed, and exploited ST (Lupton, 2014). While it is beneficial to differentiate these

modes, as there are often observable differences, it is also crucial to acknowledge that these modes can merge and overlap.

1. Private ST is done for solely personal reasons and the data is kept private or shared with a small number of carefully chosen people.
2. Communal ST is meant for those users who perceive themselves as part of a broader community and are eager to share their data and results of tracking with a broader circle of enthusiasts. They employ social media, personal data-sharing platforms, and websites for interaction and learning. Some join meet-ups or conferences to exchange data and evaluate diverse self-tracking methods.
3. Pushed self-tracking is initiated by an external actor or agency and is associated with nudging people into changes. Although voluntary, the motivation comes from outside encouragement rather than a solely self-generated effort.
4. Imposed self-tracking takes it a step further, suggesting that individuals are compelled to use self-tracking technologies to gain certain advantages, usually for the benefit of others. A prime example is the trend of implementing self-tracking in workplaces as a part of wellness programs to optimize productivity.
5. Exploited self-tracking implies leveraging user-generated data for the commercial gain of third parties, wherein companies market the data to other businesses to generate insights about customers and clients.

It is important to understand that these modes can merge and overlap, there is a fine line between imposed and exploited self-tracking, and private self-tracking can be a pet of communal self-tracking.

Cycle of tracking

Several studies aim to summarize the process of self-tracking in the form of a cycle or a chain. A person engaged in self-tracking practices can go through five stages of personal informatics: preparation, collection, integration, reflection, and action (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015).

The stage before individuals begin gathering personal data is known as the Preparation phase. This phase revolves around the motivation for collecting personal information, the process of deciding what data will be documented, and the methods used to record it.

During the Collection phase, individuals gather data about themselves. This stage involves monitoring various personal details, including inner thoughts, behaviors, interactions with others, and surrounding environments. Participants of the study conducted by Li et al. mentioned diverse collection

frequencies, such as multiple times a day (for instance, food intake), daily (like sleep duration), several times a week (like physical activity), or a few times a month (such as symptoms or books read) (Li, Dey, & Forlizzi, 2010).

The Integration phase involves preparing, consolidating, and transforming the gathered data for user reflection. This phase can be lengthy, requiring the user to undertake numerous tasks to ready the collected information for the reflection stage.

During the Reflection phase, users contemplate their data. This stage may include examining lists of gathered personal details or engaging with information visualizations. Users might reflect on their data shortly after documenting it (short-term) or after an extended period, such as several days or weeks, for in-depth self-reflection (long-term).

The Action phase occurs when individuals decide how to proceed with their newfound self-awareness. Some individuals use this information to monitor their progress toward objectives. Based on their understanding of the data, they might adjust their behaviors to align with their goals.

A study conducted by Selke (Selke, 2016) offers a similar structure but consists of 6 phases:
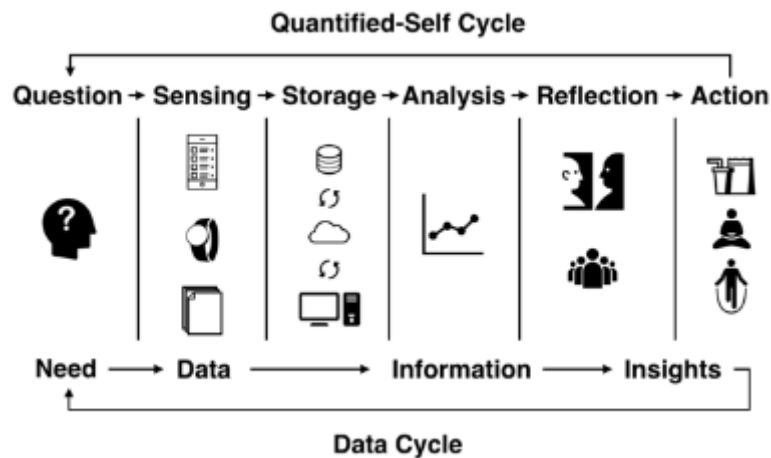
Figure 2: Different stages of QS and how a user's need for data leads to insights through its collection and conversion from data into information.
Source: (Selke, 2016)

A demand is examined using data-gathering techniques, such as smartphone sensing. Then, data is saved in a specific format and stored, for example, on a computer or in the cloud. Through data analysis (i.e., a statistical or graphical tool), data is transformed into information. The users might then reflect on the data by themselves or with others. A self-tracker may obtain understanding and take appropriate action.

The opportunities and benefits of self-tracking

In this thesis we decided to talk about the benefits of self-tracking according to the structure eliminated by Wieczorek (Wieczorek, 2023) who conducted a review of existing papers on the ethics of self-tracking. The three overarching categories are: empowerment and wellbeing, contribution to the health goals, community and solidarity.

Empowerment and wellbeing

The analysis of the literature conducted during the preparation of this thesis shows that a lot of studies eliminate the beneficial influence on the well-being and even "empowerment" of the selftrackers. For example, Hardey (Hardey M. , 2019) found that people find it "empowering" to learn that illnesses could be successfully handled "without interference" from medical professionals and that personal health, like bodies, could be shaped. A study (Stiglbauer, 2019) focused on the users with little experience in self-tracking to avoid expert bias showed that there is a "consistent effect of time on health consciousness, overall well-being, positive emotion, and accomplishment".

However, it's important to approach these promises with a critical eye, acknowledging that the discourse around self-tracking may be influenced by various factors. This includes not just the users' personal experiences, but also the broader narratives crafted by enthusiasts and marketers of self-tracking technologies. This leads us to an observation by Wieczorek (Wieczorek, 2023) who comment on this trend in the literature: "a significant number of authors only make **general statements** about these aspects that echo the promises of self-tracking professed by enthusiasts and marketing materials, and they often do so as a way to introduce their discussions of other aspects of self-quantification".

Contribution to the health goals

Using wearable tracking devices or applications seems to contribute to health goals, according to some studies. This is particularly evident in how they motivate users and encourage behavioral change (Ajana, 2020). Fitness trackers, for example, positively affect both physical health and subjective well-being, such as feelings of happiness, a sense of accomplishment, or quality of life. Using a fitness tracker can aid weight loss and reduce blood pressure (Jin, 2022). Moreover, research suggests that the communal self-tracking mode, where users share data on social media platforms, amplifies a fitness tracker's influence on physical activity levels (Jin, 2022).

The use of self-tracking tools also fosters a deeper understanding of the body and its inner processes, as reflected in the study among Danish self-trackers (Bode & Kristensen, 2015). Such insights

encourage users to pay more attention to their bodies, hence nurturing a healthier relationship with their physical selves.

In terms of convenience, self-tracking tools offer significant advantages over relying solely on memory, which often results in inaccuracies. The limitations of human memory, coupled with the inability to continually observe certain behaviors and activities, highlight the practicality of these tools (Li, Dey, & Forlizzi, 2010).

Furthermore, research supports the positive impact of self-tracking tools on task motivation, especially in goal-directed activities (Jin, 2022). However, it is worth noting that the average duration of engagement with health apps is relatively short, approximately 5.5 days, as per an analysis of individual user data from over 100,000 users (Singh, 2022). Nonetheless, the multitude of benefits provided by self-tracking devices and apps contributes significantly to users achieving their health goals.

The potential of self-tracking tools also extends to older generations. Despite the long-standing perception of self-tracking as a hobby for young, technologically advanced individuals, these tools are being increasingly utilized by elders, contributing to a blurring of lines between home and healthcare (Loe, 2010). The ability of technology to provide daily support aligns with the elders' preference to age at home, fostering a sense of community and solidarity amongst this group.

Community and solidarity

Self-tracking practices contribute significantly to community and solidarity in various spheres, from personal relationships to corporate environments. In personal relationships, self-tracking can foster a shared narrative and establish routines, as seen in couples using these tools. Some interviews suggest that this shared experience can strengthen bonds and unity within the relationship (Will, 2020).

In the familial context, health and self-tracking technology can promote mindfulness and health goals, thereby opening new spaces for empowerment. This finding, presented by Hardey (Hardey, 2022), points towards the potential for greater unity and shared commitment to health within families.

Moving to a broader scale, communal self-tracking can facilitate a sense of belonging, enhancing social connections and creating feelings of community (Ajana, 2020). This shared pursuit of health goals can bring individuals together, fostering solidarity within the community. In addition, it's also important to acknowledge the idea of "soft resistance" (Nafus & Sherman, 2014). Some motivated self-trackers, particularly those within the Quantified Self movement, subtly resist the domination of big data, thus calling into question the parameters of aggregation. This resistance, which is more

feasible in private or communal self-tracking, further contributes to the sense of community and solidarity within these spheres (Lupton, 2014).

On the corporate level, wellness initiatives that incorporate self-tracking tools can yield multiple benefits, such as lower medical and absence costs, reduced stress, increased productivity, and heightened employee engagement (Ajana, 2020). By emphasizing team values and employee health, these initiatives foster a work environment that underscores collective efforts and mutual growth.

Limitations of current research on self-tracking

The discussion on the ethical aspects of self-tracking is becoming more and more essential due to several reasons. First, due to technological advancements self-tracking is not a hobby of a small group of very informed enthusiasts like members of the Quantified Self-movement. It has already expanded way further and entered the life of a broader audience of ordinary people. Self-tracking apps for sleep tracking, period tracking, and fitness tracking are getting more and more popular among users. At the same time, while other health assistance methods are being thoroughly tested and regulated, mHealth tools have escaped this process so far (Gaggioli, 2013). Despite that, self-tracking involving mHealth and other tools is shifting from being a personal matter to being heavily involved with a lot of public spheres. The trend received a lot of interest and attention from different institutions and companies - schools, insurance companies, hospitals, etc. We are now entering a world driven by data where "digital devices and the data they generate have rapidly become a part of commercial, governmental, and academic practices" (Ruckenstein & Pantzar, 2015).

Over the years, a significant amount of research has been conducted dedicated to the study of self-tracking. While a lot has been learned, there are still important gaps and limitations in understanding of actual consequences of self-tracking. These challenges range from issues in research methodology to oversights in theoretical frameworks, all of which prevent us from getting the full picture of self-tracking technologies and their implications.

When it comes to the studies on self-tracking in general, the study by Jin et al. (Jin, 2022) identified several significant limitations in the existing research:

1. Methodology: Most of the previous studies have primarily used surveys and interviews, which may provide limited insight into causal relationships between variables. Moreover, few studies have incorporated strict control conditions or controlled for potential confounding factors in their interventions.

2. Investigating the Antecedents: There's a lack of research examining the precursors to the drivers of fitness tracking technology usage, such as how marketers can increase users' perceived benefits of such technologies.

3. Task Experience: There's a dearth of research empirically testing the effect of fitness-tracking technologies on users' task experience and enjoyment, and the existing findings are inconclusive.

4. Motivation: Most studies have treated motivation as a unilateral concept, despite it being multifaceted, with distinctions like intrinsic and extrinsic motivation potentially leading to different behavioral and psychological outcomes.

5. Overarching Theory: Many studies have primarily used traditional models for analysis, potentially limiting the exploration of novel insights.

6. Lack of Rigorous Theoretical Approach: Few studies have taken a rigorous theoretical approach, like hypothesis formulation and testing, when investigating the outcomes of fitness tracking, leaving the underlying mechanisms largely underexplored.

There is evidence that most of the scientific research pertaining to the efficacy of QS technology to track one's health is based on surveys of very specific groups of people who were already "experts" in health-related self-tracking (Stiglbauer, 2019). When studies rely primarily on experts for data, they are at risk of creating a skewed representation. These individuals, already well-versed in health-tracking technologies, possess distinct knowledge, habits, and motivations that differ from the average user. Consequently, they may interact with the QS technology differently, have a higher tolerance for flaws, or leverage the technology's benefits more effectively than a beginner. This "expert bias" can lead to an overestimation of the technology's ease of use and efficacy, consequently affecting the applicability of the research findings to the general public. It's crucial, therefore, that studies cast a wider net to include users at varying levels of expertise, ensuring more generalizable and comprehensive results.

One of the further methodological limitations that can be seen in some studies is the **duration of the experiments**. Singh et al. (Singh, 2022) claim that after ten days of constant self-tracking, many participants believed that their mood had improved, according to the content analysis data. Most of them concurred that self-tracking was highly practical. A rise in self-awareness was also noticed by participants, and some of them even saw self-tracking as a sort of self-care. However, it might be inaccurate to make conclusions from such quick research. Ten days may provide initial insights into how users perceive self-tracking, but it rarely paints a whole picture of the sustainability and long-term effects of these habits. The experiment on biofeedback and its influence on individuals conducted by Van Dijk et al. (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015) contains a claim that there is no "effect of physiology feedback on self-reported stress, indicating that, on average,

physiology feedback did not cause participants to become more or less stressed". However, after reading the methodology of the experiment it becomes clear that the duration of it was only one day. The study by Stiglbauer et al. (Stiglbauer, 2019) showing that "QS technologies may have a positive impact on user's health and well-being" was conducted during the two weeks.

Another interesting questionable feature of current research on self-trackers was brought to attention by Selke (Selke, 2016). The study analyzed different publications on the topic and figured that almost half of them "compensated the participants for their time and data". Providing compensation raises concerns about the potential impacts on research outcomes. Participants who are motivated by the financial reward may not be fully invested in the study, which could affect their engagement and the quality of the data they provide. Furthermore, this practice might introduce a so-called selection bias, where individuals may not accurately represent the broader demographic. Lastly, participants may feel a certain obligation to provide 'positive' or 'expected' answers. Therefore, while financial compensation may help with ensuring participation, it's crucial to consider the potential implications on the research's integrity and validity.

What is more, there is a small number of studies dedicated specifically to the **ethics** of self-tracking. As Wieczorek (Wieczorek, 2023) argues, their most recent overview of the ethical challenges of self-tracking was published in 2014 and did not cover a lot of significant aspects while also focusing mostly on lifelogging, which is not the same as self-tracking. There are studies that discuss the ethics of self-tracking but do not refer to them as such. Instead, they use words like "concerns," "potential," "challenges," and "opportunities" (Wieczorek, 2023). While their finding is oftentimes relevant, these studies cannot be addressed as the studies on the ethics of self-quantification.

In the existing research on the ethics of self-tracking there is sometimes a challenge with the categorization of ethical aspects, sometimes there is an overlap between several aspects. As Wieczorek (Wieczorek, 2023) notes: "Concerns connected to privacy are closely related to the ownership of data, whereas social harms can be associated with either harmful design or data being used to inflict specific harms."

Chapter 3 - concerns and critique of self-tracking

The focus of this chapter will shift towards the associated risks and critique of self-tracking. As discussed in the previous chapter, self-tracking technology has its own benefits but is not infallible. The intention is not to debunk the advantages of self-tracking completely but rather to illuminate the potential pitfalls that can be used for the creation of the guidelines for individuals engaging in self-tracking in the future.

Data-related issues

The subject of privacy issues associated with self-tracking applications will be delved into more thoroughly in Chapter 5, where we will use female health tracking as a case study. For now, we'll provide a brief overview, laying the groundwork for the more extensive examination and discussion to follow. This quick examination is intended to give a preliminary understanding of the privacy issues and set the stage for a longer and more in-depth discussion in the subsequent chapters.

Privacy and security

The subject of privacy issues associated with self-tracking applications will be delved into more thoroughly in Chapter 5, where we will use female health tracking as a case study. In order to create the framework for the more in-depth analysis and conversation that will come in the next chapters, we'll give a quick overview for now. This brief analysis aims to provide a basic knowledge of privacy concerns and provide the groundwork for a lengthier and more in-depth discussion in the next chapters.

According to the classification provided by Barcena et al. (Barcena, 2014), there are three primary risk areas exist for data collected by self-tracking apps:

1. On-Device Risk: This is where data about a single user is stored locally, which can be compromised by malware or physical theft.
2. Transmission Risk: Here, the user data or a limited number of users' data is sent to the cloud either in real-time or in batches. It is vulnerable to threats like traffic sniffing, redirection attacks, and man-in-the-middle attacks.
3. Cloud Storage Risk: This involves data about all users that is processed, collated, and stored in a central database. There's a risk of compromise due to exposure to the outside world, with potential threats including SQL injection attacks, account brute force login attacks, and distributed denial-of-service (DDoS) attacks.

The volume and variety of information that is collected about us are expanding, which poses a significant risk to our privacy. Some self-tracking apps are "data hungry" and gather an excessive amount of personal information about their users, exposing them to the outside world more than is necessary. Inadequate management of accumulated data, whether due to security vulnerabilities or intentional distribution to third parties, can give rise to several genuine threats: identity theft, profiling, stalking the user, corporate use and misuse, embarrassment, and extortion (Barcena, 2014).

In general, the subject of customer data privacy and security in all sorts of mobile applications has been a focal point of rigorous research, often revealing areas for improvement. The Norwegian Consumer Council undertook a thorough examination of a variety of popular mobile applications, including those designed for self-tracking (Bjørstad & Claesson, 2020). The findings from this investigation raised some significant concerns: "In total across all tests, we observed the apps sending more than 88.000 HTTP requests, communicating with at least 216 unique third-party domains (*.example.com), owned by at least 135 different companies". This raises red flags about the potential misuse of user data and the invasion of privacy, especially considering that the owners of these domains are mostly companies within the advertising space.

The study by Hutton et al. (Hutton, 2017) analyzed 64 popular self-tracking tools where they scored them following their heuristic on privacy. The heuristics were developed based on the broad regulatory environment, including laws like GDPR, and were centered around informed consent, control over data, access to data, and control over third-party sharing. The results revealed that no mobile health application achieved the highest possible score in all applicable heuristics. On average, each app achieved a heuristic satisfaction score equal to 46.2% of the maximum possible score. "Examples of areas in which the majority of apps scored poorly include providing programmatic access to data, allowing control over the granularity of data when it is shared, and the availability of help and documentation to support decision making".

The study also explored if a relationship existed between an application's marketplace maturity and its result. Indicators such as the number of downloads, average star rating, and the total number of ratings were used to estimate the apps' maturity. However, the analysis found no significant relationship between these maturity metrics and the performance of the applications. A further notable and concerning discovery from the research was the presence of more privacy problems in apps associated with tracking mHealth data. Due to the revealing nature of mHealth data, this situation could lead to harmful scenarios if data privacy is compromised. It was observed that apps not related to mHealth usually keep the data on the user's device, avoiding third-party sharing, and thus garnering higher privacy scores.

When the data is shared with third parties, this raises a whole new level of data exposure. Orlosky et al. (Orlosky, 2019) investigated the privacy and security of the Fitbit app and found that third party applications can change user data which could lead to it either deliberately or unintentionally tampering with user's records. The absence of sufficient user knowledge in this area further increases the risk when it comes to third-party applications. At present, there is no system in place allowing a user to authorize read-only access without also granting permission to modify their data.

The integrity and privacy of personal health and medical data face threats from various angles, including not only exploitation by self-tracking tool providers but also malicious cyber-attacks. Legally, data brokers and other entities might use such sensitive information for commercial or governmental purposes (for example, the data can be used in court (Carter, 2015)). Illegally, there's a rising trend of cybercriminals breaching digital medical databases, which can lead to severe consequences like identity theft, fraudulent health insurance claims, or unauthorized access to pharmaceuticals and medical equipment (Lupton, 2015) (Carter, 2015). Some of the popular self-tracking apps expose their users to such situations by not following simple rules of cyber security. The report by Barcena et al. (Barcena, 2014) showed that 20% of apps transmit passwords as the cleartext which is considered as a huge violation of the basics of internet security. Moreover, a lot of apps examined had poor session management, sometimes leading to most irresponsible situations: "One particular system was so poorly designed that it could expose user accounts data if you know the email address of one the users of the system or if you simply modified the user ID in the request as the IDs are sequential." Another study notes that encryption which could be one of the security solutions in many cases is not used in many mHealth apps at all (Carter, 2015). As a result, there is a lot of potential for successful cyber-attacks. Cases like the breach at American healthcare provider Anthem Inc. (Lupton, 2015), where unencrypted information about millions of patients was illegally accessed highlight the vulnerability of these systems.

Sometimes personal tracking data can be used by the app providers against individuals against their will, extending its use beyond the original goal of health and fitness monitoring. There have already been cases that despite the claims of keeping user data private the companies shared them with the authorities. One such example is brought up by Ajana (Ajana, 2017). A woman in the U.S. claimed she was assaulted while sleeping, but after her Fitbit data was introduced as evidence in the court and showed she was awake and moving at the time, the woman was charged with falsely reporting a crime and tampering with evidence. I have encountered some researchers that go as far as saying that the material collected during self-tracking can serve as an alibi. O'Hara et al. (O'Hara, 2008), for example, write about an art professor, Hasan Elahi, who was posting information on the Internet as a form of an alibi. The author, who generally seems to view self-tracking in a positive light presents this

example as a "positive effect of lifelogging" saying that "the lifelogger has material to create countervailing representations of the past".

An interesting edge case connected to data privacy was described in the study on sleep-tracking ethics by Müller et al. (Müller, 2023). Sleep-tracking tools in their current state are not able to distinguish between the noises made by the actual user and their "bedfellow". This leads to the situation where snoring, talking and other sounds produced by the bedfellow are also recorded during the night and the person might not be even aware of that.

Generally, interviews with the self-trackers show a little understanding of what the privacy of the data collected about them can imply. Many people don't completely understand the potential uses and abuses of their personal information, which can have serious repercussions for their privacy and personal safety.

Users of gadgets like fitness trackers frequently are unaware of the security implications of such devices, which may disclose private or sensitive information through aggregate or position data (Orlosky, 2019). This is also confirmed in the interviews by Lupton (Lupton, 2021), which commented that "the potential for their data to be exploited by third parties and the possibilities of data leakages, breaches or hacking did not seem to have entered their horizons".

50% of the participants of the survey in the study by Ajana (Ajana, 2020) were unfamiliar with the rules surrounding the data generated by their self-tracking devices and apps. Moreover, they did not seem concerned with the fact that their information was potentially shared: "I've never given it a second thought. I can't easily come up with a reason for keeping such information private, either". The same trend among users was mentioned by Lupton (Lupton, 2021), who observed that many of her participants simply did not believe that anyone else would find their personal information interesting or useful: "at the moment I'm not bothered about where stuff goes. If they were tracking my feelings or emotions, then I probably would check. But because I'm mainly tracking work I don't really care". People who considered the risks of their data being shared still mostly were either convinced that there is nothing they can do about it or that since the data is collected without the direct attachment to their identity it did not bother them: "They don't actually care about me, they care about just that person who fits those statistics. Generally speaking, apps and websites are tracking to get ad sales, they're not tracking me to find out my identity".

On the other hand, when people are explicitly interviewed about the security and privacy concerns of the self-tracking tools and receive input on what happens behind the scenes, they seem to express discomfort with it. Interviews (Orlosky, 2019) show that Fitbit users were not satisfied with the device

"using social network profiles to identify friends, were unsure how much of their data would be shared with 3rd party services and were especially concerned about location data breaches and misuse". This emphasizes the need for enhanced privacy education because knowledge can enable consumers to demand better protection for their data and enable them to make informed choices.

The issue is not only the lack of general education on privacy matters but also the apps failing at their duty of informing their users about what consequences they are dealing with while using the app. As discovered by Hutton et al. (Hutton, 2017), only 29 applications out of analyzed 51 provided terms of service or a privacy policy to describe how data will be used, and none required that these policies be read or understood prior to continuing with registration. A similar result showed the study by Barcena et al. (Barcena, 2014), where 52% of apps did not offer privacy policies to their users at all.

The studies that deal with the privacy issues of self-tracking tools seem to provide similar recommendations for designing health self-tracking apps. The developers of the apps must ensure users are adequately informed for consent, avoid unnecessary data collection, and minimize user burden (Liddle, 2016). Additionally, people must be given the autonomy to decide what health aspects to measure and should be comprehensively educated on the potential implications, such as increased health responsibility and altered body perception. The information concerning the collection of information about the human study must be communicated straightforwardly to ensure proper understanding in order to uphold respect for individuals and to reduce knowledge asymmetry (Tu & Gao, 2021).

Data ownership

Navigating from privacy concerns in self-tracking, it becomes evident that these issues are intrinsically linked to another critical aspect: data ownership. Who owns and controls the data generated by these self-tracking tools remains a crucial question, often blurring the lines between personal privacy and corporate interests.

The ownership and use of personal data by parties other than the person who created it are starting to have a significant impact on social discrimination and justice issues (Lupton, 2014). Software programmers use algorithms that combine digital data in specific ways to produce "algorithmic identities" that are customized on behalf of users.

This process, moreover, is not transparent and oftentimes happens behind the scenes. Many people engage in the process of self-tracking under the notion that the data they produce belongs to them, the truth is that the data is frequently owned by the firms who provide the technology. Users are often

given no option as to whether to save their data on the company's server or their own devices by service providers (Ajana, 2020). "It has been argued, indeed, that we are now living in an era characterised by 'the end of forgetting'" (Lupton, 2015). When users allow the data to flow to the cloud of the app developer they often lose the control and ability to delete this data. Some apps offer the feature of requesting the deletion of all user-related information, however, this is not a common practice. Moreover, the possibility of even getting the information about your user data that was collected by the self-tracking tool can turn into the question of privilege. As Ajana found out (Ajana, 2017), Fitbit "used to charge users $50 a year to download their records".

One of the options here would be to create your own devices that remain under your control, and that is what some members of the Quantified Self community do (Ajana, 2020). According to Deborah Lupton (Lupton, 2014) "a few self-trackers who use digital technologies, other than the most technically adept who are able to craft their own digital self-tracking tools and silo their data, are able to avoid this circulation and re-use of their personal data". But for a big audience of regular users that is not possible, as they do not have the time and motivation to be that deeply invested in self-tracking.

A special case that raises concerns about data ownership is data collected from tracking tools in research and medical setting. Data from mobile phones can be conveyed to researchers or medical professionals, but it often passes through Internet Service Providers or telecom firms, which may log this information and possibly trade it with other entities, including government institutions (Carter, 2015).

Data commodification

Transitioning from the topic of data ownership, we now step into the realm of data commodification. As self-tracking practices, encompassing the collection and analysis of personal data, become widespread across various social contexts and institutions, the distinction between small and big data, as well as between private and public domains, is fading. These practices are penetrating workplaces, educational environments, healthcare, insurance, marketing, the military, citizen science, and urban planning (Lupton, 2014). Consequently, the personal data individuals gather about themselves are increasingly viewed as valuable contributions to larger data sets.

In many scenarios, individuals are essentially compelled to use digital devices to monitor diverse aspects of their lives. This generates personal data that others can exploit for their own, sometimes commercial, purposes. The commercial value that companies derive from either creating or selling this data often lacks transparent disclosure, and notably, is seldom shared with the users themselves.

This leaves a wide-open space for data commodification, underscoring the need for further scrutiny and regulation.

Datafication

The rise of self-tracking has resulted in excessive datafication, altering the relationship between our bodies, identity, and understanding of experiences. On the one side, is not impartial to use numbers to describe a phenomenon. Quantification makes it natural to measure and interpret certain phenomena in terms of numbers (Pharabod, 2013). However, the problem arises when we start seeing the use of technology to measure bodily functions as a new kind of objective truth (Ajana, 2017). People are not used to really count the exact amount of beats per second our heart pumps (Perusquía-Hernández, 2021). What is important is to think about "how that makes us feel, and we name those feelings". But the process of quantifying feelings is perceived to be more reliable than actually feeling them directly (Chiodo, 2022), leading to a redefinition of personal experiences based on digital models: "The feedback from that digital model often took precedence over how I physically felt. When I didn't eat 'enough' protein I felt weaker, and when I had too much sugar I felt fatter. These were delayed reactions; a re-reading of my body from the model. I've yet to decide: is this model pushing me closer in contact or further away from my self and my world?"

However, even members of the Quantified Self community have expressed concern over the divide between the culture of numbers and the culture of sense (Pharabod et al, 2013). The predominance of numbers tends to result in a narrowed view of phenomena, reducing complex experiences to simplified metrics. Some self-trackers seem to understand the issue:
"So I have learned that I'm not in fact an engineering problem of calories in and calories out. There is a lot more complex and subtle interactions going on that keep me constantly adjusting. What worked the first time didn't work the second time" (Chiodo, 2022).

This reductionist approach is especially apparent in the realm of sexual activity tracking. Rich, multifaceted experience of sex is being reduced to cold, impersonal numbers, transforming a deeply personal act into a performance that is dictated by normative metrics (Lupton, 2015). Even if the measurements can lead to successful management of those concrete parameters, it does not mean that the goal is achieved on a bigger scale. An illustration of this can be the quantified relationship apps and sex-tracking apps in particular, discussed by, which primarily focus on improving the quantitative metrics. "Suppose that the apps are incredibly effective at getting us to optimize these metrics. Would this be a good thing? No, … because these metrics are not indicative of good quality sex, much less good relationships". Similar criticism has been leveled against other types of tracking, such as health and fitness apps.

As the interviews indicate, self-tracking practices can result in detracting the joy from the actual activity due to excessive self-monitoring and being focused on reaching the targets (Ajana, 2020): "it is easy to focus too much on making a certain pace or burning a certain amount of calories instead of enjoying the activities and your surroundings".

The research on justification confirms those experiences (Etkin, 2016). The inner drive that people usually have while doing simple activities, which are supposed to be joyful by themselves, can be "crowded out" by giving people "rewards" for it.

Moreover, there is often a feeling that if the activity is not tracked, it does not count: "My Fitbit recently broke down and although I continued to walk, I did feel as if it wasn't worthwhile" (Ajana, 2020). The results of research by Jin et al. (Jin, 2022) confirm this idea and conclude that daily tracking is affected by a loss in motivation for exercise when the tracker is not available. Participants who reported having a high need for cognitive closure, low prospect of achievement, and high extrinsic incentive for using activity trackers and for physical activity were more likely to experience this reliance effect.

Self-tracking often relies on simplified and restricted measurements that may not fully capture the complexities of the real-world phenomena they aim to represent (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015). For instance, using BMI as a measure of healthiness may overlook important factors. This limited representation can potentially result in unnecessary or unproductive behavior changes, as users may alter their routines to align with what the tracking system can accurately measure.

Self-tracking inherently involves negotiations even if the logic of QS emphasizes objectivity, neutrality, and unambiguity through quantification (Bode & Kristensen, 2015). One of the reasons for that is that "we know little as yet about how people are using and giving meaning to these devices" (Lupton, 2014). Sometimes self-trackers can go as far as cheating. "The reductionist assessments often offered by self-tracking systems may also cause users to optimize the tracked parameter rather than the underlying concept" (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015). An illustration of that could be shaking the step counter instead of actually walking.

The motivation to "improve" the numerical measurements in unfair ways is increasing as soon as there is an actual financial benefit that a user can get. "Many self-tracking systems offer digital rewards like badges and other markers of achievement" which some users see as a temptation to fake their scores (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015).

Data interpretation

The interpretation of data is an issue that emerges both for the self-tracking tool provider and the end user. Self-tracking data is constantly generated and can be combined in numerous ways. These data assemblages are not fixed but represent a snapshot of a specific moment and data practice (Lupton, 2014). They are dynamic, responsive, and distributed across different datasets, requiring the interpretation of self-trackers or third parties to derive meaning from their evolving nature.

The practice of self-tracking underscores that metrics are not simply objective measures. Instead, they are deeply embedded in our social fabric, influenced and shaped by our relationships, societal norms, and power dynamics (Lupton, 2013). Our interpretation of these tracked numbers isn't solely a product of data. Instead, it is a nuanced process that reflects our societal values, personal biases, and the social contexts in which we live. Essentially, despite participants in the Quantified Self movement wanting to perceive self-measurement as an unbiased representation, it remains a complex interplay of personal, societal, and technological influences. Moreover, this is further demonstrated by research findings showing that mental health differences can significantly impact individuals' subjective experience with self-tracking (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015).

One of the further issues with the interpretation of data is confirmation bias. When the self-tracking technology is providing raw data feedback, "people might only believe information that confirms or suits their beliefs" (Perusquía-Hernández, 2021). While the numbers are considered objective in Western culture, they can also serve as a comforting illusion, allowing self-trackers to shape their own narrative, especially in the situation that often arises while self-tracking where there is expert interpretation and the absence of a broader context can be observed (Chiodo, 2022). According to Van Dijk et al. (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015) experiment on how physiology feedback affects people, people's estimates of their levels of stress become more in line with their heart rates when they receive input regarding those rates: when their heart rates are high, people report a high degree of stress, and when their heart rates are low, people report a low level of stress. While an increase in body awareness may have contributed to this, there is also a good likelihood that users view feedback as a more reliable gauge of stress levels than they do subjective experience.

What is also worth mentioning is that sometimes people use new technology in unexpected ways, coming up with novel methods to engage with them and give them purpose (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015). There is no guarantee that the self-tracking technology will be used as it was originally planned, which to a certain extent compromises the results of data interpretation and subsequent decision-making. Such unexpected use cases are also hard to predict.

Data efficiency and accuracy

While numerous studies confirm the beneficial impact of self-tracking on user health, there's also a contentious body of evidence suggesting that the effectiveness of these tools may not significantly surpass conventional methods for managing similar health concerns. Owens & Cribb (Owens & Cribb, 2019) provide an example of a study of young people willing to lose weight where it was shown that devices that track and give feedback on physical activity might not be superior to conventional behavioral weight loss methods. Considering the findings by Stiglbauer et al. (Stiglbauer, 2019), it appears that the efficiency of self-tracking technologies is not merely dependent on the device itself but is also influenced by supplemental tools such as fitness apps. Using the device alone shows statistically little benefits on user's progress. The combination of a wearable device and a fitness app appears to enhance the effectiveness of self-tracking, potentially due to the additional guidance, insights, and motivation these apps provide. This difference in efficiency might impact how we perceive and trust the self-tracking process. Our trust in self-tracking may need to extend beyond the device itself and consider the ecosystem of supportive apps and tools that enhance the overall experience and outcomes.

Not only does the wear of the self-tracking device alone show low efficiency in physical health improvement, but it also was proven to provide inaccurate metrics. As the study of hospitalized people conducted by Wu et al. (Wu, 2023) shows, Fitbit data on users' step count significantly differed from nurses' and users' reports. "Fitbit devices misinterpreted wheelchair, stretcher, or arm movements (such as tremors) as steps". The sleep tracking also showed poor accuracy on patients. The authors of the research suggest that the unique conditions in hospitals, coupled with the physical states of acute illness, might interfere with how these algorithms typically operate. The issue with the accuracy of wearables is also discussed in the study by Tu & Gao (Tu & Gao, 2021). There are certain advancements in epidermal sensing systems for monitoring physical activities and physiological signals (pressure, skin temperature, and biochemical analytes in biofluids). However, up until now, they are not free of a certain degree of uncertainty, which can affect the real-time collection of accurate physiological information. The examples include the influence of mechanical strain on skin temperature sensors and the potential accuracy limitations of photoplethysmography (PPG) sensors in darker skin tones.

Often the studies on efficiency use self-report questionnaires as the main method of collecting feedback on health improvements of the self-trackers (e.g., (Stiglbauer, 2019)) which introduces a certain level of complexity. For example, a user might have a subjective feeling of an improvement in their physical health and well-being because they are more conscious of the processes in their body in general, even if there's no significant change in actual metrics. Also, self-reported data might be influenced by a broad variety of biases that people inevitably have. Therefore, while subjective data can provide an overview of positive user experiences, it doesn't necessarily prove objective

effectiveness. The results can potentially be compromised if not balanced with other more objective measures of health and fitness improvement.

The danger of inaccurate data is especially high when it influences health conclusions. Disclosing the limitations of data collection has not only societal and scientific benefits but is also essential for the safety of the self-trackers (Tu & Gao, 2021). The practice of openly disclosing data collection limitations should be a standard within the self-tracking industry.

Social harms

It's crucial to look at self-tracking's social effects as we go deeper into its implications. The widespread use of these methods not only alters individual experiences but may also have negative effects on society.

Privilege

Self-tracking, utilized as a method of exercising control over one's habits and actions, can be influenced by issues of privilege. There is a significant difference in how exactly different social groups use self-tracking (Hardey, 2022). Various socioeconomic classes and categories experience differential access to self-tracking tools and consequently engage with them differently. The concept of healthism, advocating that "ideal" citizens are those who take responsibility for leading a healthy lifestyle and are boosted by emerging digital self-tracking tools, is predominantly adopted by socioeconomically advantaged individuals. Crawford (Crawford, 1980) noticed that healthism is not as pushed by the working class compared to the middle class. These individuals, with the means to prioritize health, accentuate personal empowerment over broader social and economic health determinants. Their confidence in adopting new fitness regimens through wearables and apps also often becomes a public display of health-conscious living, shared on social platforms. This was confirmed by the interviews conducted by Hardey (Hardey M. , 2019) who among the others provided the following quote of the user who described her engagement with social media: "I post pictures of my protein shakes on Instagram and link back to my personal training schedule so others can see it".

The idea of the "ideal citizen" implies the existence of less-than-perfect citizens, who are frequently members of less privileged groups. Lower socioeconomic groups are known to be less likely to self-quantify or use digital tools to monitor their dietary intake and physical activity. We see a clear relationship between being financially secure and being "ideal" in terms of health responsibility. As Crawford (Crawford, 1980) put it, "healthism is a kind of **elitist moralizing** about what are believed to be unhealthy coping behaviors".

Another phenomenon that is also observed in middle-class people is that they frequently use self-tracking as a stepping stone to imitate and take on the behaviors of a higher social group they wish to join (Régnier & Chauvel, 2018). They seek to better their health by using these health monitoring methods, but they also want to represent themselves as belonging to the socioeconomically privileged groups. Thus, self-tracking becomes a tool to strive towards an 'ideal' status, both in terms of health and social standing, emphasizing the intersection of health behaviors and socioeconomic aspirations. The perceived elevated social status associated with wearable technology and sophisticated smartphone apps should be considered essential components of self-tracking health culture, which consequently influences social practices.

Moreover, the effectiveness of the self-tracking tools has different degrees depending on socio-economic factors. They "may enable people to improve their health by supplying information and encouragement, but they do little to change a person's capacity to act in the world and to positively enhance their opportunities for achieving better health" (Owens & Cribb, 2019). These limitations draw attention to the huge gap between the claims made by suppliers of self-tracking technology and the instruments' actual effectiveness in encouraging real lifestyle change. The whole design of self-tracking tools usually does not take "social determinants of health" (Zheng, 2021) into account at all, such as "access to healthy food, built environment and socioeconomic status and mental status", which inevitably leads to a reduction of "healthy-life" to actions that are exclusively a product of self-discipline.

Discrimination

Self-tracking technology's ubiquity and integration into several aspects of our life have significant societal repercussions in terms of the possibility of discrimination. It's important to examine how the use of these technologies can unintentionally perpetuate prejudice and inequality across a variety of dimensions, even when the objective data they collect may appear neutral. While aggregated data might not always discriminate against a single user, it can motivate discrimination against categories of users that are inevitably created during big data analysis. While the necessity to categorize users is understandable, seeing them as mere statistical units would be naive. "Categories, as we know, are by no means neutral or apolitical" (Ajana, 2017). Categories are the basis for differentiation which in its turn can lead to "discrimination, over-criminalization and other restricted freedoms" (Lupton, 2015). Self-tracking largely depends on the collection of biometric data, the theory behind it is to map a unique person to some allegedly objective dataset that can be analyzed. However, the belief that technology or the data it collects is "objective" is far from reality.

Concerns have been raised about technology being discriminative towards some groups or users (Ajana, 2017). For example, due to their "fine skin" and "faint" fingerprint ridges, Asian women

frequently have trouble having their fingerprints captured by scanners, while dark-skinned users have trouble being "distinguished" by facial scanners. (Lupton, 2014) reflects on the "algorithmic identities" that are being created based on the data collected from the user and notes that these identities can have material effects. The use of self-tracking data may occasionally serve as surveillance technology, which might worsen the social disadvantages that marginalized groups already experience. This is comparable to the use of biometric technologies to verify identity or the analysis of large digital data sets to predict human behavior. As a result, some people and groups are denied access to products and services or are classified as security concerns.

The design and aesthetic elements of self-tracking applications can play a significant role in user discrimination. This includes different stylistic elements that affect whether a user thinks the app fits their style. These elements, however, can follow some biased assumptions and stereotypes which might result in the exclusion of certain groups of people. An app with a significantly biased design towards one gender, for instance, might turn off users of that gender or others who don't identify with conventional gender norms (Lee, 2021).

When it comes to corporate wellness programs that aim to reduce costs on insurance and increase the effectiveness of employees, the risk of discrimination also is quite observable. These programs often emphasize the notion of the 'ideal employee' as someone who is healthy and does not incur high medical costs (Ajana, 2017). As a result, it is possible to establish a workplace where employees are evaluated on both their health and their work performance. However, this might be discriminatory toward workers who may suffer from debilitating illnesses, disabilities, or other health conditions that are frequently out of their control. Moreover, when such programs become an integral part of healthcare and health insurance, it can cause discrimination against citizens that do not comply with the "norms" by denying them access to public and healthcare services (Ajana, 2017).

Narrative of neoliberal ideology and biopower

Some researchers argue that technological advancement is not the only factor driving the growing emphasis on measurable data and its capacity for self-evaluation and improvement (Ajana, 2017). They see it as a sign of a larger shift toward a "neoliberal" ideology of self-governance and healthcare management. The foundation of this ideology is the atomization of society, where people are increasingly expected to take care of their health, employability, well-being, and happiness. According to Danaher (Danaher, 2018), "this is problematic because it suppresses or ignores the systemic causes of ill-health, unemployment, unhappiness".

Neoliberal ideology expects individuals to have a prominent role in the management of their own health (Ajana, 2017). This focus on personal responsibility could be potentially harmful and needs

careful consideration. It puts a significant burden on people to manage their health, which can be even more frustrating and complicated for those with limited resources or health knowledge. "The move from experts' expertise to self-expertise" can potentially cause serious harm as the self-tracker is often not able to see the picture as a whole and map various pieces of advice from the Web or the data they produced (Chiodo, 2022).

Moreover, it could decrease reliance on professional medical advice, leading to possible misinterpretations of data or missed diagnoses (Ajana, 2017). A radical example of such a case was described by Chiodo (Chiodo, 2022). One self-tracker, who was praised by Gary Wolf the founder of the Quantified Self Movement "for being disloyal to the professional, institutional version of science, for not conforming to scientific rituals" died of coronary occlusion due to the wrong medications that he decided to take himself instead of following the advice of medical professionals. All of this might undermine the collective nature of public healthcare, potentially increasing health inequalities (Ajana, 2017).

The neoliberal ideology with its emphasis on self-governance and individual responsibility for health, as described in the first point, sets the stage for the application of biopower and biopolitics. Since the 18th century, a form of power that prioritizes the population's biological survival and physical vitality—often referred to as "biopower"—has started to dominate society (Ajana, 2017). The methods, strategies, technologies, and rationalities that are employed to manage life and the living and to rule their daily affairs are collectively referred to as "biopolitics." And what sets biopower and biopolitics apart from other types of power and politics is that they focus more on normalization and control in the service of freedom itself rather than repressive discipline and compulsion. In the context of self-tracking, biopower, and neoliberal ideology converge, creating a reality where health management is heavily individualized, normalizing certain standards of health and wellness. This matrix of self-management and normalized standards subtly fosters an environment where the freedom to manage one's health is accompanied by the pressure to conform to certain norms, echoing the principles of biopower and biopolitics.

Healthism and medicalization

"Self-tracking seems to promote the idea that if something can be tracked, it can be improved" (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015). This is consistent with the 'healthism' doctrine, which argues that everyone bears a responsibility to take care of their health by adjusting everyday activities and decisions. This sociological concept developed since the 1970s suggests that personal actions and responsibility can somewhat control one's health outcome. Crawford (Crawford, 1980) defines healthism "as the preoccupation with personal health as **the** primary focus for the definition and achievement of well-being; a goal which is to be attained primarily through the modification of

lifestyles, with or without therapeutic help". This narrative tends to portray those who take charge of their health as ideal citizens, while implicitly presenting those who are ill or lack self-responsibility as morally deficient and inferior as Debora Lupton notes (Lupton, 2013). People may decide to self-track as a way to exercise control over their health and demonstrate personal responsibility when under the influence of healthism. Self-tracking device adoption thus becomes a visible reflection of this worldview. Sometimes self-trackers who have adopted the healthism doctrine have a hard time coping with stress caused by the discipline that is required to maintain this lifestyle. Here is how an interviewee of Zheng (Zheng, 2021) describes her experiences: "Around the year of 2018 I moved to Beijing and had a period of unstable time. I didn't have time to think about (the plans) ...I needed strong self-discipline to open (the app). It is stressful to stick to a higher standard of health".

The term "medicalization" was also discussed in scientific research before self-tracking tools became widespread and can be seen as a form of medicalization (Crawford, 1980). It is a concept revolving around the increasing intersection of social and medical domains. Crawford (Crawford, 1980) describes two levels on which medicalization can be perceived. At one level, it can be seen as the expanding influence of the medical profession, diagnostic practices, and therapeutic interventions into broader aspects of life, even those traditionally viewed as deviant behaviors. On another level, medicalization also involves seeing more and more social behaviors through a health-focused lens. Thus, medicalization in one sense feeds into the other, reinforcing an ever-widening medical perspective on societal behaviors and norms.

In the studies related to self-tracking activities, medicalization is portrayed as the process of turning an everyday activity and measuring it with the help of available self-tracking tools to improve it (Müller, 2023). Self-tracking tools can contribute to the process of medicalization even more by transmitting everyday activities and lifestyle choices into quantifiable data. These technologies enable continuous health monitoring, often interpreting everyday behaviors within a medical context. As individuals track their sleep, diet, exercise, mood, and other aspects of daily life, self-tracking tools influence people to view these behaviors through a health and wellness lens, potentially redefining what they consider as "normal" or "healthy" behaviors.

One of the cases where medicalization boosted by self-tracking can harm users is the tracking of sleep among people with insomnia. Without proper therapeutic guidance, the data that indicates lack of sleep might encourage unhealthy coping strategies, such as extending bedtime to compensate for lost sleep. This might exacerbate insomnia, as longer periods in bed without sleep can increase stress and the risk of chronic insomnia. What makes it even more problematic is the fact that the data retrieved by self-tracking sleep apps can in addition be inaccurate. It can falsely overestimate and underestimate the duration of sleep. Overestimation of sleep is as potentially harmful as underestimation of sleep. It

could give a false impression of healthy sleep patterns, potentially delaying necessary medical treatment for individuals with undiagnosed insomnia (Müller, 2023).

Norm prescribing

Standards and norms are crucial in the fast-changing field of self-tracking technology to direct users in their pursuit of better health. However, some of these imposed standards might not be supported by solid scientific data and might instead result from historical or commercial factors.

One of the most illustrative examples of inadequate norm prescribing is the fact of the use of 10.000 steps as the threshold across most health platforms and self-tracking devices, which should be achieved by users to stay healthy and active citizens (Ajana, 2020). It is a known fact that 10.000 steps is a myth that developed as a result of a 1964 advertising campaign following the Tokyo Olympics. The recent research by Paluch et al. (Paluch, 2021) suggests that while physical exercise is beneficial there is nothing special about the number of 10,000. The inflection point at 7,000 steps seems to be more significant. When compared to those who took fewer than 7000 steps per day, those who walked at least 7000 steps per day had lower death rates. Nevertheless, a lot of health platforms and self-tracking apps use the norm of 10.000 steps resulting in users being forced to conform to a pre-given standard of ideal health (Ajana, 2020) (Ajana, 2017)

Moreover, norm enforcement can come not only from the tools for self-tracking but also from the users themselves. For instance, consider the following statement from an interviewee: "I can only bear myself when I'm under 58 kg" (Pharabod, 2013). This illustration shows how internalizing self-tracking can result in self-imposed rules and standards that may be damaging. The person's remark implies a deep emotional connection between one's opinion of oneself and a certain numerical weight. If the desired number is not achieved or maintained, this type of internal norm-setting, which is motivated by personal expectations and self-imposed norms, can create a great deal of pressure and contribute to negative sentiments of self-worth. Such instances illustrate the need for a balanced and nuanced approach to self-monitoring and raise the possibility that the psychological harm could outweigh any physical gains obtained from measuring and adhering to these rules.

Nudging and gamification

To maintain engagement the design of the self-tracking apps relies on persuasive technologies based on nudge theory. Nudging, a concept derived from behavioral economics and choice architecture, refers to the strategic modification of an individual's environment to subtly steer them toward making specific decisions or choices (Owens & Cribb, 2019). One of the main issues with nudging is that it has the potential to be manipulative and change user behavior without the user's knowledge or consent. Users may be pressured into making decisions that they may not have independently and

consciously made, which can put personal autonomy at risk. Furthermore, nudging can oversimplify complicated health decisions by limiting them to binary options without taking into consideration the nuances or preferences of each individual.

Self-tracking systems' persuading, gamifying, and nudging capabilities are frequently viewed as beneficial motivational features that encourage users to adopt "healthier" lifestyles (Ajana, 2020). Self-tracking devices and applications seek to increase the persuasion effect on behavior by assuming the role of a "friend" who is familiar with the user or an authority figure like a nurse or doctor (Ajana, 2017). In her article, 'Gaming the quantified self', Jennifer Whitson (2013) argues that gamification encourages playful subjectivities and drives behavioral change to acquire new conducts. This is evident in the 'nudging' aspect of self-tracking devices which also function as triggers, reminding users to exercise regularly. For example, Fitbit's indicator lights up as an alarm when the device senses that the user has been sitting for too long. Apps like Aqualert and Plant Nanny act as a 'hydration reminder' encouraging the user to increase her water consumption. As one participant puts it, '[my device] reminds me to go out for walks, go to the gym, to be fitter. I'm always trying to raise my heart rate into different zones and my FitBit challenges me to do that' (female participant, age range: 18–25) (Ajana, 2020).

As Fogg points out in his book "Persuasive Technology: using computers to change what we think and do" (Fogg, 2002), people generally anticipate guidance, advice, and helpful information from the authority. They also believe that authorities are strong and clever. The authority positions that humans play include those of teacher, referee, judge, counselor, and expert. Computers are capable of playing these roles, and when they do so, they automatically acquire authority-related influence. Computer goods gain more sway by convincingly portraying an authoritative position. However, gamification as a strategic approach employed by corporations is used to not only help users track and measure their activities but also to stimulate and structure these activities to align with their interests. These virtual rewards, emblematic of gamification, are designed to generate specific types of data, thereby guiding the user to engage in desirable forms of labor. This aspect of gamification subtly promotes a neo-liberal entrepreneurial persona, emphasizing the individual as a subject of personal enterprise and work, meant for continual improvement (Till, 2014).

Surveillance

Self-tracking technologies, which have grown alongside neo-liberal philosophies, have filled modern life with a surveillance aspect that is linked to our health and welfare (Till, 2014) (Ajana, 2020). The rise of mobile and wearable mHealth technologies further strengthens this trend. Devices like Fitbit, Garmin, or Strava, by providing frequent, detailed health-related data, offer an unparalleled opportunity to not only monitor our habits but also allow governments or businesses to keep a tab on

our health metrics, thereby transforming the spatial, temporal, and interpersonal nature of health surveillance (Lupton, 2013). As a result, these devices can be perceived as material aspects and methods for transforming human bodies into subjects of knowledge (Will, 2020).

Individual privacy is increasingly perceived as conflicting with the public interest, depriving communities of crucial information (Ajana, 2017). The narrative of 'privacy against security', prominent in the post-9/11 surveillance politics, is currently penetrating the health sector and medical research, framed as 'privacy versus public good.' Healthcare professionals already started to use patient-generated data for creating health profiles (Lupton, 2015). In response to the Affordable Care Act's in the U.S., hospitals have been using big data technologies, integrating patient data from diverse sources, including home-based self-monitoring, to generate risk models aiming to predict the likelihood of patients' readmission.

Another factor in the domain of surveillance is the so-called "symptomatic surveillance" (Till, 2014). It refers to the real-time monitoring and automatic data acquisition from various sources to track health patterns which blurs the line between health and commercial data. Providing data about oneself voluntarily is not the only way insurance companies get to know and control your health choices. Till brings up a case where the data brokers were caught on sharing data collected during shopping or getting a gym membership with the healthcare providers. This ultimately leads to the profiling and categorizing of people, which has the potential to encourage prejudiced judgments based on these created profiles.

Data miners frequently generate profiles of individuals with certain health conditions like sexually transmitted diseases, HIV/AIDS, cancer, mental health issues, or those who have experienced sexual assault (Lupton, 2015). These profiles are then commercialized and made available to marketing firms, prospective employers, and financial institutions.

More and more companies are integrating compulsory tracking at the workplace. While initially beneficial in a competitive environment, the growing tendency of quantification in the workplace has the potential to cause serious harm over time. The strain that employees are under can be increased by this numerical and data-driven approach, especially with the incorporation of wearable technology, which can result in increased stress, anxiety, and even burnout from overwork Moore & Robinson, 2016. Workers' health and safety might suffer in this unfriendly atmosphere, which is characterized by constant observation and the expectation of full mobilization. However, in a neoliberal context, these negative effects are frequently written off as personal shortcomings or failures to adapt, omitting the structural problems that are inherent in this style of labor operation. The risks to employees also include the possibility of unfavorable hiring choices, discrimination, and breaches of privacy rights that are currently not prohibited by any laws Brown, 2016.

It's crucial to recognize that the critique of corporate wellness programs comes from a place of privilege, as these initiatives are often a luxury not afforded in all work environments globally. For instance, in regions where corporate commitment to employee health is lacking, individuals resort to privately using self-tracking tools to manage their well-being amidst overworking cultures, as shown by Zheng, 2022. While it's critical to bring attention to the contrasting scenarios globally, the primary focus of this thesis remains on the negative implications of self-tracking within the context of corporate wellness programs. The exploration of situations where such initiatives are absent is a significant and complex topic on its own, which, although briefly acknowledged here, falls outside the primary scope of this research. We will proceed to look at the potential downsides of wellness programs, understanding that this discussion is a reflection of privilege, as it presumes the existence of these initiatives in the workplace.

As many businesses, especially in the United States, invest more in "wellness programs" to encourage healthier lifestyles among their employees, they blur the boundaries between leisure and work, making it increasingly difficult to distinguish between what contributes to the company's profitability and what genuinely enhances the health and wellbeing of the employee (Ajana, 2017) (Till, 2014). Despite the alleged advantages of wellness programs, there is a way in which they can be considered as a key sign of neoliberal ideology that forces 'colonization' of employees' private life as leisure activities, including exercise, are increasingly included in the realm of work as well (Ajana, 2020) (Ajana, 2017). Some of the users that encounter wellness programs being offered to them at work seem to reject those offers exactly because of that reasoning: "I have strongly rejected to participate, since I will not let my employer be a part of my life that for me is very private" (Ajana, 2020).

Another worry is connected to insurance companies providing bonuses and discounts as a reward for engaging in health programs. One of the examples of such programms in Germany is "TK Bonus Programm" provided by Die Techniker insurance company (TK-Bonusprogramm , 2023). Here is a quote from the official website:

"The rules of the game
Rule number one: Score points properly.
Membership of a football club, regular check-ups at the dentist, non-smoking courses after the New Year - all these earn points. For 1,000 bonus points you already get a health bonus.
You can choose whether you want to have your health bonus paid out or use the doubled TK health dividend as a subsidy for another health measure, for example a fitness tracker."

The first thing that does not go unnoticed is addressing the program as the "game" which immediately adds a certain level of gamification to the process. The program requires participants to engage in

certain activities, like joining a football club or having regular dental check-ups, to earn bonus points. These activities and their completion need to be recorded, monitored, and verified to award the points, effectively surveilling the participant's health behaviors. Fulfilling the requirements people can accumulate points that can be converted into health bonuses or subsidies for other health measures. These initiatives blur the boundaries between what health choices are under our control and what is not (Ajana, 2020). This may result in coercive self-tracking techniques disguised as voluntary participation in wellness programs. While this mode of self-tracking can be classified as pushed self-tracking, according to the system developed by Deborah Lupton (Lupton, 2015), it brings uncertainty as to whether this will at some point transform into imposed self-tracking, where the user does not engage in the process voluntarily.

Digital labor

The aspect of digital labor has a deep connection with the topic of data commodification, which was previously discussed. Although we highlight this aspect here as a potential harm, we will not delve deeply into it within this section. Instead, this complex issue of digital labor, particularly its nuanced effects from a female perspective, will be explored in more detail in the subsequent chapter. Digital labor is a concept that refers to the activities and actions performed online that contribute to the profitability of digital platforms, often without explicit compensation for the users carrying out these activities. It includes tasks such as browsing websites, posting messages, interacting with content, and creating user-generated content, all of which generate valuable data for these platforms (Till, 2014). This data is then utilized or sold to advertisers, contributing significantly to the revenue of these platforms. While users are engaged in what they perceive as leisure activities, they are providing 'free labor', blurring the lines between work and play in the digital space. This phenomenon reflects an extension of capitalist logic into the realm of online interactions and activities. "Capitalism has reformulated people, not only as workers but as consumers who decreasingly have the means to engage in leisure activity without consumption" (Till, 2014).

Relationship with self and others

Stress and anxiety

While empowering individuals is the main goal of the self-tracking tools currently available, their use without a healthy dose of self-awareness and self-compassion has the potential to cause negative psychological effects, such as increased stress and anxiety. Technological advancements have a significant degree of influence over their users and apply a range of persuasion principles that can

motivate, pressure, convey emotions, support, care or represent an authority (Fogg, 2002). Having the opportunity to exercise power also extends to the realm of self-tracking and has the potential to harm.

The study that conducted interviews with self-trackers (Ajana, 2020) confirmed that while self-tracking technologies' ability to persuade and their self-control regime has undoubtedly helped participants become more motivated, aware of their bodies, and active overall, they have also occasionally caused feelings of anxiety and obsession with efficiency. Here is a quote describing the experiences of one of the participants: "Occasionally I become preoccupied with my GPS that I stop enjoying my run because I feel like a bad run is a failure instead of just another run, good or bad. I become so obsessed with data that I sometimes cry if my pace run isn't to target or if I can't make it to the end of my long run without walking".

When a person does not meet their "norm" set by themselves or the tool, it can be "painful, depressing and discouraging", according to the results of the interviews with the users conducted by Pharabod et al (Pharabod, 2013). The feeling of dissatisfaction intensifies as the process of self-improvement is oftentimes infinite, the result will always remain in the future which is not always clear to the user. "There is no end in collecting a totality of data in an ongoing process of living" (Bode & Kristensen, 2015).

Generally, the perception of achieving and setting goals during tracking is tied to individual differences in personality. As Van Dijk et al. (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015) highlight in their study, people with a high score on neuroticism report more stress where physiological feedback about stress was given compared to those who have a low score on neuroticism. This confirms that mental health differences influence the subjective experience with self-tracking.

Another crucial feature that can worsen the psychological reaction to self-tracking is a type of mindset. In psychology, there is a distinction between growth and a fixed mindset, the key difference lies in the belief that human abilities can either be improved or always remain the same. The study by Hancı et al. (Hancı, 2021) confirms that people with a growth mindset look at the process of a self-tracking journey through a lens of self-compassion. "Focusing on improvement rather than the outcome seemed to make them more appreciative of the effort that is put forward". On the other hand, users with fixed mindsets were more than twice as likely to criticize their reflections. They tended to get angrier and more depressed over their failure which resulted in discontinuation of using self-tracking tools.

Another psychological feature that worsens the experience with self-tracking is being "low-conscientious". The study on the psychological effects of wearable devices showed that the users who

experienced negative effects from their wearables were the users who might have been triggered by the performance-based goal systems that are mostly promoted by wearables (Jillian, Edney, & Maher, 2019). "These users would potentially benefit more from progress- or improvement-based goals and feedback."

The assumption that users are inherently "high-conscientious" seems to be rather peculiar. Individuals exhibit a broad spectrum of personality traits, including varying levels of conscientiousness which should be considered during the design of the self-tracking tools. The expectation to be high-conscientious to benefit from tracking technology could be seen as one of the exhibitions of the norm prescribing.

Furthermore, even when the users have a high level of conscientiousness there is still a risk of developing low self-esteem, anxiety, and stigma if they find themselves in adverse conditions and are unable to respond effectively to the health risks or fitness issues highlighted by the self-tracking tool. Continuous exposure to worrying health data and unattainable targets can undermine users' sense of control over their health and damage their self-esteem and well-being (Owens & Cribb, 2019) and unintentionally cause someone to become overly self-absorbed and obsessed with their health (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015), which resembles a self-monitoring variation of the well-known "white coat syndrome."

The concept of self-tracking supports the implication that by monitoring and quantifying various aspects of one's life, improvements and optimizations can be achieved in those areas. But that is not always possible (Pharabod, 2013). The distinctive feature of tracking is that it is not primarily focused on actions, parameters can be measured even though there is minimal ability to influence how they will change. And this, in return, tends to cause a certain degree of anxiety among users. One of the areas where that is especially relevant is sleep-tracking where actively improving the measured results is more complicated compared to other activities. As Müller et al. (Müller, 2023) notice: people are "particularly vulnerable during sleep, simply because they are not awake, and hence, cannot actively control themselves or surveil their environment." Moreover, in case people have actual problems with sleep like insomnia, they are also physically vulnerable which might reflect their perception of the tracking results and thus increase their vulnerability.

Another issue that can lead to psychological problems is the over-trust of data (Van Dijk, Beute, Westerink, & Ijsselstejn, 2015). Self-tracking technologies could convince users to disregard their personal experience in favor of the information the technology provides. As a result, users may start to rely too much on their self-tracking tools and get anxious or under-informed when the tools are unavailable. Overuse of self-tracking technologies might have a self-fulfilling prophecy impact. For

instance, if a sleep monitor reports poor sleep quality, the user can internalize this information as well as trust it, which would lead to feelings of greater exhaustion and decreased productivity.

"Tracking fatigue" is another potential stressor, which refers to the failure to analyze data due to its overwhelming volume and variety of formats (Choe, 2014). As one of the study participants points out: "I can honestly say that I've made the classic newbie self-tracking mistake which is that I track everything". Users do not necessarily require that much information and measurements being thrown at them. As noted by Perusquía-Hernández et al.: "sometimes, a lack of awareness might be more beneficial" (Perusquía-Hernández, 2021). Instead of directly exposing all measurements and overwhelming the user with data, the study suggests a careful presentation of quantified feedback through an avatar-like representation, comparable to seeing one's reflection in a mirror.

The very concept of measurement can be reducing the motivation to engage in the activity. Etkin (Etkin, 2016) conducted 6 experiments with self-trackers where the correlation between the joy from the activity and its measurement was observed. The results showed that while tracking can help people "do better on the measured dimensions" (such as test scores for students, for instance), it also can decrease interest in partaking in the activity, even when people chose to participate in measurement voluntarily.

A crucial discovery that Etkin (Etkin, 2016) makes is that measurement does not lead to reduced joy if it is by definition an integral part of the activity. For example, in cases of video games or gambling tracking the results that are heavily focused on numerical measurement the users do not feel the negative effect of reduced joy. Another observation was that doing something for the sake of achieving a concrete goal also does not reduce the joy from the activity that is being measured. For example, if a person doesn't just track the number of pages read for the sake of reading more but does it to learn something.

Sharing data with others

While the concept of 'self' tends to be overly stressed in the Quantified Self phenomenon, the actual practice of self-tracking extends beyond individual usage (Ajana, 2017). As described in Part 2, one of the modes of self-tracking is communal self-tracking, which includes sharing your data and results with a broader community via social platforms. 59.8% of participants frequently post their self-tracking data on relevant websites, online forums, and social media (Ajana, 2020). One of the drawbacks that have been identified by the studies is the possibility of the development of the feeling of competition and obligation to deliver great results. The activity that is being tracked goes through an additional filtration process based on the desire to appear a certain way on social media. While this can be a useful tool for improving self-discipline and self-improvement, it can also result in the

development of anxieties and obsessions with performance (Ajana, 2020). As one of the interviewed by Ajana participants states, "sometimes, if I know I am going to share data on social media I feel I need to go harder which stops me enjoying the exercise".

Another possibility for sharing your self-tracking progress is to share or engage in self-tracking with romantic partners. There is a separate market of apps that provides a possibility for the "Quantified relationship". As in all the domains of self-quantification, the tracking in relationships does have its advantages, but it may also prepare a ground for a variety of issues. One of the critiques, the "inefficiency objection" is questioning the effectiveness of Quantified relationship apps in achieving goals (Danaher, 2018). While these technologies might accurately identify beneficial objectives for improving personal relationships (like romantic gestures), they may not ensure behavioral changes, leading users to eventually lose interest and revert to their original patterns. "Simply downloading and using an app like Kouply or SexKeeper will not cause you to do those things successfully".

Even if the habit is successfully reached, it does not guarantee a perfect or even improved relationship. "Well-functioning relationships thrive on informal, non-quantified acts of reciprocation" (Danaher, 2018). Apps promoting relationship tracking might cause a shift towards the transactional model, like those used in business or commerce, disrupting the informal nature of relationships.

Moreover, there is always an opportunity for data misuse against a partner. For example, in a study by Will et al. a woman describes how her former husband insisted on tracking her weight to pressure her into maintaining or regaining a slim figure (Will, 2020). She noted that this level of surveillance would now be viewed as an outrageous violation of her independence and an example of gender-based control. The possibility of surveillance, which most of the self-tracking apps for couples provides, can destroy the mutual trust in the relationship (Danaher, 2018).

Sometimes people might not be aware of being tracked. Such an example is provided in connection to sleep-tracking (Müller, 2023) when the partner of the sleep tracker is also tracked by the app as a side-effect due to the inability of the tool to distinguish between users during the night. Moreover, someone else's sleep might not only be recorded "as a side effect" but also on purpose. In case it is done as a form of care it can "enhance the autonomy of both partners as outsourcing the guard position to the self-tracking app". On the other hand, this might lead to the loss of autonomy if the tracking turns into a power imbalance and a form of control.

Individualistic approach

The Quantified Self Community defines self-tracking as "self-knowledge through numbers". This shift from feelings to numbers can be seen as "one of the most remarkable symptoms of the increasing hypertrophication of logos characterizing Western culture" (Chiodo, 2022). On the other side, the

paradox is that the "self" in self-tracking is not even that present as Rapp & Tirassa suggest (Rapp & Tirassa, 2017). "The dominant approach to PI implicitly frames PI tools as a subclass of behavior change technologies, which yields an emphasis on behavior rather than on the self." Putting the actual "self" in the center of the tracking process would imply that self-tracking tools help "individuals explore their subjectivity, giving such exploration temporal, logical, or existential primacy over research of its behavioral consequences".

Even though self-tracking is viewed by some critics as very self-centered and overly focused on the individual practice, there's another side to it that involves a sense of unity and community. The argument that Ajana (Ajana, 2017) uses is that the data collected by these tracking devices isn't only used for self-understanding. Instead, it also serves as a way to build connections with others. This social and community aspect of tracking contradicts the idea that it's purely self-absorbed and introspective. However, Ajana follows this by asking what kind of communities and solidarity are at the center of self-tracking. Self-tracking practices create a very specific and limited form of unity, as well as an exclusive community.

The "self" in self-tracking is complex and diverse. It encompasses not just personal reflection and behavioral tendencies but also the interpersonal dynamics within a group of people who are connected by common self-tracking rituals. This raises the question of whether the complexity of the human self is effectively addressed by our present self-tracking systems. Do they merely promote a limited and exclusive sense of unity? Can they promote self-care and empathy?

These are crucial questions to explore, which brings us to an innovative concept proposed by Perusquía-Hernández and colleagues: the 'empathetic self-tracking robot' (Perusquía-Hernández, 2021). The authors argue that there is a lack of (self)-empathy in current self-tracking tools. They note that sometimes people do not need as much raw data thrown at them but rather the ability to care for themselves (or others). To help with that issue, a design of the "empathetic self-tracking robot" was developed that was based on the assumption that the user would be able to develop self-helping behaviors by focusing on compassion for the robot.
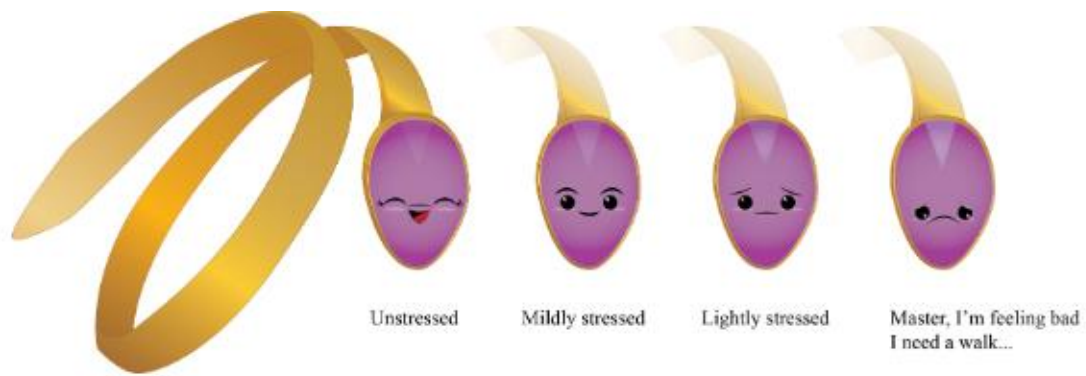
Figure 3: Pet robot feedback concept states. The robot should measure the user's stress level and provide subtle feedback about the user state by mirroring it.

Source: (Perusquía-Hernández, 2021)

Providers of self-tracking tools

It is crucial to keep in mind that many of the negative effects of self-tracking listed above are the products of an irresponsible approach from the creators and developers of these tools. Sharing data with third parties, manipulative design, and adhering to a one-size-fits-all norm are all direct consequences of poor tool design. Amid all the theoretical discussions about self-tracking technology, we must not forget that these products are created by powerful technology companies that are frequently opaque and unaccountable and have an increasing amount of influence over the attitudes, beliefs, and preferences of the public (Owens & Cribb, 2019). A huge part of problems with privacy are a result of many health and fitness app developers not providing privacy policies or disclosing that user data can be accessed by third parties. Reports have shown that personal data uploaded to digital platforms may not always be secure and can be accessed by unknown parties. The unpredictable nature of digital data and its potential repurposing by various actors make it difficult to control or predict its use (Lupton, 2014). Or when it comes to the discussion of the topic of "algorithmic identities" (Lupton, 2014), is it important to remember that the identities are created and analyzed by the algorithms that are developed by the technology providers. The algorithm becomes an 'authority' leading to the situation when "the decisions made by software coders play a dominant role in shaping an individual's life chances". What is more worrying is that the providers of self-tracking tools do not disclose how their algorithms work, all the decision and recommendation-making happens behind the hood.

While the underlying promise of self-tracking tools on the market is to support users' health and wellness goals, their design and functionality often prioritize commercial objectives. This can be fueled by the fact that "app makers and service providers in this allegedly fast-growing market have

not lived up to a profit-winning business" (Zheng, 2021). The primary aim of self-tracking apps whose owners are under pressure to make profits quickly isn't necessarily the user's health, but rather enhancing engagement metrics like Monthly Active Users (MAU) and Daily Active Users (DAU), crucial indicators of potential profitability (Zheng, 2021). Thus, fitness plans and visual achievement representations are often designed to stimulate user engagement and increase app usage, which may not always align with the individual's genuine health needs and goals. Moreover, there is evidence that features directed at behavior change used in self-tracking tools are oftentimes not based on valid scientific knowledge. The analysis of 127 apps from Apple's Health & Fitness category (Cowan, 2013), where theory scores to each of the apps were assigned, found that most of the apps "are not thoroughly incorporating health behavior change theory". The study conducted by Stawarz et al. (Stawarz, 2015) mapped 115 self-tracking apps that focus on habit formation with corresponding behavior change techniques defined by scientific theory on behavior formation:

Functionality	Habit formation elements	Behavior change techniques	Examples apps
Task tracking	-	Self-monitoring, Feedback on behavior	Daily Habit[a]
Reminders	-	Prompts / cues	Healthy Habits[i]
Graphs & stats	-	Feedback on behavior and its outcomes, Self-monitoring	Way of Life[i]
Goal setting	-	Goal-setting	HabitFlow[a]
Calendars	-	Feedback on behavior, Self-monitoring, Goal-setting	Habit Calendar[a]
Goal progress tracking	-	Feedback on outcomes of behavior, Self-monitoring	Strides[i]
Rewards / points	Positive reinforcement	Rewards & incentives	Habit RPG[ia]
Notes	-	Prompts / cues	Any Habit[i]
Habits library	-	Goal-setting, Action planning	The Fabulous[a]
Pictures	Cues	Positive self-talk, Rewards & incentives, Prompts / cues	The Habit Factor[ia]
Motivational quotes / own statements	Positive reinforcement	Positive self-talk, Rewards & incentives	Good Habit Maker[i]
Peer support / feedback	-	Social support, Feedback on behavior	Lift[ia]
Visual cues on home screen	Cues	Prompts / cues, Feedback on behavior	3 Week Habit[a]
Routine creation	Implementation intentions	Action planning, Goal-setting	Habitual Free[i]

Figure 4: Apps functionality with corresponding elements of habit formation, behavior change techniques, and examples of apps that provide such functionality
Source: (Stawarz, 2015)

The experiment highlighted that the apps primarily centered on features that facilitated self-tracking but did not assist people in creating automatic connections between the work and their environment or promote automaticity. Again, this is not some abstract issue that emerged due to unforeseen circumstances, but a very concrete design decision made by the tracking tool providers. In their rush to capitalize on the trend of mHealth, businesses often overlook the basic scientific research necessary to ensure even minimal successful outcomes for end users.

Chapter 4 - Feminist perspective on self-tracking practices

In the second chapter of this thesis, we explore the feminist perspective, which is a critical component of self-tracking technology. This chapter seeks to explore the special lens of feminism through which we might critically evaluate self-tracking activities, in contrast to the first chapter's generic description of self-tracking. We discover the gendered dynamics, power structures, and social effects that impact the experiences and implications of self-tracking for women by analyzing self-tracking technology from a feminist perspective. This chapter will provide a thorough grasp of the subject by illuminating the special difficulties, chances, and potential biases connected to self-tracking as they pertain to gender. By doing this investigation, we hope to add to the ongoing discussion around self-tracking technologies by highlighting the intersection.

Women in the tech industry

Relevant questions regarding representation and the power relationships that determine who gets to speak have been raised by feminist theory. This issue assumes a new dimension in the context of self-tracking because the discourse includes developing, evaluating data, and ultimately shaping user behavior and self-image. Cerçi (Çerçi, 2018) suggests that we need to continuously question who is given the power to speak for users' experiences and successfully write their stories.

It is possible to see that the development of emerging technologies doesn't take place in a vacuum. Instead, the issues and preferences of the experts who developed these technologies are frequently reflected in them (Fotopoulou, 2019). Various studies indicate that there has been a lack of gender diversity in software development and its end products. Many software applications have been scrutinized for displaying gender bias or excluding certain users based on their gender. Commercial gender classification systems have been found to discriminate against darker-skinned women in comparison to lighter-skinned men Shahin et al., n.d. Similarly, most text-based and voice-based conversational systems default to a female persona, suggesting a preference for representing females. For example, chatbots frequently use female identities and avatars, especially in the customer service and sales industries Shahin et al., n.d. The development of technologies that are prejudiced in their functionality and design frequently results from an imbalance of gendered input in development teams and an apparent hesitation to include and understand gender-related requirements.

The issue is not limited to software alone. Critical analyses of artificial intelligence have shown a similar pattern of prejudice towards women (Fotopoulou, 2019). For instance, speech recognition

technology has demonstrated difficulty in correctly identifying female voices, and well-known platforms like Google and Siri have come under fire for failing to appropriately consider the requirements of women. Part of the problem is gender imbalances in data gathering procedures, infrastructures, and within data analysis teams. Fotopoulou (Fotopoulou, 2019) quotes Hanna Wallach, a cofounder of the Women in Machine Learning Conference, who states that women make up only 13.5% of the machine learning workforce.

Dominance of male perspective in self-tracking

Throughout history, males have been seen as the center of society, which has resulted in the belief that men are a "gender-neutral" depiction of all of humanity. On the other hand, women are frequently marginalized and identified by their gender rather than being seen as equally representational of mankind (Jacobs & Evers, 2023).

The prejudice towards women's health issues shows up not only in society behaviors and attitudes but also has a considerable impact on the methodology and approaches used in biomedical research. According to Mularoni (Mularoni, 2021), "the application of feminist theory in science and technology studies reveals the legacy of a one-size-fits-all approach in biomedical research". Self-tracking is not an exception in this regard. As Sanders (Sanders, 2016) points out, self-tracking technology is mostly produced by men and the tech workforce in the United States consists of less than 30% of women.

This situation leads to a so-called "absent presence" of women where men dominate the discourse and decision-making processes, even when it comes to matters affecting women (Çerçi, 2018). Female health and wellbeing are being influenced by the male gaze turning a woman into an object whose needs and less well-known issues are ignored, resulting in limiting a woman's potential to reach self-knowledge by establishing a limited conceptualization of women's health (Sanders, 2016) (Webb, 2020).

For example, according to Fotopoulou (Fotopoulou, 2016), self-tracking tools that help navigate fertility, menstruation and reproduction "seem to reformulate rather than transgress gender roles, especially those associated to caring and being a mother". Many tracking apps in that sphere focus on so-called "moods" which reflect men's (and not women's) perception and stereotypes.

Additionally, there has been evidence that platforms for female self-tracking were often an "afterthought" and were implemented only after the societal critique (Webb, 2020). For example, the Health App from Apple did not allow period tracking until iOS 9 that came out in 2015 (Perez,

2015). Even when male designers do not exclude women, they still tend to encode gender stereotypes and reproduce power relations in their product (Fotopoulou, 2016).

Sanders (Sanders, 2016) adds another dimension to this discussion, noting that the ways in which men and women interact with self-tracking differ significantly. Gender differences in self-tracking habits are evident, with women inclined to monitor their daily caloric intake, while men focus more on tracking their heart rate, blood pressure, and running speed.

In order to prevent reinforcing gender inequality, an explicit feminist viewpoint should be included while developing self-tracking technology (Sanders, 2016). Even though product design may not intentionally perpetuate gender stereotypes, it's crucial to analyze it through a historical lens to avoid repeating past mistakes. As a reaction to the current stand of things there has been a rise of gender-specific tracking groups like QSXX and Women of Wearables (WoW) (Webb, 2020).

Technology of gender

The potential harms caused by self-tracking have been widely discussed in modern research. However, as Dolezal & Oikkonen (Dolezal & Oikkonen, 2021) point out, "there has been less attention paid in recent scholarship to the role of gender, race, disability, class, and age in practices and imaginaries of self-tracking". Which is an oversight as self-tracking technologies are fueled by "normative assumptions regarding the human body". There are two major tendencies that can be observed in current self-tracking products. On the one hand, there is a broad offer of self-tracking apps where the consumer is narrowed to a very generic "one-size-fits-all" persona. On the other hand, self-tracking technology has also gotten more specialized, catering to very specific demographic groups. However, even those products are using "normative assumptions about bodies, identities, and normal life course" (Dolezal & Oikkonen, 2021) which can result in potentially marginalizing those who don't fit the prescribed 'norm'.

Thus, as we navigate through the landscape of self-tracking applications, we encounter a paradox. On the surface, these apps appear to promote empowerment, yet their underlying foundations rest upon rigid constructs of gender, sexuality, and standard embodiment, seemingly contradicting the promise of empowerment (Jacobs & Evers, 2023). In the post-feminist media society, women are continually encouraged to observe and discipline themselves, a trend that has intensified to an unprecedented extent, extending its reach into completely new domains of life and behavior (Sanders, 2016). One popular tool of self-regulation is the Fitbit, which perfectly exemplifies the postfeminist and neoliberal perspectives, portraying the female body as a perpetual project, always in need of scrutiny and betterment, according to the recent research conducted by Webb (Webb, 2020).

Digital self-tracking devices have a twofold effect. On one hand, they serve to immerse women in increasingly intense, complex, and pervasive regimes of self-discipline and self-optimization. On the other hand, they also function as digital 'technologies of gender' that solidify the gender norms at a bodily level (Sanders, 2016).

In the context of the Quantified Self movement, the narrative becomes even more complex. The supposedly empowered woman finds herself continuously clashing with the commercial interests that dominate the sector, leaving her in a battle for ownership not just of her data but, in effect, her body. In this respect, wearable devices act as tools that advance the "surveillance, normalization, and discipline," thereby reinforcing the symbiosis of postfeminist patriarchal power and biopower (Webb, 2020).

In general, the feminist research of self-tracking draws a parallel between those two regimes. As Sanders notes, "both regimes work through the constitution of a field of expert knowledge and judgment that disseminates norms or regulatory ideals of healthy and feminine embodiment" (Sanders, 2016). Both are interested in the adoption of digital self-tracking technologies because they will make it possible to expand surveillance, communicate norms and interrogate people about them, as well as intensify practices that result in bodies that adhere to those norms.

What we find, in the end, is a situation where women are subjected to immense pressure to employ the latest technology in the pursuit of health and beauty. For those who do adopt self-tracking devices, they become caught in a cycle of pressure to align their choices with conventional feminine embodiment (Sanders, 2016). Webb analyzed the marketing campaigns of FitBit targeting female audience and found out that even the ads that were meant to be progressive "lose its merit when they are analyzed through a postfeminist lens" (Webb, 2020). One of such ads showed a woman taking some time for herself, however, even while engaging in "me time" she "did so within the boundaries of the QS movement, equating the act of self-care with health and bodily management" (Webb, 2020).

Fashion pressure

In the post-feminist era, the patriarchal system has shifted its control mechanisms, leaving the beauty and fashion industry as the key arbiter of standards for young women (Sanders, 2016). These sectors, together with authoritative voices from lifestyle magazines and social media influencers, construct and promote standards of feminine beauty. They serve not just as a mirror reflecting societal expectations, but also as a megaphone amplifying the call for women to align with these norms.

It's within this environment that women are nudged towards a constant chase after the better body and continuous cycle of self-improvement projects (Sanders, 2016). Consequently, dissatisfaction with one's physical appearance becomes a norm rather than an exception, making women vulnerable to an

unending stream of products and services promising to aid in the journey towards 'perfection' (Sanders, 2016).

Interestingly, the beauty and fashion industry employ a seemingly friendly approach, employing language associated with empowerment - words like 'choice', 'pleasure', 'health', and 'wellbeing'. However, this ostensibly benign tone masks the pervasive pressure on women to subscribe to and maintain an idealized physical appearance (Sanders, 2016).

In the context of self-tracking technologies, this beauty and fashion-led quest for physical perfection finds a new instrument. These technologies tend to serve to further fuel the desire for obsessive self-improvement. As a result, self-tracking tools have the potential to entrench the oppressive norms and standards advanced by the beauty and fashion industry.

Femtech

As we transition from the broader discourse on the feminist perspective of self-tracking, we delve into a more specific subject matter—menstrual applications. These digital tools are designed to track aspects of women's health, including menstrual cycles, fertility, pregnancy as well as sexual activity (Stenström, 2023), and other related elements. This segment of the chapter will concentrate on the challenges associated with female health tracking, expanding on the issues discussed in earlier sections.

Once more, we'll underscore the themes of privacy, reliability, and design, but with a focus on elaborating the unique complexities within the context of female health tracking. Our aim is to spotlight information that brings additional value to these discussions, hence augmenting the understanding of this increasingly important area in women's health technology.

The so-called femtech industry, known for its innovative creations such as intelligent tampons and connected breast pumps, has seen tremendous growth, with anticipated revenues hitting the $50 billion mark by 2025 (Webb, 2020). These tech solutions have brought women closer to understanding their own bodies in ways previously unimaginable.

However, femtech has not been immune to criticism. Despite its advances, there are concerns that femtech applications unintentionally perpetuate societal inequalities (Jacobs & Evers, 2023). From a feminist perspective, there's a call for a more multifaceted approach to technology design. This approach promotes the consideration of diverse user needs, prioritizing inclusivity over the creation of an "optimal" design that risks marginalizing certain users (Çerçi, 2018).

As we continue our investigation, we now take a critical look at the literature on femtech applications to identify and comprehend the related problems within this industry. Although these technologies were created with the goal of enhancing the health and wellbeing of women, we will assess how they can unintentionally worsen current social inequalities. In doing so, we seek to highlight the sectors of the femtech industry that need attention and development.

Femtech apps and their users

Menstrual cycle tracking is a practice that has existed for a long time before the development of self-tracking tools. Women have maintained this custom for a very long time, in fact. Yet, as one might predict with the emergence of innovative technologies, such as self-tracking applications and devices, the practice of monitoring female health matters has inevitably transitioned into the digital realm. Many contemporary women are now utilizing mobile applications to manage their menstrual cycles, as depicted in the table below (Epstein, 2017):

Age	N	Phone app	Digital calendar	Paper calendar	Birth control	Early symptoms	Remembering	Do not track
<18	103	50%	6%	9%	5%	9%	27%	6%
18-23	66	48%	9%	8%	17%	8%	15%	8%
24-29	265	43%	12%	6%	18%	6%	20%	9%
30-39	172	51%	17%	9%	6%	6%	14%	8%
≥40	67	34%	12%	9%	6%	9%	12%	20%
Overall	687	47%	12%	8%	12%	7%	19%	11%

Figure 5: The majority of survey respondents used phone apps to keep track of their menstrual cycles Source: (Epstein, 2017)

Unsurprisingly, the development of digital self-tracking devices has led to a boom in the femtech industry. The industry has acquired a sizable user base globally in addition to generating a sizable amount of cash (Xu & Sandberg, 2020). Applications for tracking menstruation have more than 100 million female users as of 2019.

Furthermore, this topic is attracting more and more scholarly attention and there are certain criticisms of the research done in this field. For instance, "menstruapps have been remarkably under-researched and under-critiqued in the emerging mainstreaming of data privacy as a fundamental right" (Alaattinoglu, 2022).

Currently, there are hundreds of thousands of female health tracking applications available across platforms like the Apple Store and Google Play. The most prominent applications in the market, as indicated by the study conducted by Vidal & Merchant (Vidal & Merchant, 2022), include Clue, Flo, Natural Cycles, Glow, and Period Calendar. As the research underscores, the companies responsible for the development of these applications predominantly hail from regions such as the United States, Europe, and Asia.

From a business standpoint, period tracking applications offered to users at no cost often rely heavily on advertising for revenue generation. When users are offered a subscription, the price is usually 30-60 euros per year (Vidal & Merchant, 2022). These period-tracking platforms usually either form a part of an established larger corporation or are dependent on venture capital for their operation and growth.

Interestingly, even subscription-based models of female health tracking applications do not always avoid the practice of data collection for additional profit. The range of data collected by these applications is notably extensive and involves intimate details that individuals would typically not disclose. This encompasses information such as menstruation dates, body temperature, symptoms, pain levels, moods, libido, sexual activity, and more (Vidal & Merchant, 2022). One noteworthy instance of a data breach is the case highlighted by Alfawzan et al. (Alfawzan, Christen, Spitale, & Biller-Andorno, 2022), involving Bounty UK, a pregnancy and parenthood digital platform. This organization was found guilty of distributing and selling sensitive data pertaining to pregnant women, new mothers, and infants to a third party. This was done "without being fully clear with people that it might do so," a clear violation of privacy rights and standards.

The potential risks of such comprehensive data collection by self-tracking applications have been previously addressed in earlier chapters. Nonetheless, we find it crucial to revisit these concerns within the specific context of female health tracking applications. The data solicited by these applications is often more sensitive than typical user information, necessitating an enhanced level of diligence in safeguarding it. Regrettably, as we will later explore, this level of caution does not always seem to be exercised.

Intriguingly, femtech applications tend to adopt empowering scientific language aimed at addressing women as strong, independent individuals eager to gain greater insights into their bodies and assume control over their health. Such narratives have been highlighted in the research undertaken by Alaattinoğlu (Alaattinoglu, 2022), which includes statements like: "Reclaim your month", "run your world", "for women who want to take control of their health and sex lives", and "be the girl in your class who understands her body".

Developers of fertility-tracking apps often present their tools as means of gaining heightened self-awareness, as mentioned by Stenström (Stenström, 2023). They suggest that these apps provide accuracy that can even outstrip a woman's firsthand experience and understanding of her own body and symptoms. The process of converting fertility data into precise numbers is often portrayed as an avenue towards self-improvement. This narrative proposes that quantified data can bring a sense of order to what might be seen as the unpredictable nature of female bodies. Sometimes this pitch is so compelling that users may find themselves putting more trust in data-driven insights over their personal memories and interpretations (Stenström, 2023).

Who forms the primary user base for female health tracking applications? Research indicates that these applications predominantly attract a demographic of young, healthy, middle-class women who possess a strong educational background (Haluza & Böhm, 2020).

The utility and appeal of female health tracking applications vary widely among users with support from a variety of reasons and perceived rewards. Based on the study conducted by Stenström, all participants who engaged in fertility self-tracking reported gaining significant insights about their bodies (Stenström, 2023).

Building on this notion, research conducted by Epstein et al. (Epstein, 2017) identifies five core motivations women have for tracking their menstrual cycles. These include body awareness, understanding their bodies' reactions across different cycle phases, preparedness, achieving pregnancy, and facilitating informed discussions with healthcare providers. Normally, it's common for women to be motivated by more than one of these factors. Moreover, the apps serve as an accessible reference for quick cycle checks, enhancing preparedness for imminent menstrual onset or enabling fertility-related decisions (Hepp, 2022).

However, despite these benefits, some users encounter shortcomings in the ability of these apps to adapt to individual physiological variability and life changes. For instance, the assumption of menstrual regularity inherent in many of these applications can cause inaccuracies for users with irregular cycles (Epstein, 2017).

Another significant finding is the desire among women to make practical sense of their "lived bodies" (Shipp & Blasco, 2020). Women use these apps as tools to understand the intersection of their menstrual cycles with aspects of their overall wellbeing, such as mood and energy levels. Frequently, women express curiosity about whether their mood fluctuations are linked to hormonal changes, a question which can introduce an element of negativity into the discourse. This stems from the potential devaluation of these experiences if they are attributed solely to cyclical hormonal shifts, thus potentially minimizing their perceived legitimacy.

When Karlsson (Karlsson, 2019) asked women about their thoughts on privacy while using these apps, most of them didn't seem to worry. They didn't remember reading the apps' privacy policies or giving the apps permission to save their data. Typical responses included statements like, "It's just my period. It's not a big deal," and "This data isn't really sensitive for me." Some even said that they'd only worry if it was something like their bank account details. So, it seems that many of these users don't see their menstrual data as something to protect.

Menstruation as a taboo

It's crucial to recognize that menstruation isn't merely a subject of self-monitoring of the physiological condition of the body. As underscored by numerous feminist critiques, menstruation is not just a biological phenomenon; it is profoundly influenced by social and cultural constructs (Xu & Sandberg, 2020). In a vast majority of cultures, menstruation, either currently or until the recent past, has been stigmatized (Karlsson, 2019) often depicted as unclean, dishonorable, and a cause for embarrassment.

The femtech sector has gained immense popularity over time, a development that is hardly surprising. Women constitute approximately half of the global population, and menstruation is an inherent aspect of their biological processes. Consequently, this sector presents lucrative investment opportunities.

Nonetheless, it is essential to note that even applications designed to assist women in tracking their health often inadvertently perpetuate historical stigmas associated with menstruation. These applications may inadvertently standardize and normalize diverse bodily experiences or employ euphemisms when describing natural bodily processes.

This trend isn't novel or exclusive to the advent of period-tracking applications; rather, it mirrors the broader societal discourse surrounding women's health issues. It is a manifestation of cultural attitudes towards menstruation that have persisted over time.

An overview of these attitudes was well described by Karlsson (Karlsson, 2019), according to whom, historically, menstruation has been enveloped in a veil of hysteria, enigma, and taboo. Philosophers like Aristotle associated menstrual blood with impurity and promoted the exclusion of menstruating women from communal activities. There existed a myth that the uterus could wander within the female body, obstructing the heart - the supposed seat of reason and thought, leading to hysteria.

According to Xu & Sandberg, "the bleeding body has a long history of being treated as the inferior Other in need of medical intervention" (Xu & Sandberg, 2020). Menstruation, being a physiological event exclusive to women, has often been perceived as an abnormal occurrence. Consequently, this led to its medicalization beginning in the early 19th century.

The stigma traditionally associated with menstruation, rooted in antiquated notions of hysteria and impurity, has since evolved due to the medicalization of menstruation. This evolution has led to an alternative form of shame, stemming from bleeding, potential pregnancy, and deviation from a regular menstrual cycle. In essence, the shame never truly vanished from the discourse. Rather, it simply morphed to adapt to new societal norms. This reframed form of shame is now being actively utilized and monetized by companies offering menstrual tracking services.

Shame, as an emotion rooted in negative self-evaluation or judgment from others, thrives in an environment of secrecy and silence (Karlsson, 2019). However, when shame is openly discussed and brought into the light, its power diminishes. In the context of menstruation, the transformation of shame associated with societal expectations and deviations from the norm can be addressed by openly acknowledging and challenging these perceptions. By shedding light on these issues and engaging in open dialogue, the potential for shame surrounding menstruation can be diminished, allowing for a more inclusive and empowering perspective.

Regrettably, the current reality is far from a state where women and app providers are willing to openly discuss menstruation. Up until now, women tend to resort to indirect conversations, jokes, and euphemisms when discussing menstruation, perpetuating the notion that it should remain concealed. This attitude is also reflected in menstrual tracking apps.

Many apps employ playful animations and graphics to represent menstrual symptoms and moods, using lighthearted framing as a means to make discussions about menstruation more socially acceptable (Gilman, 2021). However, this approach inadvertently reinforces the perception that menstruation is an inherently uncontrollable and undesirable process that should be managed and suppressed. Thus, the underlying tension between addressing menstruation openly and perpetuating societal taboos persists within the design and messaging of these apps.

Design

The design of female health tracking apps has been a subject of criticism due to its flawed portrayal of femininity and reinforcement of gender stereotypes. These apps commonly exhibit a uniform visual appearance, utilizing pink and purple color schemes along with stereotypically feminine design elements like flowers, hearts, and clouds. Such design choices often perpetuate assumptions of cisgender heterosexuality, excluding or disregarding the experiences of individuals who do not conform to these norms (Jacobs & Evers, 2023).

Users of these apps have expressed dissatisfaction with the overly feminine design, finding it insulting or condescending. The excessive use of stereotypical feminine attributes, including the color pink and floral imagery, can undermine the perceived professionalism and organization of the app's

functionality. Some users, interviewed by Epstein et al. (Epstein, 2017), even commented that the design seemed to be created by individuals who had a limited understanding of what women would truly appreciate.

Despite the longstanding critique of the design of female health tracking apps, there has been minimal noticeable change over the years. This lack of evolution is evident when examining the screenshot of the Apple Store's femtech apps in July 2023:
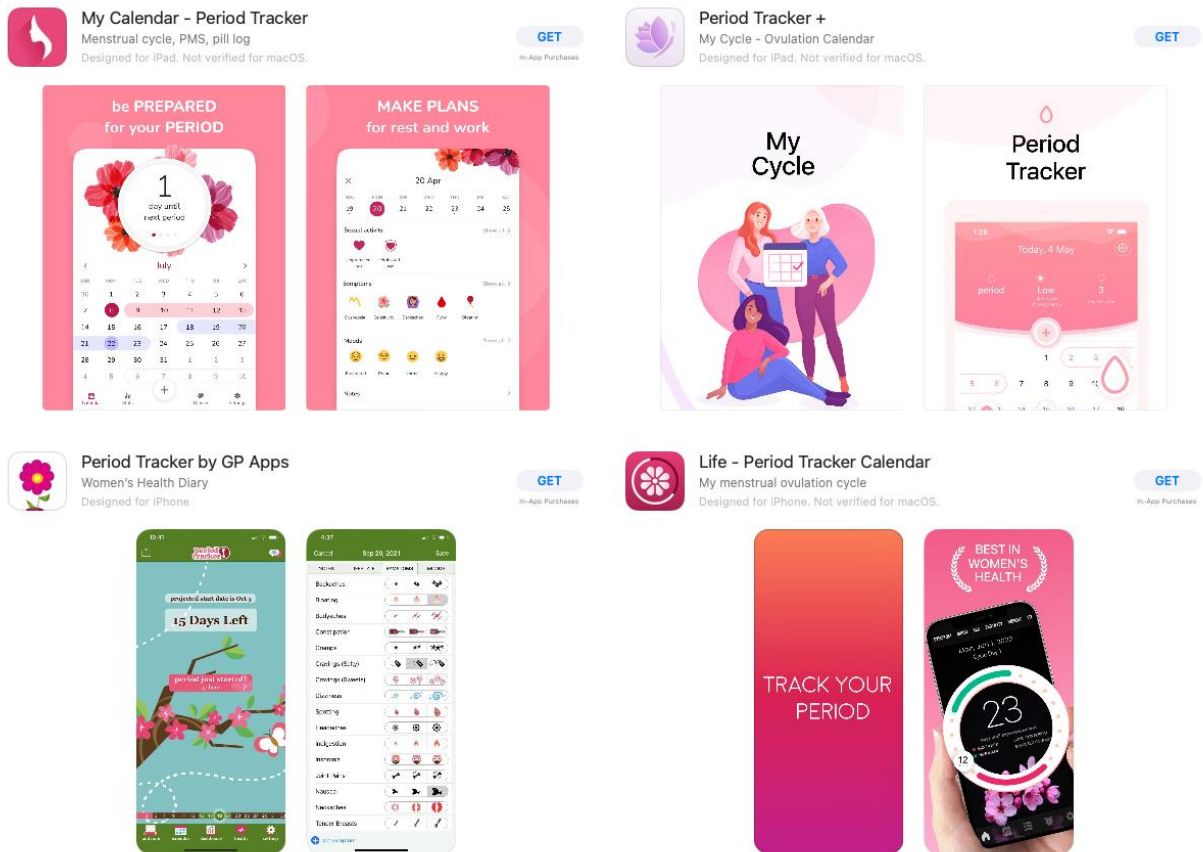

Figure 7: Screenshot of Femtech apps in Apple Store
Source: Apple Store, retrieved on 01.08.2023

Beyond aesthetics, the feminized design is just one facet illustrating how menstrual cycle apps can perpetuate and reinforce gender stereotypes and social norms. The design choices reflect embedded gender assumptions, shaping the apps' perception of users and reinforcing socio-cultural ideas surrounding menstruation, fertility, pregnancy, family planning, and heterosexuality. As noted by Hepp et al. (Hepp, 2022), this may alienate, exclude, or even annoy users whose experiences or aims diverge from these predefined notions.

In essence, the flaws in the design of female health tracking apps extend beyond the visual aesthetics. They reflect and reproduce gendered norms, often disregarding the diverse experiences and needs of users. Addressing these design flaws requires a more inclusive approach that recognizes and respects the complexity of gender identities and experiences related to menstrual health tracking.

The flaws in the design of female health tracking apps not only perpetuate gender stereotypes but also impede the desired discreteness that many users seek. Privacy concerns arise from the fear of accidentally disclosing menstrual cycle information when displaying the app's calendar to others. The visual aesthetics, such as bright pink designs, can cause embarrassment or discomfort when others glance at the app on a user's device, further compromising their sense of privacy (Epstein, 2017).

Additionally, while push notifications can serve as helpful reminders for period tracking, they pose a challenge to maintaining discreteness. Users expressed the need for discretion when receiving personal notifications related to their menstrual cycles. Disabling notifications becomes a trade-off between privacy and the risk of forgetting to enter relevant information, highlighting the ongoing struggle to strike a balance between discreteness and functionality (Epstein, 2017). As one of the interviewed women put it: "[I disabled notifications] since notifications are kind of personal, but as a result I sometimes forget to enter the period in and have to try to remember when it was later".

Stereotypization

The gender stereotypes that are immediately apparent in the designs of female health self-tracking apps are not only limited to aesthetics but also extend to the features and functionalities of these apps. One notable example of this is the app called Glow, which has gained significant attention within feminist critiques of self-tracking apps for women. The app's practices have been thoroughly discussed and scrutinized due to their perpetuation of gendered assumptions and norms.

Glow app employed reminders for women attempting to conceive, suggesting they wear attractive underwear on their fertile days, while simultaneously sending notifications to their partners to bring home flowers (Gilman, 2021).

Moreover, the Glow Nurture app designed for pregnant women includes a feature where the app prompts the partner to bring a glass of water to the woman if she has not logged the consumption of eight glasses of water through her own version of the app (Levy, 2015).

An interesting edge case was described by Levy, who mentions a subset of apps for female health tracking targeted towards men (Levy, 2015). These apps aim to track a woman's menstrual cycle for the benefit of her partner, allowing him to "manage" his relationship with her accordingly. Examples include the now-defunct app PMSBuddy, which provided push notifications about upcoming PMS

and the ability to locate nearby flower shops, catering to stereotypical gestures. PMSTracker offered a similar service, helping men anticipate and navigate the mood swings associated with a woman's menstrual cycle. In another instance, the app Code Red allowed men to enter their partner's period details and receive various push alerts, including alerts for sexual intimacy opportunities and ovulation. So as can be seen, these apps are not an exception and continue to project and reinforce gender stereotypes, suggesting a limited understanding of women's experiences and reducing the complexities of menstruation to simplistic narratives.

Moreover, the design and functionality of mainstream female health tracking apps often cater to the needs of cisgender, heterosexual, and monogamous women in their reproductive age. This narrow focus on fertility management stereotypes the user, disregarding the diverse requirements and preferences of menstruating individuals with alternative sexual orientations or from non-normative gender locations (Chami, Bharati, & Aggarwal, 2021).

These design limitations extend to experiences beyond fertility. User interviews further confirm the shortcomings of app designs. Jacobs & Evers talk a lot about negative experiences of women with female health self-tracking (Jacobs & Evers, 2023). Apps often exclude or dismiss certain experiences, such as abortion or miscarriage, thereby deflating the credibility given to users' words and shared experiences. This prejudicial exclusion causes a marginalization of individuals whose experiences differ from the stereotypical norm, hindering their full participation in knowledge creation and dissemination about menstrual experiences and reproductive health. Testimonial and hermeneutical injustices arise from the biases and limited functionalities embedded in the app designs (Jacobs & Evers, 2023).

Epstein et al. interviewed a woman experiencing infertility who expressed her dissatisfaction with the app's constant emphasis on ovulation information, which was not relevant to her situation (Epstein, 2017). She said: "my app shows predicted ovulation. I wish it didn't. We dealt with infertility and extensive treatments for 6 years. I am no longer trying to get pregnant, and I don't like the reminder of TTC [trying to conceive] or the tiny glimmer of hope that maybe by magic this will be the month when a miracle happens".

Some users expressed frustration with assumptions about their sexual partners or preferences. The iconography and options within the apps often imply heterosexual relationships, making it challenging for individuals in same-sex relationships to feel fully included. The assumption of sex with a male partner and the reminder of ovulation cycles reinforces feelings of not being a "normal" woman for users in non-heterosexual relationships (Epstein, 2017). Gilman provides a quote of Maggie Delano, an engineering professor, who said the following about her experience with Glow app: "[the app is

designed] for straight, sexually active, partnered, cis women with enough money for a smartphone to run the app" (Gilman, 2021).

Gendered assumptions and limited perspectives ingrained in femtech app designs flatten users' experiences and perpetuate stereotypes (Gilman, 2021). These assumptions exclude individuals who identify differently or have different health experiences, denying them credibility and meaningful representation. It is imperative for femtech developers to critically examine and address these design flaws, ensuring inclusivity and accessibility for all users.

The perpetuation of stereotypes, discrimination, and exclusionary visions of gender, sexuality, and race within femtech apps raises significant concerns regarding the impact on women's rights. This issue is further exacerbated by the political economy of digital capitalism, which introduces a host of potential human rights violations and disproportionately affects users from the Global South (Chami, Bharati, & Aggarwal, 2021).

Furthermore, while apps for menstrual cycle tracking are intended to support varying goals, they are not very successful in doing so (Epstein, 2017). Users expressed frustration with the limited support for goal changes within these apps. For instance, one woman mentioned the shift in her tracking goals from monitoring irregularity to checking for pregnancy but noted that the apps did not seamlessly accommodate this change: "now I track to make sure I'm not missing my period...but the apps are not flexible enough to adapt to my evolving needs." Similarly, another woman shared her experience of transitioning from tracking for awareness to tracking for conception but faced difficulties as different apps offered separate features for health and fertility: "to make the most of it, I have used various apps at the same time and entered data into them twice."

On a more upbeat note, some research findings emphasize the dynamic link between menstruation technologies and women, which offers a glimpse of optimism. According to Xu and Sandberg, women have the agency to reclaim and reinterpret these tools, giving them their own meanings and narratives, even though the technology may initially affect women's experiences and identities through predetermined gender scripts (Xu & Sandberg, 2020). This shows that active involvement with menstruation technologies has the potential to empower women and reclaim their physical experiences.

Medical reliability

According to Gross et al., the usage of menstruation monitoring apps raises questions about the presumed legitimacy and dependability of such services (Gross, 2020). These applications are crucial for helping people make decisions, however Haluza & Böhm add that research indicates that many women's health apps fall short of their promises to guarantee contraception or increase chances of

pregnancy (Haluza & Böhm, 2020). Obstetricians and gynecologists view this abuse of period trackers for natural contraception as hazardous.

The wide variety of menstrual apps on the market exacerbates the problem and raises concerns about health app overload and security (Haluza & Böhm, 2020). The wellbeing of people is at stake due to unrestricted access to health apps that are not supported by evidence.

In addition, these apps' use can have major repercussions, especially for marginalized communities, if users rely on false or deceptive information, according to (Chami, Bharati, & Aggarwal, 2021). The potential harm may be experienced by women from economically poor countries. "If you are from Southeast Asia, and a poor woman who had a miscarriage because you followed the app's advice, as you thought the app was telling the truth, what happens?".

Despite their unreliability, calendar apps are nonetheless widely used in the market to predict fertility and ovulation (Ali, Gürtin, & Harper, 2020). Recent research investigating the methodology used by menstrual tracking apps suggests that a sizable majority (54.4%) rely on the calendar approach to determine the fertile period and date of ovulation (Vidal & Merchant, 2022). The calendar technique, which assumes ovulation happens 14 days after the beginning of the menstrual cycle, is widely acknowledged as being incorrect and unscientific.

The main problem with the calendar technique is that it ignores the normal variations in cycle length and ovulation timing by assuming that ovulation happens consistently on the same day for all women. Even those who have normal menstrual cycles have variable ovulation days. This is especially problematic given that more than 50% of females have cycle length differences of at least 7 days (Vidal & Merchant, 2022). Due to these variances, forecasting fertile periods and ovulation dates using the calendar approach is futile and inaccurate.

Another issue that arises in relation to femtech apps is the lack of transparency about the underlying algorithms. The use of algorithms in popular period and fertility tracking apps raises concerns about their reliability and accuracy, as highlighted by several studies. Many of these apps utilize proprietary algorithms that have not undergone evaluation in peer-reviewed literature, making it challenging to assess their effectiveness (Duane, 2016). Moreover, medical studies have detected a lack of intelligence and precision in the algorithms employed by these apps (Hepp, 2022).

Femtech's troubling issue of inaccuracy is further supported by numerous medical research studies. Despite the claims made by these apps, studies have consistently shown that they are not as accurate as they purport to be (Gilman, 2021). The algorithms driving these apps often rely on generalized assumptions about the "normal" length and timing of menstrual cycles, which can lead to inaccuracies

in predicting fertility and ovulation. For instance, a study analyzing seventy-three fertility apps found that the rate of accurately predicting the user's day of ovulation was no more than twenty-one percent.

The accuracy of fertility and menstrual tracking apps has been a subject of scrutiny in several studies. Vidal and Merchant found that out of the one hundred apps examined, only a small percentage (between 9 and 19%) made correct predictions regarding fertile periods (Vidal & Merchant, 2022). Variations in predicted ovulation dates were also observed, with differences of 2 to 9 days among 67% of the apps tested. These findings highlight the lack of consistency and reliability in the predictions made by these apps.

Furthermore, there is a lack of high-quality apps specifically designed to address fertility problems (Haluza & Böhm, 2020). The distinction between health apps and medically accurate apps remains unclear, indicating a gap in providing reliable and comprehensive information tailored to specific fertility concerns.

Several studies have revealed that the majority of fertility apps are not based on evidence-based fertility awareness-based methods (FABMs) or do not include disclaimers discouraging their use for avoiding pregnancy (Duane, 2016). This lack of adherence to established methods and guidelines raises concerns about the accuracy and effectiveness of these apps in supporting reproductive health decisions.

The issue of accuracy is further supported by the study conducted by Moglia et al., which found that most free smartphone menstrual cycle tracking apps intended for patient use were inaccurate (Moglia, 2016). Only a small fraction of the apps met inclusion and accuracy criteria, suggesting that users should exercise caution when relying on these apps for fertility or contraceptive purposes.

In terms of content coverage, Ford et al. found that the fertility information provided by these apps often lacked depth (Ford, 2022). Algorithms for determining the fertile window were frequently based on strict cycle length and variability requirements, limiting the applicability of the information provided to users. Additionally, the lack of collaborations between app affiliates and researchers limited the potential for integrating improved fertility knowledge across the suite of female reproductive health apps.

The information provided by some menstrual tracking apps extends beyond basic cycle tracking to claim to identify abnormalities related to conditions like endometriosis or polycystic ovary syndrome (PCOS). However, the accuracy and reliability of these diagnostic claims have come under scrutiny. For example, Flo conducted a questionnaire in 2019 to evaluate PCOS risk among its users, but the absence of a clinical trial setting to ensure accuracy resulted in reported cases of false diagnoses (Vidal & Merchant, 2022).

While some apps include disclaimers that their assessments should not be considered as formal diagnoses, the issue of corporate accountability for potential bodily harm caused by misleading health advisories remains largely overlooked in discussions about surveillance capitalism (Chami, Bharati, & Aggarwal, 2021). Users may rely on the information provided by these apps, trusting them to deliver accurate and reliable insights into their reproductive health. However, when apps make claims about diagnosing or identifying specific conditions without proper clinical validation, it raises concerns about the potential harm caused by false or misleading information.

The involvement of scientific literature and health professionals in the development and validation of menstrual tracking apps appears to be limited. Few apps cite medical literature or demonstrate active engagement with healthcare experts (Moglia, 2016). This raises questions about how much reliance these apps have on evidence-based methods with accurate information.

Moreover, the publication of app-derived results in peer-reviewed scientific journals is rare (Vidal & Merchant, 2022). When such publications do exist, they are often produced by the companies themselves, with the authors disclosing their interests. One example is the Natural Cycles app, which has regularly published analyses derived from user data since 2015, following anonymization and consent. The app's algorithm incorporates the period calendar, temperature, and optional LH measurement for calculating ovulation and fertile periods. Natural Cycles funded a study in 2016 to calculate the Pearl Index, a measure of contraceptive effectiveness. They reported an index of 8, comparable to that of the pill. However, this result contradicts data from biomedical literature, which attribute a Pearl Index of 24 to natural family planning methods, classified by the US Centers for Disease Control and Prevention as the least effective (Vidal & Merchant, 2022).

Natural Cycles app is in general one of the most critiqued apps in the femtech research for providing inaccurate and misleading health information to its users. The app's effectiveness greatly depends on "perfect use," which requires and consistent adherence to the app's instructions throughout the menstrual cycle (Jacobs & Evers, 2023). In reality, the rate of perfect use among users has been very low, less than 10%. As a result, the app's actual effectiveness, based on typical use, has shown a failure rate of 6.9 pregnancies per 100 women per year, significantly higher than the claimed accuracy. Reports of 37 women becoming pregnant while relying on Natural Cycles as their primary form of contraception further raised concerns. The reliance on self-funded studies and influencer endorsements for marketing purposes underscores the profit-driven nature of these apps, which may not meet the qualifications of reliable healthcare providers.

Privacy

GDPR

It is not surprising that menstruapps, despite handling highly personal and sensitive data related to reproductive and sexual health, have raised concerns regarding privacy and data protection. As previously described in the previous chapter, self-tracking apps in general have a privacy issue. As Jacobs & Evers mention, almost all femtech apps include a profit mechanism that relies on users submitting very personal and sensitive information into the app, which is then used to define people and generate user category lists (Jacobs & Evers, 2023). These lists are then sold to third parties, who use them to target their audiences more precisely with customized adverts. The regulatory landscape for femtech apps varies across regions, with the U.S. Food and Drug Administration adopting a relatively hands-off approach, while Europe enforces GDPR regulations (Jacobs & Evers, 2023).

While the GDPR protects personal data, it also recognizes the unique nature of sensitive data, such as reproductive and sexual health information processed by menstruapps. GDPR Article 9 restricts the processing of such data unless the data subject expressly consents. Menstruapps must thus rely on users' explicit authorization to legally process this private information (Alaattinoglu, 2022). However, worries remain about the widespread sharing of personal and sensitive data by many femtech apps, notably with other parties such as Facebook, which jeopardizes user privacy (Jacobs & Evers, 2023).

Unfortunately, even in jurisdictions with robust data protection laws, such as the European Union, menstruapps have been found to violate GDPR regulations. The Norwegian Consumer Council's investigation into two popular menstrual tracking apps revealed the unauthorized sharing of user information with advertising companies, which is a clear violation of GDPR (Vidal & Merchant, 2022). Another study of popular Android menstruapps found that none of the apps studied were able to provide the necessary information on all privacy rights as determined by GDPR, including user rights to data access, deletion, and portability (Chami, Bharati, & Aggarwal, 2021) (Shipp & Blasco, 2020).

Data sharing

As was already mentioned above, female health tracking apps collect more sensitive data than other self-tracking apps. This data is related to reproductive health histories, sexual behavior, contraception use, lifestyle, and more, much of which is unnecessary for the core service of predicting menstrual cycles, as pointed out by many studies. Sometimes users may also input detailed data about their sexual activities, including the time of day and number of orgasms experienced (Stenström, 2023).

Despite the language of empowerment and self-fulfillment often used to promote these apps, their data collection practices and the sharing of aggregate datasets with third parties contradict the notion of respecting users' privacy (Stenström, 2023). Many period trackers have been found to collect an enormous quantity of data and metadata, share parts of this data without specifying recipients, and

allow extensive third-party requests, with some even automatically transferring data to platforms like Facebook (Hepp, 2022). This data collection is often driven by the app providers' intention to monetize user data in downstream data markets, such as targeted advertising and market research, rather than solely for app operation or customization (Chami, Bharati, & Aggarwal, 2021).

Popular menstruapps not only collect personal information without sufficient informed consent but also share aggregate datasets with third parties without providing users with options to manage the boundaries of such sharing (Chami, Bharati, & Aggarwal, 2021). Users are often left with no choice but to refuse to use the app entirely. The privacy policies of these apps often mention the deidentification and anonymization of personal data, which serves as an illusion of protection. But once data is aggregated and anonymized, users lose control over its secondary uses.

Privacy policies

The privacy policies of menstruapps raise concerns regarding the protection of user data and the lack of control users have over their personal information. These apps often demand broad consent from users without providing options for selective boundary setting for data sharing (Chami, Bharati, & Aggarwal, 2021). Moreover, privacy policies are often written in complex language, making it difficult for users to understand how their data is collected and shared (Stenström, 2023). Additionally, privacy policies lack user-friendliness, with some apps only presenting policies in English despite offering services in multiple languages (Alfawzan, Christen, Spitale, & Biller-Andorno, 2022). Furthermore, many apps do not require explicit consent before collecting sensitive health-related and personal data or sharing it with third parties (Alfawzan, Christen, Spitale, & Biller-Andorno, 2022).

Alfawzan et al. also bring up a range of issues with current privacy policies of menstruapps (Alfawzan, Christen, Spitale, & Biller-Andorno, 2022). According to the study, the inadequate privacy practices of menstruapps extend beyond consent and data sharing. Many apps don't provide consumers enough control over their data, such as the option to erase old information, revoke consent, or disable behavioral tracking. Another problem is transparency, since some applications fail to state whether they share user data with outside parties or whether doing so requires user consent. In many apps, there is also a dearth of information about data processing and security procedures.

"It has shown how popular menstruapps—which turn menstruation into data that are quantified, researched and sold—in their conceptualization of consent fail to live up to EU law" (Alaattinoglu, 2022). Chami et al. checked application of the GDPR regulations in current menstruapps' privacy policies and the result was not satisfactory (Chami, Bharati, & Aggarwal, 2021). The policies fail to provide clear information to users about data processing purposes, legal bases, and third-party data

sharing arrangements. The narrow interpretation of the right to privacy as the right to anonymity leaves data subjects unprotected against profiling harms.

When data is seen by others

In chapter 3 we talked about corporate wellness programs and how they are often integrating self-tracking in the process. The adoption of Femtech apps in workplace wellness programs is already part of the reality and as all other cases of self-tracking for these purposes raises concerns about the potential for discrimination and reduced healthcare benefits.

Gilman (Gilman, 2021) described an app called Ovia, which is widely adopted by companies employing millions of workers. Ovia's terms of service grant the company extensive rights to utilize and exploit user data for research and marketing purposes. According to the research, this raises concerns about the potential for employers to hold discriminatory beliefs about women, such as perceiving menstruating women as distracted or incompetent, viewing women trying to conceive as poor candidates for investment and promotion, or considering mothers less committed to their work than fathers.

A further complexity due to sharing female health data with others is added when it is shared with partners. Glow and Glow Nurture apps stand out among other fertility and pregnancy trackers by explicitly involving partners in the intimate data collection process (Levy, 2015). Glow encourages users to sign up their partners, who are prompted to provide additional data and respond to their partner's cycle in specific ways. This integration of partners extends the reach of data collection and raises questions about the privacy and consent of both individuals involved.

Furthermore, another case when data is being shared with others is when apps like Glow establish partnerships with pharmacies (Levy, 2015). This enables them to remind users when their prescription birth control is running low and prompting them to refill the prescription directly within the app. While this may seem convenient, it highlights the potential for sensitive health data to be shared with third-party entities without sufficient transparency or user control.

Chami et al. raised a further concern, this time regarding sharing data with collaborators, often researchers (Chami, Bharati, & Aggarwal, 2021). There is a lack of transparency regarding the selection criteria for these collaborators, leaving users without clear opt-in options for sharing their data for specific research purposes.

Overall, the sharing of data with external entities raises privacy and ethical concerns. It is crucial for app developers to involve health professionals and users in the design, development, and deployment

of menstruation and fertility apps to ensure responsible data practices and protect users' privacy rights (Earle, 2021).

Monetization

Menstruapps, despite being free for users, generate profits by selling users' personal data to advertisers and other industries interested in assessing women. Users are incentivized to constantly provide additional data through rewards and special features (Gilman, 2021). A study of popular apps (Forbrukerradet, 2020) revealed that user information, such as gender, age, and GPS locations, was being sent to numerous companies involved in advertising and behavioral profiling.

It is argued by some feminist studies that this kind of profit model relies on women performing the invisible labor of providing data for male-dominated corporate interests (Gilman, 2021). The monetization of menstruapp data exploits the bodies, time, and effort of users, disproportionately impacting women who already face gendered labor devaluation. The uncompensated entry of valuable and private data into these apps further perpetuates existing inequalities (Gross, 2020). Some authors go as far as argue for the payment of data, which would bring visibility, legitimacy, and recognition to users' contributions. Demanding wages for the data shared through menstruapps can stimulate critical debates and establish the quantifiable value of users' contribution, moving beyond the binary categorizations of data subjects or consumers (Siapka & Biasin, 2021).

The blind chase for monetization in menstruapps can also be quite insensitive to traumatic experiences of women. For example, it inadvertently harms women who have experienced pregnancy loss or chosen to have abortions. Targeted advertising that relies on personal data can lead to constant reminders and alerts about pregnancy-related content, which can intensify feelings of failure and emotional distress for these individuals (Gilman, 2021). The unethical nature of such advertising can further exacerbate the pain and emotional challenges faced by women navigating the complexities of their reproductive health journeys.

All in all, the monetization of menstruapp data raises concerns regarding privacy, exploitation, and the perpetuation of gendered labor inequalities. It exemplifies an economy driven by the quantified self and ubiquitous data surveillance.

Having explored the various issues surrounding femtech apps and their impact on privacy, data monetization, and user control, we will now dive deeper into a specific app to understand how it addresses these concerns. In the following chapter, we will analyze the app called Flo to examine its approach to data privacy, transparency, and other related issues. By examining the practices and policies of Flo, we can assess whether it effectively navigates the challenges faced by femtech apps

and whether it succeeds in mitigating the potential risks and ethical concerns associated with this rapidly growing industry.

Chapter 5 - Flo Health app analysis

Goals, app selection and limitations

The concept

We examined the ethical issues with self-tracking from a feminist perspective in the chapter earlier, focusing on female health applications. Now, in the last chapter, we want to move away from the theoretical setting and focus on a more detailed analysis of a particular female tracking app called Flo Health. The chosen software promotes itself as more aware and advanced compared to its competitors, which makes it a prime choice for thorough investigation from the numerous ethical perspectives previously mentioned. Our two main goals are to stimulate a thorough discussion on the ethics of self-tracking using this specific example, and to carefully evaluate whether the app's claims of improved ethical standing can survive scrutiny when examined from various ethical viewpoints.

Why Flo

During our extensive research, we embarked on a quest to find a female tracking app explicitly branding itself as "ethical." However, intriguingly, we did not come across any app that used this exact wording in its marketing. Instead, we noticed a prevailing trend among these apps to implicitly present themselves as grounded in scientific principles, data protection, and user well-being and awareness. While the discourse on the ethics of self-tracking has been gaining traction over time, it appears that the term "ethical" has not yet become overly prevalent in the marketing of these apps. Nonetheless, our investigation remains focused on scrutinizing these apps through the lens of ethics, aiming to shed light on their practices, regardless of the specific labeling they use.

Upon a survey of digital health platforms, our investigative focus has shifted to an application known as Flo Health. Hereinafter, the application will be referred to simply as Flo. An in-depth analysis of this application seems to be an intriguing choice for our final chapter, due to several distinctive attributes.

Firstly, Flo establishes a good first impression in comparison to its competitors, especially regarding its self-representation. An expansive amount of information is made available on its official website, covering a variety of topics. These range from the company's mission and responsibilities, their data protection policy, data collection procedures, commitment to inclusivity, and adherence to scientific research. Flo definitely has a scientific "glow" combined with a conscious social sensitivity,

suggesting a thoughtfully formulated corporate strategy. Notably, it has taken the effort to explain what occurs behind the veil of its operations, a level of transparency often absent in many digital applications. We will, however, critically examine the veracity and completeness of these claims in the course of this chapter.

Secondly, Flo has a considerable global user base. Launched in 2015, it has, according to their website, been installed over 200 million times worldwide and currently holds the distinction of being the most downloaded Health & Fitness application globally in the App Store (Flo Milestones, 2023). Flo also has a big presence on social media platforms, such as Facebook, LinkedIn and Instagram. Furthermore, it enjoys significant online visibility and has contributed to scientific literature through published papers. These papers, however, are quite controversial, which will also be discussed later on.

Lastly, despite its projected self-awareness, Flo has not been immune to criticism. Some feminist studies have critiqued its design approach, paternalistic tone, and data collection policies. In 2021, the application faced accusations of sharing private health data with third-party entities, including Facebook and Google, and subsequently had to reach a settlement with the Federal Trade Commission (Your App Knows You Got Your Period. Guess Who It Told?, 2021). Thus, despite its outwardly ethical persona, Flo appears to possess a hidden agenda not fully disclosed in their comprehensive website documentation. This intriguing dichotomy makes it a perfect subject for our study.

We again would like to emphasize that Flo never labeled itself as an 'ethical' application. However, we believe that it subtly communicates this sentiment through its actions and narratives. This impression stems primarily from its intentional effort to prioritize transparency and accountability. It does so by providing detailed insights into its data protection and data collection policies, and also through its active participation in scientific research. In the crowded space of health and fitness applications, such actions set Flo apart and contribute to the perception of it as a more ethical entity. This, combined with its emphasis on inclusivity, alludes to a broader commitment to principles often associated with ethical conduct.

Resources

To underpin our research and ensure its thoroughness, we used a diverse array of sources:

1. Web Content: We reviewed Flo's official website content, which includes privacy policies, cookie policies, blog posts, and more.
2. Application Content: The application's interface and functionality were extensively assessed.
3. Notifications: We studied both email and push notifications associated with the Flo application.

4. Insider Perspectives: Valuable insights were gleaned from interviews conducted with Flo's employees and founders.

5. Media Coverage: We examined independent media articles concerning Flo, as well as those sponsored by the company, in order to gauge both external and self-perceptions of the application.

6. Scientific Literature: Our review incorporated an array of independent scientific papers, as well as those potentially exhibiting bias due to authorship by Flo employees.

7. Direct Communication: Personal interactions with Flo's support team provided an additional layer of understanding regarding the company's practices and customer engagement.

8. User Data: A ZIP archive containing collected data about a specific user was utilized, providing a firsthand view of Flo's data handling practices.

Design and stereotypization

This part of the chapter will provide valuable insights into the visual and functional aspects of the app. We, however, chose to exclude an analysis of the surveillance aspect due to the limited time on the app.

Forced premium

Surprisingly, my exploration of the application's design commenced in an unanticipated manner. The first aspect that asserts itself post-installation is the aggressive promotion of Flo's premium subscription. We initially aimed to form first impressions regarding the design of the app and potential stereotype reinforcement, however, Flo's focus on premium subscription made this difficult. The website hosts an abundance of beneficial information related to health tracking. Yet, within the app, accessing any recommendations is largely contingent on a premium account. Most functionality beyond the basic logging of the menstrual cycle is obscured behind a premium subscription barrier, including logging symptoms, reading blog posts, and interacting with the chatbot.

For the purpose of the research, a premium subscription was bought. While the existence of a premium model may not, at first glance, seem relevant to our analysis, the promotional approach employed by Flo raises ethical questions. Even without utilizing the premium features, users are incessantly prompted via in-app notifications and pop-up windows to upgrade. In an intentional decision to enhance the authenticity of this study, I refrained from logging any menstrual cycle data to observe the app's response. As a result, the app began issuing notifications expressing concern about

the perceived delay. However, on engaging with the chatbot that offered assistance, no useful information was provided beyond another prompt to purchase the premium subscription.
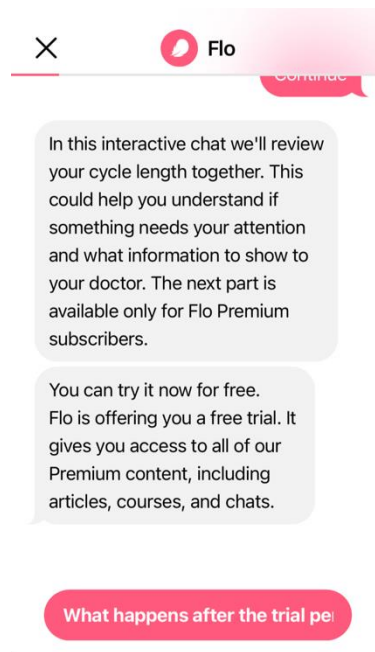

Figure 8: Screenshot of communication with Chatbot
Source: Flo app, retrieved on 01.08.2023

The application's push notification strategy manifests as a genuine concern for a delayed menstrual cycle, yet upon interacting with the app, the user is offered only two alternatives: to log their menstrual cycle or purchase a premium subscription. Although the business model of Flo is not our primary concern within this chapter, the aggressive marketing strategy, masquerading as concern for a user's menstrual health, raises substantial ethical concerns.

These ethical issues are further exacerbated considering that even premium subscribers' data may potentially be shared with third parties. As mentioned previously, The Federal Trade Commission's examination into Flo's data practices from 2021 supports this worry by highlighting a troubling potential for privacy breach. This suggests that the app's apparent concern for the users' welfare is mostly motivated by business considerations rather than actual user welfare.

Pink as predominant color

Upon initial observation, it is evident that Flo has not completely escaped the usage of stereotypical design elements. Most noticeably, the color pink features prominently throughout the application's interface. This hue is the primary accent color used in various elements such as the premium banner, notifications button, unread message indicators, footer links, push notifications, and even the

generated report for a doctor. The main tab for logging the menstrual cycle, which automatically opens upon app launch, doesn't merely use pink as an accent color but is wholly immersed in it. Consequently, users may need to exercise discretion when using the app in public spaces due to the overt gender-specific color cues.

Flo offers the ability to modify the app's design settings, providing a selection of background images. However, the imagery provided still seems to conform to traditional gender stereotypes, featuring designs such as blue flowers, a sleeping baby, and a pregnant woman. The color palette employed across these images is predominantly soft, dreamy, and sparkly, reinforcing the feminized aesthetic. The app does not provide the option to upload a personal image as a background, thereby limiting users to the provided selection. Among these, only two neutral options exist - a blank white background and a notebook-styled background. Notably, even upon changing the background, the primary accent color throughout the app remains resolutely pink.

The app logo itself is pink as well and cannot be changed. When contrasted with its competitor, the Clue application, Flo's design appears to more distinctly adhere to traditional gender color stereotypes.
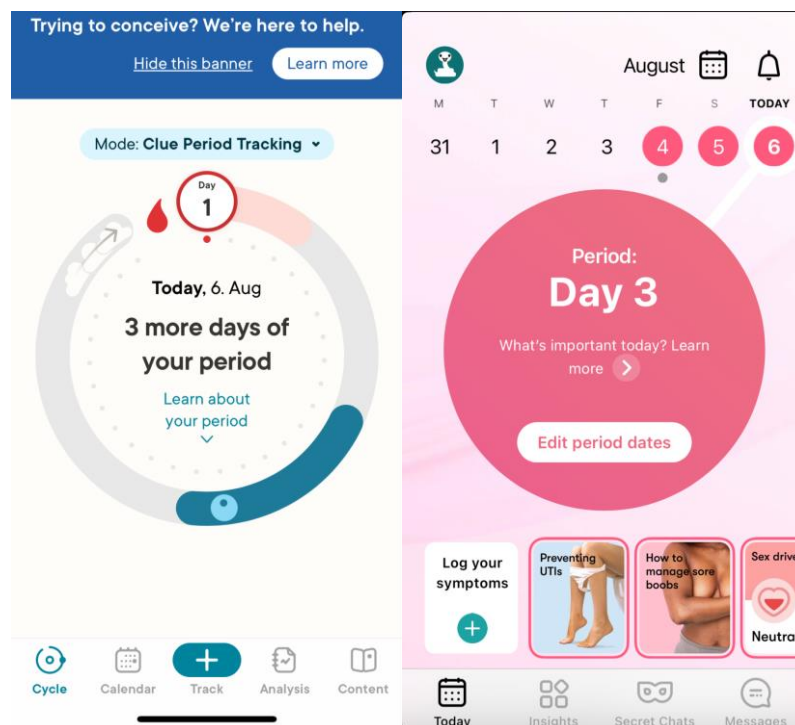

Figure 9: Main pages of Clue app vs Flo app
Source: Clue app, Flo app, retrieved on 01.08.2023

Discreetness

Earlier, we deliberated over the need for discretion that many women express when using self-tracking apps of this nature. Simultaneously, there is criticism levelled at female health tracking apps for avoiding direct conversations about women's health and instead opting for euphemisms, humorous images, and the like. There is a delicate interplay between these two perspectives that necessitates careful consideration during app design, in order to incorporate both aspects into the user experience.

In the case of the Flo app, the prominent use of bright pink isn't the only factor that potentially undermines users' desire for discretion during health tracking. Beneath the pink circle that details the current menstrual cycle phase, there are articles about various related topics, many of which have unambiguous titles and images. Consequently, as soon as a user opens the app by clicking the bright pink app logo, both they and anyone nearby may be confronted with a huge bright pink circle and articles about 'sore breasts' or 'yeast infections'. In this instance, while Flo does address the critique of not confronting health issues directly, it does so at the expense of the app's discretion, which can be problematic for some users.

Straightforwardness and stereotypisation

While there is a degree of criticism leveled at Flo for its lack of discretion, one must also acknowledge that the application makes commendable strides in tackling women's health topics head-on. The app includes an 'Insights' tab, which houses a variety of articles covering topics ranging from LGBTQ+ issues to gynecological diseases. The articles are typically accompanied by explicitly illustrative images, extending even to depictions of actual vaginal discharge.

While some articles lean towards more schematic visuals—for instance, an article on vaginismus was presented with an image of a pink lock—there is no immediately noticeable avoidance of certain topics or images. Depictions of menstrual blood, vaginal discharge, and illustrations of genital pimples are all starkly straightforward. Features such as stretch marks, pubic hair, pimples, and comfortable underwear are depicted without reservation. One the other side, based on the article published in 2021 (Habr, 2021), the app's name "Flo" is derived from the colloquial term "Aunt Flo," commonly used in American vernacular to denote menstruation. Certainly, one could critique the Flo app for employing euphemisms related to menstruation, even within its very naming convention.

As for diversity, Flo displayed some attempt to go that direction, for example the portrayed human figures and bodies exhibit a variety of shapes, sizes, and colors, revealing a clear attempt at inclusivity. At the same time, based on our observation, there were still some categories missing - disabled women, trans women and women 35+. That corresponds with the chapter "Flo and me" from the book "Feminist Methodologies: Experiments, Collaborations and Reflections" (Harcourt, van den

Berg, Dupuis, & Gaybor, 2022). In their experience with Flo app the authors cannot help but notice that the app displayed mostly pictures of women of a younger age.

Additionally, it's noteworthy that all these images adhere to a certain aesthetic standard. The majority utilize a color scheme of blue, pink, and purple, potentially conforming to conventional gender stereotypes. Moreover, despite the effort to represent body diversity and normalize bodily imperfections, the imagery maintains an aesthetically pleasing tone: plus-size bodies are not excessively overweight, and legs with stretch marks never have too many.

One fascinating observation arising from the image analysis is that Flo's efforts at inclusivity seem more successful when utilizing drawn illustrations as opposed to real photographs. The drawn images exhibit greater variety and inclusivity, while the photographs tend to resemble generic stock images featuring predominantly thin, white women in stereotypical settings.
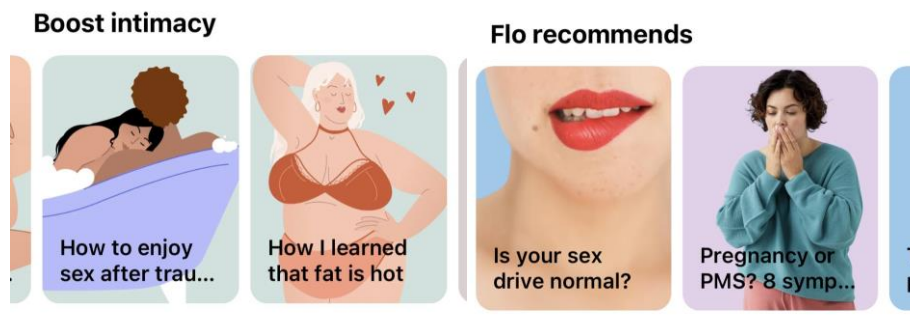

Figure 10: Illustrations vs photographs
Source: Flo app, retrieved on 01.08.2023

Another dimension for evaluating potential stereotype propagation lies in the icons utilized within the app to log symptoms occurring in tandem with menstrual cycles. A study published in 2019, titled "Period Hacks - Menstruating in the Big Data Paradigm" (Kressbach, 2021), presents critique toward Flo's design, including its use of stereotypical icons. By comparing the visuals provided in this study with the current version of the app, we can track Flo's design evolution over the years, a process that yields fascinating insights. Indeed, some of the icons from the 2023 version might be deemed stereotypical—for instance, bloating is represented by a balloon and cravings by a hamburger. However, when juxtaposed against the 2019 icons, one can discern significant progress.

The abstract mood icons featuring sun and clouds have been supplanted by more tangible emojis. The icon representing breast tenderness, which in 2019 depicted large, exposed breasts in a sexualized bra, has been redesigned. The 2023 version now features a more neutral icon of a female chest clothed in a basic white tank top. Presently, most of the icons are relatively direct and do not exhibit obvious stereotypes, as far as iconography permits.
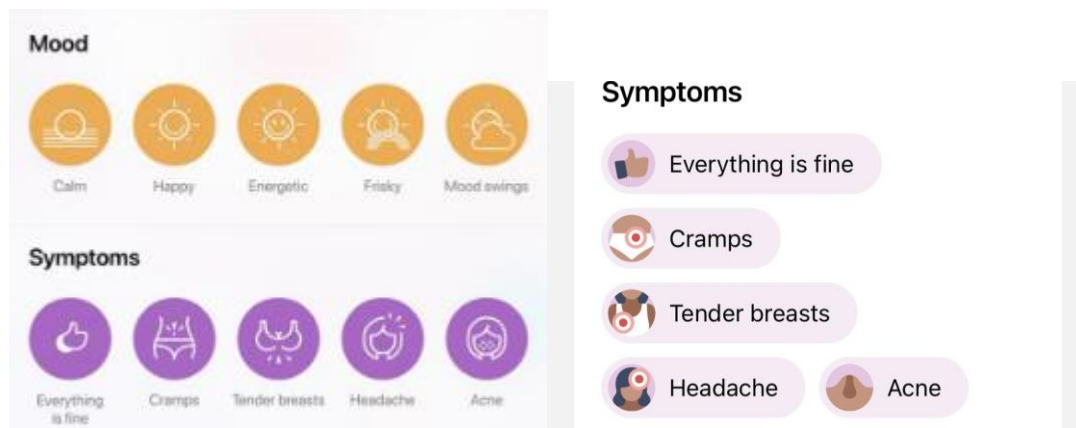
Figure 11: Icons in 2019 vs 2023
Source: Flo app, retrieved on 01.08.2023

Responsibility and scientific approach

In the following section, we will delve into an examination of the potential influence the Flo app may exert on its users, as well as assess the level of scientific and ethical responsibility the app seemingly upholds. It's crucial to note the limitations of our analysis, as our engagement with the app was both time-bound and confined to the period-tracking feature. We lack transparency into the intricacies of their recommendation algorithm, basing our observations solely on in-app recommendations and push notifications received during our interaction period.

Moreover, we abstain from conducting a medical assessment of the content presented both within the app and on their official website due to the absence of requisite medical expertise. Instead, our focus will pivot towards understanding the extent to which Flo anchors its content in scientific standards, its methodology in content curation, and the criteria for expert selection and engagement.

Medicalization and norm enforcement

Certain prior studies that have examined the attributes of the Flo app have raised a critique regarding its emphasis on negative symptoms associated with the menstrual cycle Harcourt et al., 2022. Building upon this perspective, during our exploration of the Flo app, we confirmed this critique and observed a distinct focus on potential negative symptoms linked to menstruation and other times. The app consistently disseminated push notifications, alerting about potential symptomatic concerns, even when such symptoms had not been previously logged.
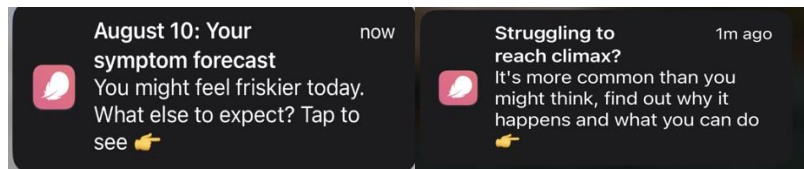
Figure 12: Push notifications
Source: Flo app, retrieved on 01.08.2023

The frequency of notifications from the Flo app was notably high, with alerts dispatched at least every three days, and occasionally multiple times within a single day.

Upon accessing these notifications, the app does provide potential reasons behind such symptoms, but it curiously attributes this information to the experiences of "n% of Flo users." This suggests that irrespective of an individual's personal experience, the app's content is generalized based on other users' reported experiences. While it is conceivable that the algorithm had yet to fine-tune its recommendations to our specific case due to limited usage, the overarching impression was that the app's approach leaned towards medicalization and stereotyping of the menstrual process.
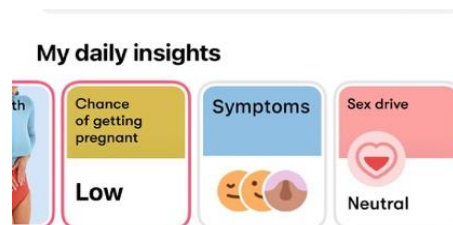

Figure 13: Personalized insights
Source: Flo app, retrieved on 01.08.2023

This theme persisted within the app's main tab. Alongside a summary of the current cycle, the application offered 'insights' that, at times, seemed presumptive. For instance, it inferred symptoms such as "headaches," a deviation from my actual experience and certainly not a symptom I had logged previously.

Moreover, there was an insight labeling my sex drive as "medium" while I have never registered any symptoms related to my sex drive for the app to have any real personalized data to base its assumptions on.

Delving further, a section titled "based on your current cycle" in the main tab displayed article recommendations. Here too, content suggestions, including articles on conditions like bacterial vaginosis and vaginal pimples, were proffered despite no related symptom logging on my part.

In essence, while the Flo app's intent might be to be comprehensive and informative, it risks veering towards undue medicalization and false assumptions, potentially instilling undue concern in users about symptoms they might not even be experiencing. While such an approach might be beneficial for users who indeed battle these symptoms, it felt somewhat alarmist, especially given the absence of any congruent symptom logging on my part.

Upon examining the Flo app's approach to normative standards, it demonstrated a heightened sensitivity. I intentionally inputted an irregular cycle length to assess the app's response. The regular cycle in considered to be up to 35 days and I extended it to 37 days. The subsequent statistical feedback classified my cycle as "irregular" and "abnormal", accompanied by a cautionary yellow indicator. However, this initial labeling offered a deeper dive into more nuanced content. Clicking on these statistics directed to a comprehensive article which, despite the app's initial "abnormal" designation, adopted a more measured tone.
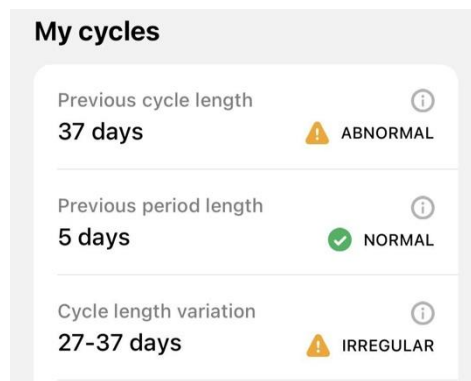

Figure 14: My cycles
Source: Flo app, retrieved on 01.08.2023

The article clarified that 'norms' can vary significantly across individuals and emphasized that their guidance is grounded in the insights from the American College of Obstetricians and Gynecologists. This context illuminated potential reasons for irregular cycle lengths, accounting for scenarios ranging from perimenopause to inadvertent data input errors. A particularly reassuring segment acknowledged the inherent unpredictability of life and underscored that many women encounter occasional deviations in their cycles.

In summary, while the Flo app's initial alerts might lean towards norm enforcement, a deeper exploration reveals a balanced perspective that aligns with established medical recommendations and a considerate user-centric approach.

Responsibility

The Flo app offers comprehensive recommendations concerning female health, even categorizing the length of the cycle as "normal" or otherwise. Yet, from a legal standpoint, it doesn't qualify as a medical device. In our review, we aimed to understand how the app navigates this nuanced position and to determine if users are made explicitly aware that the advice dispensed shouldn't be misconstrued as professional medical counsel.

Flo's website boasts an extensive section dedicated to detailing its scientific methodology, introducing its medical board, and discussing its commitment to medical accuracy, among other topics. Notably absent from these resources, however, is any clarification that Flo doesn't function as a diagnostic instrument. The sole mention of this important caveat is nestled within the Terms of Use. Here, the company has taken care to articulate that the app isn't intended to supplant professional medical advice or services. Their specific Medical Services Disclaimer reads as follows:

1. **Service Boundaries**: The company clarifies it's not an official medical entity. Its app isn't a substitute for genuine medical advice or birth control. Users should understand the app's intended function.
2. **Protection Against Errors**: The company has shielded itself against legal issues arising from inadvertent mistakes or technical glitches in the app. It means they're safeguarding against potential repercussions from app-related errors.
3. **Ethics and Community Norms**: The company respects global differences in ethical views, especially about sexual education. If their content clashes with local values, they've absolved themselves of responsibility.
4. **Handling Medical Crises**: Users are urged to get prompt professional care during health emergencies. The company has given this advice possibly to sidestep blame if users solely rely on the app in urgent situations.
5. **Seeking Professional Advice**: The company underscores the need to consult medical experts for health concerns. It's their way of highlighting that the app doesn't replace professional health council.
6. **Legal Boundaries**: The company maintains that they won't evade responsibilities in instances where it's legally impermissible. This ensures they stay within legal norms that prevent certain responsibility waivers.
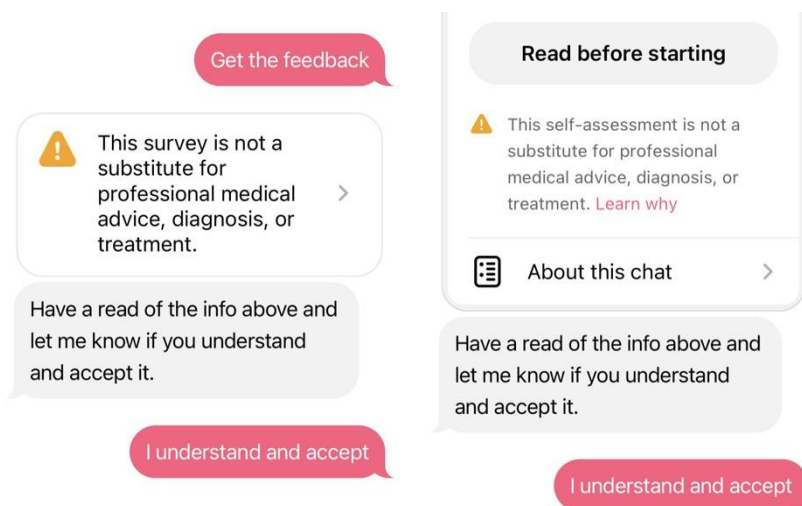
Figure 15: Self-assesment via Chatbot
Source: Flo app, retrieved on 01.08.2023

Within the app, disclaimers predominantly surface when users interact with the chatbot. This chatbot is referred to as "your medical assistant." Its primary role is to engage the user, inquiring about their symptoms and offering a self-assessment based on the responses.

Before proceeding with this interactive session, users are presented with a disclaimer, requiring their explicit consent to proceed. Users are given the option to delve deeper into the subject by clicking on the "Learn why" button. Upon doing so, a pop-up window appears, presenting an in-depth article explaining the reasons why the app should not be viewed as a substitute for a doctor. Additionally, after the assessment is complete, the user is required once again to provide explicit consent to view the results. This is done by presenting them with another disclaimer. Only after the user enters "I understand and accept" the results are displayed.

Content

As previously delineated, both the Flo app and its associated website present a diverse array of articles addressing various aspects of female health. While a detailed medical analysis of these articles is beyond our scope, we can evaluate their presentation and handling. Our assessment reveals indications of Flo's deliberate commitment to responsible content creation:

1. Each article consistently features a meticulously crafted list of scientific references. These references adhere to professional formatting standards, encompassing details such as authors, journal names, links or DOIs.

2. Notably, every article commences with a header spotlighting the expert who reviewed its content. This header provides essential information, including the expert's name, title, and years of experience. The reader can also access an extended biography of the expert on Flo's website by clicking on the header.

3. A dedicated page is allocated to each expert on the Flo website, furnishing comprehensive insights into their experience, publications, and academic credentials.

4. The website extensively elaborates on its approach to content creation. Here's a consolidated overview detailing Flo's content creation and research methodologies, derived from multiple pages on their website:

    ○ **Content Origins**: Flo produces content that includes web articles, social media posts, app courses, and graphics, which are supported by references and subject to expert verification.
    ○ **Data Sourcing**: Flo sources its medical and scientific information from various databases, health organizations, and academic bodies, adhering to a set of guidelines.
    ○ **Review Process**: Before publication, content is reviewed by medical professionals to verify its accuracy and relevance to current knowledge.
    ○ **Expert Involvement**: Over 100 health professionals from different fields collaborate with Flo to contribute to the platform's content.
    ○ **External Partnerships**: Flo has established associations with international medical and scientific entities such as the UNFPA and EBCOG.
    ○ **Legal Review**: The content is reviewed for legal compliance, ensuring it considers factors like user age, geographic location, and other pertinent details.
    ○ **Content Updates**: Flo makes periodic updates to its content, aligning with recent medical studies and health-related developments.
    ○ **Feedback Mechanism**: Feedback from users is considered by Flo for content improvements and platform enhancements.
    ○ **Reference Guidelines**: Flo references guidelines from health organizations, including the WHO, FIGO, and various research institutions.
    ○ **Content Evolution**: As medical research advances or guidelines change, Flo modifies its content to keep it in line with these shifts.
    ○ **Regulatory Adherence**: Flo aims to ensure its content is consistent with international laws and standards, accounting for aspects like age considerations and ethical requirements.

   ○ **Handling Sensitive Subjects**: Flo addresses potentially controversial health topics by presenting data and research without advocating for specific viewpoints or treatments.

Scientific research

Flo's website showcases a list of publications penned by their team members spanning from 2020 to 2023 (Science and Research, 2023). Additionally, the platform highlights a series of articles detailing collaborative endeavors undertaken alongside esteemed research institutions (Academic Research , 2023).

We undertook a comprehensive review of the total of 10 listed publications on Flo's website, aiming to address the following questions:

- Is there a declaration of potential conflicts of interest in the article?
- Is there a potential promotion of Flo in the publication?
- Did participants give explicit consent for participation in these concrete studies and data sharing apart from consenting to the general privacy policy and term of use?
- Are there any other factors that can imply an unethical approach to conducting the studies?

The table providing detailed information about each study, including declarations of conflicts of interest, overt promotion of the Flo app, consent procedures, and other relevant aspects, can be found in the Appendix 1.

The findings can be summarized as follows:

1. Studies Declaring Conflict of Interest: 7 out of 10

2. Studies with Potential Promotion of Flo: 3 out of 10

3. Consent for Participation and Data Sharing:

- Studies with Consent: 5 out of 10
- Studies without Clear Consent: 4 out of 10
- Studies with Ambiguous Consent: 1 out of 10

The studies that we marked as those which potentially promote the Flo app did not include explicit calls to use the app. However, the descriptions outlining the app's functionalities in those studies seemed more suited for the app's promotional content on its official website rather than within a scientific research context. For instance, the following wording was detected:

- *"The use of **innovative** health and wellbeing apps such as Flo…"*

- *"Flo provides its users with **evidence-based and expert-reviewed educational** content…"*
- *"This study suggests that menstrual health apps, such as Flo, could present **revolutionary** tools to promote consumer health education and **empowerment** on a global scale"*
- *"Flo provides a **globally representative and medically unbiased** perspective"*
- *"Flo also provides its users with a **secured place** to discuss intimate topics"*

Regarding users' consent for participation in scientific research, the studies employed two primary approaches for data collection. The first involved recruiting participants for surveys and requesting explicit agreement, although the precise content of these agreements remains undisclosed. The second approach utilized anonymized statistical data extracted from the app itself, without directly informing users of their involvement in the specific research. Flo's privacy policy addressed these scenarios by stating:

"We may aggregate, anonymize or de-identify your Personal Data so that it cannot reasonably be used to identify you. Such data is no longer Personal Data. We may share such data with our partners or research institutions or use for statistical purposes."

However, from an ethical perspective, concerns arise. Particularly noteworthy is the study involving women from Ukraine, focusing on pain impacted by stress related to the Russia-Ukraine conflict. Although these women consented to the app's privacy policy upon registration, employing even anonymized data for such surveys without explicit awareness raises ethical questions. The term "pain," as measured within the app, primarily refers to period pain. However, considering the context and audience of the study, this definition of pain has evolved to encompass a broader scope. It remains uncertain whether women would feel comfortable discovering that their personal suffering and discomfort were subjects of a study conducted by employees of a menstruation tracking app.

One study that we marked as the one with ambiguous consent indicated that *"all users in the study had agreed to the use of their de-identified and aggregated data for research purposes."* However, the specific method of obtaining this agreement was not detailed, and from the specific wording that was used we assume it is likely that users provided their consent in alignment with the app's privacy policy.

In summary, our analysis did not uncover any significant violations. However, there remains potential for improvement regarding conflicts of interest and user consent. Although we acknowledge that all studies originate from the Flo website, it's important for transparency that individuals encountering these studies independently be informed that the authors are Flo employees. Additionally, the language used to portray Flo's features could be toned down to present a more objective view. Lastly, enhancing the ethical approach to user consent is an area that could be refined for better alignment

with ethical standards.

Privacy and data collection

In this concluding section of the chapter, our focus shifts to matters concerning users' privacy and their control over the collected data. To ensure a systematic approach while evaluating both the app's privacy policy and its overall functionality, we adopted the heuristics for analyzing the privacy of mHealth apps for self-tracking created in the study by Hutton et al. (Hutton, 2017). A key emphasis was placed on the principle of explicit consent, a central factor highlighted in the GDPR. Furthermore, we conducted an analysis of the cookies policy, email communications, and JSON data acquired from Flo, encompassing all information tied to user accounts and their associated data.

Privacy

The privacy aspects of the Flo app have been the subject of investigation in various research papers, although none of these papers was exclusively focused on Flo itself; rather, the app was considered among other mHealth apps. In these comparative analyses, the Flo app generally performed well and often garnered higher scores than the average. Notably, it stood out among a selection of seven menstruapps, with only three of them acknowledging the processing of health and sensitive data (Alaattinoglu, 2022). Additionally, the privacy policy of Flo was particularly detailed in comparison to others, especially regarding the explicit delineation of the types of data collected.

The data collected from various research sources suggests that Flo app is responsive to the criticisms aimed at it and is actively working on enhancing its privacy policy. As outlined by Shipp & Blasco, Flo took steps to address these concerns by updating its privacy policy in July 2019 (Shipp & Blasco, 2020). This updated version includes visual diagrams aimed at providing users with a clearer understanding of how their data is processed and utilized within the app's ecosystem.

Certainly, despite the efforts to improve its privacy policies, it's important to note that Flo's privacy practices still have room for scrutiny. The studies that encompass multiple applications, although valuable, might not offer a detailed focus on the specifics of the Flo app. Given this gap and our commitment to a comprehensive analysis, we undertook an evaluation of Flo's privacy measures using the heuristics framework established by Hutton et al. (Hutton, 2017). Given that the framework's foundation is rooted in the GDPR and FTC Fair Information Practice Principles, we will refrain from undertaking a distinct analysis centered on GDPR, as its principles are inherently integrated into the framework itself.

The framework's conceptual foundation was constructed around the following fundamental principles:

1. ***Transparency:*** *Users should be informed about how their data is handled before using the application.*
2. ***Control:*** *Users should retain control over their data after they start using the application.*
3. ***Access:*** *Users should have access to the data they have provided.*
4. ***Data Sharing:*** *Users should be able to utilize features that enable them to manage the sharing of their data with third parties.*

With these principles in mind, let's evaluate the Flo app's adherence to each one. The primary subject of analysis is privacy policy posted on Flo Health website (Privacy Policy, 2023). We omitted heuristics H20-H26 related to the fourth principle because the Flo app lacks any feature for sharing data on social media, rendering H20-H26 irrelevant. It's worth highlighting that Flo's privacy policy wording remains consistent regardless of the country. The text mentions that within the European Union (EU), Personal Data is safeguarded by the GDPR and the Data Protection Act 2018. When transferring this data to the U.S. and other non-EU countries, Flo ensures protection by either using standard contractual agreements or by adhering to the European Commission's current adequacy decisions.

Principle 1: Heuristics 1 to 7

Heuristic	Does Flo comply?
H1: The app should clearly tell you who is collecting your data before sharing it with anyone else.	+
H2: The app should clearly tell you how your data will be used before sharing it with anyone else.	-
H3: The app should clearly tell you who else might get your data before sharing it with them.	-
H4: The app should clearly describe what kind of information it collects and how it collects it.	+/-
H5: The app should explain how it keeps your data safe and accurate.	+/-
H6: If the above conditions are met, the app's explanations should be easy to understand.	-

H7: You should have control over whether your data is used for things like marketing or research that aren't directly related to the app's main function.	-

Discussion

Flo Health UK Limited is listed as the primary entity responsible for collecting users' data in privacy policy which satisfies H1.

Regarding H2, things start to become contentious. Flo's privacy policy thoroughly outlines the purposes of data collection, such as enhancing the app's functionality, offering improved recommendations, marketing, and identifying potential users. However, in sections more frequently visited by the average user, there appears to be a contradiction. For example, on their "Privacy Portal" page (Privacy Portal, 2023), Flo states:

"At no time has Flo ever sold user information, nor have we ever shared it with third parties for advertising purposes".

However, the privacy policy states:

"At the same time, AppsFlyer sends your Personal Data to some of its integrated partners (e.g., Pinterest, Google Ads, Apple Search Ads, FB marketing network and others) to find you or people like you on different platforms, including social media websites"

Notably, the policy does not provide the full list of the third parties, for that the user needs to go to a separate page called "Cookie policy" (Cookie Policy, 2023). Based on the cookies list that we analysed, the app is indeed using several third-party services that are primarily associated with analytics and advertising, such as Google Analytics, Google Ads, Google DoubleClick, Facebook Pixel, Snap Pixel, and LinkedIn.

If sharing personal data with integrated partners is not for advertising purposes, then for what purpose is this data being shared? The act of finding users or people similar to them on different platforms inherently involves advertising or promotional activities.

The part of the Flo's privacy policy "Third parties processing your Personal Data" satisfies H3 by explicitly stating that the app shares data with AppsFlyer for marketing purposes and provides an illustrative explanation of the data sharing process. From the legal perspective, the part of the Flo's privacy policy "Aggregated data" satisfies H3 by explicitly stating that the app shares aggregated and anonymized data (including health data) with partners or research institutions. However, according to

the study conducted by Chami et al.: "Flo's announcements of such collaborations in the public domain reveal that "partners" have included the bio-pharmaceutical company, Myovant Sciences, and the pharmaceutical and life sciences company, Bayer AG" (Chami, Bharati, & Aggarwal, 2021). Thus, medical data of users is accessible not only to scientific organizations but also to commercially-driven entities.

Moreover, though the privacy policy does disclose that users' medical data will be shared, the everyday marketing communication seems to misrepresent the actual situation. For example, in their email communication Flo uses the following footer:
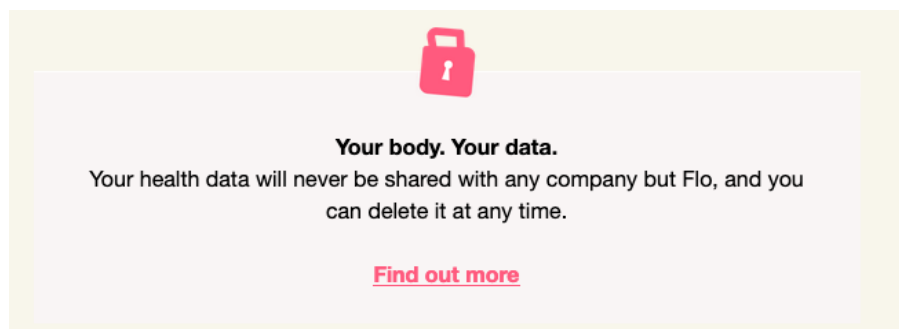

Figure 16: Footer used in emails by Flo Health
Source: Flo app, retrieved on 01.08.2023

Furthermore, Flo also provides a webpage that explains the cookies used within the app. However, the list of cookies doesn't align with H3. Specifically, for cookies transferring data to third parties, the information provided only states "Third party" under the domain, without specifying the exact entities involved. This compelled us to manually research each cookie using their names to identify the responsible companies.

As for H4, the privacy policy has a section called "personal data we collect from you" where the list of all data types is listed, the policy is relatively transparent in terms of listing the types of data it collects. However, there are two parts which do not allow us to state that Flo fully satisfies the H4. The first one being:

*"**Data from external sources.** We may receive Personal Data about you from third parties. For example, we may obtain information from third parties, to enhance or supplement existing user information, including to customize and personalize your experience and for statistical purposes and analytics, as described below".*

There is no description of what exact data is received from third parties and what those third parties can be. The second sentence that raises questions was:

"To collect this and other information, we may use cookies and other tracking technologies. See more in our Cookie Policy."

It is not clear what "other information" is and what "other tracking technologies" are. Also, as was already mentioned, the cookies list makes it difficult to understand with whom and what exactly is being shared.

For H5, the policy does a good job in detailing how Flo ensures data safety, from both a technical and organizational standpoint. However, the aspect of data accuracy is not explicitly addressed in the provided excerpt.

Regarding H6, we believe that the app's explanations are not easily comprehensible for the average user. At first glance, the privacy policy appears to offer detailed information about data handling. However, it frequently resorts to generalized legal phrasing, using terms like "we may collect," "may include," and "other" (pertaining to information or technologies). Furthermore, the information in the policy is contradicted by slogans that Flo employs on other web pages or in emails. The Cookie policy is excessively technical. Instead of providing the name of the third party, Flo lists cookie names such as "fbq," "_ga," "_gat," and "_gid," which are understandable only to individuals with an in-depth technical knowledge of cookie operations.

And finally, the H7 also does not seem to be fully satisfied by Flo. While users have a significant degree of control over their personal data, there's a provision that allows for anonymized or de-identified data to be used for research. According to the policy, "such data is no longer Personal Data". What exactly is anonymized is not clear. If a user's main worry is that their data should not be used for any research, even if it's made anonymous, the app's policy doesn't completely align with Principle H7. This is because using anonymized data for research, even if it doesn't directly point to specific users, might stray from the primary purpose of the app.

Principle 2: Heuristics 8 to 15

Heuristic	Does Flo comply?
H8: Consent acquired before data shared with remote actor.	+
H9: Consent is explicitly opt-in: no pre-ticked checkboxes, etc.	+
H10: Can choose which data types are automatically collected from sensors or other sources	*Not applicable*

H11: Data collection consent is dynamic: if new types of data are being collected, consent is renewed in situ.	+/-
H12: Data processing consent is dynamic: if the purpose of processing changes, consent is renewed.	+/-
H13: Data distribution consent is dynamic: if the actors data are distributed to changes, consent is renewed.	+/-
H14: Consent to store and process data can be revoked at any time: with the service, and any other actors.	+/-
H15: H15 Can control where data are stored.	-

Discussion

Users have to explicitly agree with the privacy policy and terms of use in order to start using the app (H8). All the checkboxes need to be clicked for it to be applicable (H9), thus ensuring explicit consent.

Figure 17: Sign up process
Source: Flo app, retrieved on 01.08.2023

As for H11, H12, H13, the privacy policy mentioned that Flo reserves the right to change the Privacy Policy and will notify users of any material changes. It also states that the continued use of the Services after the effective date of an updated Privacy Policy indicates acceptance of the changes. So implicitly, the policy satisfies the heuristics. However, the policy doesn't specify what qualifies as a

"material change." This lack of clarity could potentially allow for substantial alterations to be made to the policy without giving users clear notification.

Additionally, users have privacy rights to access, correct, restrict, and erase their Personal Data, and to object to processing (H14). Moreover, in practice, users have the option to withdraw their consent by emailing a request. Nevertheless, the precise aspects or conditions under which this consent can be retracted remain unspecified. According to the policy, "in some cases, you can object to the processing of your Personal Data, for example, if we process it under the legitimate interest basis". What those cases are is not specified.

In addition, there is no possibility to use the app without agreeing to both policies. At the point of agreeing to policies there is no possibility to choose what data you agree to share. There is no possibility to restrict certain data sharing later via the app. All the inquiries regarding revoking consent and opting out of certain kinds of information processing must be sent to the email. The app features a "Manage My Data" section where users can request information, modify account details, and deactivate their account.

However, these actions are not directly executable within the app; instead, users are redirected to a FAQ webpage for further guidance. Notably, there is no provision for revoking consent within the app itself. The only option that could be seen as a substitute is to switch your account to anonymous mode, where the email, name or technical identifiers of the user are not stored.

Lastly, there is no indication of the option to control the storage location of data, indicating that the condition of H15 is not met.

Principle 3: Heuristics 16 to 19

Heuristic	Does Flo comply?
H16: All raw collected data can be extracted from the service (in-app or via vendor's website).	-
H17: All data are available in standard text formats (CSV, XML, JSON, GPX, etc).	+
H18: Data extraction is available from within the service: e.g. without raising a request with support.	-
H19: Programmatic access to data is possible: e.g. APIs are exposed.	+

Data cannot be collected directly from the app or website (H16); instead, users need to make a specific request to Flo's customer support email (H18). According to the privacy policy, only iOS Premium users have a possibility to "download a report containing <u>some</u> of your Personal Data from within the App" (what exactly "some" imply in this sentence is unclear). However, it is impossible to actually download the report as Flo claims, so we needed to request it via email. When we did rec the data, it was provided to us in a JSON format (H17).

In summary, among the 18 applicable privacy heuristics evaluated, the Flo app demonstrated full compliance with only 5, while 6 heuristics were partially met, and 7 were found to be unsatisfactory. The review of the Flo app's privacy standards indicates a number of areas that require improvement. Even though the app's privacy policy claims transparency and control, a closer look reveals various flaws. Due to conflicting comments and a lack of disclosure of all involved third-party partners, data sharing lacks clarity. The policy's claim that data collecting is transparent is undercut by its ambiguous definitions of "other information" and "other tracking technologies." This mismatch extends to the policy's readability, with legalese making it difficult for regular users to understand the full breadth.

The app allows anonymized data to be used for research, which may go against user expectations even though it gives some user control. Additionally, users are left in the dark about their rights due to the lack of precise information regarding consent withdrawal. The app's method to manage data is similarly inadequate, sending users to outside resources rather than allowing them to take direct actions inside the app. User agency is further undermined by the lack of an in-app method of revoking consent and the inability to choose where data is stored. The indirect procedure for getting data from customer service also creates a barrier to easy access to personal data.

Data collection

Finally, it's important to touch upon Flo's data collection practices. A thorough examination of Flo's privacy policy revealed extensive data gathering. We already knew from the relevant reports that Flo app is considered to be especially "data hungry" and collects more data points on average compared to other period tracking apps. According to Surfshark's report (Rimeikis, 2022), Flo is "not the most private femtech choice out there". It took 6th place on the list of most data hungry tracking apps. Also, Flo uses third party tracking, the data does not stay on user's phone and Flo does not provide transparency reports, as another report shows (Roberts, 2022).

While obtaining explicit consent for data collection is a positive step, it's important to note that in ethical terms, users of Flo are forced to "explicitly consent" to sharing all their data since they are not allowed to proceed without agreeing to privacy policy.

According to the section "What personal data we collect from you", the following information is tracked:

- Name
- Email address
- Year of birth
- Password or passcode
- Place of residence and associated location information (including time zone and language)
- ID (for limited purposes)
- Inferred gender based on use of the Services
- Health and well-being information
- Personal Data imported from third-party services like Apple HealthKit and Google Fit
- Device model
- Operating system information (version)
- Unique device identifiers (e.g., IDFA)
- Enabled device accessibility features (e.g., display, hearing, physical, and motor features)
- Mobile operator and network information
- Device storage information
- Version of device system
- IP address
- Time zone
- Mobile service provider information
- Frequency of use
- Areas and features of the Services accessed, visited, or used
- Engagement with features

With the aim to validate the accuracy of the collected data and its alignment with Flo's claims, we initiated a test by requesting the collected data from our account. The data arrived in an archived format and included a JSON file as well as two .txt files.

We conducted a review of the contents of all three files to identify any discrepancies between the data outlined in the privacy policy and the information in the JSON file.

Our findings indicate that all the data in the file aligns with the broader categories specified in the policy. Although the policy didn't detail every specific data entry, it provided general categories that encompassed all the data from the file.

Again, it is not clear to the end whether all the collected information about our account was sent to us since in the privacy policy Flo notes: "for iOS Flo Premium users, the App also enables you to download a report containing some of your Personal Data from within the App." Since there is no specification to what exactly "some" means, it opens a lot of possibilities from a legal standpoint to avoid actually sharing all the data.

Discussion of the results

One of the reasons we chose Flo as our study's subject is that both our own observations and previous research indicate that it stands out as one of the market's most conscientious femtech applications.

The results suggest that even if the app shows signs of ethical considerations and has undoubtedly tried to increase its responsibilities in terms of design, privacy, and medical approach, <u>there is still a great deal of opportunity for improvement to say the least</u>.

The **design and stereotyping** research shows that Flo has made some strides over time toward direct, inclusive, and thorough portrayal of women's health. Moreover, our comparison of the current icons and icons from 2019, inspired by the critique mentioned in the study by Kressbach et al. (Kressbach, 2021), showed that Flo clearly evolved over time.

The widespread use of stereotyped characteristics, such as the heavy pink usage and constrained choice of backdrop images, however, indicates that progress toward an entirely inclusive design is still being made. Although Flo's candid discussion of women's health issues is admirable, some users might be concerned about the potential breach of discretion. Analysis of the app's images revealed that cartoons appear to reflect Flo more accurately than actual photographs. Moreover, the investigation also showed some inclusion gaps, especially when it came to representing women 35+.

Regarding **accountability and a scientific approach**, Flo emphasizes potentially harmful menstrual symptoms without user input, sends frequent generalized notifications, assumes information about users' experiences, tends toward medicalization and potential alarmism, enforces strict standards regarding menstrual cycle lengths, and adopts a tone that differs between initial alerts and in-depth content. Another area where we managed to find clear ethical violations are the studies that were conducted by or with the help of Flo's employees. User authorization for participation in some studies raises ethical questions, especially when using even anonymized data without explicit user understanding. Additionally, there is opportunity for development in terms of more transparently disclosing conflicts of interest in research and improving the language used in the studies to ensure objectivity.

On the other hand, we must admit that Flo exhibits admirable qualities including its dedication to studied recommendations, transparency through thorough scientific techniques, interactive chatbot capabilities, and a clear emphasis on user permission and education. Flo deserves praise for its commitment to responsible content development, which includes (according to the Flo Health website) constantly citing academic studies, including expert opinions, and emphasizing an open process for content generation. Additionally, Flo exhibits a rigorous attitude to scientific research and keeps active collaborations with prestigious research organizations.

The topic of **privacy and data collection** was, in our opinion, <u>the one that stands out as the most ethically challenging area</u>. Flo's privacy policy from the first glance exhibits transparency in certain aspects, such as elaborating on the purposes of data collection or emphasizing user rights, requiring explicit consent before app usage. All the data that we requested about our test account matched the data points mentioned in the privacy policy.

However, discrepancies emerge between the app's privacy statements and other communications, especially concerning third-party data sharing. Although the app proudly emphasizes terms like "consent" and "safety" suggesting a sense of user control, in practice, the mechanisms to exercise user rights, like navigating external redirects or the necessity to submit email requests, impede genuine user autonomy. The app doesn't offer clear choices regarding data storage locations, and the roundabout methods to access personal data compromise its user-centric claims. The policy's language frequently resorts to vague terms, notably using words like "some" and "other." Even if such practices might technically adhere to current legal standards, they cast a shadow from an ethical viewpoint. This, we believe, serves as a deliberate strategy to eschew a clear depiction of practices. When we attempted to download the data, it was merely "some" data. Similarly, instead of specifying the exact tracking technologies used, the app refers to "other" tracking technologies. Such a nebulous approach to data management not only erodes trust but also undermines users' control over their data. While some might argue users consented to these policies initially, this line of reasoning only appeases legal concerns. Ethically, based on the comprehensive research presented in prior chapters, we strongly believe this approach is untenable. A collaborative effort involving users, corporations, and potentially, regulatory authorities is imperative to shift this trajectory.

Conclusion

In this thesis, we embarked on an in-depth exploration of self-tracking, emphasizing femtech apps and adopting a feminist perspective. We delved into the overarching theories and practices of self-tracking, examining a series of user interviews to understand the hows and whys of their tracking habits. Subsequently, we shed light on the downsides of self-tracking, which span concerns ranging from data management to psychological impacts. What may seem, at first glance, like a straightforward process of collecting biometric data about oneself, is revealed to have numerous underlying intricacies, highlighting a pressing need for more rigorous regulation.

Our exploration then pivoted to a feminist lens. We considered general apprehensions expressed by feminists regarding self-tracking and transitioned to focus on femtech apps. Our findings indicate that this domain of self-tracking is particularly delicate and mirrors many of the patterns and drawbacks identified earlier. Despite the inherent sensitivities around data collection related to female health, it appears that many app providers fall short in ensuring the genuine well-being and safety of their users. Issues such as design flaws, gender stereotyping, norm enforcement, and even medical reliability frequently surface as areas of concern.

To gain deeper insights, we sought an app that could, at least from its marketing, be deemed "ethical." While no femtech currently labels itself as such, we opted for the Flo Health app, given its claim of heightened awareness and responsibility. For the purposes of our research, we worked with the assumption that Flo implicitly considers itself more ethical than its competitors. And while Flo stands out in terms of content creation and expert input, it reinforces many concerns typical of self-tracking. It doesn't merit the title of "ethical." While certain facets of its design and medical content can be commended, great concerns emerge when addressing privacy. The privacy analysis was particularly unsettling, illustrating how even the more reputable apps can misuse their power. Flo's language seems to mask concerns, but a closer reading reveals provisions that could allow them to manipulate user data extensively, including potential third-party sharing. This examination underscores the precarious position users find themselves in. Even the supposed "best" in the market fall short from an ethical viewpoint.

While we resist the urge to adopt an overly alarmist tone, urging a complete rejection of such technologies, our findings undeniably illustrate the pressing need for change. The tech industry must evolve to meet not just legal standards (which themselves can be nebulous) but also ethical ones. The rapid advancement of digital technology, though recent, isn't nascent. We, as a society, must employ and develop these technologies with a heightened sense of responsibility, ensuring we mitigate their potential negative impacts and prevent any dystopian outcomes that some media and research are worried about.

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