
Live in sync with your cycle
From period to pregnancy tracking. We got you covered.
Knowledge is power
Understanding how things really work can be empowering, but not always easy. We're constantly adding more useful facts here.
22 FEBRUARY 2022
ADD DATA
What's your biological sex?
Female
Male
I prefer not to say
NEWS
They didn't have plans to start a family but a fertility check changed everything.
The menstrual cycle tracking app that makes period and fertility tracking more secure and more transparent.
Egg white
Stretchy
Slippery
today
Next menstruation 30. dec.
Potentially fertile.
Pain
We are getting smarter...
Have questions ab...
Yesterday, 10:00 AM
BECOMING IN/FERTILE:
DATA PRACTICES AND REPRODUCTIVE RE-CON-FIGURATIONS
Lara Reime
We're creating the app we missed ourselves
We're two women with our own bumpy fertility journeys and with a dream to make it less confusing for others. No more "Why did no one tell me this before?"
The first app offering evidence-based tools to cope with infertility
EGGS TODAY?
Your cycle
CURRENT CYCLE
DEC.
30 DAYS
DAY 17
Your chances of becoming a mother are double as high when you're 25 than when you're 35.
sundhed.dk
For you, who is planning to become pregnant:
Facts
15 % of all couples that wish for children experience reduced fertility. That means they have actively tried for more than a year or had three or more misscariages.
%
35
30
25
20
15
10
5
0
34
28
24
17
12
6
0.5
18
20
25
30
35
40
45
AGE

Image description front page:

A sketched collage of several objects used to make sense of fertility. The collage depicts: screenshots of several tracking apps; statistics of fertility decline; a poster informing about fertility decline; an excerpt from the website sundhed.dk informing people that 15% of all couples in Denmark experience reduced fertility; a guide to sense cervical mucus consistency, a test, pills, and thermometer; a headline of a newspaper stating how a fertility test changed the reproductive plans of a couple; advertisements of Menstruation and Fertility Tracking Apps, stating that their usage will help people to 'live in sync with their cycle', and allow them to understand 'how things really work'.

*** This dissertation shares and analyzes experiences around menstruation, fertility, infertility, and mentions aspects of pregnancy loss and abortion. ***

BECOMING INÆFERTILE:
DATA PRACTICES AND REPRODUCTIVE RE-CON-FIGURATIONS

A dissertation submitted in compliance with the requirements
for the degree of Doctor of Philosophy (Ph.D.)

submitted by

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SUMMARY

This dissertation explores how bodies, temporalities, and orientations become figured, configured, and reconfigured within everyday practices of fertility sensemaking. Fertility sensemaking refers to the ways people understand their bodies through data (e.g., about them, or in relation to statistics), alongside socio-cultural norms of reproduction and temporal scripts. Such practices become increasingly supported by various technologies that enter homes, clinics, and bodies, to generate and analyze data around reproductive bodies. It is thus necessary to understand how such data practices, and the technologies they enroll, augment and afford relations to, and understandings of, fertility.

Throughout this dissertation I develop a qualitative analysis of fertility sensemaking that is grounded in interdisciplinary engagements with work in feminist theory, Human-computer interaction (HCI), and Science and Technology Studies (STS), and anchors in theories on posthumanism and crip/queer temporalities. I build on a range of empirical material, including bodily experiences around data obtained through mundane reproductive technologies, such as Menstruation and Fertility Tracking Applications (MFTAs), online forums, as well as medicalized datafication practices in Fertility Awareness Counseling (FAC), to scrutinize how different sites of datafication (the intimate, the shared, the medicalized) participate in the re-con-figuration of fertility. Rather than only being a 'quality of the body', this dissertation brings forth a conception of fertility as entangled, material, and relational practices.

The three papers included in this dissertation contribute to HCI, STS, as well as feminist theory, and argue respectively 1) how reproductive bodies become *figured* through the datafication technologies; 2) how different objects and subjects come together, and *configure* fertile time and temporalities through relational and distributed practices of fertility sensemaking; and 3) how orientations to fertility become *reconfigured* in terms of possibility, time, and space, as infertility rather than fertility becomes anticipated.

SAMMENFATNING

Denne afhandling undersøger hvordan kroppe, temporaliteter og orienteringer bliver figureret, konfigureret og rekonfigureret gennem meningsskabende praksis relateret til fertilitet (hvad jeg kalder fertilitetsmeningsskabelse). Fertilitetsmeningsskabelse refererer til de måder folk bruger data (f.eks. om deres krop eller fra statistikker) til at forstå deres kroppe i kontekst af sociokulturelle normer og forventninger til reproduktionens tidslinjer. Sådanne praksisser understøttes i stigende grad af forskellige teknologier, som bliver en del af hjemmet, klinikker og kroppe med det formål at generere og analysere data om reproduktive kroppe. Det er derfor nødvendigt at forstå hvordan sådanne datapraksisser og teknologier øger og faciliterer relationer til og forståelser af fertilitet.

I denne afhandling udvikler jeg en kvalitativ analyse af fertilitetsmeningsskabelse. Analysen er baseret på tværfaglige nedslag i feministisk teori, Human-Computer Interaktion (HCI) og Science and Technology studies (STS), og er yderligere forankret i teorier om posthumanisme og 'crip'/queer '-temporaliteter. Jeg bygger analysen på en række empiriske materialer, herunder kropslige erfaringer med data indhentet gennem reproduktionsteknologier (f.eks. Menstruations og Fertilitets Tracking Applikationer), onlinefora, samt medikaliserede dataficeringspraksisser i fertilitetsrådgivning (FAC). Formålet med den empiriske analyse er at undersøge, hvordan forskellige områder (det intime, det delte, det medikaliserede), der således 'dataficeres', deltager i re-konfigurationen af fertilitet. Afhandlingen fremlægger en opfattelse af fertilitet som en relationel og materiel praksis, fremfor værende udelukkende en 'kvalitet af kroppen'.

Afhandlings tre artikler bidrager til HCI, STS samt feministisk teori og argumenterer for henholdsvis 1) hvordan reproduktive kroppe bliver figureret gennem dataficeringsteknologier; 2) hvordan forskellige objekter og subjekter mødes og konfigurerer 'frugtbar tid' og temporaliteter gennem relationelle og

distribuerede praksisser; og 3) hvordan fertilitetsorienteringer bliver rekonfigureret når *in*fertilitet, i modsætning til fertilitet, er det forventede.

ACKNOWLEDGEMENTS

I wouldn't have made it if it wasn't for the various forms of care and support that I have received in the last three years and throughout my life. Whatever I write here cannot express how immensely grateful I am for all of it.

First of all, I thank everyone who trusted me with their stories and experiences. Without you there would be no dissertation.

Marisa Leavitt Cohn and Vasiliki Tsaknaki, you have been the absolute best supervisor team one could have wished for! The ways you complemented each other and have supported me in this process were phenomenal. Both of you created the space that I, and this project, needed to be explorative, vulnerable, and personal. Thank you for your unwavering support, encouragement, and constructive criticism. Vasiliki, I'm especially thankful for your contagious energy and your enthusiasm for exploring ideas as well materialities with me. Thank you for sharing your expertise so generously and guiding me in so many ways. Marisa, I'm deeply grateful for your openness and thoughtful insights you have shared with me, both scholarly and personally. Your creativity and wisdom were such an inspiration both for me and the ways I conducted this research. It was a privilege to learn from you both.

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It has been a privilege and a pleasure to be a part of the Technologies in Practice research group (soon to be section) during my PhD. I could never have done an open call PhD, if it hadn't been for this inclusive and collaborative space. I have learned so much from everyone in the group; from theories, practices and being an academic. Special thanks to Rachel Douglas-Jones, as head of TiP, for fostering this fantastic environment, as well as for supporting

me on my journey prior to, and through the PhD. I also thank every TiP assistant for making our collaborations possible.

I'm deeply grateful to have been part of an inspiring PhD cohort, and feel privileged to have worked and learned alongside such brilliant minds. To all PhDs that shared this journey with me – past and present, both within TiP and beyond – I couldn't have made it without your care, wisdom, and openness. Heartfelt thanks to: Anna Brynskov, Andy Lautrup, Barbara Nino Carreras, Caroline Anna Salling, Cæcilie Sloth Laursen, Imke Grabe, Katja Pepe de Nergaard, Louie Søs Meyer, Luna Rasmussen, and Simy Kaur Gahoonia.

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I thank Prof. Thomas Lemke and everyone at the section of Biotechnology, Nature and Society for welcoming me to the Goethe University in Frankfurt during my stay in 2023/2024. I greatly appreciated the discussions around temporalities, as well as being around people with similar theoretical and empirical interests. It was the perfect environment to get started with the writing of my dissertation.

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PAPERS INCLUDED

This dissertation includes the following three research papers:

Paper 1: Reime, Lara, Vasiliki Tsaknaki, and Marisa Leavitt Cohn. 2023. 'Walking Through Normativities of Reproductive Bodies: A Method for Critical Analysis of Tracking Applications'. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, 1–15. Hamburg Germany: ACM. https://doi.org/10.1145/3544548.3581450.

Paper 2: Reime, Lara, Marisa Leavitt Cohn, and Vasiliki Tsaknaki. 2023. 'Fertile Becoming: Reproductive Temporalities with/in Tracking Technologies'. In *FemTech: Intersectional Interventions in Women's Digital Health*, edited by Lindsay Anne Balfour, 73–98. Singapore: Springer.

Paper 3: Reime, Lara. 2024. (submitted). 'Orienting towards (Non)Reproductive Futures: Anticipating Infertility'. Submitted to *Catalyst: Feminism, Theory, Technoscience.*

PAPERS NOT INCLUDED

I have also contributed to and collaborated on a variety of other publications. They are not explicitly included in the dissertation but have greatly influenced my ways of thinking and working. Thus, I have included them in the following list:

'Speculations on Feminist Reproductive Health Technologies'

Lara Reime, Nadia Campo Woytuk, Joo Young Park, Marie Louise Juul Søndergaard, Deepika Yadav, Vasiliki Tsaknaki, and Sarah Homewood. 2022. In *Adjunct Proceedings of the 2022 Nordic Human-Computer Interaction Conference*, 1–5. NordiCHI '22. New York, NY, USA: Association for Computing Machinery. https://doi.org/10.1145/3547522.3547698.

'Workshopping Troubles: Towards Feminist Digital Methods'

Perriam, Jessamy, Marisa Leavitt Cohn, Michael Hockenhull, Lara Reime, Luis Landa, Katrine Meldgaard Kjær, and Henriette Friis. 2024. *Australian Feminist Studies*, February. https://www.tandfonline.com/doi/abs/10.1080/08164649.2024.2321576.

'Knotting Data as a Feminist Approach to Data Materialization'

Vasiliki Tsaknaki, Lara Reime, Marisa Leavitt Cohn, and Tania Peres-Bustos. 2024. In Gray, C., Ciliotta Chehade, E., Hekkert, P., Forlano, L., Ciuccarelli, P., Lloyd, P. (eds.), DRS2024: Boston, 23–28 June, Boston, USA. https://doi.org/10.21606/drs.2024.879

'A Zine for Feminist Design of Reproductive Technologies'

Nadia Campo Woytuk, Joo Young Park, Lara Reime, Marie Louise Juul Søndergaard, Deepika Yadav, Vasiliki Tsaknaki, Sarah Homewood, and Mafalda Gamboa Samuelsson. 2024. In *Adjunct Proceedings of the 2024 Nordic Human-Computer Interaction Conference*. NordiCHI '24. Association for Computing Machinery.

'Caring for Reproductive Justice: Design in Response to Adversity'

Benedetta Lusi, Adrian K. Petterson, Kamala Payyapilly Thiruvenkatanathan, Michaela Krawczyk, Emily Tseng, Lara Reime, Madeline Balaam, Katie A. Siek, Cristina Zaga. 2024. In *Companion Publication of the 2024 Conference on Computer-Supported Cooperative Work and Social Computing*, 693–96. CSCW Companion '24. New York, NY, USA: Association for Computing Machinery, 2024. https://doi.org/10.1145/3678884.3681832.

'The Digital State Overflowing Its Boundaries: Considering the Case of Digital Inclusion in Denmark'.

Papazu, Irina, Thorben Simonsen, and Lara Reime. 2024. In: Digitalization in Practice. Intersections, Implications and Interventions, edited by Jessamy Perriam and Katrine Meldgaard Kjær, 75–92. Berlin/Boston: Walter de Gruyter

LIST OF ABBREVIATIONS

AI	Artificial Intelligence
AR	Assisted Reproduction
ARTs	Artificial Reproductive Technologies
FAC	Fertility Awareness Counselling
FemTech	'Female Technology'
GDPR	General Data Protection Regulation
HCI	Human-Computer Interaction
IVF	In Vitro Fertilization
LH	Luteinizing Hormone
MFTAs	Menstruation and Fertility Tracking Applications
NRTs	New Reproductive Technologies
PCOS	Polycystic Ovary Syndrome
STS	Science and Technology Studies

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CONTENTS

PRELUDE

The feminist commitments of this project impact the theories I am building on as part of feminist citation practices; the ways in which I have conducted the research as part of feminist methods; and the analytical lenses applied as a means to make visible structures of power and knowledge. They also impact the look of this document visually and through its format. I unpack the first points throughout the following pages. In these early pages, I share some thoughts on the visuals.

This dissertation includes a range of sketches that I have created to capture my experiences of encountering datafication technologies, or to summarize discussions I have participated in online (as I unpack more in Chapter 4). For readability, I have added the image descriptions in-text.

Overall, I have taken visual inspiration from various works by which I am most impressed. Readers may recognize visual aspects from Emily Martin's *The woman in the body* (2001), Michelle Murphy's *Seizing the Means of Reproduction* (2012) or Donna Haraway's *Staying with the trouble* (2016b).

Inspired by Haraway's iconic phrase "it matters what knots knot knots, what thoughts think thoughts, what descriptions describe descriptions, what ties tie ties" (2016b, 12), I find it matters what typefaces type types of research. Consequently, all fonts used are downloaded from an open-source archive that promotes the typeface designs of women (https://www.design-research.be/by-womxn/). I used these fonts (and write about them here) to acknowledge the work of women in often male-dominated design space, and to pay attention to

the ways their labor in the creation of typefaces has been historically invisibilized (Breuer 2023). But also, because their names carry meaning for me.

The typeface used to write the majority of the body text is called *Bitter,* designed by Sol Matas. Aside from the font being aesthetically pleasing, I am also intrigued by thinking that this dissertation is written 'in bitter', which reminds me of Ahmed's (2017; 2024) work on the figure of the *feminist killjoy*, where she discusses how feminists often become negatively figured as difficult, bitter and angry.

The headings and titles are written with the font called *Junction,* designed by Caroline Hadilaksono and Tyler Finck. I chose this font to contrast the body text, in order to make clear when new sections and subsections start but also, again, because its name fits conceptually. A junction is a point of connection and intersection. Here, data, technologies and bodies intersect and become together through fertility sensemaking. But junction can also be a form of a crossing/crossroad, where turns need to be taken, thoughts and ideas split.

PART ONE

‘Kappa’

MAKING SENSE OF FERTILITY

Introduction

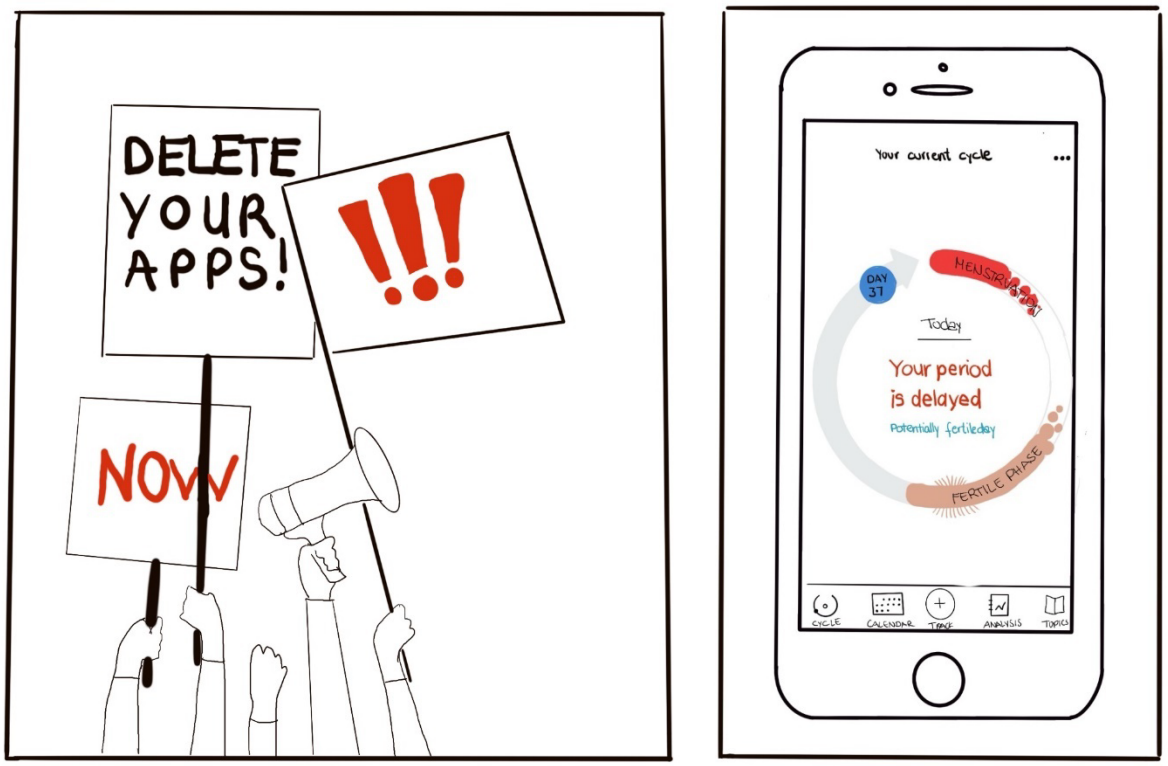

Figure 1: *Two sketches. On the left: several hands demonstrating, some hold banners stating: "Delete your apps! Now!!!" On the right: A drawing of a phone with the tracking interface of a Menstruation Tracking app, showing how the next menstrual bleeding is marked as delayed.*

Prior to, and post, the United States (US) Supreme Courts' overthrow of Roe v. Wade in 2022[1], protest against this decision rose in the US, and in solidarity in various countries.[2] Protestors, scholars, and news articles warned about the dangers of personal data in this changed context, encouraging people to delete apps that track bodily data. Apps which store aspects of pregnancy, menstruation and/or fertility were at the center of such debates, as they collect, generate, and analyze various datapoints on reproductive bodies. As abortion was made illegal in some states, people worried that data generated through such apps could be misused as proof that a pregnancy was terminated.

While it seemed obvious to condemn apps that are specifically designed to hold reproductive data (and which are already criticized for third party data sharing), more recent research and news, however, have pointed out how data from Menstruation and Fertility Tracking apps (MFTAs) might not be the most relevant data source used for prosecution, as other data sources (such as credit card transactions or online search histories) are much more readily accessible for those who seek to prosecute (see e.g., McDonald and Andalibi 2023). Deleting one's MFTA is consequently not enough to avoid potential prosecution and "safeguard [one's] reproductive privacy" (McDonald and Andalibi 2023, 2), as there are multiple other data traces that are generated about our bodies, while we are moving through the world using digital devices, platforms, apps and sensors. Our bodies are part of these sites knowingly, when we, for example, add data about menstrual cycle symptoms into a MFTA to better understand our bodily rhythms or make sense of pain and chronic illness. But also,

[1] With the overturn of Roe v. Wade the constitutional right of access to abortions was revoked, allowing individual states to decide in how far they want to provide, restrict or criminalize abortion.

[2] And maybe also in concern, that such a decision in the US might set precedent for other countries (who currently have abortion rights but an increased influence of conservative and far right politics) to change their legislations as well.

unknowingly, when governments make sense of our reproductive potentials to determine national fertility declines, to restrict access to reproductive technologies, or when companies share intimate data with third parties that are algorithmically analyzing them to confront us with targeted advertisements, or when location data is being grabbed while we add symptoms into a MFTA.

I introduce this dissertation with the overturn of Roe v. Wade and the consequent debates around intimate reproductive data as they bring forth how bodies are (unknowingly) part of multiple sites of datafication, illustrate the potentiality of data(harm), and highlight the need to further investigate data narratives, norms, and practices. Furthermore, these debates have shaped, to a degree, how people understand and relate to their intimate data, beyond the US context. I conducted my research on fertility datafication in Denmark, while the overturn was protested and decided in the US, and it was clear to see how this impacted an overall increased awareness around data privacy. For example, when talking about people's use of MFTAs and the data they would share with it, I often encountered phrases such as "just think what's happening in the US". While there seems to be trust in regulations for data protection and access to reproductive technologies in Denmark ("at least we're not in the US"), people nevertheless reflect on their data practices in light of developments beyond their national context.

It is, hence, required to think and understand data not only as embedded in certain contexts, but also across sites to highlight understandings of data as fluid, as well as map how data shapes bodily relations and makes particular worlds possible (Douglas-Jones, Walford, and Seaver 2021). Data practices are not innocent. They impact how lives are lived and bodies are understood, such as when one's freedom is at stake, or when possibilities of reproduction become made and unmade. We need to better understand how reproductive bodies participate in and become oriented towards multiple sites of datafication, and how fertility becomes figured at these sites.

Through this dissertation, I aim to generate such knowledge, by investigating how people in Denmark navigate within and across complex and entangled sites of fertility datafication.[3] This research follows people who generate reproductive data to better understand their body and its fertile potential, and, in some cases, use this understanding as a means to plan for and imagine the possibility of procreation in the future (reproductive future). Data here is produced and analyzed, for instance, through self-tracking practices (using tracking apps), shared efforts (when data is collectively analyzed), or in medicalized contexts (for example through fertility testing). Throughout this dissertation, I refer to these multiple practices as *fertility sensemaking*. While fertility sensemaking does include practices of self-tracking and datafication, calling it 'fertility tracking' would suggest that fertility exists inside bodies readily to be captured through datafication technologies. Rather 'sensemaking' highlights the processes through which fertility is being made sense of, that is: understood and interpreted through data, alongside socio-cultural and biomedical norms of reproductive bodies and temporalities, as well as including the labor of interpreting and affectively relating to data predictions. It refers to the complex and individual ways data around fertility can come to matter in people's lives depending on how they make sense of it and are being made sense of through various sites of datafication.

In chapter 1 I map in detail three sites that people participate in and/or become enrolled in to make sense of their fertility and speculate on their reproductive futures through data: 1) sites of *intimate datafication*, 2) sites of *shared datafication*, 3) sites of *medicalized datafication*. To briefly outline these sites here: with *intimate datafication* I mean practices where data is generated out of bodily and intimate explorations with oneself, such as touching and

[3] I understand datafication here as processes through which felt, bodily experiences (e.g., menstrual bleeding, cramps) become transformed into quantifiable datapoints (see also Lupton 2016; Neff and Nafus 2016).

sensing one's body and fluids. *Shared datafication* maps practices through which data is generated and made meaningful through sharing with others, in order to understand one's own fertility or to collectively make sense of reproductive processes. *Medicalized datafication* encompasses how datafication takes place in medical contexts, for example through ovarian reserve and sperm tests aimed at predicting fertile potentials. In this dissertation I analyze how these sites of datafication figure fertility and reconfigure the ways bodies become oriented towards temporalities (durations and timeframes) and spatiality (where) of reproduction.

Within these sites of datafication, technologies play an increasing role, as a means to generate data on bodies to predict, preserve, and manage people's fertile potential. While there is a broad variety of technologies that are used to render different aspects of people's lives and bodies into digital data (Lupton 2020), this dissertation is particularly concerned with Menstruation and Fertility Tracking Applications (further called MFTAs), online forums to discuss, analyze, and exchange fertility-related data, as well as medicalized datafication practices, as part of the national healthcare service in Denmark to increase fertility awareness (further called Fertility Awareness Counseling, FAC). I take these technologies as exemplary objects that become enrolled in fertility sensemaking.

The technologies I study are not novel. For instance, online networking sites (such as Facebook and Reddit) have been around since 2004/5, the first MFTA was made available in 2008[4], and the FAC started with a test phase in the municipality of Copenhagen in 2011, before it was rolled out in further municipalities in 2023. With the commercial growth of reproductive (datafication) technologies, different academic disciplines have become interested in these technologies and practices, producing work often grouped

[4] However, the majority of MFTAs entered the market after 2013, in line with the concept of 'FemTech' highlighting the market value for 'female oriented technology' (Balfour 2023).

under research on FemTech, Women's Health or Reproductive Health. Here, researchers have pointed out different motivations for generating data on one's menstrual cycle and reproductive practices: as a means to increase knowledge around one's body (Algera 2023; Epstein et al. 2017; Homewood 2018a); to be 'prepared' for menstrual bleeding (Fox et al. 2020; Homewood, Karlsson, and Vallgårda 2020); manage pain caused by endometrioses or polycystic ovary syndrome (PCOS) (Park, Hsueh, and Woytuk 2024); prevent pregnancy, or to "catch ovulation" when trying to conceive (Hamper 2020). They investigate how such practices and the resulting data shape how people experience their bodies (Pantzar, Ruckenstein, and Mustonen 2017; Ruckenstein and Schull 2017), as previously invisible bodily functions are made tangible. They also argue how technologies of (self-)datafication shift responsibilities away from medical contexts and onto individuals to maintain a 'healthy body' (Carroll and Kroløkke 2018; Waldby 2015; Lupton 2015a). They critically examine how such technologies partake in the reproduction of cultural normativities around childrearing and essentialization of gender as they (often exclusively) focus on the female body as the reproductive one (Balfour 2023; Costa Figueiredo and Chen 2021; Epstein et al. 2017; Homewood 2018b). This dissertation contributes to this research space by providing accounts of the ways fertility becomes un/made as bodies, data and technologies come together in fertility sensemaking practices.

Even though these technologies have been employed and researched over the last decade, I find that they nevertheless require continuous investigation as the contexts those technologies are being part of and constituted by are constantly changing, as the first paragraphs of this introduction show. Just in the duration of my PhD research, legislation and availability of reproductive technologies have changed in Denmark, as well as globally (see also Chapter 1). Global crisis, such as the Covid19 pandemic, wars, and the climate crisis are impacting understandings of fertility, temporalities, and possibilities of reproductive futures (Bach and Breengaard 2024; Lautrup 2022; Murphy 2013). New generations of users have grown up with different relations to

technologies and with changed narratives around fertility and reproduction (e.g., from overpopulation to national fertility decline). We can also see how particularly self-tracking technologies adapt to and are part of a changing environment of reproductive technologies (for instance, when language or visuals change to also include non-binary or trans menstruators), thus their meaning potentially changes within shifting contexts.

During the three years (2021-2024) of my PhD project[5], I have employed methods such as the walkthrough method, autoethnography, digital ethnography, speculation, and qualitative interviews in order to gain insights into the ways people (and myself) experience and navigate across different sites of datafication to make sense of their fertility. Based on these empirical data, the three scientific articles of this dissertation explore how fertility becomes *re-con-figured*. I use re-con-figuration (instead of re-configuration or reconfiguration) to make clear how this dissertation is not only interested in the reconfiguration (one word), but also the figuration and configuration of fertility: The papers analyze how reproductive bodies become *figured* through normativities within self-tracking technologies, how temporalities of reproduction *configured* as people collectively make sense of them, and how orientations to futures *reconfigured* as infertility (rather than fertility) becomes anticipated (see more details in later section of this introduction, as well as in Chapter 7).

Overall, this thesis speaks to readers interested in feminist theory, as well as ethnographic and design methods to understand fertility sensemaking practices. This work is not classically bound within one discipline but takes inspiration from a variety of methods and traditions, such as feminist scholarship, as well as critical data studies, Human-Computer Interaction (HCI) and Science and Technology Studies (STS). While I build on this broad variety of

[5] The PhD research was funded by ITU through an open call scholarship and was not part of a larger project.

work, I primarily locate my work, and these technologies and practices, in the realm of reproductive technologies, rather than in self-tracking/self-quantification literature. I understand these datafication technologies (MFTAs, online forums, FAC) as mundane reproductive technologies, and read them together and against work that is concerned with gamete freezing or IVF, rather than with work that is concerned with quantifying self-movements. I do this to pay attention to people's relation to biodata in their fertility 'journey', how they become data in larger projects (for example as part of medical trials), how they encounter various data in their fertility sensemaking practices (not only data produced by them), and how menstruation and cycle tracking is 'more than self-tracking'.

Other research has done well in understanding these datafication technologies (particularly MFTAS) as self-tracking/self-quantifying technologies, locating them within practices of self-optimization or self-exploration (Lupton 2015b; 2016). While there are important points to be made in terms of living with data (Kristensen and Ruckenstein 2018), understandings of the 'self' (Homewood, Karlsson, and Vallgårda 2020), as well as shifting boundaries between subject and object positions (Lupton 2015b), I find it nevertheless leaves out how these technologies come to matter on the backdrop of and in correlation with other sites of datafication, such as medicalized or shared, and technologies such as oocyte freezing or kinship. As Franklin argues in her work on IVF technologies:

> "to understand the workings of IVF not only as a technology, but as a complex or cultural form—including its past, its coming into being, the history of its recent present, and its evolution and dissemination, as well as its future—requires an account of how it works in and through other systems. This includes other technologies—such as technologies of kinship as well as clinical equipment, and technologies of sex as well as the medium of the Internet." (Franklin 2013, 9)

Following this, I take fertility sensemaking not as one stable phenomenon that can be scrutinized but as made up of multiple practices and objects that come

to be through the ways they move sites, and enroll cultural understandings of reproduction, technologies, medical models, and much more. I understand fertility sensemaking as *assemblages* of bodies (one's own and others), hormones, sites of datafication, reproductive technologies and governmental regulations around them, access to healthcare, tests, cultural narratives (e.g., on gender, reproduction, fertility decline, temporalities), and biomedicine, as I unpack in the followings section.

FERTILITY SENSEMAKING AS ASSEMBLAGE

As I lay out in the previous sections, this dissertation separates three sites of fertility datafication (intimate, shared, and medicalized) as exemplary sites where fertility sensemaking unfolds through a configuration of technologies, bodies, and data. I unpack the formation of these sites in Chapter 1 and the methodological consequences for researching such sites in Chapter 4.

I do not, however, understand these sites, as well as bodies, technologies and data, as singular, bounded units that meet each other in fertility sensemaking. Rather they are *assemblages*, that come to be through each other. I draw my understanding of assemblages from the work of Deleuze and Guattari (1987) who conceptualize them as gatherings and multiplicities that generate agency through relations, blurring clear distinctions between subject/object, or human/non-human. In this case, fertility sensemaking does not only rely on the configuration of bodies, data and technologies, but bodies, data, and technologies come to matter through their relations: they are composed "not by the list of tools and components, but by the interminglings that make the tools possible" (Murphy 2012, 29). Through assemblages, parts come to matter in certain ways, and not in others (ibid). For example, a MFTA has no meaning without the body they are set out to track and depend on smartphones, internet access, and medical models of menstruation, just to name a few. They come to matter through relations with those parts. That is, a MFTA is not just added to the list of tools needed to make sense of one's fertility, but through fertility

sensemaking, MFTAs come to matter in a certain way, that is as a means to predict, control and manage fertile time.

Work in posthumanism and new materialism, further argues how bodies are always already assemblages of e.g., genetic materials, politics, relations, normativities, and technologies. As I expand upon in Chapter 2, neither bodies nor technologies can be understood as singular units, separated from each other, as bodies are always already technologized, and technologies always embodied (Barla 2019; Barad 2015; Haraway 1991; 2016a). Fertility then can be understood as a set of entangled and relational practices between, for example, different tools, bodies, histories, legislations, economics, and normativities, rather than a quality of individual bodies (Murphy 2012).

Understanding fertility sensemaking as assemblages also has methodological consequences. Rather than focusing on one site (e.g., a fertility clinic), approaches are needed to access and separate different parts of the assemblage (Suchman 2006). *Assemblage ethnography* (Wahlberg 2022; Fox and Alldred 2015; Ghoddousi and Page 2020) describes an approach to locate practices and processes within particular "juridical, medical, social, economic, cultural, and institutional configurations" (Wahlberg 2022, 136). Building on this, I have collected diverse empirical material on fertility and data narratives in Denmark (newspaper articles, online conversations), initiatives of fertility clinics (advertisement material, websites, information on the national health platform), legal regulations, and intimate practices of datafication (of participants and my own experiences) to foreground fertility as a constant becoming, and to understand how fertility is being reconfigured and negotiated as bodies, data, technological and scientific progress as well as governmental legislations intra-act (see Chapters 1 and 4 for more detail).

This messy empirical material builds the basis to analyze the ways cultural norms around gender, bodies, and temporalities become embedded in MFTAs and thus afford particular understandings of reproductive bodies, as I show in Paper 1. In Paper 2, I investigate practices through which reproductive temporalities become collectively navigated by questioning social and medical

models of fertile time (e.g., when is a good time to become a parent or cycle length). In Paper 3, I scrutinize how public healthcare offers (FAC), as well as public narratives of fertility decline shape how people imagine their reproductive future in terms of possibility, and what objects come to matter for them. For instance, how people preemptively navigate processes of IVF treatment. The availability of such technologies and the ways they are legally governed (e.g., what bodies can access these technologies in terms of sexuality, age, weight etc.) shape how people imagine futures and become oriented towards such technologies. In Chapter 5, I further discuss how economic structures remake fertility data into something valuable beyond bodily self-knowledge, as such data is being sold back to the users via premium functions (and the promise of more self-knowledge through more analysis), or to third-parties that turn this data into profit via ads for products such as other tracking tools, tests, fertility clinics or baby products. These processes shape attention and relations to fertility, as I also discuss in Chapter 5, through my autoethnographic experiences of losing data, as well as through observing my 'data self' change from fertile to infertile based on the advertisement I was confronted with on other websites.

RESEARCH QUESTIONS AND CONTRIBUTIONS

Through engaging with feminist theory, work in HCI, and STS, theories on posthumanism (Braidotti 2022; Barad 2010; Haraway 2016a) as well as crip/queer temporalities (Kafer 2013; Freeman 2010), and building upon various empirical material, this dissertation develops a qualitative analysis of fertility sensemaking practices, which center a relational and distributed understanding of fertility. Through asking the following questions, this dissertation provides accounts of the ways fertility becomes re-con-figured in terms of norms, temporalities, and orientations through practices of fertility sensemaking:

How is fertility figured, materialized, and understood through sensemaking practices across sites of datafication?

As well as the following sub questions:

1) *What kinds of normativities are underlying current datafication technologies?*
2) *How are normativities around reproductive time collectively navigated?*
3) *In what ways does the availability of datafication technology shape how people become oriented towards data as a means to predict reproductive futures?*

The overall research question is explored through this part of the dissertation (kappa), as well as the three papers, while the three sub questions particularly map to the papers (Paper 1/RQ1, Paper 2/RQ2, Paper 3/RQ3).

By scrutinizing normativities (in terms of gender, sexuality, and ability) as they become embedded in self-tracking technologies, such as MFTAs, *Paper 1* explores how reproductive bodies become figured through such technologies. *Paper 2* shows how temporalities (as felt experiences of cultural ideas of when reproduction should take place), are collectively navigated as people's experiences disjunct from medical models of reproductive time (e.g., cycle length). It argues fertility as constant becoming (e.g., within a cycle or one's lifetime), rather than a fixed state. Based on an analysis of the different sites of datafication, including medical practices of ovarian reserve and sperm testing (FAC), *Paper 3* brings forth how orientations to futures become reconfigured as infertility, rather than fertility, becomes anticipated. Together with this kappa, the three papers bring forth how fertility becomes re-con-figured through practices and objects of fertility sensemaking.

WHERE I AM COMING FROM

Rather than a gaze from 'nowhere' by an objective observer, feminist research methodologies foreground knowledge production as always situated and subjective (Harding 1986; 2004; Haraway 1988). That does not necessarily mean that we can only research what we experience ourselves, but that the knowledge we create is impacted by our being in the world. However, to a degree, this research project is very close to my own experiences (see Chapters 4 and 5). At this point I share some (bodily) positions from which my knowledge practices come from. I discuss how they are unstable in Chapter 5, while including other positions (feminist methodologies) in Chapter 4.

My body is in, and part of, this research. It moves in and out (though never fully) of this research space, while I move in and out of fertility. My research and writing of this dissertation has to a large degree overlapped with my own 'reproductive journey'. Bound up in yet another time-limited and demanding employment, I decided to delay the horizon of my reproductive future (like some of my participants who delayed their reproductive futures for the sake of education or stable employment). Alongside this research, reading online discussions and information materials, as well as talking to people, I was also trying to understand my own reproductive future at the intersection of education timeframes, employment precarity, and social norms.

Being a white, heterosexual, cis-woman with a higher education shapes the access I have to health offers and reproductive technologies, the ways I navigate them and become oriented towards them. While these positions privilege me to a degree, I am also a foreigner trying to navigate a different country, language, and especially a different healthcare system. One that seems reactionary, rather than proactive, like I am used to. In Germany (where I come from), visits to a gynecologist are encouraged at least once a year, opposed to Denmark where appointments seem gate-kept by one's allocated general practitioner. While I am rather critical in this research towards the over-medicalization of bodies by 'medicalizing the normal', I also have to acknowledge that not having routinized visits to the gynecologist is an

unfamiliar practice to me. For me, these routine examinations went beyond the managing the reproductive body (e.g., by prescribing or inserting means of contraception, or measuring fallopian tubes), because they also included checking for ovarian, cervical, or breast cancer, as well as consultations regarding menstrual pains, for instance. In a way, I felt more secure in my body then, than I feel now, where it is exclusively up to me to touch my breasts and be attentive towards changes in my body. That is to say, I am coming into this field with 10+ years of experiences of medicalization and examination of my own (reproductive) body, which shapes my understanding of my body and fertility differently than the context I am in now.

NOTES ON TERMINOLOGY

Before moving on, I want to clarify some of the terminology used in this dissertation. I often use the term *reproductive body*. I have done so in order to avoid overly gendered jargon that essentializes cis-women as participants in fertility sensemaking. I could have used 'people', or just 'bodies' to refer to those engaged in these practices. However, by using reproductive body I highlight that these datafication practices are specifically aimed at understanding people's reproductive potential and practices. Understanding reproductive bodies as a figure allows me to engage with their technological, biological, cultural, datafied entanglements, rather than reducing a body or a specific body to its reproductive capabilities. The reproductive body here is always multiple, rather than a stable representation. However, thinking about the reproductive body as gender neutral might obscure the fact that it is to a large degree the feminized body that becomes scrutinized, marginalized, and does a lot of labor. But in lack of a better term, I continue using it.

When I use the term 'woman' or 'female body' I do this either because the person I refer to understands herself as a woman, or as a way of echoing gendered terminology that is used in medical contexts and public narratives "to reflect a social and cultural reality" (Browne 2022, 27). For example, when such terminology is used by a MFTA in the description of their users, or in the

information material by the FAC that highlights the female body as the reproductive one. In these cases, using similar terminology aims to reflect upon gendered discourses around reproduction and fertility (i.e., as a 'woman's problem').

CONTENT

This dissertation is made up of two parts, the 'kappa' (Part One) and a collection of three scientific papers (Part Two). This introduction of the kappa is followed by **Chapter 1**, which sketches out how intimate, shared and medicalized sites of datafication are separated in this dissertation. I also include more detailed contexts of the respective technologies within these site descriptions, such as details on the MFTAs investigated in this project. This chapter further situates these technologies and practices in the local context of Denmark, providing background information on national imaginaries of data and fertility, as well as current legislations that are governing reproductive technologies.

Chapter 2 discusses the theories I think with throughout the dissertation. In this chapter, I offer my reading of theories of posthumanism and new materialism (Braidotti 2022; Barad 2010; Haraway 2016a) to anchor this dissertation in ideas that bodies, technologies (and data) are always already entangled, and discuss the consequences of researching 'bodies' when they are porous and in constant becoming. I further include theories on crip and queer temporalities (Kafer 2013; Freeman 2010; Edelman 2004; Halberstam 2005) to discuss the ways temporal scripts re/make fertility and reproductive bodies by placing them out of sync or out of time. These scholars bring forth how time is non-linearly and subjectively experienced. Building on these theories allows me to question for whom reproductive futures are imagined, and how fertility is experienced non-linearly.

Chapter 3 discusses the work I am building on in the fields of HCI, STS, critical data studies, and feminist theory. Here I am introducing work that is concerned with the body and reproduction as socially and culturally made; how

technologies embed, reproduce and sometimes reject such cultural norms around reproduction; and how data shapes bodily experiences.

Chapter 4 offers the methods and methodology of this project. Drawing upon feminist methodology and ideas of assemblage ethnography, this dissertation combines different methods to investigate the multiple sites of fertility datafication. In this chapter I outline my use of the walkthrough method, autoethnography, digital ethnography and interviews to generate insights on the ways those different sites come to be, and ways people navigate them. This chapter also holds my considerations around some of these methods (such as around ethical practices of digital ethnography).

Chapters 5 and 6 share additional explorations to reflect on the ways they have shaped my analytical focus and discuss additional empirical material. More precisely, **Chapter 5**, 'Walking With', accounts for the experiences of doing autoethnography and how they have shaped me (as a reproductive body and a researcher), and consequently this project. I share four autoethnographic vignettes to discuss how these experiences relate to aspects of data loss, third party data sharing, reproductive data labor and research orientations.

Chapter 6 offers re-visions of current data practices and technologies. Starting with a counternarrative of fertile time, this chapter explores practices of speculation and materialization as approaches to investigate and critique current data practices. Beyond my own explorations, this chapter also holds re-visions as I found them in the 'field'. For example, in the form of a voluntary coding collective that created a MFTA detached from economic profit, or a crowd-sourced data archive on infertility treatment.

Chapter 7 presents my contributions and findings by discussing the included papers under aspects of figuration, configuration, and reconfiguration. Finally, the last chapter **concludes** this thesis and offers points for future research.

Following the 'kappa', **Part Two** includes three papers that contribute to scholarly debates in HCI, feminist STS, and feminist theory. Mapping to the title of this dissertation (*re-con-figuring fertility)* the papers bring forth analyses of the ways fertility becomes figured, configured and reconfigured through

fertility sensemaking. Paper 1 shows how reproductive bodies become figured through cultural and gendered normativities; Paper 2 how fertile time and temporalities are configured through shared practices of data sensemaking; and Paper 3 how relations to futures are being reconfigured as people become oriented towards anticipating infertility. In the following, I briefly summarize the three papers in terms of aims, context, and findings. A more extensive summary can be found in Chapter 7.

Paper 1: Reime, Lara, Vasiliki Tsaknaki, and Marisa Leavitt Cohn. 2023. 'Walking Through Normativities of Reproductive Bodies: A Method for Critical Analysis of Tracking Applications'. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, 1–15. Hamburg Germany: ACM. https://doi.org/10.1145/3544548.3581450.

This paper contributes to HCI and the field of reproductive health by exploring the walkthrough method (Light et al. 2018) as a method for critical engagement with existing MFTAs. We discuss this method as a tool for designers and researchers to productively engage with understandings and perceptions of technologies. The Paper also presents an analysis of three contemporary MFTAs based on data obtained from the walkthrough method and autoethnographic engagements.

This analysis brings forward understandings and normativities of reproductive bodies, as well as the narratives through which they become reproduced within these technologies. The aim of this study is to understand how underlying app infrastructures replicate, reinforce or diverge from cultural ideas on i.e., gender, sexuality, and ability. While the social practices (how people are using it) matter in later explorations, this study was important to closely examine the technologies themselves and the normative values around reproductive bodies they embed in the design and interactions. For example, we saw normativities surfacing in different elements and features offered by the investigated MFTAs (Clue, Drip, Tilly). These include themes such

as, 1) underlying assumptions of normativities of reproductive bodies, including (gendered) and temporal understandings of reproductive bodies, 2) normativities of self-care and body literacy, 3) normativities of dis/engagement.

The Paper thus provides an assessment of the walkthrough method for studying existing technologies aimed for bodily data tracking, as well as our analysis of how normativities of reproductive bodies unfold across an expanding MFTA space.

Paper 2: Reime, Lara, Marisa Leavitt Cohn, and Vasiliki Tsaknaki. 2023. 'Fertile Becoming: Reproductive Temporalities with/in Tracking Technologies'. In FemTech: *Intersectional Interventions in Women's Digital Health*, edited by Lindsay Anne Balfour, 73–98. Singapore: Springer.

This paper contributes to the field of STS by sketching out lived experiences of reproductive temporalities and a critical investigation on the ways they are being reshaped through technologies. Here, we analyze how MFTAs represent and organize reproductive time and temporalities, how they build datafied relations to pasts and futures, and how users become oriented towards temporalities that are embedded within broader social and cultural narratives of reproduction. In response to this, we find that people engage in collective practices to make sense of their fertile potential and find ways of 'queering' their reproductive temporalities.

The paper is part of an edited volume which brings together critical work in feminist STS on the growing FemTech market. Our contribution gives an account of the ways reproductive bodies are 'becoming' through MFTAs and other means of sensemaking, such as online forums. It contributes to the field by offering an analysis of reproductive temporalities as entangled in technological mediations and worldly temporalities of wars, pandemics, and climate change. It brings forth people's complex relation to reproductive health.

Paper 3: Reime, Lara. 2024. (submitted). 'Orienting towards (Non)Reproductive Futures: Anticipating Infertility'. Submitted to *Catalyst: Feminism, Theory, Technoscience.*

The last paper builds on the previous two by further exploring how normative technologies, such as MFTAs, reconfigure bodily temporalities of reproduction and fertility. Here, I also consider more medicalized datafication practices such as ovarian reserve and sperm testing, as this offer is being rolled out as part of the national healthcare service in Denmark.

I locate the paper within work in feminist theory as it draws from such work to account for the ways reproductive bodies become materialized alongside reproductive technologies. The paper aims to contribute to this scholarship by analyzing how the availability of mundane datafication technologies and narratives around fertility decline shape orientations to fertility.

I find that through this conjuncture, people within liminal spaces are being moved into anticipatory regimes of infertility. That is, they act as if infertility has already 'occurred'. By anticipating infertility, rather than fertility, people move timelines of reproduction and preemptively synchronize with healthcare services and legal requirements. The paper thus shows how reproductive labor becomes cast onto 'pre-conception bodies'.

1

SITES OF FERTILITY DATAFICATION IN DENMARK

Context

To separate sites of datafication is necessary in this dissertation, as fertility sensemaking is not one stable practice, but is configured through shifting actors, objects and contexts. The focus on sites helps to demarcate the various practices that constitute fertility sensemaking, and how fertility changes meaning across those sites. Here I am building on Mol's (2002) investigation of atherosclerosis treatment in a hospital context, where she showed how the disease is made and understood across different sites. Each site, for example the consultation room, lab, or operation theater, produces different knowledge around the disease based on the practices and availability of instruments and technologies. She argues how particular realities come into being and take shape at particular sites, that is *multiple ontologies* (ibid). Understanding fertility sensemaking as *one* site would thus fall short to account for the ways data around fertility comes to be through multiple sites and travels across sites, how understandings of bodies and relations to fertility change across sites, and how different technologies (or instruments) are configured at those sites.

As I point out in the introduction, I do not understand these sites as physical spaces. Rather, I understand them as contexts and practices where different actors come together to generate and analyze data. Different to, for example, a fertility clinic where sites with a distinct architecture, spatiality and purpose can be mapped out (e.g., waiting room, the consultation room, the lab), the sites of this research project are fluid and open for reconfiguration, defined by interactions and relations. This also means that these sites do not exist in a readymade form, open to researcher scrutiny. Rather, my research practices make them:

> "Beginning with the premise that discrete units of analysis are not given but made, we need to ask how any object of analysis – human or nonhuman or combination of the two – is called out as separate from the more extended networks of which it is part." (Suchman 2006, 283)

Following Suchman, separating units and setting boundaries is necessary to turn assemblages into objects of analysis (ibid). I do this through the sites I present here. To account for my understanding of them, and how I have separated them, this chapter is structured into two subsections situating 1) the different sites (intimate, shared, medicalized) as they are made up of a range of practices and technologies (MFTAs, online forums, FAC), and 2) the local context of Denmark, to provide some of the background through which the previous sketched sites come to be. This includes national narratives around data and fertility, as well as legislations around reproductive technologies.

SEPARATING SITES

To engage with my research questions, I have mapped three sites that come together and shape each other. Some people are not only tracking through apps, but then share this data online, or also engage in medicalized forms of datafication, such as ovarian reserve testing. Results of such testing might then be brought back to discussions in online forums or shape attention to self-tracked data differently. Within the respective sections I sketch out what I

mean by the different technologies and practices, how they partake in sites of datafication, and why I came to focus on them.

INTIMATE DATAFICATION: MENSTRUATION AND FERTILITY TRACKING APPLICATIONS

With *intimate datafication* I mean data practices that come out of intimate bodily relations and understandings that stem from touching and sensing one's body and fluids. To make sense of fertility, or fertile potentials, markers such as temperature increases, menstrual bleeding, or cervical mucus consistency are often used as indicators of hormonal changes in the body and occurrence of ovulation. These changes are observed and felt through different senses of the body (Algera 2023). For example, changes of mucus consistency and processes of ovulations can be felt through cramps, but they can also be sensed through seeing, touching and smelling vaginal discharge.

Intimate datafication *as a site* is composed of various technologies that support such practices, and can include objects such as thermometers, which enter the body (orally or vaginally) to measure temperatures, tests to constitute hormonal increases, or digital technologies that prompt for such sensing, and through rendering this qualitative data into quantitative data outputs make predictions on future menstrual bleedings and 'fertile windows' (Lupton 2015b; Hamper 2020), such as MFTAs.

In this project, I focus on MFTAs as objects of intimate datafication, as these were relevant for my participants who are trying to make sense of their fertile potentials through sensing their menstruating bodies. Generally, most of the MFTAs available aim to support users in 'learning about', 'getting control over' or 'getting in sync with' their menstruating bodies by analyzing data inputs and providing predictions (Lupton 2015b; Hamper 2022).

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There are plenty of pink options (see Figure 2) when searching for a menstrual tracker or fertility tracker in the iOS and Android app store, though most cater to both uses. Most MFTAs are categorized as 'well-being' or 'fitness' tools. So far, only one app has been categorized as a medical application, approving it as a means for contraception[6]. Such categorizations have an

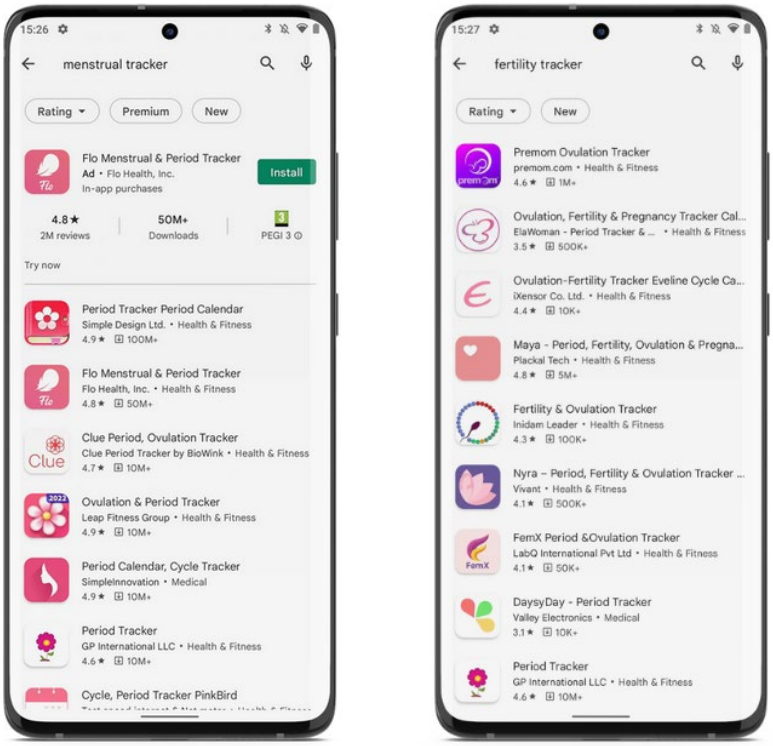

***FIGURE 2**: Screenshots of search results in Google play store for menstrual tracker (left) and fertility tracker (right). The screenshots show a range of menstrual and fertility tracking apps in the app store. To note is that almost all app icons are pink and to a large degree include flowers.*

impact on how data is understood, stored, and protected (Mehrnezhad and Almeida 2021). For example, when using a medical application, the 'user' is understood as a 'patient', whose data is sensitive. Whereas a 'well-being' app has a 'user' whose data can more or less be freely used and shared with third-

[6] https://www.naturalcycles.com/

parties. Based on a broad screening of available MFTAs (that is: reading app store descriptions, their websites and downloading a couple of them), I chose three MFTAs (Clue, Drip, and Tilly) to investigate more closely through the walkthrough method and autoethnographic engagements (more details in Chapter 4). Paper 1 of this dissertation offers an in-depth analysis of the functionality, affordances, and design of these three MTFAs.

Clue[7] with its total of 10+million active users (according to their website), builds part of the status quo of more established apps that newer apps, like Drip [8], are positioning themselves against. Drip (available since 2021) is developed by a coding collective, who states that this app departs from other MFTAs, by having addressed and improved previously critiqued aspects, such as transparency and data privacy. Lastly Tilly[9] is particularly aimed at users who already have encountered fertility issues and is conceptually developed by two women who have gone through fertility treatment themselves – a 'stressful journey' as they presented it on the second starting screen of the app. Tilly's purpose is to support others going through such journeys by employing "data-driven personalization".

[7] During my research, Clue underwent a mayor update, which added new features and design changes. Note that my analysis and engagements are before the update in 2023, meaning that some categories or visuals might not exist anymore. https://helloclue.com/

[8] https://bloodyhealth.gitlab.io/

[9] Recent updates have included an increased focus on mental health aspect while experiencing infertility, offering space for diary entries or prompting reflection. https://mytilly.co/en

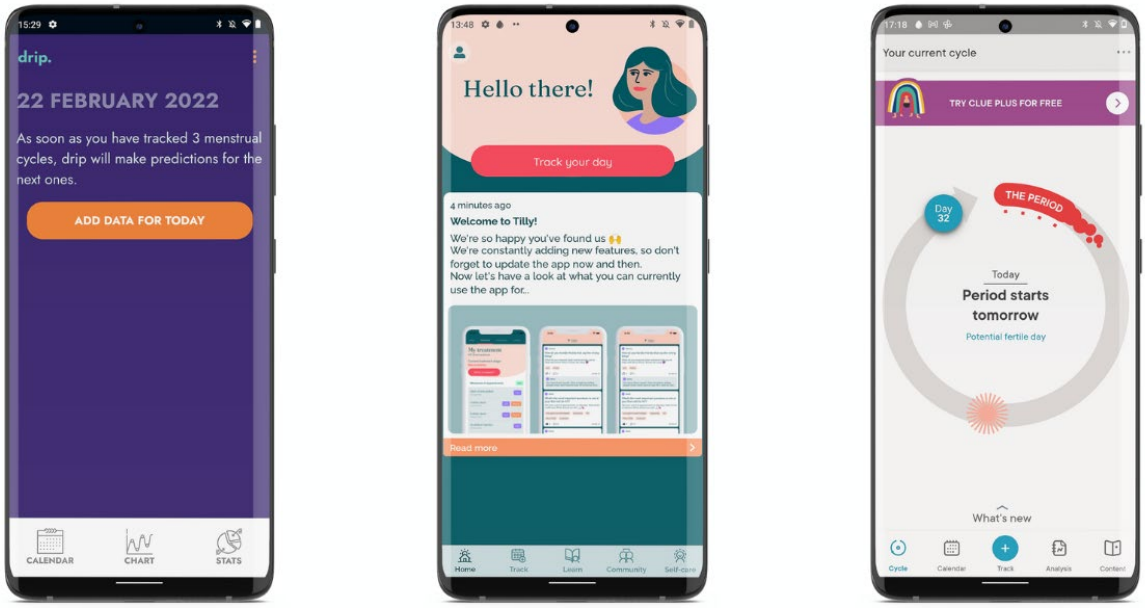

FIGURE 3: *Screenshots of starting screens of drip (left), Tilly (center) and Clue (right). The screen to the left offers a sleek design, showing the data and an orange button prompting to 'add data for today' on a purple background. Three icons signal a view for calendar, chart and stats in the bottom of the screen. The center screen looks busier, having a small drawing of a woman on the top corner, saying "Hello there!", below is a red button to 'Track your day'. Below the button is an information box welcoming me to Tilly: "We're so happy you've found us. We're constantly adding new features so don't forget to update the app now and then. Now let's have a look at what you can currently use the app for...". The bottom of the screen has icons for home, track, learn, community and self-care. The right screen holds a circle to visualize the menstrual cycle indicating menstrual bleeding in red, ovulation through an abstract flower-like icon and the current day through a blue dot. On the bottom of the screen, icons guide to cycle, calendar, track, analysis and content.*

MFTAs become enrolled at sites of intimate datafication, because they are developed to collect and generate data on intimate bodily process and aspects (e.g., menstrual bleedings, sensations, sexual intercourse). Sometimes, they make sense of data that is produced through devices that are intimately in contact with the body as they are worn on or inside (e.g., smart watches, bracelets or rings for temperature measurement). And most of the time they are aimed at creating intimate relations with the user by prompting for data input, presenting information, or providing support "when everything becomes too stressful" (see Tilly). They are thought of as tools to 'gain control over one's body' and 'live in-sync with one's cycle'. Or in other words: to make the inner (intimate) workings of the body visible and controllable (Hamper 2020; 2022).

However, in everyday practices, such relations might not be intimate at all, as data then is (un/knowingly) being shared out of this site or data from the other sites comes in, as I unfold in the following sections.

SHARED DATAFICATION: ONLINE FORUMS

Shared datafication as a site refers to the various practices where data comes to be through sharing, for example, bodily sensations, test results and emotions, or where data from other sources is being shared to collectively make sense of it. In a way, *intimate* practices are always already shared when bodily experiences are being shared with devices. But in this section, I want to consider the sharing between different bodies. Following Murphy (2012), reproductive health has always been a shared effort. Especially since critical researchers and activists have pointed to the shortcomings in medical systems as the female body has been understudied and subsumed to the male one, feminist movements have started to fill these gaps through communal health practices:

> "self-examination, despite its name, was not an exercise in individual self-reflection.[...] Through comparative analysis in a group, women were called upon to translate their individual experience of looking at their cervix into information about 'women' as a class." (Murphy 2012, 81)

Inspired by these established feminist practices, I have looked for places where 'self-tracking' too is being shared beyond the 'self'. This includes online forums and in-app forums that allow for communication, sharing of data and collective analysis. In some cases, such as in Tilly, participating in in-app forums is encouraged by daily reminders. Additionally, I looked for online spaces outside of MFTAs. Information on in/fertility can be found on a merit of social media sites, for example through 'fertility influencers' on TikTok or Instagram (Stenström and Pargman 2021; Krause 2022) or in/fertility blogs (Harrison 2014; Cummings 2019). While it is possible to comment under a picture and have a

conversation this way, there is still not 'one room' but dispersed content that becomes algorithmically suggested to people. However, my search was for places where people can come together, so to speak. I found those in Facebook groups and on Reddit. After sporadically scrolling different sites, I decided to follow conversations on Reddit, as these spaces seem to be more organized (through moderation and rules), as well as more anonymous (not linked to a personal profile like on Facebook), and easier to enter since no previous sign-up is required. I lay out more details in Chapter 4 on how I conducted research in these spaces. For now, I want to stay with the 'what' (content) and the 'why'.

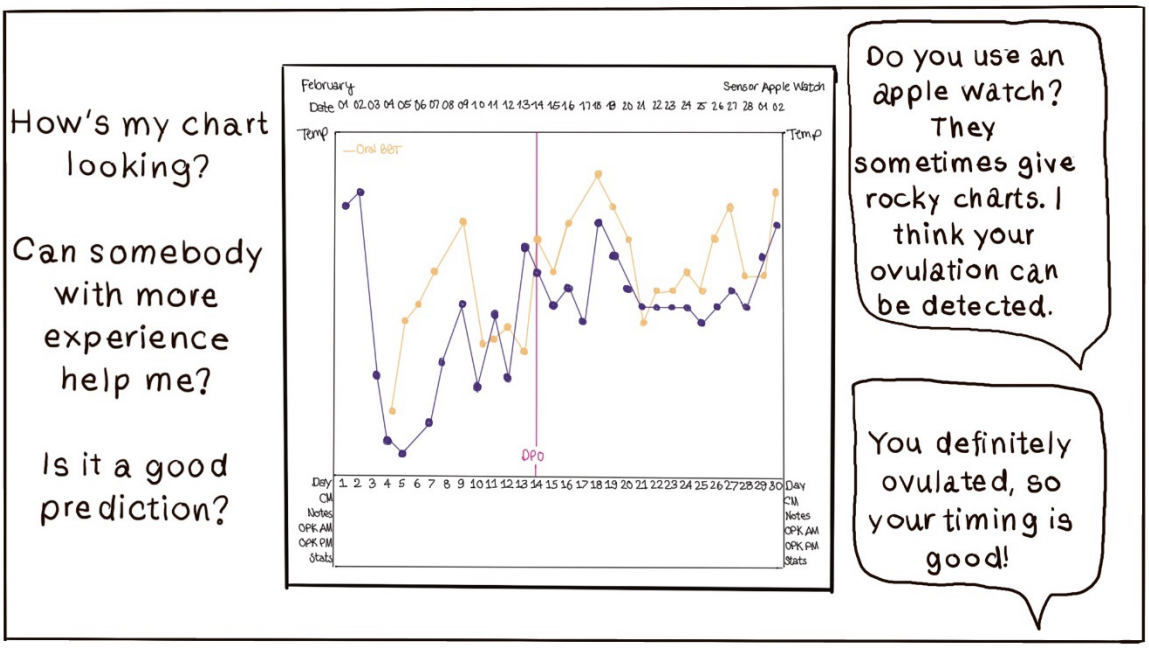

***Figure 4**: A fabrication sketch to capture conversations around data online. In the middle a temperature chart, indicating in/decreases of temperature. The questions on the left ask: "How's my chart looking? Can somebody with more experience help me? Is it a good prediction?" The answers in speech bubbles on the right read: "Do you use an apple watch, they sometimes give rocky charts. I think your ovulation can be detected." and "you definitely ovulated, so your timing is good!".*

I started to engage with forums that discuss infertility from various perspectives and positions, such as at the intersection of medical and social

infertility.[10] Based on my personal encounters with these sites, I later moved towards forums that discuss fertility from a liminal perspective, where people are not trying to conceive yet, but want to do so in the future (further discussed in Chapter 5). In these spaces, experiences and emotions regarding 'fertility journeys' are being shared, questions on bodily symptoms and fertility treatment asked, as well as data collectively analyzed and made sense of (see Figure 4).

I include these sites in my research, as they offer examples of how data travels, how it is being made sense of collectively, how intimate data becomes part of shared datasets, and how fertility is being negotiated and navigated across sites. As previous work has already established (see Andalibi and Garcia 2021; Andalibi et al. 2022; Harrison 2014; Stenström and Pargman 2021), online networking sites are relevant for understanding "(sub)cultural patterns and placing stories from qualitative interviews in a broader context" (Dahl 2020, 64). They also offer a space to observe how existing norms are being understood, mediated, navigated and either reproduced or rejected (ibid). These norms are mainly in terms of fertility, but also in terms of parenthood, family-creation and kinship, including ideas of healthy bodies, productivity and childrearing. These spaces also reveal the 'failures' of other technologies, such as MFTAs or tests, as people come to these places to make sense of 'faulty' results provided by these technologies.

[10] As I also briefly discuss in Paper 2, in collaboration with colleagues from ETHOS Lab (Perriam et al. 2024), and in Chapter 4, I do not share the precise forums I participated to ensure their anonymity.

MEDICALIZED DATAFICATION: FERTILITY AWARENESS COUNSELLING

I called the third site *medicalized datafication* to map how datafication is also taking place in medical contexts. Sometimes this includes bringing data from self-tracking practices into a medical space by discussing such data with medical practitioners, but also the generating of data in a medical context that is then traversing out into people's everyday lives and orientations to futures. These practices are also shared (with medical practitioners, or brought back into forums) and are medicalizing the intimate (as intimate bodily processes are being scrutinized). I understand the particularity of this site in that these practices cannot be done by the 'lay body' alone. That is, it involves particular technologies and knowledges that are not freely available but require enrollment into processes governed by a healthcare system. This could be, for example, the recent rollout of Fertility Awareness Counseling (FAC) in Denmark which includes free ovarian reserve and sperm testing at the public fertility clinics.

Through these tests, potentials of future fertility are being established as well as advice given to further maintain that potential (Hvidman et al. 2015). The recent rollout of the offer into additional municipalities is the result of a 10-year trial in the capital region of Copenhagen. It is legitimized by the argument that there is an increased need for Danish citizens to be aware of their fertile potential in order to plan the family futures they want, and to be aware of the timeline they can afford (Hvidman et al. 2015; Koert et al. 2022). However, participation is limited by restrictions (what bodies can participate) and the scarcity of the offer (as discussed in Chapter 5). The test is targeted to people above 18 years old, but not older than 41, if they are a woman. They should not have any suspicion or diagnosis of infertility (for instance, if the woman has a known diagnosis such as PCOS, or if a couple has tried more than a year without getting pregnant, they should go to a fertility clinic directly). Further, the language used seems to suggest that mainly women in relationships take up the offer and that the partner will partake a sperm testing. While it states that

one can also come as single, it seems to be assumed that most people come as a heterosexual couple. Paper 3 builds on this example by exploring how orientations to temporalities and spaces of reproduction become reconfigured at such sites.

NARRATIVES AND LEGISLATIONS IN DENMARK

Denmark is a particularly interesting context for researching fertility re-configurations through data practices, due to circulations of paradoxical narratives of both fertility decline and overpopulation (Bach and Breengaard 2024), normativities of family formations (Andreassen 2018; Dahl 2018; Harrison 2019), ideas of responsibilization and self-reliance of individual citizens (Carreras 2024; Papazu, Simonsen, and Reime 2024), as well as the ongoing datafication of the public healthcare sector (Hoeyer 2023).

It is relevant to understand certain imaginaries and structures of the Danish welfare state in order to pay attention to the ways the previously described sites become governed, and how fertility sensemaking is desired in the first place. They allow me to trace "how 'problems' [are] brought into perception to become actionable, to become objects and relations to be named, governed, acted on, and intervened in" (Murphy 2012, 148). It is these norms and values that shape how these sites come to be, how fertility is made actionable and how objects become available. Furthermore, this is the country in which I am physically located and employed, so I too am part of datafication processes, must navigate access to healthcare services, and encounter public narratives about fertility decline.

I have sorted this section into three subsections: first discussing general practices of datafied healthcare in Denmark, then narratives around fertility and particularly fertility decline, and lastly, how reproductive technologies are being legally governed and made un/available.

DATAFIED HEALTHCARE

The digitalization and datafication of the healthcare system are already well established under broader efforts of digitalizing the Danish welfare state. Denmark is a country

> "with thoroughly digitized health services, pervasive data sourcing, highly integrated data infrastructures, and personal identity numbers that make it possible to track citizens across sectors and throughout and beyond their individual lifespans. It is a country eager to be at the forefront of the prophesized data revolution." (Hoeyer 2023, 3)

Consequently, fertility datafication is not an exception, but rather just one example of pervasive and intensified data politics, infrastructures, and sourcing. Moreover, self-tracking is an "integral part of infertility treatments at public hospitals" (Dahlman et al. 2023, 106). That means that patients in infertility treatment (but also prior to it), become actively encouraged to use self-tracking tools to make sense of and preserve their fertile potential. Using a tracking-app is not always an individual choice but one that becomes embedded in treatment practices within healthcare services.

Citizens either become prompted to use an available MFTA, or a tracking app created by the healthcare system, such as an app for people in infertility treatment [11] (discontinued), or the "My pregnancy app" (min graviditet [12]) launched in 2023, and thought as a digital accompaniment for women through their pregnancy, offering guides and additional information. They further started a trial project to test a tracking app aimed at supporting women that have been diagnosed with gestational diabetes in 2024. Dahlman et al. (2023) argue that the sociotechnical imaginaries of FemTech in Denmark are building

[11] https://www.sundhed.dk/borger/service/om-sundheddk/nyheder-og-presse/fertilitets-app/

[12] https://www.sst.dk/da/Borger/Graviditet-og-smaaboern/Graviditet/Min-Graviditet---app-til-gravide

on similar ideas as in other parts of welfare datafication and digitalization, namely on the idea that more data results in more knowledge: "the female body becomes available to individual understanding and control when rendered as data points, and the same rationality supports visions of efficiency and precision at the collective level" (ibid, 74). We can see how such imaginaries impact the ways technologies become governed and made available, such as when a testing offer (FAC) is rolled out to generate more data on people's fertile potential.

NATIONAL FERTILITY DECLINE

This section presents some of the narratives around fertility, particularly of fertility decline, that circulate in contemporary Denmark. Through these narratives, potentials of fertility are increasingly understood as potentials of infertility (as I discuss in Paper 3). Reasons for this expected infertility are often individualized. Especially, when it comes to the 'ticking clock of the uterus'. Here, women's choices and decisions for delayed parenthood, often for the 'benefit' of education and career are narrated as reasons for (age-related) infertility (Adrian, Kroløkke, and Herrmann 2021). While the 'sperm-crisis' is also debated as reasons for the lack of children born, the narratives around 'bad sperm' differs from narratives around 'bad eggs' (Kroløkke 2021). The latter is often understood as a result of 'choice' (ibid). This also becomes visible in the articles following the change of legislation regarding IVF treatment (discussed in more detail in the next section). Here articles claim that such a change will only benefit the rich and that tax money will be used to fix 'their bad life choices' (to delay reproduction). In contrast, a decrease in sperm quality is portrayed as an environmental problem, in which the sperm falls victim to pollution, paraben-rich shower gels, and nutrient-less food (Kroløkke 2021). This narrative of 'self-induced' infertility versus 'victim of infertility' are also visible in a campaign by the municipality of Copenhagen from 2015. While the color-coded posters in blue and pink acknowledge fertility challenges in both men

and women, it directly addresses women calling for action by asking "Have *you* counted your eggs today?"[13], while the advertisement for men asks "are *they* swimming to slowly?"[14] (see Kroløkke 2018).

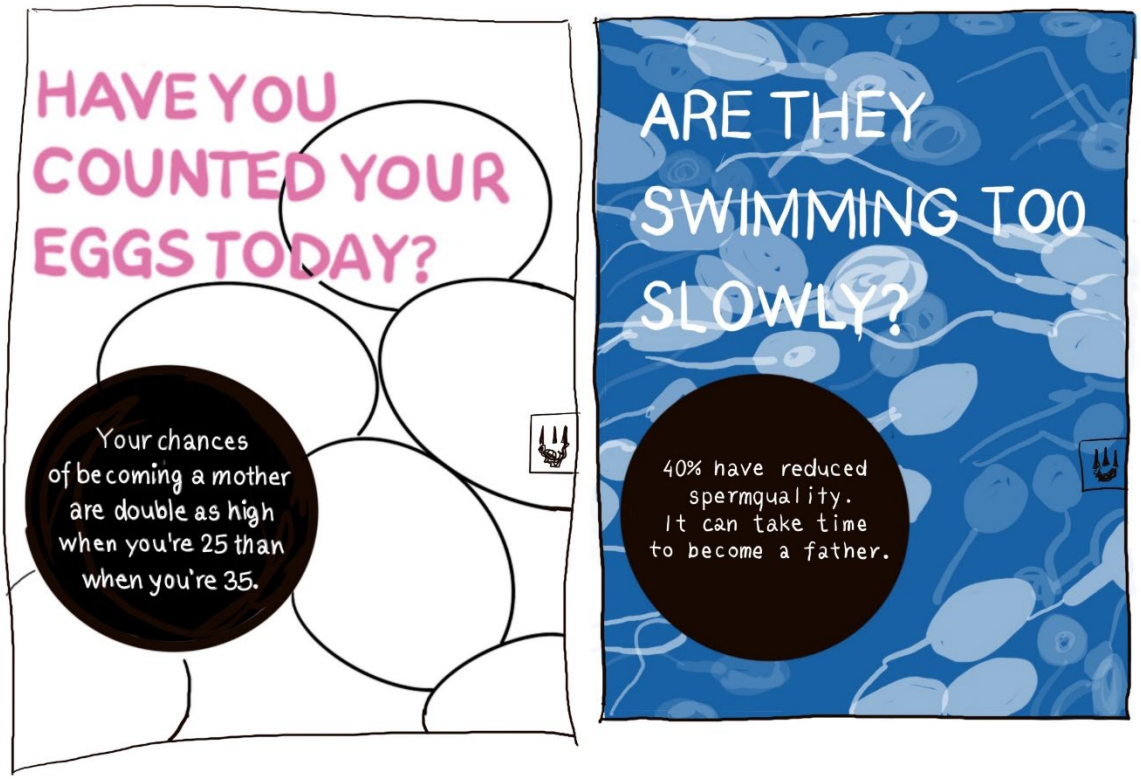

Figure 5: *A sketch of the two posters of the Fertility Awareness campaign by the municipality of Copenhagen. The left one shows a poster with chicken eggs and the title in pink: have you counted your eggs today? A black circle holds the information: Your chances of becoming a mother are double as high when you're 25 than when you're 35.*
The right one shows sperm cells swimming on a blue background, asking: Are they swimming too slowly? The black circle informs that 40% have reduced sperm quality. It can take time to become a father.

This promotes the idea that women's fertility can be controlled, either by becoming a parent early, adopting a healthy lifestyle or freezing one's egg at a young age ('the chance of becoming a mother is double as high when you're 25

[13] Emphasis added. My translation from: "Har du talt dine æg i dag?"

[14] Emphasis added. My translation from: "Svømmer de for langsomt?"

than 35'), while men just need to be aware that it can take time to become a father ('40% have reduced sperm quality. It can take time to become a father'). This campaign was part of the test run of the FAC (see also section on medicalized datafication) aiming to raise awareness of fertility decline, and to encourage people to participate in the testing and plan their reproductive futures: "young female bodies are purposefully disciplined and oriented toward a particular temporality of reproduction: have your children early" (Kroløkke 2018, 26), as I also discuss in Paper 3.

GOVERNANCE OF REPRODUCTIVE TECHNOLOGIES

> "Our regulatory apparatuses reflect both this densely stratified and competitive marketplace where the most intimate of aspirations, technologies, and family fortunes potently mingle. [...] In all these social locations, reproductive entanglements make our global bonds and local strategies more visible."
>
> —Rapp 2011, 710

Reproductive care and technologies are mandated under a range of legislative regulations. The following paragraphs summarize the legal frameworks relevant to this research.

At the end of 2023, the Danish prime minister Mette Frederiksen announced in her new year's speech, that the government is planning to increase public funding for assisted reproduction (AR). The proposal included raising the amount of financed tries for IVF and AR to six times, and to offer government financed infertility treatment for a second child. This would mean to double the number of AR/IVF attempts financed by the public healthcare system, as well as an additional six tries for a second child. Up until 2024, public funding for AR/IVF was only offered for a first child.

Including this matter in the new year's speech, stresses how "the making of children is [...] encouraged and seen as a state matter, and as essential in the continuation of the Danish welfare state" (Kroløkke 2018, 11). The proposal is a

response to recent research and statistics proclaiming Denmark to be in a national fertility crisis (see previous section). To (medically) combat dwindling fertility rates and to support citizens in 'creating the families they want', the government officially raised the numbers of paid IVF tries in 2024. The same year, Denmark also raised the duration of oocyte freezing. Previously, oocytes were allowed to be frozen for only five years. When someone followed the previously described calls for freezing one's egg, for example, they still had to use them within a time span of five years. In 2024 the legislation changed, allowing oocytes to be frozen until the legal limit of fertility treatment (until the woman reaches 46).

Further regulations in terms of AR/IVF treatment state that the body receiving treatment ("women") cannot be older than 41 years and have a BMI (body-mass-index) above 35. Within the private healthcare system, women can receive IVF until 46 years old and have no weight restrictions, though it is cautioned that an increased weight or other health factors might impact the success of impregnation. It is possible for single women to receive AR/IVF treatment, as well as for heterosexual and queer couples.

These legislations figure reproductive bodies through the ways they regulate access to reproductive technologies. As I show in Paper 3, these regulations shape people's understandings of temporalities and reproductive futures. Some people speculate on their reproductive future on the basis of such regulations, for example, by calculating when they should start trying to account for enough time 'in the system'.

2

THEORIZING ENTANGLED BODIES & NON-LINEAR TIME

Theories to think with

Fertility sensemaking complexly entangles different sites, actors, and objects. Consequently, fertility is not only a quality of bodies, but rather comes to matter through these relations. Through grounding this research in theories of posthumanism as well as queer and crip theories on time, I analyze the configurations of fertility through materials and objects as well as figurations through temporal scripts and normativities. The following sections give accounts of my readings of work in posthumanism and new materialism, including the consequences of posthuman theory for understanding the reproductive body, and then moves to work on time and temporalities from crip and queer perspectives.

POSTHUMANISM & NEW MATERIALISM

This dissertation is grounded in posthumanism [15] and new materialism as ontological approaches to account for the assemblages and entanglements of fertility figurations, what they consist of and how they come to be. They afford me to understand reproductive bodies and fertility as porous, unstable, entangled, and constant state of becomings rather than as fixed entities (see also Paper 2 and 3). This framing pays attention to the ways that agencies "emerge with and through the entanglements of actors as they be/come together in assemblages and respond to and enact each other" (Lupton 2019, 1999).

Posthumanism works towards the breakdown of anthropogenic phenomenology and exceptionalism by taking into consideration non-human actors, such as animals or technologies, acknowledging agency beyond humans and relational practices between humans and more-than-human ecologies (Braidotti 2022; Haraway 2016a; Wolfe 2010). More specifically, research within new materialism (as a strand or predecessor of posthuman thought) aims to understand the role non-humans play in everyday practices. Here, initial boundaries of active subjects and passive objects become dissolved for the sake of an analysis of subject-object entanglements. That is, subjects and objects are always already part of each other and becoming together (Allen 2018; Barad 2007; Barla 2019; Lemke 2015).

The 'matter' beyond bodies we are dealing with in reproductive health research are for example: the phones that contain various apps; sensors that are worn on the skin (e.g., smartwatches or heart rate monitors), and at times also inside (e.g., oral or vaginal thermometers); tests that are used to create data

[15] Posthumanism, as well as new materialism escape bounded definitions. There are varied understandings of posthumanism, some of them "even irreconcilable" (Wolfe 2010, xi). Despite their diversity, most share "a premise of a relational ontology in which analytical attention is pointed away from the essence of entities and towards relational dynamics" (Adrian, Skewes, and Schwennesen 2018, 9).

about hormone levels that either indicate a pregnancy, or a LH surge to validate processes of ovulation; scales that produce data on bodily weight in/decrease; phones/computer/tablets as they offer the entry point to social media sites where different aspects are being discussed; tele infrastructures that put one in connection with clinics; bikes/cars/public transport that put 'reproductive places' in proximity and allow for a frequent movement back and forth; herbs and spices used to impact cycle regularity; food in general (to sustain reproductive bodies); sensing body fluids as a way of understanding bodies (e.g., menstrual bleeding and cervical mucus consistency); networks and cloud storages that archive datapoints; and also technologies of kinship, sex, gender, and the list could go on. It is within this "rich, vibrant, messy, complex, thick worldly entanglement[s]" (Allen 2018, 23) that reproductive bodies and fertility are un/made.

REPRODUCTIVE TECHNOBODIES

Particularly relevant for this dissertation is the implication that such grounding in posthuman and new materialist theory has for understandings and configurations of reproductive bodies (Braidotti 2022). Following Braidotti (2022), reproductive bodies have become posthuman as they become figured within bioscientific progress. They have become *reproductive technobodies* (ibid). A posthuman conception of reproductive bodies means to highlight their multiplicity (ibid) as they are becoming produced "in world-changing techno-scientific practices by particular collective actors in particular times and places" (Haraway 1991, 297).

Feminist posthumanism challenges the idea that there is, or even can be, a 'natural' body. That does not mean that we do not inhabit physical bodies, that the fingers I am typing this with do not exist in their materiality, but rather it means that there is no natural state of the body. Posthumanism understands bodies as always already multiple, more-than-human and technologically entangled and mediated (Braidotti 2022; Barla 2019; Haraway 1991; 2016). This

approach "sees human bodies as extending their fleshy envelops into the physical environment, while the environment likewise colonizes human bodies" (Lupton 2020, 15). Bodies are leaky and porous (Shildrick 2015). They are not fixed and bound, but rather webs of relations of technology, humans and non-humans, as illustrated, for example, through Haraway's figuration of the *Cyborg* (2016) or the *OncoMouse* (2018). This constant production and becoming results in an understanding where bodies are "neither natural nor cultural" (Braidotti 2022, 12) but simultaneously "a historical, natural, technical, discursive, and material entity" (Haraway 2018, 210). This means that there is no 'pure' body that can be discovered, understood and lived through. Braidotti then asks:

> "What happens indeed when the traditional notion of the body as bound and specified entity explodes into a web of human and non-human components? What happens when skin is no longer the firm boundary of the body, but rather reveals its true nature as a porous membrane that is open to the outside world? What if the body, in addition to perceiving, storing and retrieving flows of information and sensorial data by itself, can also be accelerated through technological enhancement?" (Braidotti 2022, 142)

This fluidity and unclarity of what a body 'is', makes it particularly difficult to have 'the reproductive body' as an object of inquiry, as it cannot be discovered. This vantage point of thinking of bodies as posthuman and porous means for this project that fertility cannot be traced at the site of reproductive bodies, but requires an investigation of the ways fertility becomes located and materialized within bodies through assemblages across multiple sites of data and technologies. This dissertation does so by mapping the ways fertility becomes re-con-figured through technological progress, narratives of data and fertility, normativities of gender, sexuality and bodies, as well as temporal scripts.

Despite its potential for the inclusion of a variety of experiences, materials and species, posthumanism is also subject to frequent critique from various standpoints. These critiques are questioning how we can move past a human conception, when some bodies have not reached 'humanness' yet due to structural inequalities (Gane 2006; Forlano 2017b): "What is the posthuman

future of those who were never fully human?" (Braidotti 2022, 13). Even Haraway, who is understood as one of the key figures of posthuman thinking, moves away from this conception in later work, arguing for the notion of companion species rather than posthumanism (Gane 2006).

Posthumanism might not be the right terminology, as the wording implies transcendence beyond the human, yet from a human starting point (Puig de La Bellacasa 2017). This notion nevertheless offers a focus on, and expansion of, agency and relationality, which helps this research to do exactly that: consider how fertility becomes un/made not in individual bodies but through the assemblages that materialize them.

QUEER TIME & TEMPORALITIES

> "My future is written on my body."
>
> — Kafer 2013, 1

Temporal scripts are part of the assemblages that de/materialize reproductive bodies. They become materialized, for example, through narratives of 'good timing', and dematerialized through age-limits of IVF treatment, or figurations such as the *monstrous mothers*, illustrating women who become mothers at an age that exceeds the normative conception of the reproductive body (Adrian, Kroløkke, and Herrmann 2021).

I engage with work on queer and crip temporalities to scrutinize how time and temporalities within MFTAs and FAC are participating in normalizing, constructing, and regulating bodies into set patterns of (reproductive) time. In this research temporal normativities include timeframes of childrearing, how long it takes to conceive, length and duration of menstrual cycles, or the 'suspension' of fertile time through different means of 'control'. These normative temporalities in turn have affective relations to bodies as they move through time encountering their pasts and move towards futures as they are being oriented towards lives for them. By focusing on embodied and shared experiences of reproductive temporalities, my papers take up the work of

analyzing how temporalities become configured (Paper 2) and how relations to futures reconfigured within fertility assemblages (Paper 3). The future becomes an important horizon in this research, as fertility is liminal until constituted not only by conceiving a pregnancy but also by birthing a child.

I build upon theories of queer and crip temporalities because they critique structures of normative time(frames) by pointing to the ways time is experienced and embodied in ways that challenge the linear, progress-driven narratives, as often put forward within neoliberal structures. Rather than linear understandings of past, present, and futures, these works highlight the non-linear experiences of time, particularly from the perspective of bodies that often fall 'outside' such normative conceptions (Kafer 2013). To break with normative understandings and to be attentive towards the ways some bodies are always already placed outside of such timeframes, I build on the works of scholars who offer critical and alternative understandings of temporalities and living in time. Through concepts such as *queer time* (Halberstam 2005), *crip time* (Kafer 2013), *repro-futurity* (Edelman 2004), or *chrononormativities* (Freeman 2010) these scholars point to, and reject, normative narratives of linear and productive time. By bringing forward disjunctive experiences of bodily rhythms and normative timeframes, they point to the ways in which time and temporalities are constructed along (hetero)normative scripts of education, childrearing, marriage and home building (Halberstam 2005; Freeman 2010). For example, through the notion of *crip time,* Kafer (2013) highlights how experiences of illness and disability disrupt normative timeframes of progress and ideas of how 'time should be lived', as people move and think through pauses, slowing-down or speeding up in asynchronous ways. Work on crip and queer temporalities challenge the idea that time is, and can be, a universal experience, and instead rather points to the ways temporal experiences are shaped by embodiment and context, and are thus multiple.

Time can be written on bodies, as Kafer (2013) suggests. Here, she refers to the ways constrained futures are being imagined for her based on her crip body in terms of the futures she can have (a bleak one) and should want (one that

includes a cure) (Kafer 2013; 2019). The future, as a temporal orientation, is also of concern for Edelman and Halberstam. For example, Edelman (2004) is critical towards the future-orientedness of present practices, where lives only become lived towards the future (reproductive futurism). Edelman critically questions the child as the figuration of the future, highlighting how present decisions are made to protect and ensure the future of 'our children' (ibid.). Halberstam's (2005) work furthermore shows how orientations to futures are largely heteronormative. Halberstam argues, how the AIDS crisis forced queer people and communities out of normative temporal frames, as the continuous uncertainty of 'a future' forced them to focus on "the here, the present, the now" (ibid., 2). These theories de-center the future by rejecting a mere 'living towards the future' and pointing to the "multi-layered and multi-directional" (Braidotti 2019, 465) experiences of temporalities.

QUEERING REPRODUCTIVE TEMPORALITIES

I utilize this work within crip and queer temporalities, as fertility often becomes figured through affective relations to the future. However, these works show how temporal orientations are neither simple nor innocent. They are not simple, as an orientation to the future non-linearly entangles the past as well as the present. While the potential of fertility in the future is in question, it is being made sense of through past experiences and decisions in the present (as I discuss in Papers 2 and 3). They are not innocent, as by orienting towards futures, some people are left out of such orientations, and their future is made illegible. Building on these accounts thus helps me to ask what futures are imagined through sites of datafication, and for whom? In what ways do they allow, for or restrict, understandings of fertility as non-progressive and non-linear?

Previous work on reproductive bodies, such as Browne's (2022) work on pregnancy and miscarriages, also take up these future-critical conceptions.

Browne argues that normative timeframes and orientations collapse the *"lived time* of the pregnant person [...] into the *gestational time* of the fetus" (2022, 5), reducing the complexity of pregnancy to a "one-way 'countdown' to birth" (ibid.). Within such a reinforced future orientation, miscarriage can only be understood as 'wasted time', as the present was not 'productive' to progress one towards the future of parenthood (ibid.). Browne challenges this notion by proposing the concept of *suspended time*, where the present is re-centered "arguing that if pregnant time is not represented in exclusively future-oriented terms as *being-towards-birth*, miscarriage need not be understood as wasted time, or as pregnancy's undoing" (2022, 30). Thinking time as suspended allows us to recognize alternative, non-linear and entangled temporalities within pregnancy, such as "catching up to what is already happening" or "growing sideways" (ibid., 30). This conception challenges the idea of linear progression, in this case towards birth, as the only meaningful temporal narrative.

INTERLUDE I

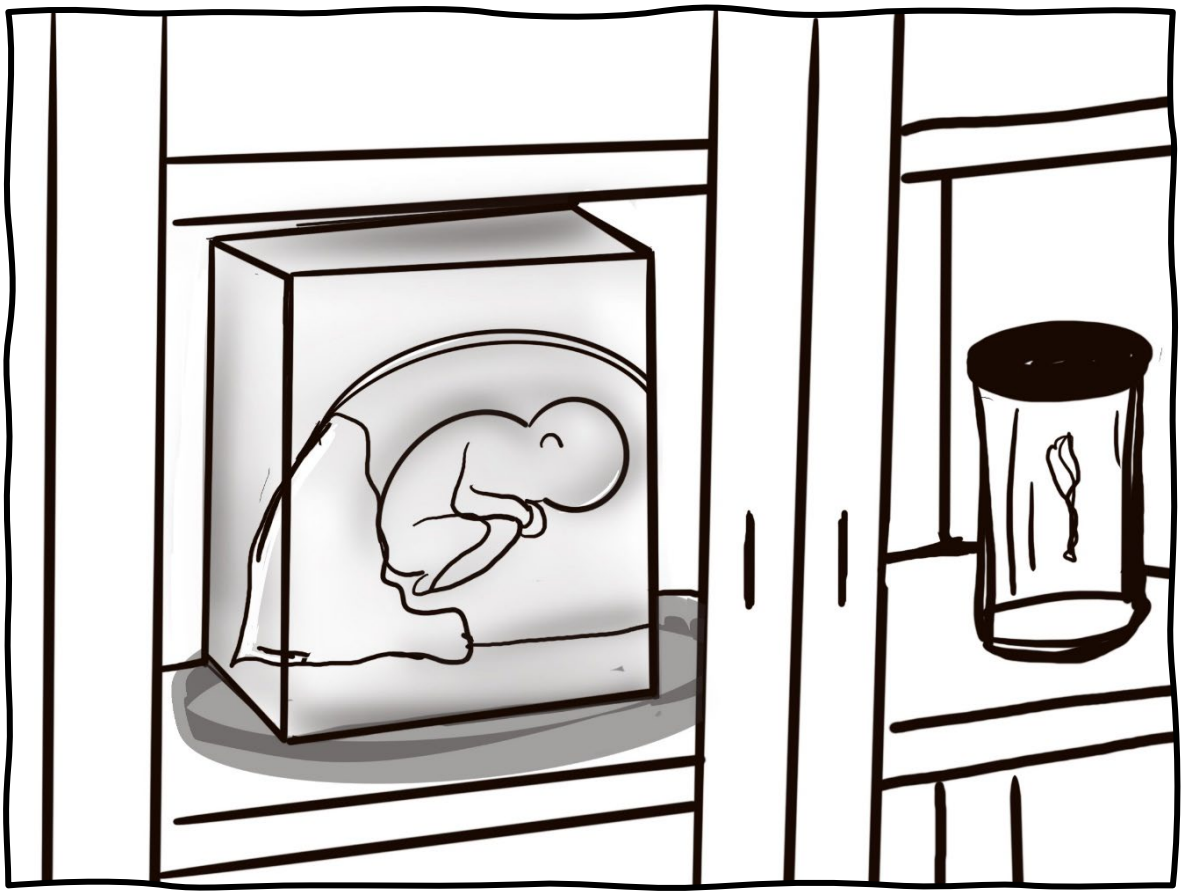

***Figure 6**: A drawing capturing my experience of seeing a cabinet full of specimen of dead fetuses at different stages of gestation at the Medical Museion in Copenhagen. In focus is one jar, holding a fetus, almost fully grown, surrounded by the womb, which is cut in half to allow a view 'insight'. Parts of the fetus are covered by a balloon, which was used for a procedure called balloon tamponade (a means to stop heavy bleeding).*

You were ready to come into this world. You look fully grown. I wonder if you've been in pain on your journey to an exit that never happened. I wonder about the womb that surrounds you. I assume it is your mother. Your life never became outside the womb, and her life ended. I wonder how many siblings you've left behind, what family you would have been born into. What life you would have lived. I wonder about your mother, who is she leaving behind? Was she anxious and/or excited to birth you? How many children have resided in her before? Was anyone there to hold her hand? You're fully here but what happened to the rest of her? I wonder about the midwife that tried to save both of you. And I wonder about all the babies and wombs that came before you that made it possible to develop these practices of blowing up a balloon. And all the ones that come after you. I wonder what people have learned from looking at your preserved remains.

I wonder about the liquid that preserves you, the places you have travelled. The eyes that have seen you, but you couldn't see.

You look peaceful. At rest. I hope you are.

***

3

CONVERSATIONS AROUND REPRODUCTION

Related Work

I include the preceding interlude as it, in my view, materializes and represents the ways scientific approaches reduce primarily female bodies to their reproductive capacities: while the fetus was visible as a whole, the grown body was reduced to its womb. The womb is physically detached from the rest of the body. I carried this image with me throughout my project and thought about it often when I encountered datafication practices that reduce bodies to their reproductive potential, instead of seeing them holistically.

I share this in this part of this kappa, as this chapter discusses work that is concerned with aspects of reproductive bodies, reproductive technologies and (reproductive) data. Some of this work critically points out how cultural narratives around and the biomedicalization of bodies, as well as increased datafication of reproduction have contributed to the ways that particularly female bodies have been "systematically defined by and reduced to reproductive functionality as a lynchpin of gendered, racialized and ableist biological essentialism" (Browne 2022, 57).

In this chapter I outline how this dissertation draws upon work done under, and at the intersection of, the disciplinary umbrellas of feminist theory to

account for theoretical and historical conceptions of reproduction and reproductive bodies, HCI/STS work as empirical and critical examples of engagements with reproductive technologies, and critical data studies to conceptualize bodily relations to data.[16]

I include and review a wide range of work that offers accounts of the ways reproductive technologies, data and cultural understandings of reproduction (re)configure relations to temporalities and bodies to put this project in conversation with work that brings forth feminist approaches to understand technologies, bodies, and data, as well as their intra-actions.

REPRODUCTIVE BODIES

While the previous chapter discusses theoretical accounts of *reproductive technobodies* as posthuman figurations, this section draws upon feminist theory to engage with empirical accounts of the ways reproduction and reproductive bodies become gendered through cultural and scientific narratives, including which bodies are understood to be reproductive.

Feminist theory has long been concerned with different aspects of reproduction. Starting from a Marxist notion of reproduction as "the process by which life and labor power continued themselves in time, both in terms of eating and sustaining the life of an individual body and in terms of aggregate life, the life of workers across generations" (Murphy 2017, 33), feminist theory highlighted the value of reproductive labor, and criticized how capitalism both devalues as well as relies on it (Federici 2021; Murphy 2017). Here, they point to

[16] Not all authors might identify their work within the categories I have summarized them under. The following presents my reading of this research space. Furthermore, the included disciplines are not neatly bounded. For example, a large part of work done within feminist STS draws on feminist theory to theorize how bodies become technologically entangled. HCI work builds on theoretical concepts from feminist theory and STS to ground their design explorations and critiques. These fields are already interdisciplinary.

direct links between production (as in economic aggregation) and reproduction (as in sustaining lives).

As part of this, feminist theory has also been concerned with reproduction, as in human procreation. Especially through the rise of various reproductive technologies (explored in more detail in the next section) and the biomedicalization of reproductive bodies, scholars in this field argue how the female body has been further essentialized as the reproductive one (Rapp 2011; Thompson 2005), making it 'available' for medical intervention and regulation:

> "The very fact that women are able in general to menstruate, to develop another body unseen within their own, to give birth, and to lactate is enough to suggest a potentially dangerous volatility that marks the female body as out of control, beyond, and set against, the force of reason. In contrast to the apparent ordered self-containment of the male body, which may then be safely taken for granted and put out of mind, the female body demands attention and invites regulation." (Shildrick and Price 1999, 3)

They point to the ways reproduction is socially and culturally entangled, and critique how bodies become regulated, normalized and disciplined as biomedical science produces 'normal bodies' and pathologizes others (Braidotti 2022). For instance, Franklin argues in her work on IVF how the "'biological facts of sexual reproduction' have served as a kind of ground zero for normative ideas about gender, sexuality, kinship, fertility, and the family" (Franklin 2023, 404). Martin's work (2001) further examines how scientific 'discoveries' within biomedicine have underlying cultural assumptions that stabilize through the metaphors used. For example, when reproduction becomes narrated as forms of production (similar to industrial processes), menstruation and menopause can only be understood as failed production. She further points to the gendered language used to describe reproductive processes in which the sperm is active, racing to fertilize the egg, while the egg passively waits for the sperm to arrive (ibid). Thus, Martin, and others (see Shildrick 2015; Ginsburg and Rapp 2023) question the 'natural facts' established by science, inquiring into the "naturecultures of gendered bodies and human reproduction" (Lie 2022, 111),

and point to the ways the narratives of biomedicine "actively and continuously construct the body" (Shildrick and Price 1999, 8). Other work has discusses how reproduction is neither 'one thing', nor a capacity that is "self-evidently [...] located in sexed bodies" (Murphy 2012, 181). Through technologies, shifting understandings and practices, reproduction has become multiple rendered and assembled (ibid).

This reconceptualization of reproduction has also opened pathways for queer reproduction, both within legal frameworks and through the availability of reproductive technologies. Scholars within queer and crip theory investigate how this development can be understood as both an opportunity for queer bodies to combat social infertility, as well as an oppression of queer bodies when legislations or norms exclude their access (Dahl 2020; Leibetseder and Griffin 2018). Social infertility in this case captures the ways people are rendered infertile through the social context of which they are part. For example, Mamo's (2007) research discusses how particularly lesbian bodies might be capable to conceive a pregnancy, but that the lack of sperm, and the ways sperm donation (or egg donation between partners) and usage are legally governed can render them socially infertile. The interdisciplinary research in this space brings forth how changes in legislation and availability of reproductive technologies on the one hand challenges normative ideas of family and kinship, and on the other hand iterates the biological family as social norm (Dahl 2020; Mamo 2007). And while the rise of ART and their availability embraced some bodies as reproductive, other scholars point out how they simultaneously create new normativities that exclude others. They discuss for instance, how queer reproduction becomes raced (Andreassen 2018; Dahl 2018; Tao 2022), or how selective reproduction follows ableist assumptions of futures and lives well lived (Kafer 2013; 2019; Ginsburg and Rapp 2023).

I draw upon this work to account for the ways that reproductive bodies, and reproduction, are fluid and multiple, as well as embedded in cultural and social norms. This is particularly relevant in Paper 1 where I scrutinize how such cultural norms become embedded in technologies, thus amplifying cultural

normativities and figurations of reproductive bodies. In Paper 3, where I further discuss how access to reproductive technologies, and the narratives around them shape which bodies are understood to be 'reproductive'. This work also helps to understand how the bodies are imagined and narrated, for example, as unruly, which allows for technologies to be imagined as technofixes to control such unruliness, as I discuss in the next section.

REPRODUCTIVE TECHNOLOGIES

This section discusses work within the fields of HCI and STS that examines a broad variety of reproductive technologies, such as IVF, oocyte freezing or tools for self-tracking and exploration. By investigating various, yet entangled, sites of datafication (intimate, shared, medicalized), this project shows how fertility is being un/made at different sites. Building on the work presented in this section delineates the ways the investigated technologies and practices are shaped by a wider ecology of reproductive technologies.

Within HCI, work on reproductive technologies is rather recent and generally conducted under the umbrella of feminist HCI within the 'subumbrella' of women's health (Almeida, Comber, and Balaam 2016). While the term *women's* health was helpful in establishing a previously tabooed research field within a male-dominated environment (Keyes et al. 2020; Almeida et al. 2020), it has lately been criticized to further essentialize female bodies as reproductive (Keyes et al. 2020) and center westernized health perceptions (Kumar et al. 2020).[17] While I build upon work done within the field

[17] This is not a new critique but one that seems recurrent in various disciplines and movements. For example, the women's health movement in the 70's was critiqued for its too narrow understanding of "women's health in terms of *reproductive* health – focusing on reproduction not only reified women as simply child bearers; it also so often failed to connect health to racism or larger political economic matters" (Murphy 2012, 8).

of women's health, I understand my work to be concerned with 'reproductive health' (Reime et al. 2022).

Through design explorations and provocations, HCI work in this field covers a variety of topics with the aim to "improve and care for women's experiences during various life transitions, promoting health equity, and in turn politically emancipate women" (Ng, Bardzell, and Bardzell 2020, 4). This includes, for instance, work on menopause (Bardzell et al. 2019; Ciolfi Felice, Søndergaard, and Balaam 2021; Homewood 2019; Lazar et al. 2019), breastfeeding (Balaam et al. 2015; Helms 2021; Yadav et al. 2019; Yadav, Balaam, and Lampinen 2023), pregnancy (Gamboa 2023; Vallgårda et al. 2022), -loss (Andalibi 2021; Andalibi and Forte 2018), abortion care (Lusi, Vallgårda, et al. 2024; Petterson 2024), postnatal bodies (Almeida et al. 2016), as well as different aspects of menstruation and fertility (Campo Woytuk et al. 2020; Park et al. 2023; Park, Hsueh, and Woytuk 2024; Søndergaard and Campo Woytuk 2023). I build on this work to offer insights into people's experiences of their reproductive bodies through mundane technologies. The technologies discussed here are either commercially available, or design explorations, where researchers engage (speculative) design objects to generate knowledge about people's experiences. The latter part makes this work particularly interesting, as it expands how we can imagine technologies and interactions differently.

For instance, they explore forms of touching and sensing as a way of intimate knowledge making and embodied experiences. This includes sensors for measuring and sensing vaginal fluids (Campo Woytuk et al. 2023), "curious cycle kits" to look at and feel menstrual blood (Campo Woytuk et al. 2020), or augmented systems to support pelvic fitness while prompting for intimate bodily knowledge (Almeida et al. 2016). Through design fiction and speculation, work here critically engages with contemporary practices of menstrual and fertility tracking to bring forth social and political issues. For instance, projects such as PeriodShare (Søndergaard and Hansen 2016) or Vivewell (Fox et al. 2019) inquire into present practices of menstruation to question possibilities and desires for the future.

Work in this space also critically engages with already existing technologies to account for the ways design takes part in augmenting and essentializing lived experiences and to give design implications for future design. For example, the work of Andalibi (2021) demonstrates how experiences of miscarriage can be annihilated through the design of pregnancy tracking apps, as most apps do not allow to note a miscarriage based on their underlying progressive logic in which a pregnancy always ends with a child. I contribute to this type of work by offering reflections for methodological considerations and tools for understanding such affordances (see Paper 1). Park et al.'s (2023) work exemplifies how relations towards and ways of using MFTAs are complex and constantly shifting. Similarly to our argument in Paper 1, the authors argue to design with ambivalence rather than against it. The work of Tuli et al. (2020; 2018), Kumar et al. (2020) and Ibrahim et al. (2024) criticize how MFTAs embed and normalize western understandings of reproduction, menstruation, and gender. For instance, Tuli et al.'s (2020) work argues how gendered and cultural practices of technology use are not taken into consideration when designing apps for women. The work of Ibrahim et al. (2024) brings forward how religious practices impact understandings and practices of menstruating, as well as cycle tracking. This work is relevant for this research, as it scrutinizes how design (as in functions, visuals, imagined users) afford engagements that often misalign with people's lived experiences as relations to reproductive health are complex and shifting within different temporal horizons.

Work within STS is also concerned with the ways technologies augment reproductive experiences, for example they point out how reproductive technologies indeed (re)make reproductive temporalities, though differently as often narrated in public discourses. Rather than being progressively future-oriented through the ability to prolong fertile time into the future, these scholars give accounts of how different temporalities become non-linearly entangled. For example, in her research on egg freezing Waldby (2015) shows how narratives of 'aging eggs' and biological clocks create misalignments between lived rhythms and experiencing bodies as 'youthful'. Van de Wiel's

(2018) work offers accounts on how egg freezing produces prenatal images that mediate reproductive time as entangled temporal relations. Van de Wiel (2022) further argues how contemporary practices of IVF disjunct from their initial imaginaries, moving such practices from *reactive* treatment of infertility to *proactive* fertility management, where viable gametes are being preserved for a potentially less viable future. This work is particularly relevant for Papers 2 and 3, where I discuss how temporalities become re-configured through reproductive technologies, as they foster proactive engagement with the potential of infertility.

Since the late 1980s, early scholars such as Strathern (1992), Haraway (1991) and Franklin (2022) have scrutinized the ways reproduction becomes technologically entangled, and the consequences for conceptions of gender, kinship, and state. Building on this work, scholars in (feminist) STS have critically followed the rise and extension of reproductive technologies and investigate, for instance, how these technoscientific entanglements manipulate and reconfigure fertility (and bodies) through temporal pauses and/or extensions (see Franklin 2022; Lemke 2021; Thompson 2005; Wiel 2018). I include these works here, because they are concerned with the meanings of such practices in terms of biology, technology, and formations of gender, as well as kinship. Scholars in this field are expanding what 'reproductive technologies' are and can be. They are moving this categorization beyond medical and digital technologies, by including technologies of kinship, sex, and gender (Franklin 2022; 1997), as well as ethical/government reports (Rapp 2011) or norms (Dahl 2018), as they too govern life and death by "mak[ing] specific worlds possible" (Lindén and Ljungberg 2018, 35). Research in this field includes accounts of reproductive technologies such as IVF (Franklin 2022; Wu 2023; Thompson 2005), embryo research (Franklin 2006), gamete freezing (Van De Wiel 2020; Lemke 2021; Adrian and Kroløkke, 2024), and sonographic imaging (Franklin 2013; Wiel 2018; Gammeltoft 2013) to discuss practices of selective reproduction (Wahlberg and Gammeltoft 2017), economization of reproduction (Kroløkke 2018; Murphy 2017), feminist self-help (Murphy 2012), and family

formation (Thompson 2005; Mamo 2007; Dahl 2020). Here, inquiring into reproductive technologies and their practices is a means to inquire into the formation of societies (Franklin 2022; Kroløkke 2018; Wu 2023).

These accounts analyze how contemporary biomedical and technological progress have impacted how we understand and practice reproduction. Through technological entanglements, reproduction has become distributed into different fields that can be/are technologically mediated, such as "insemination, fertilization, implantation, gestation, termination and (preterm) birth" (Wahlberg and Gammeltoft 2018, 1). These different processes seemingly do not only allow for selective reproduction at different stages, such as the choice of gametes, or implantation of embryos, and abortion of fetuses (ibid) but also for different technologies to be part of reproductive processes and the reconfiguration of reproductive bodies. These technologies in turn are entangled in broader socio-cultural ideas of family, kinship, and nation state. For instance, Thompson (2005) shows how ART shape notions of family and parenthood, as such technologies are 'making parents' by putting biological, technological and bureaucratic elements into synchronization with each other. Further, Wu (2023) explores how the progress of reproductive technologies is intrinsically tied with ideas of national progress and exceptionalism. Such ideas in turn have very concrete implications for people's reproductive lives and labor. Wu focuses on the example of Taiwan, where multiple embryo transplants are allowed. Such a decision, Wu argues, is motivated by ideas of being 'the best nation of ART' (ibid). However, it leaves individuals with the burden of navigating a potential pregnancy with quadruplets or more (ibid). Furthermore, Franklin's (2013) work shows how the sociocultural practices around IVF have moved the technology from a novel practice to a normalized one. That is, through social narratives and practices, it has become normalized for children to be conceived through IVF and for people to seek IVF treatment to support their reproductive processes, rather than an exemption (Franklin 2023). These works give insights into the ways national imaginaries of kinship, family and the nation state shape the availability of reproductive technologies.

This is relevant for this dissertation, as these narratives partake and shape fertility sensemaking. I discuss this in Paper 3, where I show how people preemptively navigate IVF treatment as a future path due to their anticipation of infertility. This anticipation, I argue is due to the ways fertility becomes understood as controllable and governable, moving people into spaces where they 'have to try it all' (Franklin 1997) and where the usage of technologies (e.g., FAC or MFTAs) is not (always) an individual choice but becomes narrated as one's social responsibility (Carroll and Kroløkke 2018).

Common within these works across disciplines is that they navigate the friction between emancipatory potential and oppressive structures of reproductive technologies. For instance, MFTAs are at once liberating, as they allow for generating knowledge around reproductive bodies, menstrual cycles and menstrual pain, thus filling a research gap, but at the same time their embedded normativities (in regard to users, menstrual cycles, temporalities) leave some people out of this knowledge creation. I address this friction in Paper 1where I argue to take seriously people's needs for objectivities, but to do so without subscribing bodily experiences under harmful normativities. In Paper 2, I show how different temporalities become entangled in the sensemaking of fertility, including the past in which female bodies have been understudied and neglected in medical research. My work thus contributes to this research space by offering accounts of how mundane, everyday technologies also shape temporalities and experiences of reproduction and thus, take part in the socio-material un/making of fertility. That is, fertility and fertile bodies are being (re)configured through technologies and cultural narratives of reproduction. MFTAs, as well as FAC, play an increasing role, in that they reproduce such narratives (see Paper 3) and make reproductive bodies 'known' (Hamper 2020) through visualizing, reminding, and predicting when and how long a body is fertile.

(REPRODUCTIVE) DATA

The third anchoring is in research within critical data studies. I draw from this strand of work to broaden understandings of what data is, how it is being governed and how people are living with and around data. I put the 'reproductive' in parentheses for this section, as the focus is on data practices more generally. However, I use this work to understand practices around reproductive data.

Work within critical data studies is mainly concerned with the impacts that technological developments and datafication practices, such as algorithmic predictions, AI, and big data, might have on people's lives (see D'Ignazio and Klein 2020; Douglas-Jones 2021a; Ruckenstein 2023). Work in this field provides accounts of the ways data can be (mis)used to further marginalize certain groups, reproduce power relations, and invisibilize labor (D'Ignazio and Klein 2020; Harrison 2024; Lupton 2020; 2015a). Notions such as *dataveillance* (Dijck 2014), *data colonialism* (Couldry and Mejias 2019), and *data harm* (Redden 2022) are used to highlight and critique the potential extractive and harmful nature of certain data practices, particularly when they include the third-party use of personal data.

D'Ignazio and Klein's (2020) work on *data feminism* aims to go beyond critiquing current data practices by proposing alternatives that are grounded in feminist thought. Here they offer understandings of data (as located in experiences) and data practices that reflect on the sourcing and locating of data (i.e., where they come from, for what are they are being analyzed, who is involved in data labor). Instead of asking what we can know through data, they are highlighting what we cannot know by pointing to missing data, such as, when data sets about birth complication leave out experiences of women of color in poor neighborhoods (ibid). More recent work on queer data studies points out how completing missing data sets is not always a solution, as sourcing and analyzing data can further marginalize (queer) people (Guyan 2022; Keilty 2023). They point to the friction of wanting to be counted on the one hand, and the struggle to subsume under fixed categories that make counting

possible on the other hand (Guyan 2022). This work is relevant for this research as it points to extended understandings of data (more than numbers) but also to the ways that collecting data is not innocent and does not always lead to more just practices. As I discuss in the previous section, datafication practices around fertility are often legitimized by a need to create more data about understudied phenomenon and bodies. MFTAs, for instance, often justify the sharing of user's intimate data as a means to contribute to research (see also Paper 2).

To account for the ways people affectively respond and relate to data I include work that I summarize here as work on bodily relations to data. For example, Lupton's research on the quantified-self movement and numerous self-tracking practices, ranging from sports, diets, or menstruation gives insights into the ways people make sense of a variety of data produced about and through the body. Lupton terms the notion of *lively data* to account for human-data-assemblages, arguing that neither humans nor data are objective and isolated, and that data is always already part of the human body (Lupton 2020). Data is also lively in the sense that they can develop a life of their own, that is, *data double*s might travel beyond the body's knowledge and consent, changing shape and content as they do (Douglas-Jones 2021a). Forlano's work (2017) further shares autoethnographic accounts on living with data around diabetes offering insights into the "everyday rituals that emerge when living with real-time data around sociocultural norms" (ibid, 5), particularly normativities around temporalities. I build on these works as they bring forth lived experiences of data practices, including the labor it takes to interpret and affectively relate to such data.

Besides a focus on asymmetrical power relations, marginalization and everyday practices, critical researchers also investigate aspects of privacy and security, particularly pertaining to intimate (health) technologies. This work ranges from technical investigations, such as insights on what is being shared about users, what the GDPR statement includes, how access to one's data is provided/restricted (Mehrnezhad and Almeida 2021; Almeida et al. 2022), to the

felt experiences of such data leaks and the creepiness of data (Lupton 2020). Work on the latter part argues that it is not always relevant what precise datapoints are being shared without the user's consent, but what people *think* is being shared about them. Ruckenstein (2023) calls this *algorithmic folklore*, that is not so much how algorithms actually work but the stories we tell about them. As other work also points out: data does not need to be 'correct' to have an effect in the world (Douglas-Jones, Walford, and Seaver 2021). As I write in the introduction: privacy and security issues of MFTAs in particular have gained a broader public attention through the overturn of Roe v. Wade in 2022 exacerbating instances in which data could be used against data subjects (McDonald and Andalibi 2023).

I build on this research as they challenge conceptions of data as objective, stable objects. Rather they point out how data is subjectively experienced, analyzed and collected, making datasets highly contextual.

4

RESEARCHING FERTILITY SENSEMAKING ASSEMBLAGES

Methods & Methodology

To explore how fertility sensemaking takes shape within a configuration of bodies, technologies and data, I draw on both feminist, as well as assemblage ethnographic methodologies to not only understand individual experiences but also how they come to be through their relations. In this chapter, I first consider what this grounding means for the shape of this research project, before sketching out and reflecting on the methods that were used to generate empirical data.

METHODOLOGIES

As I point out throughout this dissertation, this project is primarily a feminist analytical one, rather than a project subscribed to one distinct discipline that comes with its own sets of methods and theories. This grounding in feminist methodology means, for example, that I choose to omit work that is often taken as analytical and theoretical framework within research on reproductive technologies (e.g., Foucault's biopolitics). Instead, I put "the intellectual labour,

ingenuity and creativity of women and gender nonconforming people front and centre" (Browne 2022, 24). That does not mean that I categorically excluded work written by men, but rather I prioritized work with a feminist and intersectional grounding that brings forth nuanced understandings of bodies, temporalities, and reproduction, and accounts for asymmetries of knowledge and power, as well as relationalities. I have thus grounded this research in theoretical frameworks of posthumanism and queer temporalities (see Chapter 2), and engage with work that highlights embodied experiences of such human/non-human networks. For instance, Ahmed's (2006) work on *orientation* to analyze how objects and subjects come to be and take shape through their orientation and affective relations to each other, foregrounding a more nuanced understanding of 'agency' (further discussed in Paper 3).

A grounding in feminist methodology also means undertaking research with several feminist commitments in mind, such as aiming to work non-extractive and acknowledging a plurality of knowledges and experiences. In that, I am also engaging with my own positionality and situated knowledge (Harding 1986; Haraway 1988). Chapter 5 shares my reflexive considerations about the ways I, as a researcher and as someone inhabiting a (reproductive) body, become part of, and shape, this research assemblage (Lupton 2019). It makes visible how my embodied position and research approaches guide my focus and ways of analyzing my material.

Doing feminist research is more than being aware of one's own position in the world, or reflexive about the knowledges that this can produce. Feminist research is political (McRobbie 1982). Besides my own experiences, I also have a set of (political) opinions that affect my research and methods. For example, I

have strong commitments to reproductive justice.[18] This includes equitable access to healthcare, reproductive freedom, and scientific practices that do not discriminate. Rather, they acknowledge that bodies are always already 'irregular and deviating' from normativities. We should be able to generate knowledge about our bodies through data, without our labor and intimate data being exploited for someone else's profit.

These beliefs impact the ways in which I conducted my research in terms of methods and analysis, but they also motivated me to foster networks with critical and feminist scholars across disciplines and to share my research beyond academic publications and contexts.[19] For example, I participated in the *Feminist Futures Hackathon* by inviting participants to speculate on futures that "recenter care and bodies in living with technologies".[20] Together with Vasiliki Tsaknaki, I contributed to the *CyFer exhibition* to raise awareness on issues of data privacy in FemTech products, particularly MFTAs.[21] I organized local meet-ups for people to exchange experiences with and knowledge around fertility (more on that in the Failed Access section of this Chapter). I also co-

[18] Originated in Black feminist movements, reproductive justice brings together notions of reproductive rights and social justice to go beyond discussions of abortion rights but to include "(1) the right not to have a child; (2) the right to have a child; and (3) the right to parent children in safe and healthy environments" (Ross and Solinger 2017, 9).

[19] see Reime et al. 2022; Campo Woytuk et al. 2023; Lusi et al. 2024

[20] Quoted from: https://feministfuturescph.org/pages/tracks/trackbodies.html
The hackathon was organized through a collaboration of various people within and beyond the IT University but initiated by Henriette Fries, who also took over most of the labor of making this happen (https://feministfuturescph.org/).

[21] The exhibition was organized by Maryam Mehrnezhad, Teresa Almeida, Ehsan Toreini and Joe Burne as part of the CyFer research project (https://sites.google.com/view/maryammjd/cyfer-project).
The collection was exhibited at the Royal Holloway library in London, UK, from 19th June – 10th September 2023 (https://www.royalholloway.ac.uk/about-us/the-library/the-exhibition-space-at-the-emily-wilding-davison-building/cyfer/)

facilitated a workshop at the NordiCHI 2022[22] conference exploring ways to speculate on reproductive technologies using feminist values (Reime et al. 2022). As an outcome of this workshop, we published a zine, as an accessible and non-academic publication, to share speculations and provocations for the re-design of reproductive technologies using feminist values (Campo Woytuk et al. 2024).

Feminist research often relies on method(ologies) such as ethnography (Abu-Lughod 1990), that bring forth lived experiences grounded in social and cultural contexts. However, previous work has already pointed out how 'conventional' ethnographic methods such as interviews and participant observation are suitable to gain in-depth understandings of respective practices tied to specific communities but less suited to account for developments over time as well as the flows of relations and objects that sustain knowledge practices (Kroløkke 2018). I have thus followed ideas of *assemblage ethnography* which "involve[s] a shift away from the study of 'societies' or 'people' as such, and towards the study of infrastructures, assemblages, complexes" (Wahlberg 2022, 127).

Assemblage ethnography is not a defined set of methods but a methodological approach that seeks to investigate "the complex ways in which the lived experiences of individuals, groups, and communities come to be profoundly shaped by the socio-historical processes of which they are unavoidably a part, with the aim of demonstrating the contingency of these processes" (Wahlberg 2022, 139). By moving across scales, sites, and practices, assemblage ethnography offers a methodological adaptation, as the practices we aim to research become increasingly technologically afforded and are emergent (ibid).

[22] The workshop was co-organized together with Nadia Campo Woytuk, Joo Young Park, Marie Louise Juul Søndergaard, Deepika Yadav, Vasiliki Tsaknaki and Sarah Homewood.

Forms of assemblage ethnography have been relevant in previous studies of reproductive technologies (though not named as such), with early scholars such as Franklin (2022), Martin (2001), and Thomspon (2005) moving away from conventional ethnography by including aspects of 'multi-sitedness' in their works (Wahlberg 2022). This allowed these scholars to investigate how reproductive technologies and in/fertility are being constructed through the configuration of political debates, media representations, clinical practices, socio/cultural contexts, globalization, and histories. To map how bodies and conceptions of health and in/fertility emerge, these scholars move back and forth between sites and practices made up by professionals (scientists, doctors), documents (legal, news, advertisement), and 'laypersons' (Martin 2001, see also Wahlberg 2022).

The extension of sites within assemblage ethnography (towards webpages, media debates, advertisement material, legal documents) also requires an extension of methods to inquire into these dispersed sites beyond interviews and participant observations (Ghoddousi and Page 2020). While I discuss the respective sites in Chapter 1, this chapter describes the methods I use to make the different parts of these sites tangible. These include semi-structured interviews (DeVault and Gross 2012), digital ethnography (Pink et al. 2016), autoethnography (Dauphinee 2010; Pathak 2010), materialization and making (Jungnickel 2018; Pérez-Bustos, Sánchez-Aldana, and Chocontá-Piraquive 2019), speculation (Auger 2013; Jungnickel 2022), and the walkthrough method (Light et al. 2018). These methods have shaped the project and its data to different degrees. Some have helped in collecting data (interviews, walkthrough, autoethnography, digital ethnography), while others functioned more as a 'thinking through' device (speculation, materialization). Overall, they allowed me to collect a diverse set of empirical material ranging from texts on legal regulations, governmental and media debates, interviews, fertility campaigns, targeted advertisement as well as ethnographic accounts of online communities, design affordances, and everyday engagements. While interviews and digital ethnography were useful to zoom into particular peoples'

experiences, the extended material, including documents, screenshots of app interfaces, legal regulations and websites where useful to zoom out to the cultural contexts in which these practices take place and come to be (Kroløkke 2018).

In the following subsections, I clarify my choice of methods, limitations, and considerations. The different methods are presented in a chronological order to show my process and how methods intersect and lead to each other in this project. In this chapter, I only provide details of the methods that I used to generate data, while reflections on the methods used for 'thinking through' can be found in Chapter 6.

WALKTHROUGH METHOD

I first employed the walkthrough method (Light et al. 2018) as an entry into the research space of MFTAs to gain an overview of the available technologies, but also because it allowed me to start my research during the Covid19 lockdown in January 2022.[23]

Following Light et al (2018), the walkthrough method can be employed to "make explicit the otherwise implicit and (by design) apparently seamless process of engaging with a digital media object" (ibid, 885). Material collected through this method consisted mainly of screenshots and reflections on the ways the MFTAs guided me through interactions and interfaces. An analysis of this data, coupled with autoethnographic reflections, resulted in Paper 1, where we show how underlying app infrastructures reproduce or resist cultural

[23] After experiencing the unpredictability of Covid19 lockdowns for the two years prior my PhD project, witnessing my fellow PhD colleagues replan and refocus their research over and over again, as well as participating in a Covid19 research project (Hverdagens Digitalisering), I wanted to set my project up in a way that would make it resilient towards future lockdowns. And as a first step, that meant not relying on 'other bodies' being in the same room.

normativities around gender, sexuality, temporalities and ability. Through employing a feminist analytical lens, we surfaced how elements such as functions and design embed ideas of the app's expected use and users, as well as the expected context of use.

Data from the walkthrough method also features in the other Papers 2 and 3, where I discuss how temporalities are being configured through temporal orientations within MFTAs (Paper 2), or how infertility becomes narrated through framing cycles as being out of sync or irregular (Paper 3).

WALKTHROUGH METHOD IN PRACTICE

Through using the walkthrough method as a tool to perform critical app analysis, as conceptualized by Light et al. (2018), I engaged with the respective apps in three stages: entry (sign-up process, what information is required, what user imagined?); everyday use (how are interactions flowing and what engagements are being afforded?); and exit (what possibilities are given to users to leave, what data can be deleted, and which data remains?). In combination with autoethnographic engagements, I walked through three apps: Clue, Drip and Tilly.

During all three stages, I took extensive notes about the process, as well as on my own reflections and embodied reactions. I took screenshots of different interfaces, illustrating the different features and flows of interactivity. Through this reflexive approach, I "slow[ed] down the mundane actions and interactions that form part of normal app use", thus making them "salient and therefore available for critical analysis" (Light, Burgess, and Duguay 2018, 882). Additionally, to 'walking through' the apps, I also investigated the surrounding material, such as websites, app store information and reviews, promotional material, or GitLab spaces, in order to contextualize the sociocultural infrastructures in which they are embedded.

During the everyday use phase of the walkthrough, I used first-person reflection notes to document my experiences with the respective apps. While

the initial walkthrough method suggests a 'mimicking' of everyday use, I found it to be meaningful to engage with these apps over a longer time, as the affordances of notifications and temporalities of tracking would not be visible in a short 'mimicking' engagement (see Autoethnography).

I find that conducting the walkthrough method, however, is non-innocent. Expected use or normativities can stay hidden from researchers who are not the expected users (see Paper 1). Engaging in actual self-tracking, rather than mimicking, helped me to make this visible. Additionally, most MFTAs need to be used over the duration of at least three months to have sufficient historic data in order to provide future predictions. This critique towards the method was later also brought up by one of the authors of the initial paper (Duguay and Gold-Apel 2023), which discusses the future and shortcomings of the proposed method, arguing for taking the researcher's positionality into consideration, as well as being attentive towards the data structures required by an app before 'true' engagement is possible.

With these caveats in mind, the walkthrough method, in combination with the autoethnographic engagements, allowed me to point to moments where norms around reproductive bodies become visible within the respective MFTAs. This could be through the narratives used, visual representation, or expected patterns of use. After scrutinizing these norms, we can see how they come into tension as they are both resisted and reinforced as people make sense of their fertility alongside and with data.

AUTOETHNOGRAPHY

To expand the walkthrough method, and to be reflexive about the ways my own experiences impact my research, I engaged in autoethnographic engagements. I actively used Clue, Tilly, and Drip throughout a period of 6 months, while sporadically using Tilly and Drip throughout the whole project. My autoethnographic engagements also include constant reflections about my own body, calling fertility clinics to get early testing, as well as offering my own body, data, and experiences to online forums and clinical settings.

For example, I shared my own experiences around tracking with other users in online forums. Thus, I did not only offer this perspective to the users present in the conversation but consequently also further research that will potentially scrape such online data (see also Digital Ethnography). I offered my data to the various MFTAs I used, and I also lost data in the process. First, when an update in Clue prevented me from accessing my data without a registered account (see Chapter 5), and then again when I deleted Clue and Tilly as part of the exit phase of the walkthrough. I navigated the decision processes of calling the fertility clinic and participating in research projects. I said yes to most of the research and examination requests I received through my digital post.[24] For example, I conducted a pap smear on myself that I then sent via mail to the laboratory, as well as answered multiple research questionnaires on my 'reproductive behavior' and use of contraception. I was constantly navigating my position as researcher and becoming a reproductive body myself.

My body and understandings of the world move with, and are moved by, the encounters and stories of this project. They moved with me into this ethnographic field, as I oriented myself more towards some spaces over others, and transcend out by disseminating this research. The lines between research and my personal everyday life became blurry. I understand autoethnography as an attempt to make these blurred relations visible.

Within HCI, it is increasingly practiced to design out of one's own experiences and test prototypes on one's own body (see Helms 2021). However, my approach differs from some of these traditions in HCI as I do not test prototypes I have developed myself, nor design something new based on my own lived experiences. Rather, I rely on my own lived experiences to navigate

[24] The digital mailbox that Danish governmental institutions use to communicate with citizen.

this research space and to make visible how my reproductive body in this research project, and becomes materialized through it.

AUTOETHNOGRAPHY IN PRACTICE

The data from my autoethnographic engagements is vast and differently shaped. For example, using three MFTAs myself included being attentive to changes in my body, tracking symptoms daily, and having notifications turned on. Besides doing the tracking, I wrote reflexive notes on the process of tracking and on my experiences with the MFTAs. So, on the one hand I have the data collected about me in the form of tracked biodata. On the other hand, I have more qualitative data in the form of reflections on the process of creating this quantitative biodata archive. I also took reflexive notes in other situations, for instance when I called the fertility clinic to get an appointment for FAC, or when I talked to people online.

DIGITAL ETHNOGRAPHY

To further understand conversations that are happening around reproductive data, I engaged in digital ethnography on various online forums, in which different aspects of fertility, infertility, futures, and data sensemaking are being discussed from different perspectives (for example from queer or infertile, or an intersection of these perspectives). These were mainly different subforums on Reddit, but also in-app forums such as on Tilly, as well as conversations around features and design on the GitLab site of Drip.

Following Pink et al. (2016), digital ethnography is an approach to "do ethnography as the digital unfolds as part of the world that we co-inhabit with the people who participate in our research" (ibid., 1). The digital unfolds as part of fertility sensemaking and is being inhabited by my participants and me. The digital is a space where I am becoming simultaneously researcher, peer, and reproductive body seeking information. Digital ethnography differs from other digital methods, as the online space is being approached as an ethnographic site. I was consequently interested in qualitative approaches in order to

understand the relationality of these spaces, rather than quantitative ones. This means that I did not scrape any data through computational methods, but rather was present in conversations as a participant observer. I followed conversations while they were unfolding in real-time, rather than scraping delocalized and unsituated data that reaches far back. When I was not present, I would simply miss the conversations, similarly, to not being in 'the field'.

I chose this approach to better situate conversations and comments. Since (online) data is always incomplete (Markham and Gammelby 2018), I felt that I would not have gained more insight through more data, but through following distinct conversations as they are unfolding allowed me to understand dynamics and relations. I also engaged in upvoting comments and posts, as well as making my own posts and comments, as a form of reciprocal engagement (Svedmark 2016). In that way I did not only extract data on experiences, thoughts, and feelings, but also offered my own in exchange.

CONSIDERATIONS

I navigated a lot of hesitancy and reservations working with the data obtained through digital ethnography. [25] To a large degree, I felt that working with this data was going against my own (feminist) research commitments to carry out research in non-extractive ways. But I was also oriented towards these spaces through the other sites of fertility sensemaking (the intimate and medicalized). It is in these spaces, for example, where people collectively navigate (mis)conceptions about data and bodies (see also Chapter 1). Following these digital spaces directly (rather than only through my interlocutors) was thus an

[25] A lot of these thoughts have been developed and worked through in collaboration with my colleague Katrine Meldgaard Kjær through a multitude of conversations and (unfinished) writing projects.

attempt to understand the ways that "digital activities, technologies, content and uses become part of wider configurations" (Pink et al. 2016, 10).

I have reflected on these considerations and hesitations with colleagues from ETHOS Lab, where we, through a range of workshops, "stayed with the trouble" of digital methods (Perriam et al. 2024). Rather than ignoring the discomfort and moving on, I stayed in these spaces and reflected on the ways this hesitancy guided my movement through them and oriented me towards spaces that I understood to be 'less vulnerable' (see also Chapter 5). Based on my own positionality and my understandings of vulnerability, I "create[d] a particular path through meaning. [...] [my] choices and decisions about what to focus on create, not discover, what [I] eventually examine as data" (Markham and Gammelby 2018, 4).

However, I did not feel that I could generate data from these spaces in the form of screenshots. To mitigate some of my concerns, I chose to collect and share my data through *fabrication sketches*, upon which I elaborate in the next section.

FABRICATION SKETCHES

I am using illustrations and sketches to reframe conversations that I encountered online. These sketches are also fabricated (Markham 2012); they are *fabrication sketches*.[26] This means that they are not depicting one conversation but bring together multiple conversations and rephrase individual comments to illustrate a wider conversation across different posts. They are thus not simple illustrations but "modes of evoking the feelings,

[26] Thanks to Katrine Meldgaard Kjær for discussing fabrication with me and to Barbara Nino Carreras for your inspiring work with comics and drawings (see Carreras and Ross Winthereik 2023). These discussions gave me the inspiration and confidence to work with 'fabrication sketches'.

relationships, materialities, activities and configurations of these things that formed part of the research context" (Pink et al. 2016, 13).

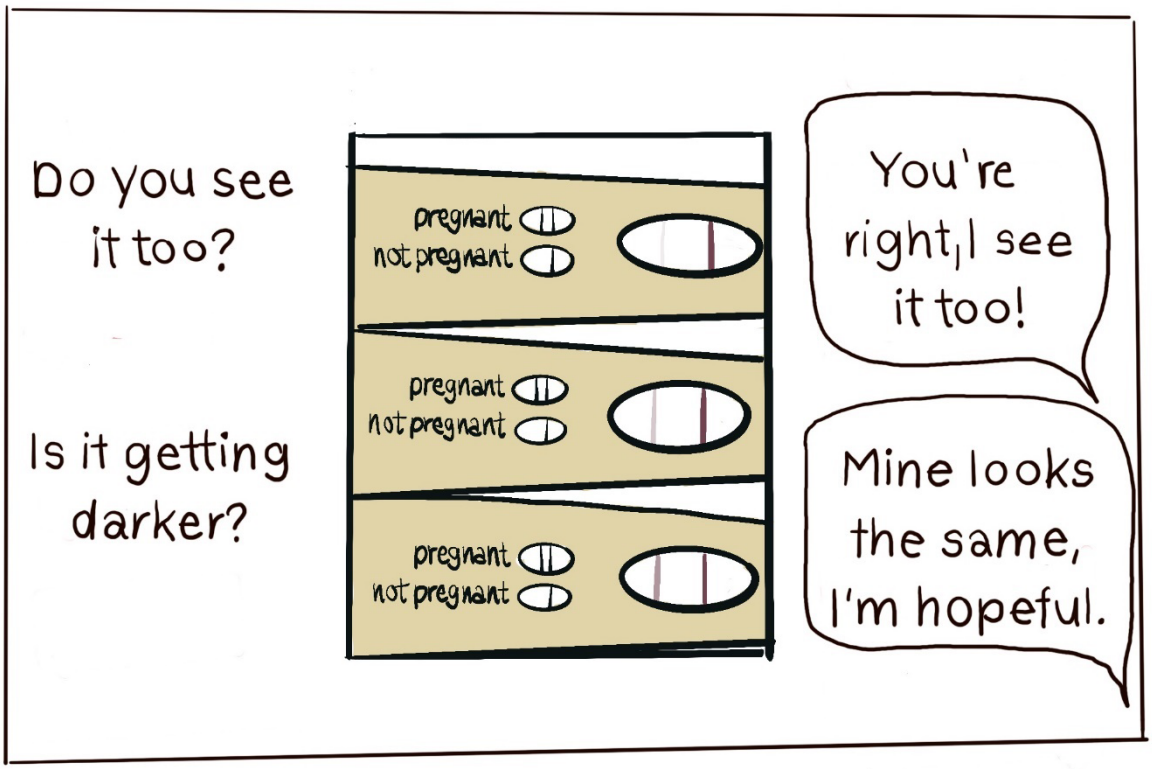

Figure 7: *Sketch of a conversation around pregnancy test results. In the middle are three pregnancy tests showing two lines of which one is increasing visibility indicating a pregnancy. The questions on the left side of the tests ask: "Do you see it too? Is it getting darker?". The answers in speech bubbles on the right say: "You're right, I see it too!" and "Mine looks the same, I'm hopeful".*

Sketching as a knowledge practice is already employed in multiple ways. For example as mnemonic tools for a researcher (as a means of noticing and documenting) (Douglas-Jones 2021b), or in participatory research methods (Gamboa, Ljungblad, and Sturdee 2023; Carreras and Ross Winthereik 2023). Fabrication is also already being used to 'stitch stories' together as a means to ensure anonymity (Markham 2012). Through fabrication sketches, I combine these two practices, as I draw together different conversations. In other words, the conversations I have sketched do not exist verbatim, but rather as differently phrased and distributed comments across the respective online spaces. Let us take the sketch I shared in this section (Figure 7) as an example: I came across an abundance of images showing one or multiple pregnancy tests

and people asking for confirmation of seeing the lines. So, these practices and conversations around it are happening, but not in the precise form I have depicted here. The comments are paraphrased and summarized from multiple conversations.

I use fabrication sketches here as analytical devices (Douglas-Jones 2021b), to make sense of the conversations I followed online, but also to share these conversations in my writing (in this kappa and in Paper 3), as I did not want to include direct quotes from these spaces. In this kappa, and in Papers 2 and 3, I also use sketches of screenshots or advertisement material. I do this in cases where I want to make a point about visuals, but the content is in Danish or in cases where I do not want to reveal my precise cycle data, when it is not relevant for the argument I want to make.

Fabrication sketches are certainly not a universal solution to avoid reproducing vulnerabilities or marginalizations while doing research in social online spaces. But in my specific research setting, I find fabrication sketches to be useful in mitigating some harm that could have occurred through exposing these spaces.

INTERVIEWS

To gain more in-depth understanding of people's experiences of fertility as they are taking shape within specific cultural contexts, I conducted semi-structured and person-centered interviews with three participants (DeVault & Gross 2012). These interviews allowed me to inquire into my informants' understanding of their relations to their own bodies and experiences of fertility, while engaging in datafication practices. They focused on a narrative approach in order to place my informants' practices in relation to the social structures and contexts in which that they are situated (Maynes, Pierce, and Laslett 2008).

Participants were recruited through a call for participation posted in different online spaces (Reddit and Facebook). They could sign up either through writing me an email directly, or by using a sign-up option on my

website. I also posted flyers at different universities and spaces around the city, but no participants were recruited this way.

The call for participation was quite open, not restrictive of gender or experiences. Everyone who in some way was navigating their reproductive health and future was invited to participate. The interlocutors were between 25-37 years old, identifying as women or non-binary, and had different motivations for navigating their reproductive bodies through data. Overall, they engaged in data practices to better understand the (ir)regularity of their cycles.

The interviews lasted around 30-60 minutes, where one was conducted online and two in person. All interviews were recorded and transcribed afterwards. During the interview I asked very open-ended questions such as: where are you in your life right now? What is your relation to reproduction? What do you do to understand your fertility and cycle?

FAILED ACCESS

I include this section here to acknowledge the messiness of qualitative research. While I designed my research to include these methods to a certain degree, it is also the result of 'failed access' to the field and stakeholders.

As I write in the introduction, this project was funded by the IT University through an open call. While this had many advantages, such as allowing me to do 'my project', it also had a few downsides, particularly when it came to access and means of doing research. For instance, there was no pre-established access to the field. I was alone in trying to obtain access. Those cycles of reaching out, waiting, and negotiating took valuable time from the three years of this project. Moreover, I had only limited funds to conduct workshops, and no funds to remunerate participants. As I could not pay for people's time, I was cautious not to take up too much of it, which resulted in a small group of interlocutors.

Another reason for this is also that I simply could not get hold of more people, despite the efforts I described earlier. Additionally, I tried to organize a

local meet-up for people to share experiences, ask questions to me and to each other, and help each other in navigating reproductive futures. This was inspired by the practices I saw online, where people seemed more comfortable talking about considerations around reproductive futures with strangers than with family or friends. I booked space in a local café to keep the atmosphere casual, posted the event online, as well as hung posters around town. People online seemed excited about the idea and appreciated the creation of such a space. However, no one joined.

I also wanted to interview people who have participated in the FAC. However, there is no physical place as such where one can just go and hang out. I spent several months reaching out to multiple clinics to try to get access. Finally, one of the responsible doctors agreed to have a meeting with me. They seemed supportive of my project and were willing to share some information with people coming in for the testing. We even discussed the possibility of me shadowing some examinations. Eventually our conversation faded out. I reached out multiple times but did not receive a reply again. Several months of writing back and forth did not fruition into something, and I did not know how to get access to these people otherwise. I tried to find them by posting on various online forums. Here, I engaged with some people in discussions and chats, but they did not feel like doing an interview.

I also reached out to medical personnel, such as midwives, to inquire into the ways they encounter and produce data, and to the respective companies that are developing the apps I use, to learn about their thoughts and considerations. It was not possible for me to arrange an interview with any of them.

I share this section to make visible how this project was shaped not only by my decisions, but also by practicalities such as access, as well as the timeframe that forced me to move on quickly rather than dwelling too much in one space. As a result, the dissertation builds on a range of data from various sources and engagements.

CREATIVE ANALYTICAL STRATEGIES

Non-prescriptive processes or rigid protocols only bring us so far when encountering our empirical material. If approached too narrowly (i.e., too strategic) we might miss important relations within the material, and our ideas of what we will find may already be too predetermined. If approached too loosely (i.e., too creative) we might 'drown' in the possibilities of our empirical material (Ballestero and Winthereik 2021). Consequently, analysis is at once a "creative and organized process of generating insights" (ibid., 3). This section accounts for both my creative and strategic approaches to analysis.

Given the grounding in both feminist and assemblage ethnographic methodologies, the analytical strategies of this dissertation are employed to scrutinize the material and discursive practices that un/make fertility and reproductive bodies. In all papers I employed a feminist analytical lens (McRobbie 2009) to structure my empirical data, and surface related and recurring narratives that manifest norms around reproductive bodies, temporalities, and fertility. In practice, this included annotating screenshots of MFTAs (see walkthrough method) to surface what norms (around gender, sexuality, temporality, and ability) are embedded in data technologies. Here, I paid attention to wording, icons, and flow of activity (see also Paper 1). To map how people navigate these, I clustered material from online conversations and interviews around themes of gender, sexuality, temporality, and ability. However, these forms of grouping and thematic structuring on screen were not fully allowing me to see relations across sites. I thus turned to drawing and sketching on paper.

Douglas-Jones proposes drawing as "a mode of being with material in a way that acts as a companion and scaffolds space for thought" (2021, 95). I used drawing to map relations across sites and technologies. For example, I first encountered tracking options for sexual activity in the researched MFTAs, I met these options again in online forums where people discussed how such a conception of sexual activity (as a means to procreate) misaligns with their own

experiences, and then again in information material around fertility by the public healthcare service (when the marker for infertility is measured as one year of sexual activity without pregnancy).

I further used drawing as an analytical strategy through my approach of fabrication sketches. Here, I first collected several comments on a sheet of paper and loosely sketched objects and materials as they are being discussed or shared in pictures. In the next iteration I thematically grouped comments before paraphrasing and combining them. This thematic grouping helps me to synthesize how conversations are centered around recurring objects and experiences, and how people have similar or varying responses to it.

These strategies allowed me to make connections across my empirical material to investigate how fertility becomes re-con-figured through cultural narratives, ad campaigns, information material, technologies, data structures and legislation, as well as how particular (yet fluid) bodies become constructed, contested or naturalized through such materialities.

5

WALKING WITH

Reflections

> "As we craft back and forth our ethnographic collaborations with attention to how they transform us, we take seriously the kind of work that moves with us [...] whether it is visible or not."
>
> — Endaltseva and Jerak-Zuiderent 2021, 46

I participated in a conference about reproductive technologies and the ways they remake life and death. Most contributions were discussing aspects of death. People presented research ranging from children hospice to practices of death around IVF, such as abortions or embryo disposal. Hearing the mainly ethnographic accounts from these fields left me with deep sadness. On my way home, I was wondering how (and if) these researchers were impacted by their research. For example, do relations with one's own children change after spending months in a children's hospice? How does it feel to enter IVF processes oneself after spending most of one's career following the heartfelt and unsuccessful experiences of interlocutors, or after having observed the various processes of animal testing that make 'human' reproductive technologies possible?

I read inspiring examples where researchers, sensitively and intimately, account for the ways their position not only impacted their research, but how

they also became impacted by their research (see Adrian 2020; Arumugam 2023; Endaltseva and Jerak-Zuiderent 2021; Pearce 2020; Rapp 2000; Williams 2015). However, I have also been in many spaces where this was not part of the conversation. Where there was no time to pause and reflect upon how our research is not only shaped by our standpoints (which is often done as part of feminist research practices), but how these standpoints change, become negotiated, and re-negotiated through our research.

In this dissertation I want to make time and space for this type of reflection. Given my research topic and my own positionality, I find that I need to affectively navigate this research process. This section shares four autoethnographic vignettes that discuss further engagements with the respective technologies as well as reflections on doing this type of research while inhabiting a reproductive body. It is titled 'walking with', as I did not only 'walk through' the technologies (via the walkthrough method) but they also walked with me and I with them. This means quite literally as the technologies were in my home and in my pocket when moving around, collecting data from me as a person as I was moving through time and space; they "followed me wherever I went" (Forlano 2017a, 5). But also, in the sense that I walked with them, following their prompts and guidance, which transformed my bodily understandings and oriented me towards different directions (Endaltseva and Jerak-Zuiderent 2021).

The following vignettes share day-to-day engagements and make visible how I moved within this research space, paused, and oriented myself towards, and away, from different technologies and practices. They are not deeply grounded in theory or thoroughly analyzed. Rather, they serve as accounts of the ways that my research is situated in my own experiences of these technologies and how they changed through this research, pointing out that my position is also not a stable one.

DATA LOSS AND UNSTABLE INFRASTRUCTURES

I want to open Clue to track some irregular bleeding. I press on the icon, waiting for it to load, when a log-in screen appears instead of the expected interface for tracking. What is happening? I have previously used Clue without an account, so I do not have a log-in. After Clue has continuously reminded me that I might lose my data when using the app without an account, said threat has become reality, and I cannot enter the tracking space any longer.

Apparently, the data still exists somewhere, and I can get it back once I create an account. But until then, I do not have access to my extensive data on my menstrual bleedings, mucus consistency, mood, bodily sensations, and much more.

In this moment it is hard to distinguish my reaction as a user and a researcher. I am angry that my data is being withheld from me, and that I can only get it back in exchange for more information about me. I also feel vulnerable, as I did not open the app for an ordinary data entry but because something felt wrong in my body and for once was seeking confirmation from the app. I wanted to check the last dates of my period to verify my memory and to confirm that this was in fact an irregular occurrence of bleeding. All this tracking must have been good for something, I thought.

I am reluctant to create an account just to get my data back. I am certain that I do not want to continue using the app. But that means I either have to accept losing all my data, or create an account just for the sake of exporting it. I feel like I am being blackmailed. The ransom for my data is more data about me, and I am not willing to pay that price.

At this point I am more concerned about retrieving the data from a researcher's perspective. What would it mean for my autoethnographic engagement, when my data is gone, and I would not continue using the app? I decided that I do not need the 'actual data' but along the way have generated plenty of data about my engagement with the app in the form of screenshots and reflective notes.

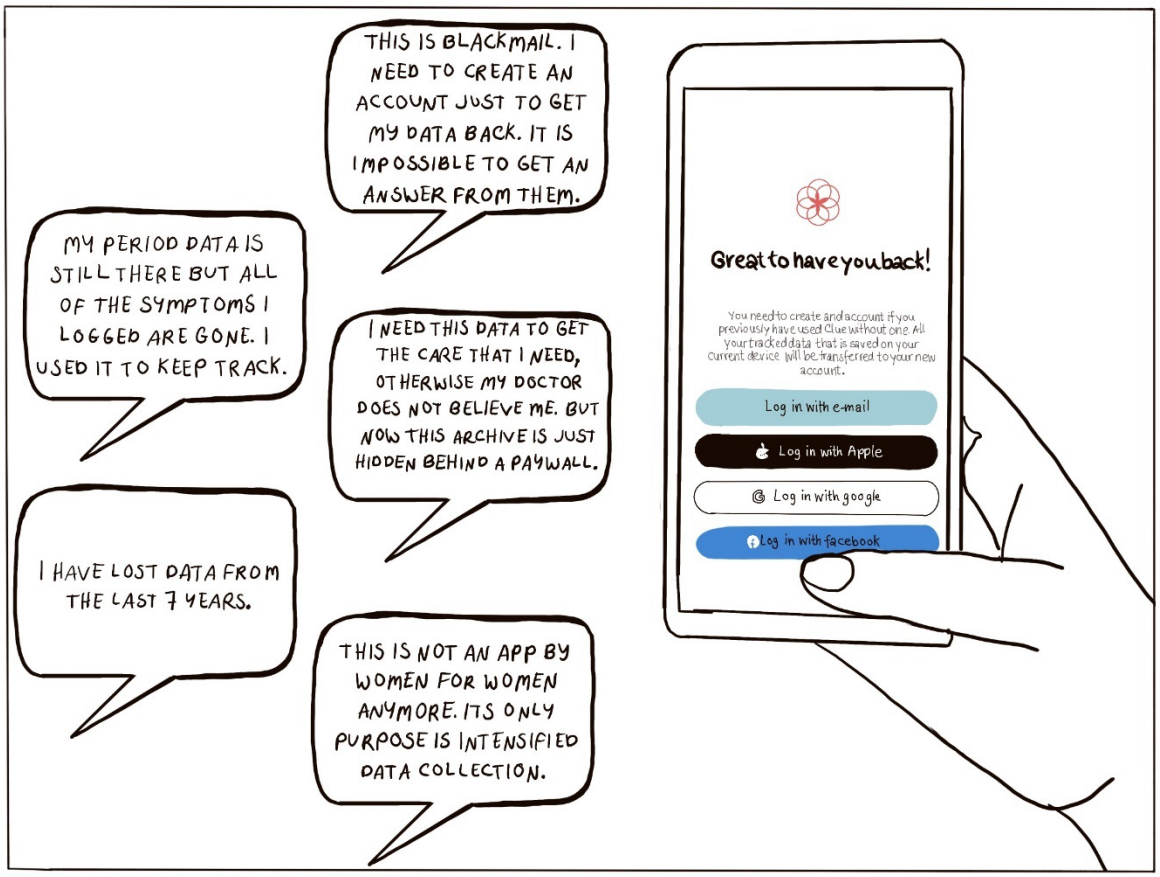

***FIGURE 8**: A sketch capturing online discussions around the update of Clue. On the right edge a hand is holding a phone. The phone shows the starting screen of Clue stating, "Great to have you back" and prompting different means of logging in. On the left side is a collection of paraphrased quotes, sharing experiences of data loss: "I have lost data from the last 7 years", "I need this data to get the care I need, otherwise my doctor does not believe me." "This is not an app by women for women anymore. Its only purpose is intensified data collection" or "This is blackmail. I need to create an account just to get my data back"*

I later found out that my access was revoked due to an extensive app update. This did not only include a visual design update, but also of functions, which resulted in the loss of data for many users. Everyone like me, who did not have an account was required to create a log-in 'for increased security'. But even people with registered accounts lost data, as some of the new functions overrode the ways people have created their own tracking categories or tagged their data (see Figure 8).

Accepting the loss of this data comes from a privileged position, where the data 'does not mean anything' to me and I can easily live without it. However,

the backlash on social media (see Figure 8) shows how some people are dependent on such infrastructures and data archives, while they make sense of illnesses or fertility treatment. Even if I do not care that much, I still feel like I have been robbed of something that belonged to me. I put time and work into creating this bodily archive, and now it is gone. This incident has changed my relation towards the app. I never much trusted the app in terms of data security or predictions, but now the instability of our relation has become visible: my access to my data could be revoked at any time.

The reason I share this vignette here is to point to power asymmetries and vulnerabilities of such relations. This did not just happen to me but also to many other users. It is not only an update that can change our access or practices, as functions may be different or visuals less intuitive, but sometimes, such digital companions also cease to exist, as they themselves are part of vulnerable (funding) structures. For example, as part of my PhD application, I looked at a fertility tracking app that was aimed at supporting patients during IVF treatment by allowing direct data sharing and chats with the fertility clinic. By the time I started this research, the app did not exist anymore. A while later, it came up again but had turned into a platform for managing IVF treatment from an organizational site (for the clinics not for the patients). Another example is Tilly, which I started following when it was quite new and still in the process of finding and defining itself. While I was following it, it changed from a tracking app to one that is specialized on mental health aspects while undergoing infertility treatments. Tilly seemed to have been running out of funding too, as they started a crowd funding campaign. And as I describe in more detail in the next chapter (Feminist counter conducts), Drip is mainly kept alive by volunteers, making it vulnerable and dependent on people's capacity to do such voluntary work. These examples show how the increased value and funding of the FemTech sector is not (only) to "operate outside of professional and profit-driven biomedicine", empowering women and closing research gaps, but also show how they are "strategically and uncomfortably conditioned by the financial flows, discursive patterns, and interstices of more dominant

configurations of biomedicine, family planning, and economic development" (Murphy 2012, 10).

These aspects of data economization also tie in with work done around *data colonialism* (Couldry and Mejias 2019). Couldry and Mejias argue, that the "human body has been reworked into something that requires a distant infrastructure, from which, incidentally, profit can be made" (2019, 2). In the previous Chapters 2 and 3, I show how reproductive bodies have been 'reworked', resulting in an understanding of fertility as something that can be controlled and managed through the datafication of certain bodies. This datafication does not only aim for an increased bodily knowledge to support people in their attempts to conceive, but "potentially every layer and aspect of it, is becoming the target of profitable extraction" (Couldry and Mejias 2019, 2). I understand the presented vignette as an example of how (some) MFTAs participate in such forms of data colonialism, as they take data from the user to not only sell it to third parties but also to sell it back to the user. One part of the data that is being collected is the data that the user inputs, which might be to some degree controllable (e.g., by choosing not to track things). But as I also show in Paper 1, such control might be difficult to exercise in practice, as some apps prompt more data input to give more precise predictions. So, by choosing to track less, one might forfeit a 'better' analysis. Another uncontrollable aspect is the data collected about user activity while using the respective MFTAs (e.g., location, IP address, phone model) (Mehrnezhad and Almeida 2021). In Paper 2, my co-authors and I further discuss how different temporal frames are being kept from the non-paying user, such as limited predictions in the future and restrictions on how much past data can be seen.

This asymmetry to data access is arguably problematic for multiple reasons. Firstly, withholding or deleting data can have harmful consequences for users beyond monetary value, as some of the conversation online showed (see Figure 8). Secondly, users are partaking in unpaid reproductive labor, as they are taking up the work of tracking and datafying their bodies, which becomes a

commodity for the app providers. In most cases, they profit by selling this data to third parties and by selling the data back to the user.[27] The following vignettes continue these conversations by pointing to practices of third-party data sharing and reproductive data labor.

BECOMING FERTILE BEYOND MFTAS

Shortly after starting the autoethnographic engagements of my research, I noticed how my 'data double' changed. This was partly to be expected, as algorithms cannot distinguish whether I google processes of fertility treatment and what kind are offered by the Danish healthcare system, engage in fertility related online forums, search for tracking apps, download and use them because I am a woman interested in childbearing or because I am a researcher working on such topics.

Consequently, targeted advertisement on Facebook and Pinterest, for example, suggest different MFTAs to 'gain control over my body' or to help me to 'conceive naturally', recommend devices such as digital vaginal thermometers and share stories of women that 'suddenly conceived' after years of trying (see Figure 9). On Pinterest some suggested pages discuss breastfeeding, as well as knitting and sewing patterns for baby clothing, bringing together two of my apparent interests (handcrafting and babies). Even Spotify at one point suggested a playlist for 'calm labor and delivery'.

[27] However, since data regulations of the different apps and their national legal contexts vary, not all apps might be able to do this, but a large number does (see Mehrnezhad and Almeida 2021; Almeida et al. 2022).

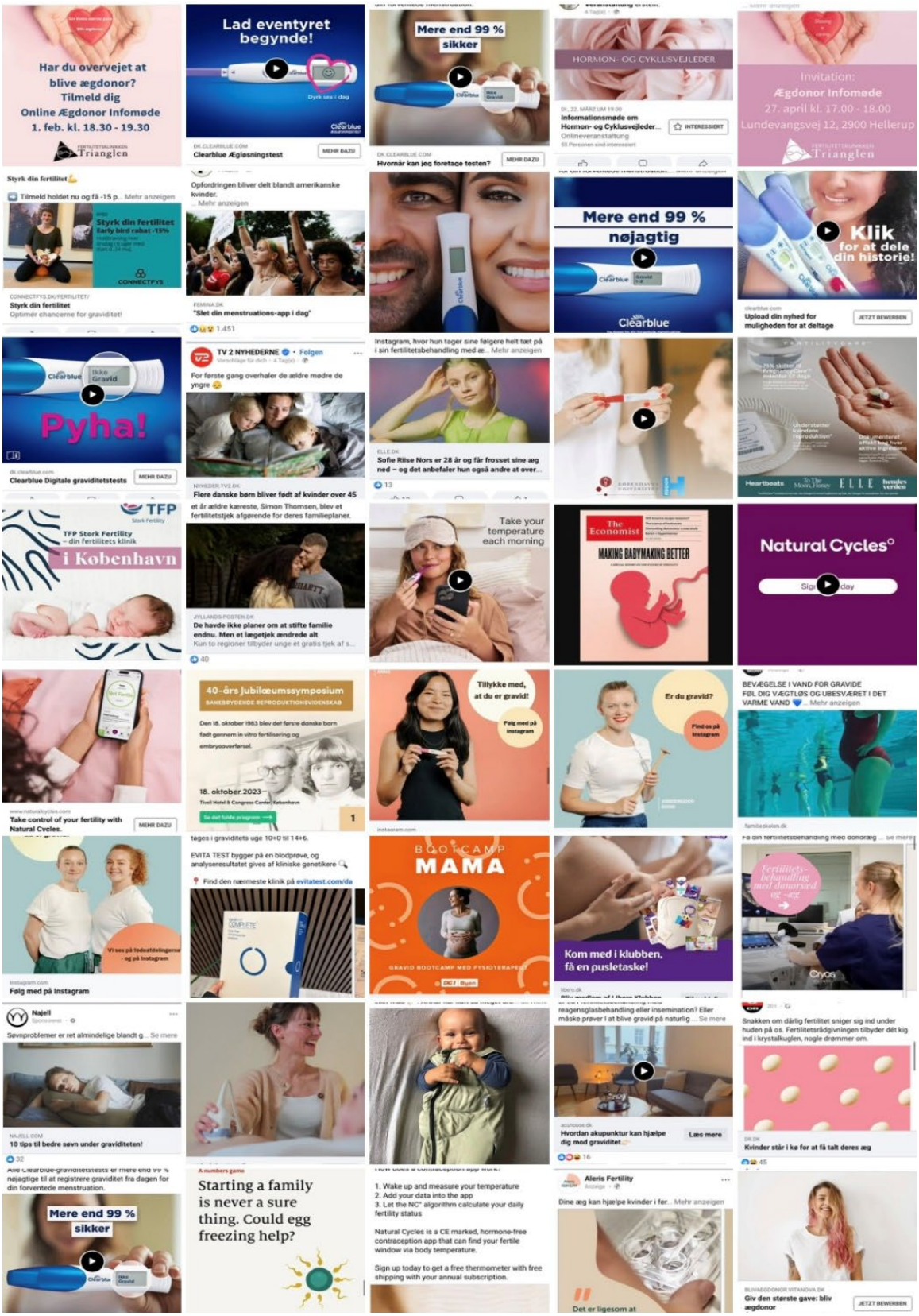

FIGURE 9: *A collage of 40 screenshots containing advertisement for fertility services (such as IVF treatment), information on egg freezing, egg donation and fertility decline, pregnancy tests, healthy pregnant bodies, post-pregnancy workout, ovulation tests.*

As a researcher I appreciated these targeted advertisements, as I could be sure to be informed of the newest trends and products. Initially I could also remain detached from this targeted information as a person, because my research persona was involved, so to say. This dynamic continued for a while, and I became accustomed to this advertising that appeared to overshadow my other interests. I could, for instance, freely browse real estate sites knowing that Facebook will only show me pregnancy related ads. This feeling changed when I started to notice patterns in the advertisements that coincided with my menstrual cycle, such as ads for ovulation tests when I was in my 'fertile window' according to the MFTAs on my phone. One evening I was scrolling through Facebook when an ad for a Clearblue pregnancy test popped up, stating that this test is valid from the first day of expected menstrual bleeding. I took a screenshot, as was my practice during the last months, but looking at the date of the screenshot, I realized that I should be nearing the start of my menstrual bleeding. I opened one of the apps: "Day 29 of your cycle, your menstruation will start tomorrow" (see Figure 10).

So, the day before my menstruation is calculated to start, I get an ad for a pregnancy test that shows reliable results from one day prior expected menstruation. These 'coincidences' became more frequent after this. I knew that I could not keep other systems from knowing that I am interested in such topics, but somehow, I naively believed that my very specific data (in the form of specific moments of my cycle) would not be included in this.

I share this vignette not to point to leaky infrastructures and strengthen points made by critical scholars on data security in such apps (Mehrnezhad and Almeida 2021; Almeida et al. 2022), but to highlight how data travels and requires one to navigate multiple sites. Technologies do not come in isolation, but are part of configurations. I might be using my MFTA, but at the same time, different social media platforms also suggest different apps to me or prompt different practices and awareness.

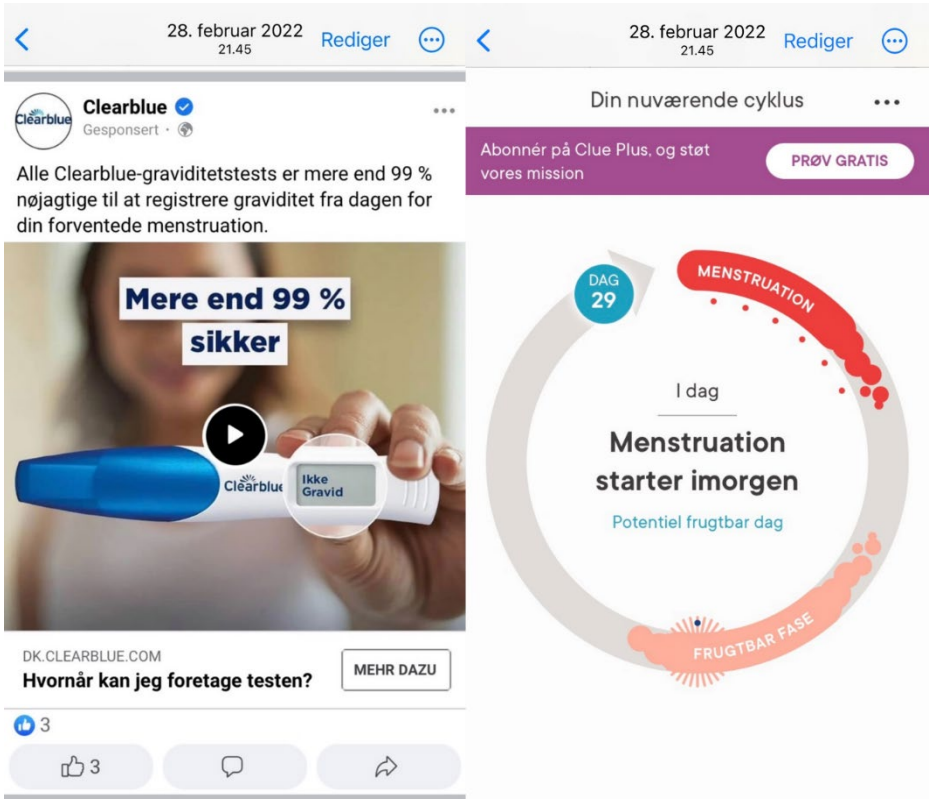

FIGURE 10: *Showing two screenshots. The left one from a Facebook ad of a Clearblue pregnancy test, offering 99% reliable results from one day before expected menstruation. The screenshot on the right is taken from Clue, showing that my menstrual cycle is on day 29, with expected menstruation the following day. The screenshots involve a timestamp stating that both were taken on the 28th of February 2022 at 10.45 pm.*

Autoethnography has been particularly helpful here, as I could follow how I became a reproductive body, not only for the apps that I use, but also for all the systems and data infrastructures around them. While I do not feel different in my body, my online self has changed into a reproductive one. Additionally, this 'reproductive data double' has changed over time. Starting from one that is interested in reproduction and tracking (ads for more MFTAs and tools to help you figure out your body), to someone who seems to be struggling as menstrual bleedings were still tracked pointing to a lack of pregnancy (ads for fertility clinics, information on IVF, and success stories of couples) to a supposedly pregnant one, once I stopped tracking cycle related data (ads with information on parental leave, pregnancy health, baby health, products).

The point here is that if we want to understand how certain technologies impact one's understanding, we need to look beyond them as isolated units but map the assemblages through which they come to be (as prior research has already pointed out, see Kroløkke 2018; Wahlberg 2022; Franklin 2023). Additionally, engaging with them for a longer duration can account for their instability as they change over time, adapting assumptions about users and orienting them towards different spaces and objects (as I also discuss in the last section of this chapter).

REPRODUCTIVE DATA LABOR

I am trying to call the FAC to get an appointment. This decision came after a back and forth discussion with my partner and navigating if I wanted my body to be even more impacted by this research and include his. Eventually we decided that we wanted to take part in this testing, for this research, but also 'for us'.

I am ready and waiting 15 minutes before the line opens. I have prepared our CPR numbers (personal identification numbers) and next to it I have my tablet open with our calendars to check possible dates.

I call at exactly 9.15; the line is occupied. I try again right after, at 9.16, thinking maybe our clocks are not in sync. I feel a small relief when I hear the occupied sound. Maybe I was not ready after all to participate in this testing. I just want to leave it at that, but I keep calling trying to get through. How emotionally draining.

A long beep at the beginning – some hope – some anxiety – and then rapid beeping.

Finally, I make it through, there is waiting line music, but the voice at the other end repeatedly says 'the dialed number does not exist' both in Danish and English. I quickly search for the website; the number was correct, check again, still correct. I stay on the line, thinking it may just be the wrong tape they are playing. Eventually I get kicked off the line.

Meanwhile, my working day begins and I must join a meeting. Luckily, it is online, so I can continue calling the FAC, while participating in the meeting. I dial again – I am in the waiting line! It's 9.32. The recorded voice tells me 'special information for women' (in Danish: *særlig information til kvinder*): this examination does not give a transferal to fertility treatment or to a gynecologist, and the maximum age is 41. After that, an automated voice tells me I am in place number 50. The lines are open for 45 more minutes, my chances are rather slim, but I stay on. The recorded voice returns to tell me that it will take a while, but if I want to stay on, I should get my and potential partner's CPR number, and our calendar ready. I am ready. The waiting melody returns, and then suddenly I am kicked off the line. I call again, get through, now I am moved down to number 61 on the waiting list. I listen to everything again, which takes approximately two minutes, get kicked off again. Try again, number 83 now, get kicked off again. Try again, I cannot get through. Again, not getting through, again, and again, and again. It is 10.15, the phone line is closed, and I did not get through. I called 23 times in total.

My partner says I should call again next week; little does he know that there is no next week but only next month.

I tried one more time after this, again without success. In the meantime, I found out that there is a two-year waiting time for the FAC in other municipalities. Assuming a similar, if not even longer waiting time in Copenhagen, the testing becomes irrelevant for us. Both as a couple but also as part of this research.

I share this vignette to make visible the labor it takes to datafy one's body. It is not only the daily practice of tracking one's experiences, being prompted for daily reflections (see Figure 11), but also navigating different platforms as well as spending time on calling healthcare services, navigating the pros and cons, and the emotional labor involved. I call this section Datafied Reproductive Labor, to highlight how reproductive labor is involved in datafication practices. I also develop some of these considerations through my papers, specifically in

Paper 3, where I discuss how reproductive (data) labor becomes placed onto pre-conception bodies.

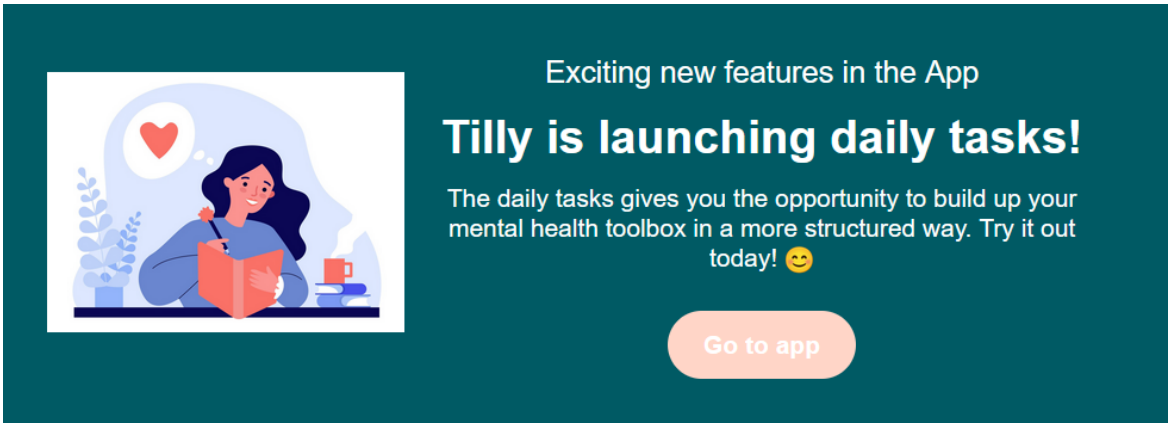

FIGURE 11: *Screenshot from an e-mail received from Tilly advertising their new 'daily task' program. The screenshot includes a graphic of a woman sitting at a table, writing into a notebook. A thinking bubble with a heart in above her. The text of the email says: "Exciting new features in the app. Tilly is launching daily tasks. The daily tasks give you the opportunity to build up your mental health toolbox in a more structured way."*

As Lupton (2020) also points out, self-tracking practices more generally do not only require the labor of regular data input, but also the labor of becoming familiar with devices and maintaining practices, making sense of the data outputs, and the emotional labor of navigating data predictions and visualizations. This is also the case for fertility sensemaking. As shared through the previous two vignettes, it takes labor to navigate data structures, and new interfaces as well as to regain or mourn lost data. It also takes labor to navigate and sometimes deal with the emotional impact of ads that one is being confronted with. While for some it might just be amusing, annoying or creepy, for others such content might be harmful.

It does not only take time and emotional labor to datafy one's body, but other research also points to the free labor people perform for the benefit of others' when participating in datafication practices: "the voluntary data collection and sharing associated with fertility and pregnancy tracking constitute a form of biolabour, where women's use of apps is imbricated in a web of value and knowledge about female bodies" (Hamper 2024, 3). Such practices often have little outcome for the people doing the work. In the FAC, at least, people get test

results that may or may not help them navigate their reproductive future. However, other ways their data is used, and how they benefit from the broader data collection of reproductive bodies in a Danish context is unclear.

The vignette also shows how some people are being excluded from this type of practices, as their life situations might not allow for the time and space of this additional labor. For example, my work set-up allowed me to participate in a meeting online while trying to call the phone line that is only open once a month for one hour. Other people might not have this flexibility, which restricts their access to these kinds of publicly funded offers.

MOVING TOWARDS AND MOVING AWAY

When I started this project, I wanted to understand how experiences of infertility become mediated through different technologies, which often embed ableist imaginaries of reproductive bodies. I started by looking at MFTAs, particularly ones that are aimed at supporting people on their 'fertility journey' (see also Paper 1). Simultaneously, I engaged with people who are currently on such a 'journey' by following online discussions, watching vlogs on YouTube, and tv-programs by the Danish national broadcast that follow couples in fertility treatment. I not only immersed myself into anything related to infertility but also, got immersed.

As I share in the previous section, my data traces travelled platforms. So, while I was a 'fertile online-self' in at the start, presented with information on alternative MFTAs, ovulation and pregnancy tests, pre-natal vitamins, or healthy pregnancy, that perception slowly changed through my engagement with this extensive material on infertility. I was now confronted with information on IVF, egg donation/freezing, causes for infertility and much more. I became an 'infertile online-self'. But that also meant that I became further oriented towards such vlogs and testing offers, as they showed up in my social media feeds, or were linked by people in online discussions.

After being in this space for several months, I could feel a certain discomfort around my research field and data. I did not quite know what to do with that feeling, but ultimately it made me move away from my initial focus on infertility. Reflecting on why I felt this discomfort, I realized that this immersion into infertility content has ultimately changed how I feel about my own reproductive future. Reading stories about people that were 'just like me' and the intense datafication of my body made me question my own fertile potential. I first took a break, thinking I would get back to it eventually. Whenever I tried to get back the feeling of discomfort resurfaced. But I needed to find ways to continue, as I could not just change research topics. Consequently, I was looking for something in between happy pregnancy images and shattering infertility stories. I became oriented towards spaces where there are more 'people like me': people in a liminal space of reproduction. The ones that have not made any attempts to conceive yet but are still concerned with the potentiality of it for various reasons.

While these were my experiences, I found that they also map to those of others who were navigating these spaces. I often came across calls by users of MFTAs or in online forums amplifying the need for spaces to discuss fertility without a focus on infertility.

I share these reflections to demonstrate how my research was full of moments of disorientation and reorientation. My autoethnographic engagement shaped this research project as I was moving away from and towards different spaces based on my embodied experiences of tracking my reproductive body and being in conversation with different people. This exceeds the idea of making one's standpoint and positionality clear (as in what can we (not) know) but fosters a reflexivity of what we *want* to know. It is simultaneously a 'staying with the trouble' (Haraway 2016b) and discomfort while also allowing to move away from it.

INTERLUDE II

"You still got time! Wait now to become a healthier and wealthier parent", says the government-issued advertisement at the bus stop, declaring the benefits of late pregnancies in support of the new era of late parenthood. After successfully mitigating chemical pollution of the soil, the health authorities are now suggesting pushing parenthood towards one's early 50's. Looking around, Emma can feel the buzz of the city. People around her are strolling the streets with a certain lightness in their steps. She too has been overcome with a newfound energy, knowing that her fertile years still lay way ahead of her.

Emma, a 30-year old woman, envisions her thirties not as a series of biological clocks ticking away, but a time to collect experiences, wealth, and wisdom. She enjoys living in a society that values late parenthood, as well as the pursuit of knowledge, career, and self-discovery. She ties another knot into Arakne, marking another joyful passing of ovulation without getting pregnant.

Looking down at the loop and feeling the tactility of the knots, she remembers her mother often contemplating how her life could have been if she didn't get pregnant so early in her life, how she could have provided more for Emma if she had the chance to work in a job she was passionate about, and how she wished that Emma could have stayed an only child. Encountering Arakne, Emma can see that time was following a different rhythm than it did for her mother and grandmother. Becoming a mother was no longer a duty to society, but an ode to a life well-lived.

Recounting the experience of her mother, small traces of doubt occasionally creep into Emma's thoughts. Would she be as spry as other people who embraced parenthood in their early 50s? Would her body withstand the rigors of pregnancy with the same resilience? As both her mother and grandmother became parents early, Arakne does not hold any of their reproductive data after the age of 40. What if Emma couldn't get pregnant after all? She half-jokingly already made plans around this with her friend Paula. If neither of them conceived in a heterosexual relationship by the time they turn 50, they would pretend to be a couple to qualify for IVF treatment and jointly, with their potential partners, raise the child.

***

6

THINKING THROUGH THE OTHERWISE

Re-visions

The previous interlude 'thinks through the otherwise' of reproductive temporalities and technologies. Written as a counternarrative (Light 2021)[28] to the findings of Paper 2 (how people make sense of fertile time and temporalities), the vignette imagines a past in which all bodies have been equally studied and medically scrutinized, where IVF has been developed as a queer-only technology, and where the elimination of chemical pollution and prevention of climate crisis has extended fertile time. Instead of rushing into parenthood in one's early 20's or 30's to avoid age-related infertility, parenthood is now planned for one's early 50's, at the end of one's career.

The vignette is an example of how I worked with explorative methods such as speculation, fabrication and fabulation to 'think through the otherwise' of

[28] A counternarrative, following Light considers futures by "exploring different imagined pasts and making a journey towards alternative presents" (2021, 1).

fertility, data and technology relations. The previous chapters and the included papers lay out how fertility becomes re-con-figured through sites of datafication as they are used to make sense of reproductive bodies. The introduction in particular highlights the potential harm in such data practices. But that does not mean that we should understand reproductive bodies as victims of datafication, rather they also shape and resist normativities as well as exploitative data structures. In this chapter, I examine ways to re-vision fertility, data and technologies. *Re-vision*, originally coined by Adrienne Rich (1972), refers to the long established feminist practice of questioning taken-for-granted stereotypes of everyday lives in order to imagine alternative futures (see also Clarke and Olesen 1999). [29] I discuss two examples of collaborative projects that use speculation to re-vision reproductive technologies and materialization to re-vision affective relations to data.

I did not only engage with these practices as a means to think through the otherwise of technologies and data, but also to think through the otherwise of my empirical material. These approaches allowed me "to know things differently, a way to reflect anew upon the themes of my research" (Benjamin 2016, 3). They were both informed by my empirical material (how I turned to speculation in the first place) and informed the analysis of it, as they have sensitized me to the re-visions in my empirical data. I found them in the ways feminist coding collectives question and remake data structures, and in the circulation of crowdsourced data archives, as I discuss in the end of this chapter.

[29] Rich describes re-vision as the "act of looking back, of seeing with fresh eyes, of entering an old text from a new critical direction" (1972, 18) to understand assumptions and normativities that shape how lives are lived. Through making those visible, Rich argues, we can understand how our position comes to be and imagine lives differently.

TECHNOLOGIES OTHERWISE: SPECULATIONS

The counternarrative in the beginning of this chapter portrays Emma using *Arakne* as a tracking tool to make sense of her reproductive future via her ancestral past. Arakne is a speculative object that archives ancestral reproductive data. Instead of linear forward oriented, Arakne builds on relations to the past, and through knots, as well as through the practice of knotting, different beginnings and ends become entangled. Arakne materializes the entanglement of different (reproductive) bodies that build upon and relate to each other. In that, Arakne follows non-linear ideas of time, in which the ancestral is not only in the past but incorporated into the present and as a vantage point for the future.

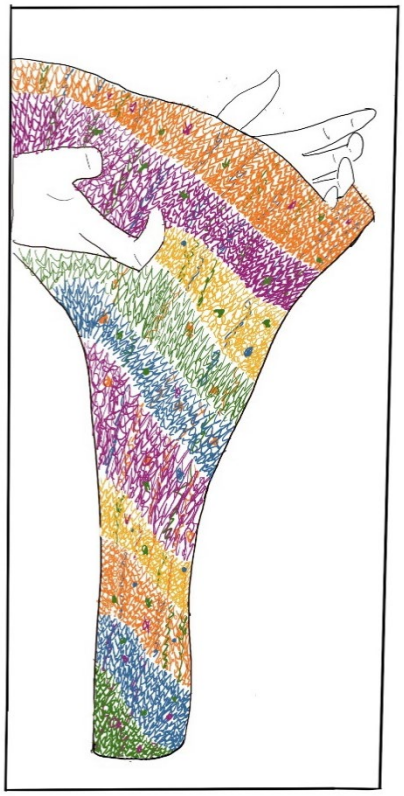

Figure 12: *A sketch of the speculative generational tracking tool Arakne. Two hands are holding and feeling a knitted loop. The loop is striped with different colors and has additional knots that vary in thickness and color.*

Arakne – yarns of life was speculated together with Nadia Campo Woytuk, Sarah Homewood and Vasiliki Tsaknaki as part of our NordiCHI 2022 Workshop (Reime et al. 2022). Through Arakne, we imagined menstrual and reproductive data as a generational heirloom. The knitted loop allows for knitting emotions, feelings, and (historical) events on the inside and reproductive data on the outside. We based Arakne on the idea that in contemporary medical practices one's own cycle and reproductive capabilities are often put in relation to other kin: When did your mother enter menopause? Did your mother/grandmother have any troubles conceiving? Rather than being a device that is solely focused on reproduction, Arakne aims to build relations between generations based on cycle patterns (see also Campo Woytuk et al. 2024).

The vignette and Arakne are examples of how I engage with speculative practices "to push the boundaries of my own thinking" (Benjamin 2016, 2). Working with speculation as a method is a means to engage with the multiple ways I encounter 'speculations' in my empirics, since fertility is always already speculative. Firstly, fertility is speculative on the very personal and intimate level of an individual's future planning and anticipatory practices. This allows for a narration of datafication as a means to make this space less speculative and more 'controllable'. Secondly, in technological progress through which the future of reproduction becomes imagined differently. This led to technologies such as IVF, AR and cryofreezing, which were once speculative but are now more or less common practices (Franklin 2023). Other technologies, such as the artificial womb, are still speculating future practices of reproduction (de Vries 2023). Thirdly, it is speculative on a biopolitical level when governments are gearing towards reproductive futures of their citizens, making technologies available, or restricting access to such. My engagements with speculative methods did not include a problem-solving approach (i.e., how to create more inclusive MFTAs), but were intended as means to problematize futures by taking vantage point in current practices.

Here, I am also building upon a rich body of work within HCI that explores speculative design/thinking as a means to reflect on "social norms and values, anxieties, expectations, and desires braided around emerging technologies" (de Vries 2023, 240). This includes, for example, work that speculates on bodily data relations and production (Tsaknaki et al. 2022), practices of data sharing (Søndergaard and Hansen 2016), menstrual care (Fox et al. 2019), or more-than-human fertility entanglements (Søndergaard and Campo Woytuk 2023).

My engagements with speculations have also been inspired by feminist sci-fi writing, in which reproduction and its technological entanglement have been theme for both utopian and dystopian imaginations of the future. For example, Margaret Atwood's *Handmaids Tale* (1985) famously offers a reproductive dystopia, situated in a time where fertility has so drastically declined that a small number of fertile women are forced to bear children for privileged

couples. These human wombs become machine-like child bearers, similar to Joanne Ramos' *The Farm* (2020), where bodies marginalized by race and poverty become surrogates (hosts) for wealthy women, losing all rights to their own bodies. Caeli Widger's *Mother of Invention* (2018) imagines how lives could be lived if pregnancy would not take up too much time and energy of the gestating person's body. *Women on the Edge of Time* by Marg Piercy (1976) imagines reproduction as independent from sex and gender, where children are gestating in artificial wombs, offering a more utopian scenario where everyone can become a parent, independent from their sexual and gender orientation. Ursula Le Guin's *Left Hand of the Darkness* (1979), speculates on a world where people do not have a fixed sex, but are ambisexual, changing their sex every month during 'kemmer', the reproductive phase aligned with the lunar cycle, in which they become either male or female depending on their partner or relationship. Le Guin's work speculates on the role of gender in society at large, but also specifically in terms of childrearing.

These feminist sci-fi writings offer entry points into different narratives of reproductive futures and temporalities. What would it mean for our sociocultural practices if human pregnancy would only last 9 weeks, as Wigers speculates? What if the labor of childrearing would be detached from sex, as Le Guin and Piercy imagine? These works remind us that lives could be otherwise and "expand our visions of what is possible" (Benjamin 2016, 2), for better, or for worse.

DATA RELATIONS OTHERWISE: MATERIALIZATIONS

To think through the otherwise of relations to data, I explore different ways of materializing data. This is inspired by prior research which discusses how practices of making and materializing foster different understandings and ways of knowing (Jungnickel 2018; Pérez-Bustos, Sánchez-Aldana, and Chocontá-Piraquive 2019; Muehlbradt et al. 2022), as well as by work that argues how bodily data already is a form of materialization "of selfhood that both represent elements of the self and also require[s] attentive labor to

generate value for those who make them" (Lupton 2020, 40). To further engage with bodily data through the body, and to pay attention to the labor of datafication, I was especially interested in changing the tactility of data: from visual representations on the screen, towards something that can be touched and experienced through the body differently to "highlight the more-than-digital dimensions of these assemblages" (Lupton 2020, 20).

Through a range of collaborative workshops[30], I experimented with ways of translating, creating, and annotating datasets onto tactile surfaces such as knotted yarns and embroidered fabric. These explorations helped me to re-vision data and bodily relations to it. For example, they make visible how data becomes shared and negotiated. Transforming data into stitches and knots facilitates the building of relations and conversations across participants about their bodily experiences (around fertility or the Covid19 pandemic), and sensemaking of these experiences in affective ways. While we prompted for a focus on the Covid19 pandemic more broadly, aspects of fertility and reproduction were included by some participants who became parents during this time, experienced miscarriages, or tried to conceive. It made visible how experiences of the Covid19 pandemic were also experiences of fertility, as relations to fertility became shaped by restrictions of movement and access to healthcare (see also Paper 2).

[30] The first workshop was organized with Vasiliki Tsaknaki inviting colleagues at ITU to embroider data around the Covid19 pandemic. Building on these first engagements I collaborated with Vasiliki Tsaknaki, Marisa Leavitt Cohn and Tania Pérez-Bustos to explore knotting as an alternative way of thinking about and relating to bodily data (see also Tsaknaki et al. 2024). To bring data materialization into spaces of fertility datafication, Vasiliki Tsaknaki and I contributed to the CyFer exhibition (https://www.royalholloway.ac.uk/about-us/the-library/the-exhibition-space-at-the-emily-wilding-davison-building/cyfer/), which set out to critically reflect on topics of privacy and security in relation to FemTech through artistic engagements. Our contribution, a knotting kit, guides people to create their own archive of cycle/fertility data using yarns and knots. The kit further prompts participants to engage with and reflect on privacy and security statements of the intimate datafication technologies they are using.

Materializing data allows to foreground subjective understandings of data (as opposed to data as objective and representative), make visible the labor that is involved in creating and engaging with data, and how people relate to data across scale and sites (for example, data that is simultaneously part of governmental and personal data sets) (see Tsaknaki et al. 2024). It highlights how relations to data are affective, how people revisit trauma and past experiences through different datasets, and how materialization helps to re-vision such experiences. Furthermore, by inviting people to encrypt their data (making them illegible for others), the practices of knotting and materializing critically engages with power asymmetries of data collections, particularly when they involve third party sharing. It also helps to broaden understandings of what data is and can be, for example, when people brought pictures or receipts as datasets.

Relating this back to practices of fertility sensemaking, I could see more clearly how the different sites of datafication narrate data as objective (when they are in fact subjective and contextual) and how, for instance, MFTAs frame what counts as data through the ways they allow for data points to be included or left out.

DATA(FICATION) OTHERWISE: FEMINIST COUNTER CONDUCTS

Taking the experiences from the explorations of speculation and materialization into my empirical material, I could see how my informants, discussants online, as well as some app developers, also renegotiate and re-vision what data is, how it can be produced, and how it should be governed. This section exemplifies this via two cases which I read as (feminist) counter conducts. I follow Murphy's conceptualization of feminist counter conducts. That is, practices that

> "operate outside of professional and profit-driven biomedicine, and hence [grapple] with the role of capitalism and authority in knowledge making by virtue of crafting alternative affective,

> embodied, and political, rather than economically productive, epistemic values" (Murphy 2012, 72).

I present the MFTA Drip, and how their open source and non-profit structure, detached from economization, does not only aim to empower users by providing cycle analysis, but also by having control over their data and 'unblackboxing' prediction algorithms. Further, I discuss a crowd-source data archive found in online communities to share different data points about IVF treatment.

These are just two examples of a wider movement to change narratives of what data is, and what data can do (D'Ignazio and Klein 2020; Keilty 2023). The examples I bring here are in some ways organized conducts which can, to a degree, be made observable for the researcher. But there are also myriad of individual everyday counter practices that often remain invisible. For example, when people do not track the actual days of their menstrual bleeding or other cycle related symptoms but have their own encryption key (such as, marking symptoms two days behind), or find other ways to make their data useful for them but un-useful for any further analysis when data is sold to third parties.

FEMINIST CYCLE TRACKING

> "The guiding epistemic values within feminist self-help protocols are captured here: using your body to know your body, valuing and producing affirmative affective relations, appreciating variability, and collective research."
>
> —Murphy 2012, 73

In this quote, Murphy refers to the vaginal self-exam protocols that were part of a feminist self-help movement in the 70's. Similar values can be found in some MFTAs, such as Drip. Even though Paper 1 discusses how Drip reproduces normativities, despite trying to avoid them, this app, and their developers, can also be understood as challenging certain normativities, and as following some of the principles laid out in the quote. This includes, for example, the use of gender inclusive language of 'the

menstruator', avoiding gendered design and imaginary ('not another cute pink app'), prompting users to sense their bodies through touching, feeling, and looking at their mucus and cervix, and by making clear what data points are being used for the prediction of fertile windows. Rather than comparing normative timeframes, and letting people know when they are 'out of sync', Drip stresses that bodies are different, acknowledging variability rather than regularity.

I thus understand the development of Drip as a form of (feminist) counter conduct undertaken by a feminist coding collective. While the app is similar in its functions and presentation to other MFTAs, Drip's most significant difference might be their non-commercial usage. There are no advertisements, premium add-ons or data storage. Users have access to all their data unconditionally. The data is stored locally on the users' phone, and does not give Drip access to monetize it with third parties. Drip is not a company, but a collective of feminist coders that were concerned about the ways cycle health is mediated in technologies. They are a volunteer group collectively working on the app while having other employment or care responsibilities.[31] Similarly to previous studies on women's health movement (e.g. Murphy 2012), they develop an "alternative set of data collection practices in order to build feminist knowledge about bodies, sex/gender and reproduction" (Roberts, Mackenzie, and Mort 2019, 64). Rather than only offering Drip as a solution to 'control unruly bodies', they are actively questioning the limits of self-tracking and what algorithms can do, instead of proclaiming the aggregated data as "accurate or 'true' representations of bodies" (ibid, 65). They are simultaneously becoming the experts with "the technical means of altering reproduction" (Murphy 2012, 4), as well as becoming the bodies benefitting from such alterations. While it

[31] see: https://bloodyhealth.gitlab.io/

could be argued that more things could have been rethought than 'just' the data infrastructure, it is also important to account for the environment and structures this app results from. That is, they are working outside of monetizing schemes, and alongside other work and care obligations, which begs the question whether there can be just practices for both users and developers? Can MFTAs that do not sell user's data ever be profitable for the people creating and maintaining them? And if not, how can we ensure that such initiatives sustain, and refuse data exploitation? For instance, Clue began as a 'women for women' app, but has since subsumed under monetizing schemes, where 'feminist' becomes more of a marketing keyword, rather than a commitment.

CROWD-SOURCING A FERTILITY DATA ARCHIVE

Another example worth discussing here is a crowd-sourced database on fertility treatment processes. As I discuss in previous sections (see Chapter 1), different data is constantly being shared in online spaces. This could be in the form of screenshots of MFTAs that are showing temperature charts or LH surges, pictures of pregnancy tests or ovulation sticks, pictures of mucus consistency or blood stains, or more 'basic' data on people's age, relationship status, weight, and occupation. This data is usually dispersed over several forums or hidden in comments as a response to a question. But there are also more formalized attempts at data collection. What I call the 'crowd-sourced fertility data archive' is a collection of people's data regarding their infertility treatments. The data can be filtered and sorted to find people 'just like you'. For example, I can look at the treatment data of other people my age and with similar bodily markers. What was the success rate of their treatment? How many tries did they go through? What kind of protocols were they under? What medication did they take?

The reason I am including this here is because this archive presumably fulfills no other purpose than sharing experiences with future treatment receivers. There is no direct economic value in creating or maintaining this data. In contrast to other datafication practices, where data is being collected

and shared beyond the user's knowledge, it is a choice to add one's data to this archive (though people cannot really know what happens after as it is freely available online). And often, when data is being collected in the name of research, it has very little immediate impact on the people who have donated their data. Whereas in this case, people can see themselves in direct relation to other data sets: "the sharing of personal experiences online becomes a communal data practice, in which people's personal details become part of a crowdsourced body of knowledge that is available to users of the sites" (Lupton 2020, 101).

Coming back to Murphy's (2012) work on the women's health movement in the 70's, we can see that crowd-sourcing reproductive and bodily data is not a new practice. However, the means that data can travel and connect people have changed from flyers and face-to-face meetings to distributed and global exchanges, which make the boundaries of national contexts quite fluid (people are exposed to content outside their national bubble). Further, D'Ignazio and Klein (2020) point out how crowd-sourcing data, as a feminist practice, is employed to combat political/scientific data sets or make up for missing data.

It is also these mundane, everyday practices that open possibilities for reconfiguration, as Suchman argues: "it is labors like this that represents our best hope for genuinely new reconfigurings of the technological, based not in inventor heroes or extraordinary new devices, but in mundane, and innovative, practices of collective sociomaterial infrastructure building." (2017, 372). Here, access to, and the meaning of data becomes re-visioned in the creation of a fertility data infrastructure. These infrastructures in turn potentially reconfigure encounters with medical institutions, as people come in with a set of experiences (which are not necessarily their own), and understandings of 'success' as well as temporalities of 'trying'.

To sum up this chapter: I share these reflections and lose analysis here, in order to highlight my alternative knowledge-making practices. While I myself was trying to reimagine feminist reproductive technologies and data (through speculations and materializations), I became more attuned to the ways other

people are already doing it. Rather than only being critical about it (like in Paper 1), I gained a more nuanced understanding of how these projects not only positioning themselves within and against more capitalistic practices of data extraction, but also how complex it is to fully escape such structures. This means that rather than only analyzing what these projects do not do, or how they are still reproducing normativities, I can more clearly delineate aspects through which they re-vision data practices and relations as much as possible within current economic structures.

7

RE-CON-FIGURATIONS

Contributions & Discussion

In this chapter, I provide an overview of the findings of the three papers included in this dissertation, and discuss their contributions by reading them with work on figuration (Haraway 2013; 2016a; 2018), configuration (Barad 2007), and reconfiguration (Suchman 2006, 2017). This illustrates how this dissertation is about fertility re-con-figurations (rather than reconfigurations) through different sites of datafication, and the respective entanglements of bodies, data, and technologies. Re-con-figurations thus capture the ways fertility sensemaking takes shape through the figuration of reproductive bodies, configuration of reproductive temporalities, and reconfiguration of orientations to futures.

While all papers hold moments of figuration, configuration, and reconfiguration, I highlight their main contributions by sorting them as following:

Figuration
Reime, Lara, Vasiliki Tsaknaki, and Marisa Leavitt Cohn. 2023. 'Walking Through Normativities of Reproductive Bodies: A Method for Critical Analysis of Tracking Applications'. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, 1–15. Hamburg Germany: ACM. https://doi.org/10.1145/3544548.3581450.

Configuration
Reime, Lara, Marisa Leavitt Cohn, and Vasiliki Tsaknaki. 2023. 'Fertile Becoming: Reproductive Temporalities with/in Tracking Technologies'. In *FemTech: Intersectional Interventions in Women's Digital Health*, edited by Lindsay Anne Balfour, 73–98. Singapore: Springer.

Reconfiguration
Reime, Lara. 2024. (submitted). 'Orienting towards (Non)Reproductive Futures: Anticipating Infertility'. Submitted to *Catalyst: Feminism, Theory, Technoscience.*

FIGURATIONS: REPRODUCTIVE BODIES

Figure 13: *A sketch depicting a discussion around non-heteronormative tracking apps. On the left: an outlined phone, with one notification reading "Relationshipguide: how to cope with sex on demand." Below a reminder notification to add sex. Speech bubbles on the right answer: "No, the apps reflect how pregnancy is gendered in society."; "This app uses inclusive pronouns but will still prompt you for intercourse during your fertile window"; "I feel so judged when it tells me to 'just' have more sex. That is not the issue." and "there is too much focus on getting pregnant naturally."*

In Paper 1, I trace how reproductive bodies become figured through reproductive technologies, particularly MFTAs. Inspired by Haraway's work on figurations as material-semiotic actors (2016; 2018), I map the figure of the reproductive body as it becomes produced through embedded normativities within MFTAs. Figurations, following Haraway, are "performative images that can be inhabited. Verbal or visual, figurations are condensed maps of whole worlds" (2018, 179). Rather than an understanding of some bodies as more reproductive or inherently reproductive than others, the 'reproductive body' is a figure that I have both encountered in my research, but also use as a term to

account for the multiple gendered, cultural and social normativities of reproduction that collapse on the body.

The figuration I present here in more detail is made up of the normativities my co-authors Vasiliki Tsaknaki, Marisa Leavitt Cohn, and I encountered when investigating the MFTAs Clue, Drip, and Tilly. Through this critical analysis, we have scrutinized how normativities surface in different elements and features of the apps, such as, 1) underlying normative assumptions of reproductive bodies in terms of gender, ability, and temporalities, 2) normativities of self-care and body literacy, 3) normativities of dis/engagement.

To unpack this further: through these embedded normativities, this particular reproductive body becomes figured as a heterosexual cis-female, at a 'good' reproductive age, that is they are at a point in their lives where they are willing to procreate, but ideally not too old to be encountering issues with age-related infertility. This reproductive body possesses a high degree of bodily literacy, that is they are attuned to their bodily symptoms, sensations and emotions, and are familiar with their different stages of cervical mucus consistency. They have time to engage with their own body, to get to know it and potentially control it through extensive tracking and additional forms of self-care such as a healthy diet, exercise, and meditation. This reproductive body engages frequently and regularly with their respective app, as they believe that they need technology to access their 'inner' workings, which otherwise would be invisible. Through datafication, this reproductive body can control and make sense of their 'messiness'.

The paper is published in the proceedings of the 2023 CHI conference, contributing to the field of reproductive health in HCI. We offer the walkthrough method as a tool for designers and researchers to productively engage in how we perceive, understand, and feel about our experiences with, and through, technologies. While we criticize the figuring through normativities that takes place within current MFTAs, we also want to take seriously the ways people sometimes want to relate to norms and objectivities

(rather than having tracking tools that do not give any guidelines of what is 'normal'). Based on our analysis, we further argue that design approaches should include a greater plurality of data-objective structures:

> "Instead of attempting to design against dominant narratives of the reproductive body as cis-gendered, cis-hetero and able-bodied, we might instead seek to design for a plurality of reproductive bodies by acknowledging and engaging with a multiplicity of normativities that comprise underrepresented experiences of fertility and reproductive health. We propose inclusive design of MFTAs should not completely abandon or eliminate data-objectivities but engage with them through intersectional and multiple perspectives, accounting for different contexts, users, and types/durée of engagement." (Paper 1, 12)

It is thus important to understand how the reproductive body is figured at different sites of datafication (in this case intimate datafication) to account for the ways the figure partakes in the experiences of fertility sensemaking (Barla 2019). Rather than abandoning normativities, we might question how the reproductive body could be figured differently, allowing for it to have a different impact in the world-making of which it is part.

CONFIGURATIONS: BECOMING FERTILE TOGETHER

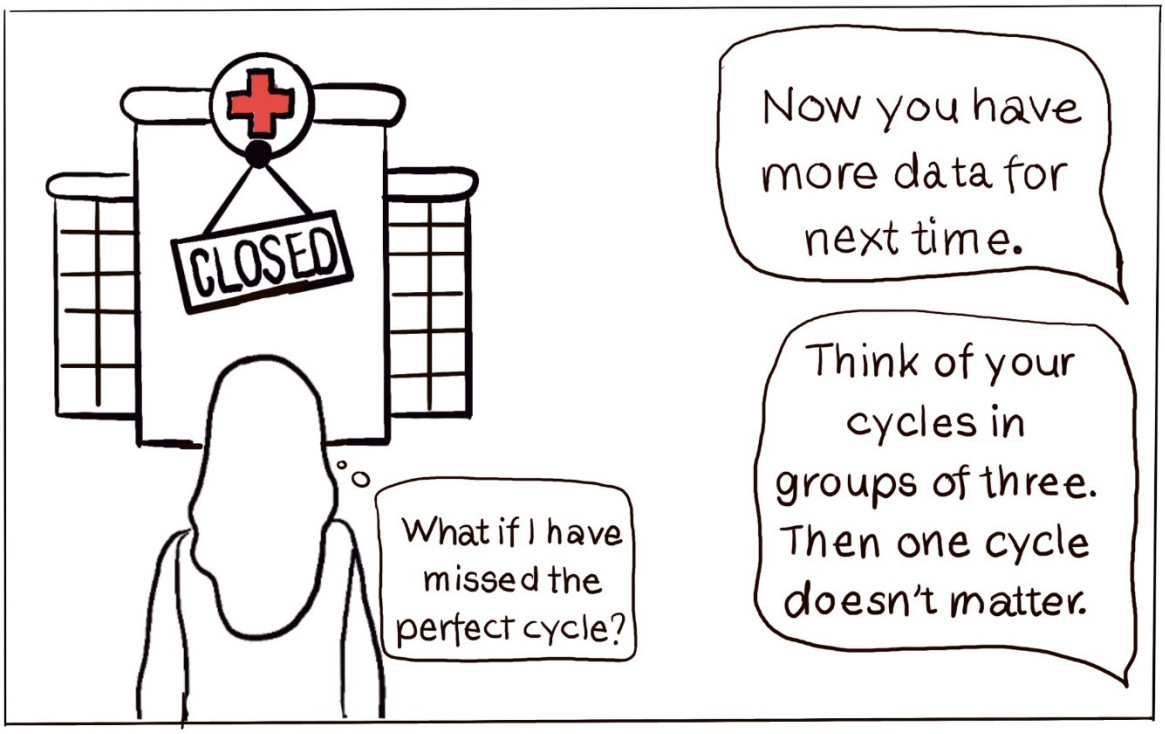

Figure 14: *Sketch illustrating a person's experience with the closing of fertility clinics during the covid19 pandemic. The sketch shows a person from the back in front of a closed hospital. The person wonders: "What if I have missed the perfect cycle?" Answers in speech bubbles on the right aim to mitigate the loss of one cycle by stating: "Now you have more data for next time" and "Think of your cycles in groups of three. Then one cycle doesn't matter."*

Paper 2 is concerned with the configurations of reproductive temporalities. Within sites of shared datafication, different bodies, datasets and technologies come together to produce knowledge around fertile time (as in bodily possibilities for conception, i.e. ovulation) and temporalities (as in felt experiences of socially constructed timeframes, i.e. when is a good time to reproduce in one's lifetime).

In the paper, I explore how different objects and subjects come together and partake in the "everyday sociomaterial configurations" (Suchman 2006) of reproductive time and temporalities. The paper is part of an edited volume which brings together critical work within feminist STS on the growing FemTech market, edited by Lindsay Balfour (2023). My co-authors Marisa Leavitt Cohn, Vasiliki Tsaknaki, and I contribute to this space by providing an

analysis of the ways fertile time and temporalities become materialized and configured through relational and distributed practices of fertility datafication.

We scrutinize the ways fertile time and temporalities are being collectively navigated through sharing, comparing, and discussing fertility data (as in tracked data, medical data and experiences/feelings) online to, show how making sense of fertile time and temporalities is not "a singular practice but a range of different local practices involving a myriad of material configurations and discursive formations" (Barad 2007, 204). Experiences of, and knowledge about, time and temporalities thus emerge out of specific configurations within fertility sensemaking, and become integrated into people's everyday lives and practices (Martin 2001; Lupton 2020).

Building on the normative figuration of reproductive bodies from Paper 1, I analyze in Paper 2 how particular understandings of fertile time and temporalities materialize through configurations of data, data-sharing practices and technologies, as well as through cultural narratives. For example, MFTAs represent and organize reproductive time within normative timeframes, they build datafied relations to pasts and futures, and orient people towards temporalities that are embedded within broader social and cultural narratives of reproduction. I further explore how people engage in sharing practices online as a way to make sense of their fertile potential and time.

But the paper also shows how these configurations remake, contest and queer time and temporalities, deviating from the normative understandings found in MFTAs. Temporalities become located beyond individual bodily experiences, and entangled in worldly temporalities of wars, pandemics, and climate change. These findings highlight that it is not one body (i.e., the user) and one technology (i.e., an MFTA) that become configured within fertility datafication, but multiple distributed relations. The title 'Fertile Becoming' points to such configuration of multiple sites, actors and practices in the sensemaking of fertility, and particularly fertile temporalities. Rather than invisibly/uncertainly located in bodies, through configurations, fertile time

becomes shared and understood as predictable. Fertility temporalities are then not (only) an "attribute of the body" but of "a system of relations [...] in a specifically configured social material environment" (Suchman 2006, 262).

RECONFIGURATIONS: ANTICIPATING INFERTILITY

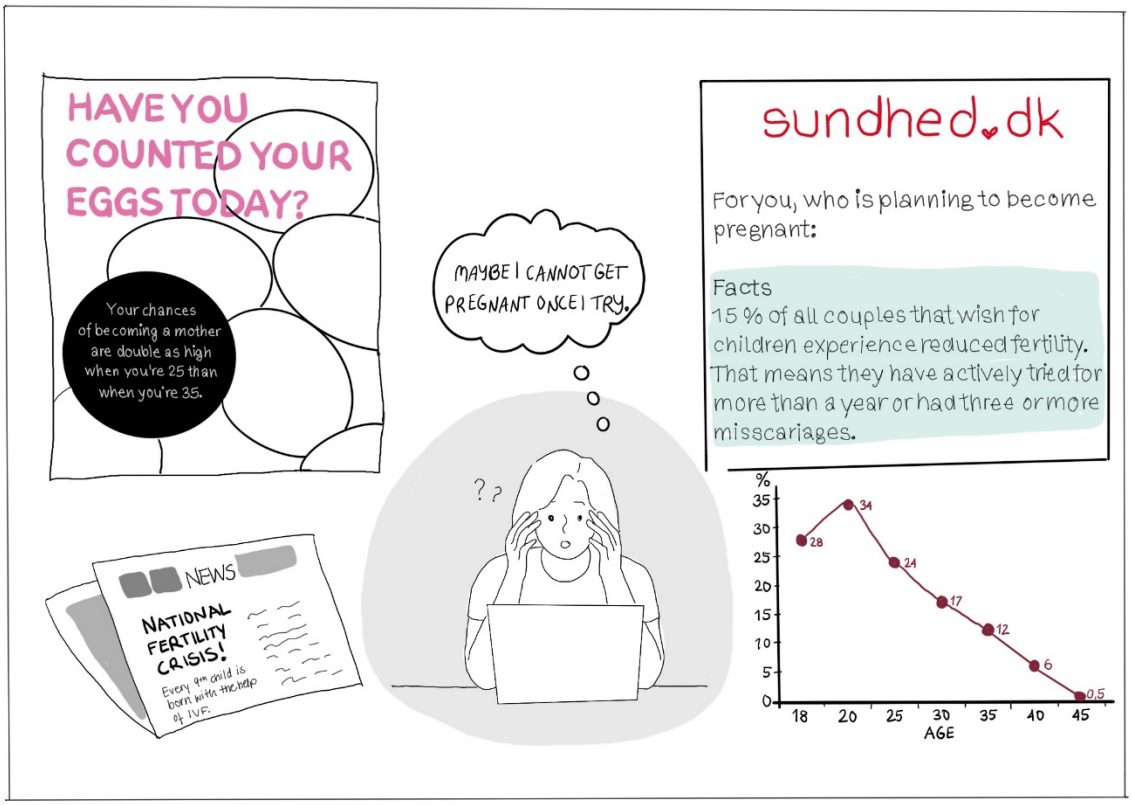

***Figure 15**: Sketch illustrating a person encountering different statistics and information about fertility. In the middle of the sketch, a person sits in front of a laptop wondering "Maybe I cannot get pregnant once I try." Around the person are different materials. On the top left, a poster asks, "Have you counted your egg today?", informing that chances of becoming pregnant are much higher at a younger age. Below is a drawing of a newspaper, proclaiming a national fertility crisis, in which every 9th child is born with the help of IVF. On the top right is an excerpt from the Danish health website sundhed.dk, informing readers that 15% of all couples in Denmark experience reduced fertility. Below is a statistical graph, depicting fertility decline with increasing age.*

Building on Paper 3, this section is concerned with the *reconfiguration* of orientations towards reproductive futures. By drawing from theories of anticipation (Adams, Murphy, and Clarke 2009) and orientation (Ahmed 2006), I analyze how medicalized data-practices and narratives of fertility decline

reconfigure relations to fertility in terms of possibility, time, and space. I find that through anticipatory regimes, people become oriented towards the (im)possibility of reproductive futures. I discuss how anticipation is not only a temporal orientation towards the future but also towards objects and spaces of reproduction. The paper is single authored, submitted to the journal *Catalyst: feminism, theory, technoscience,* and contributes to building feminist theory on reproductive orientations as they take shape through entanglements of bodies, data and technologies.

Its analysis builds upon the previous two papers in regard to the ways normative technologies such as MFTAs (con)figure bodies and bodily temporalities of reproduction, and how people come together to navigate this collectively. In this paper, I further expand on this by considering datafication practices in a medical context and through more medicalized technologies, such as ovarian reserve and sperm testing. Following the (almost) national roll-out of subsidized fertility testing (FAC), self-tracking practices, and national debates around fertility decline, Paper 3 analyzes how relations to reproductive futures become reconfigured as people become oriented towards anticipating infertility, rather than fertility.

The paper explores how objects, such as FAC or MFTAs, come in proximity to bodies through affective relations to reproductive futures. That is, these technologies do not necessarily orient people towards (non)reproductive futures, but by moving towards the not-yet of reproductive futures, bodies come across such objects as a means for reproductive futures to materialize. These technologies then become objects of anticipation.

Through such an orientation, (medicalized) datafication practices introduce new stages in the process of trying to conceive, making people "arrive in clinics at different times of their lives, with newly articulated goals and with a very different sense of their life course" (Roberts, Mackenzie, and Mort 2019, 65). I show how pre-conception bodies (Waggoner 2015) become enrolled in fertility clinics, not due to medical reason, but due to affective orientations to the future. Building upon Thompson's (2005) work I have termed this *preemptive*

synchronization, to capture how bodies are placed in synchronization with bureaucratic and medical structures even before entering processes of IVF.

DISCUSSING IMPLICATIONS

With these three articles, this dissertation contributes to a feminist theorizing of fertility data practices. Such an analysis is relevant, as it brings forth how fertility becomes re-con-figured, and moves fertility datafication beyond self-tracking (and beyond the self) by pointing to the ways fertility becomes materialized through entangled forms of sensemaking, including relational practices and data across sites. In this section I further discuss the implications of figuring, configuring, and reconfiguring fertility.

Scrutinizing how reproductive bodies become figured helps to "understand the world" (Mazmanian, Cohn, and Dourish 2014) and account for the "dance of world-making encounters" (Haraway 2008, 249). In other words, such a figure simultaneously represents the world they are a part of, and takes part in world-making practices. As Karlsson pointed out in her research on self-tracking technologies: "technology is political and can have an impact on societal change, or it can affirm an existing culture and view of humanity" (Karlsson 2021, 120). To paraphrase, while this figuration inhabits sociocultural norms of reproduction, it also partakes in further reproducing such norms, by affirming, and occasionally rejecting them. The reproductive body here is at once a normative figuration (as discursive formation), but also participates in the figuring of reproductive body (as lived experience) (Roberts, Mackenzie, and Mort 2019).

To analyze figurations thus means to scrutinize "how they are put to work in time and place" (Suchman 2006, 244), that is, to understand what bodies are afforded to do and which bodies are excluded. This matters for individuals, as they potentially have access to less 'knowledge' about their bodies, and need to emotionally navigate spaces that are 'not for them'. But it also matters as bodies, that do not fit into the figuration are being left out of the data sets created

through such practices. If these data structures are a means to fill a research gap by generating data about reproductive bodies, then that gap is filled with a certain type of bodily data while others become invisibilized and pathologized. When we then follow this data across other sites of datafication, we can see how reproductive bodies are further de/materialized, for instance when such partial data builds the basis for (medical) research and claims around reproductive bodies.

Through configuring reproductive temporalities, people are being placed out of sync or out of time, which is often in disjuncture to their lived experience. Centering normative time scripts leaves out how temporalities are experienced non-linearly, including retrospection and affective relations to futures. Through linear-progressive logics, some people will always be figured outside of such timeframes, as Browne (2022) and Kafer (2013) argue. Particularly progress-oriented logics of fertility (as a means towards future parenthood) simplify the complex and entangled experiences of reproductive temporalities. Can we re-vision technologies and data structures in ways that allow us to "think sideways" and "catch up" as Browne (2022) suggests? Could data practices embrace slowing down, pausing, and looking back? In this dissertation I show how some sites of datafication restrain thinking sideways (MFTAs), how others foster non-liner understandings of time (online sharing), while others urge to 'run ahead' (FAC). Even though data and digital technologies cannot fully account for the complexity of fertility temporalities, they are nevertheless part of shaping that complexity. It is thus paramount to continuously create knowledge on the ways they participate in the augmentation and configuration of reproductive temporalities, which this dissertation contributes to.

To map reconfigurations means to understand how practices co-evolve in everyday encounters with technology, sometimes against their imagined use, and how relations, practices, as well as boundaries become reconstructed through such encounters (Suchman 2006). Even though the FAC was made publicly available to give people more security through predictions about their

reproductive potential in the future, Paper 3 argues how the availability of such a technology, and the narratives around it, have reconfigured fertility as precarious. This rather disorients people, as their reproductive futures become even less stable. Consequently, rather than anticipating fertility, people find themselves in anticipatory regimes of infertility. That is, they preemptively navigate infertility, encounter legal and practical frameworks of assisted reproduction, and create timelines for trying to conceive. Placing responsibilities for reproductive futures onto individual bodies thus enrolls them in preemptive reproductive labor. This further neglects how fertility is not only a matter within bodies, but rather becomes materialized through relational practices. Individualizing reproductive futures further disregards how bodies live and move within environments that are not made by them (such as wars and chemical pollution). Providing tech-solutions to be in control and manage fertile futures leaves people with potentially false hopes, preemptive grief, and the additional labor to 'try it all' (Franklin 1997).

Haraway urges us to find the right 'speculum' as a tool to open parts, making them accessible for observation (Haraway 2018). The speculum here refers both to the material object often used in gynecological settings to make the uterine insights available for examination, as well as to other (non-material) instruments and practices that allow for observation (ibid). In this dissertation I discuss how different sites of datafication, such as tracking apps, online forums, and fertility tests, participate in the 'opening' up of reproductive bodies. They could thus be considered a 'speculum'.

Rather than judging if these are the 'right' tools, I consider their potential to be repurposed, similarly to the speculum: American feminist health movements in the 1970s repurposed the speculum – a tool that previously symbolized the oppression and scrutinization of the female body through male doctors – as a tool of empowerment and self-knowledge (Haraway 2018, Murphy 2012). We might thus ask: can we repurpose the speculum that is data?

This dissertation critically examines how some sites of datafication perpetuate the oppression of marginalized bodies by essentializing the feminized body inherently reproductive, exploiting their data labor, and responsibilizing them to safeguard and maintain future fertile potentials. At the same time, I also highlight instances where not only bodies, but also technologies and data become reconfigured, as their relations become re-visioned (see Chapter 6). In these cases, data structures and technologies are repurposed in ways that account for complexity and prioritize the well-being of the bodies they include. However, to fully repurpose the speculum that is data, we need more practices that challenge existing norms and allow for caring configurations, rather than exploitative ones.

CONCLUSION

In this dissertation, I set out to investigate how fertility becomes figured through material data practices. Building on an analysis of empirical material composed of app engagements, online discussions, advertisement material, reflection notes, and qualitative interviews, I have shown how such data practices and technologies figure fertility in temporal terms (as an orientation towards the future) and within certain bodies (through norms around gender, sexuality, ability).

By drawing on theories of posthumanism, I argued for the necessity to think data across sites to understand how fertility becomes de/materialized through shifting assemblages including bodies, technologies, and objects. This entailed to look beyond singular objects towards the assemblages through which they take form. For example, at the legal regulations that place bodies out of fertile time and restrict access to reproductive technologies based on age, or the temporal scripts of life courses that narrate when a good time is to procreate, or the ways biomedicalization essentializes female bodies as the reproductive ones. The assemblage of all these parts, and more, un/make fertility. They shape how fertility is understood, navigated, and anticipated. Additionally, I utilized

theories on crip and queer temporalities to scrutinize how datafication technologies are participating in normalizing, constructing, and regulating bodies into set patterns of (reproductive) time. This grounding brought forth an understanding of fertility as constantly becoming through entangled and relational practices rather than a fixed state, or a quality of individual bodies. I thus proposed the term *fertility sensemaking* to highlight how fertility is not readily available to be tracked but materializes through sensemaking processes that include the interpretation of bodily data in light of socio-cultural norms around reproductive bodies and temporalities, as well as the affective labor of interpreting and relating to data predictions.

I separated the sites of intimate, shared and medicalized datafication (Chapter 1) as exemplary sites to investigate how reproductive bodies become oriented towards datafication as a means of control and knowledge, how they navigate within them as their embedded normativities disjunct from their lived experiences and how they are collectively making sense of them. Building on this, I argued that fertility does not only become figured, but *re-con-figured*. I exemplified this further through the three papers included in this dissertation, they argue: 1) how particular reproductive bodies become *figured* through sociocultural norms of reproduction, but also partake in further remaking them by affirming and occasionally rejecting them; 2) how different objects and subjects come together, and *configure* fertile time and temporalities through relational and distributed practices of fertility sensemaking; and 3) how orientations to fertility become *reconfigured* in terms of possibility, time, and space, as infertility rather than fertility becomes anticipated. The papers contribute to HCI, STS, as well as feminist theory.

In addition, the dissertation makes contributions in terms of methods and methodologies by 1) adapting a method for critical examination of existing technologies (Paper 1); and 2) through reflections on the labor it takes to conduct research that is at once vulnerable for individual bodies (as it is intimate and personal), within research structures (as contributions are often dismissed as 'less important' or not rigorous enough), and for the researcher (to

affectively navigate research topics and own experiences). I shared multiple accounts of staying with hesitancy and discomfort (Chapter 5). For example, I reflected on the use of conversational data obtained from digital ethnography, how to work with such data, and how to consider my bodily discomfort encountering content around infertility. Rather than avoiding such affects, we might question what causes them and how we can productively dwell in them (Kofoed and Staunæs 2015; Perriam et al. 2024). My own autoethnographic engagements additionally brought forth aspects of data loss, reproductive data labor and how experiences of fertility become shaped across sites that make assumptions about our 'data-selves'. Particularly the last point underscored the value of autoethnography in this research space, as these platform relations first became visible through an extended use MFTAs that included my own phone and data practices (opposed to e.g., using a research pone that remains in an isolated space or mimicking engagement).

I further asked how we can think reproductive technologies and data otherwise (Chapter 6). Through experiments of re-visioning data through materialization, and technologies through speculation, I strengthened understandings of data as affective and subjective, and of reproductive temporalities as non-linear. I also shared reflections on the ways these explorations have sensitized me to re-visions in my empirical material. I discussed a feminist tracking app and a crowd-sourced data archive, as examples where data practices are being questioned and re-imagined.

FUTURE RESEARCH

As I discuss in Chapter 1, separating sites and cutting networks was necessary in order to research these entangled practices. Future research could (and naturally will) draw boundaries differently and expand sites of bodily datafication. For instance, I often encountered practices of dieting alongside generating data about menstrual cycles and fertile potentials. Particularly in the liminal space of fertility, where this dissertation is situated, people are

trying to ensure that their bodies are as fit and healthy as possible. This is presumably because MFTAs, for instance, prompt for such additional datafication (as I also discuss in Paper 1) but also because 'fat' bodies become marginalized within reproductive health, as they have restricted access to reproductive technologies (e.g., weight limits for IVF and AR), become governed during pregnancy (e.g., placement as 'high risk pregnancy') or not understood as reproductive in the first place (see LaMarre et al. 2020). Further research could thus include a broader variety of sites of bodily datafication, including for example weight loss/gain or chronic illnesses (that are *not* PCOS or endometriosis) to investigate how they too partake in and shape sites of fertility datafication.

Future research could also consider a long-term project investigating how relations to sites of datafication change throughout one's life course. While my participants where at different points in their lives, having different experiences with datafication technologies, these accounts remain in the moment or were reflected on retrospectively. Not only do people's life situations change, but throughout time they will most likely also encounter changed technologies and bigger data sets composed through even more sites. In Chapter 1, I already share that most of the data technologies I researched changed just in the short duration of my PhD. Those technologies will continue to change, also in light of the increased 'hype' around AI. How will these practices change through time and space? How will narratives around them change? How are people living with data over a longer time, where data will be lost, become obsolete, and matter differently?

CONCLUDING REMARKS

This dissertation showed how fertility comes to matter not only through using one datafication technology, but through different sites of datafication, availability of reproductive technologies, and through cultural narratives around decline, as well as through norms around temporalities, gender, and childrearing. I showed how experiences of reproductive health and fertility

sensemaking are complex and relational. This matters both for our research practices, as we need methodologies that allow us to create knowledge about individual experiences as situated in larger economic, legal, and cultural contexts; and to strengthen reflexive considerations of our own positions, and participation within our research projects. But this also matters for the potentials we ascribe to data, and consequently the relations we can surface between data, bodies, and technologies.

It is thus important for our practices to remain attentive to the ways these assemblages comprise shifting sociocultural and material contexts. This includes to understand datafication technologies not as isolated tools but as configurations that become relevant on the backdrop of other reproductive technologies (e.g., when self-tracking is used to avoid future IVF, or when data is shared online for collective sensemaking). By acknowledging these leaky and fluid contingencies, our research (and design) practices can give more nuanced accounts of the complex and individual experiences of reproductive health, while resisting to standardize them.

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PART TWO

PAPERS

PAPER 1

Walking Through Normativities of Reproductive Bodies: A Method for Critical Analysis of Tracking Applications

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Walking Through Normativities of Reproductive Bodies: A Method for Critical Analysis of Tracking Applications

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ABSTRACT

Menstruation and fertility tracking applications are of increasing concern in HCI research, as their use becomes more widespread. Methods are needed to understand how such applications become entangled in everyday practices. While these apps promise increased self-knowledge of reproductive potential by collecting intimate data about reproductive bodies, they also restrict the knowledge produced about users' bodies and embed normative understandings of reproduction and gender. In this paper, we scrutinize the normativities of reproductive bodies by deploying the "walkthrough method" to uncover sociotechnical entanglements of the menstruation and fertility apps Clue, Tilly, and Drip. We discuss how the walkthrough method contributes to HCI's methodological repertoire for studying intimate bodily tracking apps and unpacking their normativities. We offer suggestions for using this method to critically analyze existing apps and extend approaches to design with and for a plurality of in/fertile bodies.

KEYWORDS

reproductive health, self-tracking, methods, fertility

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1 INTRODUCTION

Since 2013, more than 300 mobile applications (henceforth called apps) pertaining to menstruation and fertility tracking have entered app-stores (both IOS and android) and the number is continuously increasing. Menstruation and fertility tracking apps (MFTAs) prompt users to track their bodily sensations, activities, and practices. Through rendering this information into quantifiable data [33], these apps provide predictions on future beginnings of menstrual bleeding and fertile phases. The rise of this so-called *femtech* sector brings methodological challenges and questions for research approaching this field. We propose that it is particularly important for HCI to develop methods that help to map this rapidly expanding area, understand how users navigate available MFTA and make sense of the alternatives. Such methods should consider not only in-depth use but how these apps open up forms of dis/engagement in everyday practices and how we might differentiate amongst alternatives in terms of data privacy, values, community, and norms around bodies and use. In this paper, we attend to the methodological needs within MFTA research by investigating three examples, namely Clue, Tilly and Drip. Employing the walkthrough method [32], we aim to map the ecologies these apps are part of and bring forward normativities within the MFTA space. The paper recounts both 1) our assessment of the walkthrough method in studying existing technologies for tracking the body and 2) our analysis of how normativities unfold across an expanding MFTA space. We conclude that the walkthrough method is particularly generative for exploring a range of alternative apps to think across the normativities in the expanding ecology of MFTAs but also requires consideration of the researchers/designers' positionalities and their implication. A growing body of research in HCI (and adjacent fields of STS and media studies) has drawn attention to the sociocultural, ethical, and political implications of apps designed for tracking intimate, bodily data. Under the broader concept of 'women's health', research on MFTAs has been conducted for example on data privacy (see e.g., [35]) or configurations of sexuality and reproduction (see e.g., [15, 21]). Research in this field not only highlights critical aspects, but also points to the empowering potential these apps may hold for users through increasing body literacy and self-explorations (see e.g., [14, 22]). Within this domain there has also been effort to redress the essentialized articulations of gender present in 'women's health research' [28] by exploring marginalized health and incorporating intersectional perspectives to consider how normativities embedded into (health) design can further marginalize particular users through essentializing aspects of gender, sexuality, ableism, and race (see e.g., [28, 29, 43, 46]). We build on this recent work into underrepresented bodies, by exploring normativities and underrepresentation within MFTAs, specifically related to queer and nonbinary identities and infertile bodily experiences). When we began looking closer at the emerging apps within this domain, we noted that they have begun to position themselves in relation to these underrepresented communities such as non-binary, transgender persons, or people experiencing infertility, who may have been excluded from prior technologies. While this might just be a marketing approach to define a niche in differentiation from existing apps, it nonetheless points towards the complexity of this space. Interested in further unpacking how normativities of health are exhibited within these design spaces addressing (previously) marginalized bodies, we started exploring methods available in HCI and how they can help to make sense of apps positioned as alternative and serving underrepresented users.

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As others have pointed out (e.g., [3, 40]), research into women's and reproductive health is a relatively new domain and therefore methodologies from other domains cannot be transferred without consideration and adaptation. Research into aspects of reproductive health requires methods that attend to lived bodily experiences [38], plurality of bodies and their intersectional entanglements [28]. Attention to marginalized users also requires a sensitivity to the increased exposure that participation in research studies involves and considering how to design for those whose lives are affected [40]. Moreover, when research is conducted into areas that have been historically underrepresented and even been tabooed, a new level of exposure to subjects' experiences as intimate is brought along. This requires careful methodological reflection, which was a core motivation for conducting this work.

Current methods in this domain include approaches such as autoethnography [e.g.,19, 24], participatory design [e.g., 15] or interviews. As we will discuss, these methods bring certain advantages such as attending to in-depth engagement with lived bodily experience of reproductive bodies. However, what we were looking for was a method that could enable us to examine a range of apps where we are not necessarily the intended users while still maintaining rigorous and critical investigation of the interactions the apps afford. We found the "walkthrough method" (as discussed by [32]) allowed us such a rigorous exploration of three MFTAs (Drip, Tilly, Clue), as we will elaborate throughout this work. By introducing an additional method to the research space of reproductive health, and HCI more broadly, we also respond to Bardzell's [7] call for more rigorous and critical methods to investigate interactions. We found the method combined with first-person reflections accounts as one way to fruitfully explore these methodological needs and outline paths forward in critical HCI research on interactions within MFTAs. We found it particularly useful for ***broadening attention to the processes of normativities that unfold across a range of apps even as previously marginalized subjects (such as queer or infertile bodies) are embraced into commercial design***, as we will expand throughout this paper. The method also allowed us a rigorous "interrogation of the complex relationships between (a) the interface [...] as well as its broader situatedness in [...] culture and (b) the user experience, including the meanings [...] and social sensibilities that arise in the context of interaction and its outcomes" [7]. In other words, the walkthrough method allowed us to actively ***explore how design and interaction attributes of MFTAs are entangled and situated in social and cultural ideas of reproductive bodies***. Thereby, the method offered us possibilities to better understand the oppressive and potentially emancipatory role of technology [40]. Through a critical analysis, the method exposed (unintended) consequences of designs [7] on normativities of reproductive bodies.

We begin by sketching recent contributions to reproductive health, as well as reproductive and menstrual health self-tracking within the HCI community. We further explain the walkthrough method as deployed by Light et al. [32] and present how we have used and adapted it for our study, before presenting the analysis of our own experiences of employing this method to the MFTAs Clue, Drip and Tilly. Through reflecting on our own entanglements as researchers/designers and women, we examine issues of power, normativities and marginalization that are surfaced and negotiated through the researchers' positionalities. More broadly, we discuss how researchers in HCI can benefit from working with the walkthrough method for critically exploring existing (design) features and interactions, specifically within MFTAs to account for an exploration of the plurality of (in)fertile bodies. Due to the scope of this research and our own positionality, we are however limited in our analysis to aspects of gender identity and infertility, as we describe further below.

Our contribution to the field of HCI, and reproductive health in particular, is thereby twofold. Firstly, we contribute to HCI by exploring the walkthrough method that allows for a critical engagement with existing apps and thereby offers a tool for designers and researchers to "productively engage in changing how we perceive, understand, and feel about our experiences with technology" [7]. Secondly, our analysis of three contemporary MFTAs brings forward understandings and normativities of reproductive bodies and investigates narratives through which they are becoming reproduced with technology, even when such technology is produced by members of these marginalized groups themselves, as we unpack during this paper.

2 RELATED WORK

A growing field of HCI research is concerned with exploring fertility and menstruation tracking technologies. Under the broader concept of women's health, research into different aspects of bodies and data entanglements, such as topics of menopause [8, 11], menarche [41], menstruation [10, 14, 16, 21] and reproduction [34, 36] is being conducted. This paper draws on work in women's health that is looking into the intimate data surrounding bodies. We also draw on critical work on self-tracking, which is often concerned with menstruation and fertility tracking and therefore overlapping with work in women's health. We build upon the critique that the framing of "women´s health" is unnecessarily essentializing in its focus on reproductive health as tied to cisgendered women [28]. While we draw from a field that understands itself as 'women's health', we want to make clear the distinction that our work is concerned with reproductive health, that encompasses male, non-binary and trans reproduction. It is also critical to consider our findings in light of intersectionality regarding how experiences of marginalization can overlap creating marginalization even within spaces that attempt to design for underrepresented groups [12, 43]. We will explore these vantage points in the following sections.

2.1 Marginalized Reproductive Health in HCI

Reproductive health is a relatively new subject within HCI research, with a specific focus on women's health becoming more established over the last several years. Early contributions to this area include the work by Almeida et al. [3] who discussed women's health as well as reproductive and sexual rights and thereby put these themes on research and design agendas in HCI. In that paper, the authors suggest that these issues have been understudied in the HCI community due to cultural taboos and the male domination of the field [ibid]. Since then, research into these topics has been growing. For example, Almeida et al. [2], have edited a special issue on women's health, bringing together diverse perspectives on the female body in HCI and discussing recent movements within the

field. Overall, women's health research in HCI aims to take into consideration the lived experiences and sociocultural discourse, in order to "improve and care for women's experience during various life transitions, promoting health equity for, and in turn politically emancipate women." [38]. This area of HCI develops design projects that "intend to destigmatize women's health experiences through challenging the role technologies should play herein and proposing better possible futures" [40]. This work investigates and designs for topics such as intimate care [3], menarche [41], menstruation [14, 16, 17, 21], fertility/reproduction [23, 36], and breastfeeding [20]. For example, projects such as Homewood's *Ovum* aim to break current conceptions of designing for reproductive bodies by designing for fertility tracking as a "shared, domestic and do-it-yourself experience" [23]. Similarly, Søndergaard and Hansen [42] explore in *PeriodShare: A Bloody Design Fiction* the social, cultural, and political issues of intimate technologies by creating a speculative menstruation cup that shares menstrual data directly on social media. Another example includes the work by Campo Woytuk et al. [10], who explored "touching" for constructing new knowledge about the self and a nurturing appreciation for the changing body. We build on this previous work within HCI which is investigating and designing for topics such as intimate care [3], menarche [41], menstruation [14, 16, 17, 21], fertility/reproduction [23, 36], and breastfeeding [20] and draw from it accounts of intimate care work that relate to parts of the body, or sexuality [3].

Recent work, however, has problematized this area of HCI as failing to address intersectional marginalizations in reproductive and bodily health and tends to exacerbate overrepresentation of views on reproductive health from the global north with an emphasis on white female experiences. For example, Kumar et al.'s [29] work brings forward a holistic approach to women's health or rather well-being, that encompasses aspects beyond health such as safety, empowerment, and knowledge. Here, they argue, HCI falls short to address more intersectional perspectives taking into account not only the technologies but also the ecologies those technologies are brought into including their different forms of oppression. Other examples, such as Tuli et al.'s [46] research gives insights into how menstruating bodies navigate spaces in which menstruation is stigmatized. Through personal experiences and exchange with friends and family, women in Delhi, find ways to navigate infrastructures to manage their menstruating bodies. Recent initiatives to help women find safe spaces, such as clean bathrooms via apps, have not found much use, as they are not offering the right information (such as cleanliness or availability of soap) but also overlooking gendered uses of mobile apps, in a context where women use apps less frequently. Through building on this work, we can make assumptions on the context the researched MFTAs are embedded in, namely targeted on users who have the infrastructures and resources for continuous tracking, exploring one's body and engaging in self-care actions. While some of the MFTAs are taking a period-positive approach, they are clearly situated in contexts where a certain degree of de-stigmatization has already taken place.

Additional critique from Keyes et al. [28], points to the essentialized articulations of embodiment and gender in women's health research in HCI, and scant discussions on intersectional perspectives in women's health research, thereby stressing the importance of studying bodies from non-normative and non-binary perspectives [43]. They propose reframing this research on 'marginalized health,' to reimagine women's health in HCI. While they acknowledge the work that is being done under the frame of women's health in troubling the 'status quo', they are also cautiously reminding us to not reproduce the normative and binary structures we are critiquing [ibid]. We aim to address this gap by considering (in)fertility as well as marginalized user groups of MFTAs, specifically those who identify nonbinary, queer, as well as how these different marginalizations possibly intersect. Recently, several apps have emerged in the MFTA market aiming to provide tracking support for persons in these marginalized groups. Through our research we empirically assess how these "gaps" in MFTA are being addressed commercially. The scope of this research does not allow us to go in depth with the multiplicity of intersecting normativities that are embedded in contemporary MFTAs. Further work could be done to analyze assumptions around race, geography, and class.

In our empirical work we have encountered a similar complexity of reproducing normativities, while trying to challenge them both in our own approaches but also within the MFTAs we analyzed. By using the walkthrough method, accompanied by first-person reflections and actively engaging with our own positionality, we found approaches towards unpacking these tendencies. As we address later, there are limitations to this method given our positionality, in addressing intersectional marginalization in reproductive health. We focus exclusively on aspects of gender, sexuality, and ability.

2.2 Understanding Bodily Relations in Self-Tracking Apps for Reproductive Health

Within the field of reproductive health, research on bodily experiences of self-tracking is increasing. Relevant research encompasses a variety of concerns ranging from the empowering potential of such apps [14, 21] towards critical analysis of normative design practices through making visible the underlying normative ideas of bodies and reproduction [16, 24]. For example, Fox et al. [15] aimed to unpack current menstruation tracking apps by downloading various apps and using them throughout a period of nine months. Through these engagements, they made claims about what the researched apps encourage, namely extracting intimate information about the body. Coupled with participatory design and historical analysis of menstruation tracking practices, their work provides a "vision for menstruation sensemaking" [ibid]. Other examples of research into reproductive health tracking employ similar methods to uncover privacy issues in fertility tracking apps. By downloading approximately 30 fertility tracking apps on their phones Mehrnezhad and Almeida [36] followed the path of data sharing, once consent is given/not given and explored how data is shared beyond the user's consent. To disrupt everyday practices with technology, Homewood et al. [25] studied menstruation tracking by non-usage. By removing the apps from everyday usage, they explored the emotional, embodied, and cultural knowledge of the lived experience of self-tracking [ibid].

We build on this work by exploring the walkthrough method [32]. This method contributes to existing methods by enabling rigorous and critical engagement with contemporary self-tracking apps pertaining to intimate bodily data to map the interactions

they afford. The walkthrough method [32] is most often used by researchers performing a critical analysis of a given app. The process of the walkthrough, as outlined by Light et al. [32], is divided into the three stages of 1) entry, consisting of the articulation of the initial steps made when entering an app, 2) everyday use, including replicating the intended everyday use of an app as realistically as possible, and finally 3) closing/exiting, including how users can exit an app. In this form, the method has found increasing usage in media studies (see e.g., [1, 6, 37] as well as STS (see e.g., [1]) and has sporadically been used in HCI (see e.g., [31]). It is worth noting that the walkthrough method employed here is distinct from the 'user walkthrough' or 'cognitive walkthrough' (see e.g., [47]) often used within HCI research to evaluate interfaces and the way users interact with those, focusing on usability and navigability. The walk through method, in contrast, starts from an understanding that the design of apps takes place within a cultural system and embeds cultural understandings. The method aims to surface "the material traces of those intentions" of designers through embedded cultural imaginaries of the intended user in order to make the app available to critical examination "as sociotechnical artifact" [32:886]. The walkthrough method, following Light et al.[32], suggests that through attentively and meticulously 'walking through' an app's interface, social and cultural understandings embedded in it can be unpacked. The method in this sense more closely resembles methods of close reading, as applied within HCI design interaction criticism [7], but with the addition of a highly structured and thorough set of steps.

We found that this method provided us with an entry point into studying MFTAs in relation to bodily relations, as we elaborate in the findings. It is distinct from other methods such as the cognitive walkthrough, participatory methods, or diary studies in terms of empirical scope, methodological commitments, and mode of analysis, as we discuss further. Consequently, by 'walking through' the MFTAs Clue, Drip and Tilly, we aimed to unpack sociocultural understandings of fertility and (in)fertile bodies. We chose these three distinct MFTAs for different reasons, as we will elaborate further. We expand on how the method was deployed and what the method enabled us to investigate in further sections below.

3 METHOD

3.1 Overview of the Walkthrough Method

Following Light et al. [32] we now present the three stages of the walkthrough (entry, everyday use, and exit) in more detail, before turning to our practice of applying the method. By performing these steps, this method can offer a tool to perform a critical app analysis. The first stage of *entry* refers to the detailed observation and articulation of the initial steps made when entering an app, meaning when registering to it. More concretely, when entering an app, the researcher should pay attention to the sign-up/registration process and scrutinize design elements of the app pertaining to the first contact a user has with it. These can include, for example, what information is required from the user and in what form, which questions are asked, how does the app ensure that the user information provided is handled carefully (e.g., privacy, GDPR). This step is crucial, since it is a matter of experiencing and reflecting on how the app has been designed and what design decisions have already been made that can impact the user interaction at this stage. As stated by Light et al. [32] the expected use of an app is often already communicated during this phase of registration. Thus, this stage can potentially reveal nuanced understandings surrounding an app's intended use and approach towards users.

Once the researcher has passed the *entry* stage, they move on to the second one, which is *everyday use*. The aim of this stage is to replicate the intended everyday use of an app, as realistically as possible, while focusing on recording the functionality, options, and affordances that the app provides to users [32]. This second stage of the walkthrough takes more time to complete and can expand on a time span of a few hours to months, depending on the app and the user engagement it invites for. According to Light et al. [32], who elaborate on this stage in detail, walking through even an app's basic functionality can provide a sense of what activities it enables, limits and guides users towards. And through paying attention not only to the app's features but also to the flow of activity (i.e., the order of screens and functions) can provide valuable data for the researcher conducting the walkthrough. The third stage of the walkthrough method includes the *closing/exiting*. This stage focuses on zooming into, and reflecting how users can exit an app, including if, and how one can delete their account, and what happens to the users' data once they delete an app. While going through those three steps the researcher should take extensive notes, accompanied by screenshots of different screens/interfaces, including features of the app and 'flows' of (inter)activity, where observations take place. As articulated by Light et al. [32], detailed observation and extensive note taking is important as "*slowing down the mundane actions and interactions that form part of normal app use" contributes to making them "salient and therefore available for critical analysis*" [32:882]. The process of 'walking through' an app is usually accompanied by research on other material that surrounds an app, aiming to a more holistic contextualization of the sociocultural infrastructure that the app is embedded in. These can include the app's website, promotional material, descriptions, and tags, as well as reviews it has received in app stores.

3.2 Our Approach to Conducting the Walkthrough Method

We have conducted a walkthrough of the three apps, Clue, Drip and Tilly, as they cover a range of commercial apps for fertility and menstruation tracking, spanning from more established MFTAs (Clue) to newer ones (Drip and Tilly) that are developed by marginalized groups themselves, namely menstruating and/or infertile women. Focusing on three different apps also allowed us to zoom into aspects of menstruation and fertility tracking from slightly different perspectives, as guided by each app, while at the same time providing a ground for comparison across the apps.

Clue is one of the most used apps on the market for fertility and menstruation tracking, with a total of 12 million active users [49]. Clue therefore builds part of the 'status quo' that some newer apps, like Drip, are positioning themselves against but also being measured against, as our analysis will show. Consequently, to understand what academic and commercial critiques are based on, we found it important to include this app in our study. Clue allows users to track bodily symptoms (e.g., bleeding, pain), activities (e.g.,

intercourse, exercise), emotions as well as means of birth control (e.g., pills, IUD). The data is then analyzed and visualized by the app to predict future fertile windows and menstrual bleeding.

Drip on the other hand is a rather new app (first available for download since 2022), open source and embodies ideals of inviting users to be in control of their data. Additionally, it is developed by women, and its creators communicate explicitly that this app departs from current MFTAs, by having addressed and improved particular aspects that have been criticized in other apps, such as transparency, data privacy and bodily sensemaking. In Drip, users are actively encouraged to explore their bodies through touch, as the consistency of the cervical mucus is one of the markers Drip uses to make fertility predictions. The other markers used are temperature and menstrual bleeding. Thereby Drip diverges from the other examples, as it makes clear which data points are being used for making predictions, as we will further discuss in our findings. Drip's open-source nature furthermore offered us dense material surrounding the use of the app, as we were able to investigate Drip's Gitlab space in which the development process is being discussed and users can give direct feedback. Drip, compared to Tilly and Clue, is the only app that has made visible the processes and negotiations around its development by offering all the designed screens and features of the app as open-source code, which is freely available on the Gitlab online platform.

Tilly is specifically targeted on tracking when in fertility treatment, which adds a different dimension and medicalization to menstruation and fertility tracking. Apart from tracking bodily sensations (e.g., cramps, bleeding, temperature), emotions (e.g., happy, calm) and activities (e.g., intercourse, exercise), Tilly also offers the possibility to track one's fertility protocol and medication. In addition to sending reminders to track or announcing the upcoming of menstrual bleeding or ovulation, Tilly also sends reminders when medications should be taken. We also chose Tilly, as the app is conceptually developed by two women who have gone through fertility treatment themselves – a 'stressful journey' that they now want to support others with through data-driven personalization.

A1 conducted the walkthrough on all three apps, expanding the 'everyday use' phase over approximately three to six months. The detailed data gathered, in the form of written notes and screenshots as well as personal reflections, were analyzed and discussed by all authors. In order to partake in this analysis, the second and third authors also downloaded the apps on their phones but have only sporadically interacted with them. The main part of analysis was therefore centered around the data gathered by A1. Each walkthrough started by finding the app in the app store, going through the description of the app, and installing it on the author's mobile phone. Then the steps and documentations of the walkthrough method were followed for each app separately. Finally, apart from engaging with the apps, we have also analyzed the surrounding material including the apps' website, and reviews as well as the GitLab space for Drip. The way we have used the walkthrough to analyze the experience of using the three fertility-tracking apps Clue, Drip and Tilly follows Light et al.'s [32] suggestions of using it with the goal to "*make explicit the otherwise implicit and (by design) apparently seamless process of engaging with a digital media object*". In particular, we used this method to make sense of the ways underlying app infrastructures replicate, reinforce or diverge from cultural ideas on i.e., gender, sexuality, and ability [13]. When deploying this method, we were aiming at examining one app at a time, engaging with its (invisible) infrastructure and more visible forms of guidance and affordances. By going through the three steps, this method helped us to uncover elements including each app's expected use, who are the expected users, what is the expected context of use and how are users being guided in using each app.

During the everyday use phase of the walkthrough, A1 made use of first-person reflection notes [27] of her experiences interacting with the respective apps. While the initial walkthrough method rather suggests a 'mimicking' of everyday use, we found it useful to engage deeper and longer with these apps, as notifications and temporalities of tracking shaped the way we understood governing mechanisms and affordances of the apps. This allowed us to gain rich data, which we then analyzed together with the walkthrough data.

We analyzed the material by collectively reading and discussing the notes, screenshots and documentation of the walkthroughs conducted by A1. This process was executed over several meetings. During this phase, A1 also explained and contextualized her first-person reflection notes accompanying the walkthrough data. After all authors were familiar with the material, we analyzed it together, considering where we see norms surfacing in relation to reproduction, gender, and body through each app. We took a reflexive approach to conducting a thematic analysis [9] on our material, in which "*meaning and knowledge are understood as situated and contextual, and researcher subjectivity is conceptualised as a resource for knowledge production*" [9:334]. Thus, we started from our own reflections when coding themes from the data and surfacing patterns. In particular, we looked for moments where norms around reproductive bodies became visible within the MFTAs in terms of their narratives, visual representations, and patterns of use. Once identified, we clustered these within themes such as "body literacy" or "gender assumptions". In the following section, we present the findings of this analysis by focusing on a subset of these themes, which we think best illustrate the dynamics of normativities at play, uncovered in instances when norms come into tension, and are both resisted and reinforced. Therefore, we were interested in unpacking and presenting not only which norms are embedded into these MFTAs, which are too numerous to exhaustively present here, but also, and most importantly, where we observe norms in moments of reconfiguration [44]. By this we mean the extraction of features in the apps, or specific context of using an app, where the app designs are specifically aiming to interrupt or resist norms.

3.3 Author Positionality

Throughout this paper, we point towards potential issues in researching spaces of intimate bodily data tracking due to the entanglements of researcher's and designer's own positionality and lived experience. We find it therefore important to spend a few words on our positionality and relation to this research before progressing further. Each of us identifies as a woman, who, to different degrees, have been engaged with our own menstruating bodies and their fertile potential. One author has navigated infertility and participated as a subject of medical research on infertility as well as participating

in data sharing among LBGTQ* groups related to fertility, while the other two authors previously tried to make sense of their fertile potential in order to avoid pregnancy. Therefore, our lived experiences in this regard are varied. We are sharing queered understandings of bodily experiences and relations with the world around us, that go beyond male/female dichotomies. We all work fulltime in academic settings that are dominated by ideas of Computer Science and Informatics, which often, as also highlighted by Fox et al. [15], work to reinforce the hierarchies of knowledge and sensemaking that our work aims to surface and unpack. Additionally, all three of us are situated in a western ethnographic context which shapes the understandings we have of our own reproductive bodies but also the resources and spaces we have available for conducting this research. We are located in a Northern European context (Denmark), were we have public access to reproductive health services including abortions and assisted reproduction and where taboos around menstruation and reproduction are not prohibitive of e.g., hosting academic workshops on MFTAs to discuss related topics. The selection of apps to examine are shaped by our location in that we are among the intended users, e.g., as English-speaking persons living in areas with access to reliable technological and health infrastructures for tracking and navigating reproductive health.

4 FINDINGS: UNPACKING NORMATIVITIES OF REPRODUCTION

Through the conducted walkthrough we could see different elements/features in each app surfacing issues related to normativities of reproduction, which we present and unpack through concrete examples in this section. In presenting our findings we do not include the entire walkthrough analysis and A1's first-person reflections. Instead, we present three themes that we developed through the analysis of our data. These themes highlight 1) underlying assumptions of normativities of reproduction, including gendered understandings of reproductive bodies, which we unpack through examples of the *entry phase*, when accessing the apps Tilly and Drip for the first time and following the sign-up/registration process (sub-sections 4.1). 2) Normativities of self-care and bodily literacy, which we address through examples of the *everyday use phase* of Drip and contextualize it with Drip's website material and Gitlab space (sub-section 4.2). 3) How possibilities for dis/engagement are structured in the apps, which we explored through examples of the *everyday use phase* of Clue and Drip, as well as through the walkthrough material of Tilly (subsection 4.3). Thus, we present each theme through at least one example illustrating how we have developed it through the walkthrough, and in the collective analysis of the data gathered. Not all apps are included in each theme, since one theme might have been surfaced mainly through the walkthrough of Clue, for example.

We present each of the themes below through a series of questions that anchor our analysis. These questions were articulated retrospectively once we had thematized the findings around certain dynamics of normativities that arose in the walkthrough and subsequent analysis. While the questions are therefore not identical to those offered in the walkthrough method presented by Light et al. [32], they demonstrate how the walkthrough method lends itself to framing questions around bodily norms. We believe these questions can thus inform those who might wish to deploy the walkthrough method towards similar analytical aims.

4.1 Normativities of Gendered Reproductive Bodies

The first theme includes underlying assumptions of reproductive bodies and normativities that MFTAs might hold for end-users. We will present this theme through A1's experiences of the *entry* phase of the walkthrough performed on Tilly and her experiences of the *everyday use* phase.

4.1.1 What gendered Identities are included? As a first step of the walkthrough, and app usage more generally, A1 goes through the sign-up process of Tilly. Here, she must answer several questions, so the app can "get to know [her] better". Tilly is asking for information on her fertility journey, height, weight, name, birthdate, and level of fertility stress, as well as biological sex. A1 enters all the requested information but is wondering about the framing of 'biological sex'. Does that mean they are anticipating other users than cis-women? That wonder quickly becomes silenced when seeing the answer options which are 'female,' 'male' and 'I prefer not to say' [see Figure 1]. While this initially appears to anticipate user identifications that are non-binary, it eases these alternative gender identities by subsuming them within a preference not to identify. Thereby the possibility to state and make known any other identity becomes excluded. It suggests that the design cannot be held accountable to those identities that remain 'unstated'.

When moving further into the app space, the content in the 'learning' section, as well as conversations in the community space, make us think the difficulty a person might experience with conception is often attributed to the male or female infertility as a first step in diagnosis when a couple is cis-hetero. This also becomes visible through notifications send by the app of new guides and articles about the psychological effect of infertility on couples' relationships [see Figure 2] that discuss the stresses of "sex on demand". Thereby carrying assumptions that users of the app are in a heterosexual relationship, aiming to conceive "naturally" on their own. Interestingly, information on relationship status or sexuality is at no point requested but apparently becomes assumed. Queer, trans, non-binary couples, polyamorous relations, or singles are thereby not explicitly taken into consideration.

4.1.2 How are Reproductive Bodies configured? Returning to the signup process, A1 chooses female but cannot stop wondering about the formulation and what app-space she would have entered when choosing another option. With the small sub-heading "This helps us provide you with relevant facts and guidance," (see Figure 2) she almost feels obliged to disclose her biological sex in order to get guidance that is relevant. This leads us to think that the assumption the app poses on fertility, is a cis understanding of fertility that is related to which reproductive organs one has. The option of 'I don't want to say' has little to do with identifying as non-binary or non-cis users, as they would also require access to appropriately relevant information and guidance, which is not available. Through collectively discussing and analyzing the data gained from the walkthrough, we found that ideas of what and who a reproductive body is, are being implemented at different points of interaction.

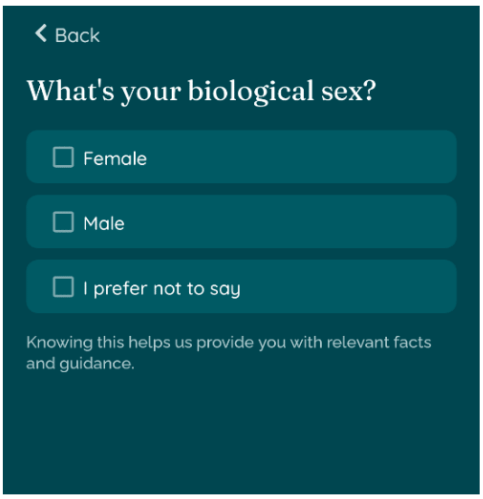

Figure 1: showing Tilly asking for the biological sex of the user, giving answer options of 'female', 'male' and 'I prefer not to say'. The subheading reads: Knowing this helps us provide you with relevant facts and guidance.

Figure 2: showing the various notifications received by Tilly within several hours.

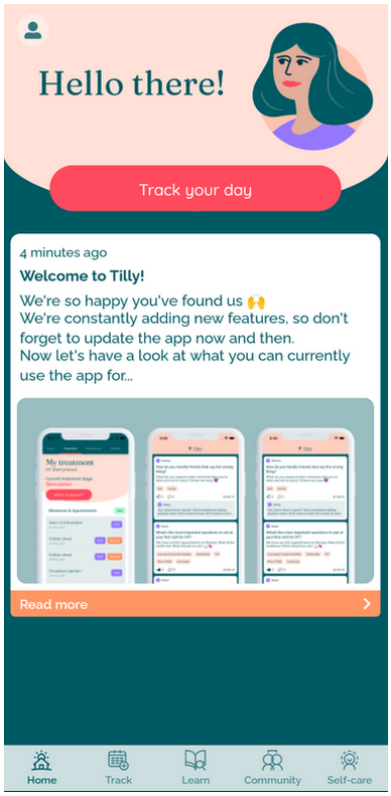

Figure 3: showing the interface of Tilly. Menu banner on the bottom shows the different spaces: home, track, learn, community and self-care.

After downloading the app, maybe reading the description in the app store, the sign-up process is where the first interaction between the user and the app takes place. Here, ideas of who might use the app, hence is a potential reproductive body, are becoming visible through the walkthrough method.

Let's stay with Tilly for a moment. After the sign-up process, A1 enters the app space where the tracking, and community interaction takes place (see Figure 3). Curiously A1 explores the various categories that can be tracked as well as the 'community', 'self-care' and 'learning' space. A1 accesses the tracking space to concentrate on the interaction that can take place there. Tilly enables and encourages users to track information on bleeding, cervical mucus, temperature, sex, pain, digestion, other symptoms, mood, happiness, stress level, diary, exercise, diet, weight, ovulation test, pregnancy test and appointments. Thus, users are not only facilitated to track symptoms pertaining to intimate bodily processes (i.e., bleeding, cervical mucus) but also about activities (i.e., sex, workout) and feelings (i.e., mood, happiness). Not only does the existence of these categories say something about the ideas of a healthy reproductive body but also the icons used as well as the answer choices that are given. For example, Tilly offers the possibility to track one's diet but seemingly makes judgment on what a good and bad diet is by color coding a healthy one with green and an unhealthy one with red. Similarly, the icon for breast pain shows the torso of a small waisted and big breasted woman (see Figure 4).

Here the walkthrough method enabled us to pay attention not only to the meanings of icons but also to the meaning the mere existence of a tracking category might carry. In other words, by including tracking categories like sex, diet, exercise, meditation, the app carries certain ideas of a reproductive body, sexuality, and selfcare. We will continue with ideas of self-care in the following section and return to the importance of tracking categories in section 4.3, where we elaborate on the possibilities of engaging and disengaging with the MFTAs.

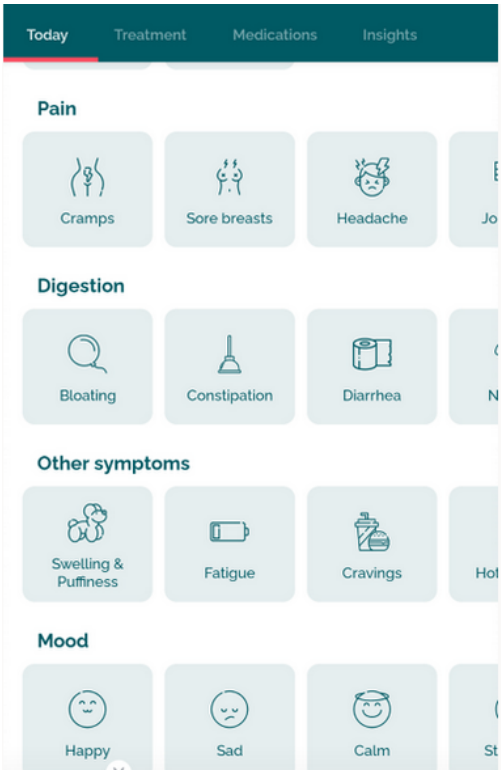

Figure 4: showing an example of tracking options, as well as their icons.

4.2 Normativities of Self-Caring and -Knowing Reproductive Bodies

The second theme we constructed through our data unpacks ideals of self-care and self-knowledge that emerge within spaces created by marginalized groups themselves. We will present this theme through further data generated through the walkthrough of the Tilly app and additionally look at first-person reflections and walk-through of the Drip app.

4.2.1 What Modes of Knowing do the Apps promote or promise? After completing the sign-up process for Tilly, A1 is greeted by a message from the two founders. The short text under their picture welcomes her to Tilly and assures, that 'we are in this [the fertility journey] together' and that she has found a community now. Part of the sign-up also includes a photo of the founders saying, "we are glad you found us." A1 also gets the information that they're providing her with an app they wished they had when going through fertility treatment themselves. Their goal is to relief "fertility stress through data driven personalization" [40], carrying ideas that treatment inherently is a stressful process that needs to be/can be balanced through personalized recommendation and (self-)care. Consequently, there is a lot of focus on self-care which becomes visible through its own dedicated space in the menu header. The space provides different guides for yoga and meditation. Consequently, this space carries ideas that one takes good care of oneself through yoga and meditation, inherently through obtaining and maintaining a 'healthy body.'

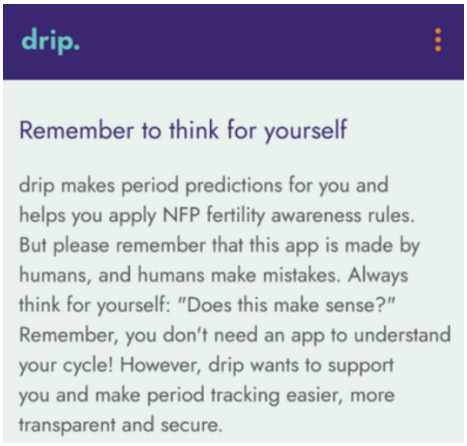

Figure 5: showing screenshot of Drip's statement to 'remember to think for yourself'

The learning section under the slogan 'knowledge is power', provides information on different aspects on fertility, male as well as female fertility. While this apparently acknowledges that different bodies can be involved in fertility issues (though only binary bodies), it only seems to be the female body that requires tracking and self-care. Not only practices of meditation and healthy diet are presented as self-caring actions, but also self-knowledge is being promoted as self-caring action. Through collecting data, users can take better care of their bodies and reproductive potential. Diverging from these understandings, Drip follows the idea that users should be mainly supported in sorting, collecting, and saving their data, while relying on their own self-knowledge when making sense of this data.

Information on Drip's website suggests that its users have experienced other fertility and menstruation tracking applications that make too many assumptions and predictions about their body. Drip offers an alternative to these other apps by suggesting that one knows one's own body best: "It's really cool when you can be competent in knowing your body and making confident decision for myself," Drip states on their website [51]. This idea of being 'competent in knowing' gets mirrored when browsing through the various information on the tracking categories, where Drip often prompts the user to 'think for yourself' (see Figure 5). We understand their approach as encouraging for self-reflection and sense making, going away from ideas of data objectivity and more towards listening to our embodied knowledge. However, after reading this prompt several times, A1 almost feels offended. Am I not thinking for myself when using data provided by the app? Was it wrong of me to seek more information here, should I just have thought for myself? Am I not reflective enough? she notes down in her reflective notes on this experience. It almost feels like the app is assuming that the users are not thinking for themselves, so that they constantly must be reminded of doing so.

4.2.2 What Modes of Knowing do Users seek? As mentioned earlier, part of the walkthrough method includes engaging empirically with

the materials that support an app's ecosystem. In the case of Drip, this included an analysis of the app's associated Gitlab, a platform where the app's open-source code is available and open to user and developer discussion. Users discuss, for example, the types of tracking opportunities, predictions, and visual representations the app offers. Walking through this user feedback on Drip's Gitlab made visible the processes and negotiations around its development. By following the Gitlab tag 'user feedback', we explored the demands users placed on the app. As pointed out previously, Drip tries to make the users think for themselves and break with normative temporalities of bodies, menstrual cycles, and fertility. Yet at the same time, looking through the user requests on Gitlab we see demands for functions users appreciated in other apps, e.g., "can't you make the cycle visualisations like in Clue?" In Clue, the menstrual cycle is represented on a circle, starting with the first day of menstruation, marking predictions of the fertile phase and locating one's current position on this cyclic trajectory that ends with the first day of menstruation and at the same time starts all over again. Drip on the other hand uses a calendar overview, which represents cyclic time linear in that format. This visualization of tracked data makes it less intuitive to understand in which part of the cycle one currently is in relation to fertile window and beginning of menstrual bleeding. Which is in line with Drip's incentive to make users think for themselves, rather than giving them too simplified orientations of their cyclic position. This is one of multiple examples in our walkthrough analysis, which shows that (some) Drip users are in fact relating the app to practises its designers are trying to evade, particularly normative representations and predictions of fertility and menstruation data.

Both Drip and Tilly are spaces designed by marginalized groups namely (in)fertile and/or menstruating women for the marginalized groups they are part of. Thereby their own ideas of reproductive bodies and well-being are, perhaps unsurprisingly, inscribed into the technologies they produce. This became visible through the walkthrough method we employed. As discussed in the previous sub-section, with Tilly we see the ways they are focusing on self-care and how specific ways of taking care of oneself become the norm. Through everyday engagement with Drip, we explored the normativities arising in form of self-knowledge and self-reflection. Thus, there are two main insights that emerged regarding normativities within these design spaces that are oriented to sub-communities of menstruating and (in)fertile bodies. The first one might be obvious, but even when addressing a gap in the market of existing MFTAs, normativities and assumptions about reproductive bodies within these spaces endure. Our second point is that users are often seeking out normativity. Knowing one's own body best, as Drip suggests, is not always what users seek, as there is a desire for comparison and understandings of what is "normal", as we have seen when analysing the user feedback of Drip. This raises questions whether design can simultaneously challenge normativities while providing marginalized users with common bodily understandings that they are seeking.

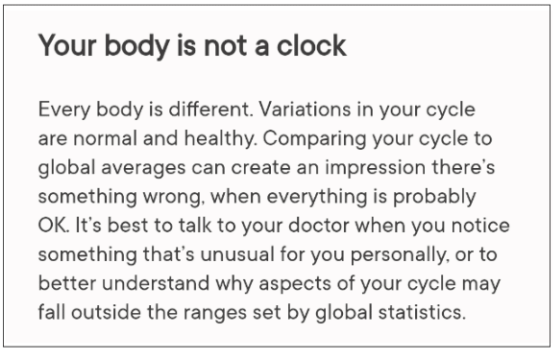

Figure 6: showing Clue's notification accounting for ideas that bodies are not clockwork, but also saying that comparisons to 'normal' are being made based on global statistics.

4.3 Normativities of Dis/Engaged Reproductive Bodies

So far, we have presented the ways MFTAs prompt for interaction through for example tracking reminders or invitations to partake in a community. But the walkthrough method also allowed us to pay attention to affordances of opting out/disengaging. Through the third theme we therefore would like to draw attention to possibilities of engagement and disengagement regarding how apps can leave space for users to decide the degree of engagement, which might change from day to day or based on different circumstances. We will present this theme through insights from the walkthrough conducted on the Clue app, accompanied by insight from the walkthrough of Drip.

4.3.1 Which Bodies are made predictable? "If your cycle length varies, you might want to turn off Clue's predictions. There might be a higher chance that your cycle length varies, when you are a teenager (younger than 20); you are or recently have been pregnant; you're breastfeeding, you are in transition age (45 year or older); you are suffering from something that can affect your menstrual cycle (e.g., PCOS or endometrioses).": Clue states in the extra information field when turning predictions on. This leads us to think, that Clue acknowledges that their algorithm can only account for a certain kind of body, namely a body that averages global statistics (see Figure 6). Instead of adapting and personalizing tracking options, accounting for individual bodies and different rhythms, the app is informing the user when not to rely on predictions. However, research suggests, that one of the main reason users engage with MFTAs is because they want predictions on their menstrual bleeding or fertile phases, in order to feel more prepared [6, 15]. According to Clue, A1 has a 'normal and regular' cycle, with a cycle length of approximately 27,5 days on average.

A1 thinks that she is tuned in to the sensations of her body. She knows when she is ovulating and most of the time can feel on which side of her ovaries the egg is releasing from. By paying attention to the consistency of the cervical mucus A1 knows when she is getting close to the start of her menstruation. And by looking at her blood flow, she knows which day of her menstruation she is at and how much longer it will last. However, she cannot seem to get Clue

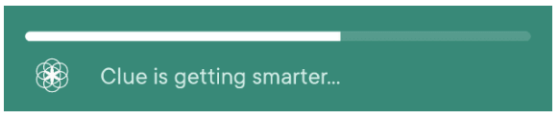

Figure 7: showing the little banner "clue is getting smarter" after tracking a symptom

to understand and represent her body the way she is experiencing it. For example, 'when I am tracking ovulation pain on a day where Clue predicted that my ovulation already has happened, that does not make the app edit the prediction. Frustration about this made me opt out of using this function as the app would not learn/accept how my body works, which in return made me question my bodily sensations.' This example shows that there are normativities within normativities – that is, one can have a "normal cycle length" but a long or short "luteal phase" meaning that predictions of this kind based on cycle length can also be wrong, consistently. For the user who is using the app to understand one's bodily experience, this will create a misalignment. For the user who has had failures in (assisted) reproduction, these errors may represent huge losses of time, energy, or expense.

4.3.2 What do the App's Predictions require from the User? By the time of this study, both Drip and Tilly did only have three months of A1's cycle data, therefore imprecisions were expected as they state that minimum three months of cycle data is required to make valid predictions. Consequently, we cannot make any comparison of accuracy between the apps, which is also not the goal of our analysis. Rather, we want to tune into examples of how particular apps afford for a(n) dis/engagement. While Clue offers some limitations from the beginning by stating which bodies should turn off predictions, as they inherently will be wrong, A1 feels like disengaging despite not falling under these categories. Looking to Drip, we recognize different means of dis/engagement, which we unpack below. As one of Drip's goal is to be transparent, the app informs that only data tracked in the categories *basal body temperature, cervical mucus,* and *menstrual bleeding,* will be used for fertility/menstrual predictions. Clue and Tilly do not make such clarifications. In the first-person reflections on Clue, A1 wondered what digestion, or her height have to do with her fertility or menstruation. She tried to recognise patterns of e.g., feeling bloated and ovulation or energy level to menstruation. She was thinking that when tracking more symptoms, the more precise predictions she will get, as Clue is "getting smarter"—that is at least what the little banner says every time new data is being added (see Figure7). However, knowing which data is used for analysis and prediction in Drip, felt empowering to A1. In particular, it made her feel empowered knowing that the rest of the data she is providing is only for herself, and not for the app to get smarter, as the app does not need this information for making predictions about her cycle.

What the walkthrough made visible here, is that different apps offer different possibilities of disengaging, which can empower or disempower users depending on the degree of transparency provided by the app on how dis/engaging from tracking particular type of data can affect the precision and quality of predictions offered by the app. While Clue's information of insufficient prediction does not give the user much of a choice weather to engage or not, as the app clearly states that they cannot accommodate their bodily rhythms once they are departing from standards. Whereas opting out of Drip becomes more of an active choice, as Drip makes transparent which data is being used for fertility predictions and which data is just for one's own information, leaving it to the user to track beyond the required parameters, or not.

4.3.3 What are the Costs of Engagement over Time? As touched upon in sub-section 4.3.1, errors in prediction might mean different things to different people. For example, imprecise prediction might have different consequences for users using MFTAs as contraception methods than for users tracking their cycle to get to know their fertile days in order to schedule intercourse or other forms of insemination. Users who have accrued years of experience with infertility and assisted reproduction might yet have another approach to knowing their own bodies and using MFTAs due to an ongoing datafication and medicalization of their bodies. The apps' predictive abilities do not only depend on whether a person has an extensive enough data archive on their body and reproductive potential that can be fed into the apps (all researched MFTAs require a minimum of 3 months of data), but the promise of getting smarter about one's body over time depends entirely on an ableist assumption that the body is not made unpredictable by conditions such as PCOS or other infertility diagnoses. This fails to consider how users might be on a journey towards diagnosis while using such MFTAs.

Additionally, the norms embedded in an app in terms of prediction can come to shape the experience of becoming infertile prompting users to dis/engage in ways that often misalign with their felt bodily experiences. Not only can some predictions be routinely wrong for people, whose cycles exist outside the norms (or even when inside, as we have previously explored), but there is also a question of how these apps monetize in ways that are shaped by temporal norms. For example, most of the apps, as we have discussed, offer predictions that assume a user is engaged in understanding primarily the current and upcoming cycles in the near term. Predictive ability of these apps is disrupted both by irregular cycles but also by miscarriages. None of the MFTAs we analyzed offer possibilities to track pregnancy, miscarriage, or insemination (assuming users conceive naturally). Even apps like Tilly that aim to address experiences with infertility do not offer such options. Tilly, however, provides features that consider the journey of users as they encounter and then learn more about their potential infertility, such as offering additional information material or online workshops. Here we see how an MFTA such as Tilly manages users' engagement over time. For example, introductory materials in the learning space of the app discuss possible causes of infertility and how to time sex for ovulation (in addition to assuming heterosexual reproduction). These free modules address the most common advice given to people who have just started to encounter challenges when trying to conceive on their own – i.e., how to time intercourse better for conception. Which is also assumed to be one of the reasons someone might begin tracking, to use predictions to improve the timing conception. More in-depth guides specific to diagnoses such as PCOS (polycystic ovary syndrome) or immunological issues are behind a paid subscription.

More precisely, questions such as "*How do I know when I am ovulating? What is the egg reserve?,*" and *"What can your cycle tell you about your fertility?"* are offered for free. Articles beyond the paywall are full of terms that would (only) be familiar to someone already acquainted with infertility jargon. *"ICSI or not?", "Do I need PGT-A?"* or "*Why does IVF fail?"* These are questions of interest to someone who has already begun treatments, received diagnoses, and experienced further challenges. This shows how this particular app is structured to promote users through a journey from exploring possible infertility into more specialized knowledge such as particular infertility diagnoses or undiagnosable challenges in assisted reproduction. Broadening out from predictability, we can see how apps thus configure engagement and disengagement through monetization schemes or imagined use cases at different stages of lived experiences. These patterns of imagined engagement are in turn shaped by how the apps consider reproductive health over time. While the Tilly app makes a quite clear distinction between paid and unpaid content, we can consider across other MFTAs how the costs of disengagement might also be non-monetary. For example, what would be the costs of disengagement from apps once data has been stored there for a long time? How do the costs of engagement or disengagement from apps change over time and how does this relate to temporalities of reproductive health over the long durée?

5 DISCUSSION

The walkthrough method allowed us to critically investigate how the MFTAs Clue, Drip and Tilly afford interaction and govern sensemaking of reproductive bodies. Through zooming into the entry phase, everyday use, and first-person reflections, we have explored how we see normativities surface at different points of interaction with these apps. We suggest that the walkthrough method can be employed as a tool for critical interaction research, which could help unearthing how reproductive bodies are entangled in socio cultural systems. In the following we further discuss what the walkthrough method allowed us to uncover and point to limitations we experienced through our own positionality in the field. Our discussion takes the themes presented in the Findings section 4 as a starting point, but moves beyond those, offering a set of design orientations for designers and researchers working with MTFAs, which can support in navigating issues of normativities of (in)fertile bodies.

5.1 Challenging or Reinforcing Normativities?

As laid out in our findings, the walkthrough method aided us to track different interactions where normativities emerged when using the MFTAs Clue, Drip and Tilly. Such an example was Tilly's focus on self-care. Through making data visible and sharable, intimate processes are being externalized, so they can be taken into consideration for self-care actions or shared with a partner. In her research on self-tracking apps pertaining to fertility and sexual activity, Lupton [33] observed how practices of wellness and self-care originate in neoliberal politics "emphasizing the personal behavior and self-tracking responsibility of citizen" [33: 449]. Thus, self-care has become a new norm within neoliberal narratives. By placing the focus on self-care and the female body, we saw that Tilly supports rather than challenges normativities of self-care and responsibility of fertile bodies. The focus on the female body within this fertility journey also points to a lack of intersectional perspectives. Here, intersectional perspectives refer to the idea that bodies are marked by multiple forms of minority status and are therefore also multiple marginalized [18, 28, 39]. This means that after scanning the vast amount of MFTAs, one might finally find an app that is specifically designed for infertile users, but if they are also non-binary or non-cis-hetero, users will still encounter erroneous assumptions about their body and its relation to reproduction.

Not only self-care, but also self-knowledge gains increased importance in this space as we saw from narratives emerging in Tilly as well as Drip. We pointed towards Tilly's promise to reduce fertility stress by enabling users to collect information on their bodily activities as well as functions and consequently rendering them into quantifiable data [33]. Tilly's focus on data-driven personalization speaks to ideas that "self-knowledge and detailed understanding of one's body and its function are achieved primarily via numbers, as is evident in the emphasis on 'data-driven advice' and 'data-science"' [ibid: 446]. Lupton argues that quantitative data becomes represented as objective forms of information on one's reproductive potential, which is understood to be more reliable than subjective experiences of bodily sensations and rhythms [ibid]. While the broad category of self-tracking apps encourages people to think about their bodies through numbers [ibid], Drip encourages understandings and explorations through touching and being with one's body, aiming to disrupt contemporary ideas of data-objectivities. Here, we recognize ideas from design research that point to a lack of women's knowledge of their own anatomy and through the augmented system *Labella* aiming to support intimate bodily knowledge [4]. The authors also point to the socio-cultural entanglements of bodily understandings that result in a tabooization and privatization of intimate areas (see also e.g.,[46]). Further existing research explores touching of menstrual bodies, proposing that these explorations are actively coming from the body instead of only being about it [10]. Opportunities for reflecting on one's 'self' are opened up while a new potential for intimate bodily knowledge is prompted [ibid]. However, we have shown that some users seek out certain data-objectivities they can relate their personal sensations to and request sensemaking through algorithmic objectivity. For example, in cases where users engage with MFTAs to explore their bodies in relation to potential reasons for infertility. The more challenges one encounters in this process over time, the more knowledge is required to make sense of one's situation. However, the more one moves into a niche within a sub-community, the less data is available, and sense-making becomes subjective in moments when users are seeking some objectivity and norms. Yet, this type of objective sense-making for bodies in these sub-communities can often not be accommodated by the design of current applications.

This desire for data objectivity presents a dilemma for designers who may wish to avoid the potential harm of normative data-objectivities. For example, Drip aims to evade such objective sensemaking of intimate processes with a focus on supporting bodily awareness. Prior work has focused on the harm of normative categories embedded into MFTAs and their objective meaning-making. For example, these apps can reinforce "authoritative narrative[s]" and harmful ideologies around bodily experiences of

reproduction which can further become a form of "symbolic annihilation through design" such as when apps "omi[t], trivializ[e], and condem[n]" experiences of marginalized groups [5:623]. When non-normative experiences such as pregnancy loss are excluded or segregated in the design of apps, this can further reinforce and reproduce stigma and marginalization around such bodily experiences [5]. In the case of Drip, some users find purpose in having this objectivity, as we have shown in our analysis by pointing towards user requests for more data-objectivity and their needs to relate to norms in non-normative spaces. This disjuncture raises questions as to **how design can evade normativities while working within structures of objective sense-making**. As Ng et al. [38] note in their research on the design case of the menstruation cup Farmoonsa in Taiwan: "the precarity of working within the system risks reenacting, and thus perpetuating, the very structures of power that one is attempting to resist." [ibid:20]. While Drip and Tilly are trying to break with current understandings of reproductive bodies by tuning into infertile bodies and self-knowledge, they cannot fully escape reproducing normative structures.

Even though we critique the researched MFTAs for reproducing such potentially harmful norms, we also want to take seriously user needs for objective sense-making. We align with Homewood and Vallgårda [26], whose menstruation tracking tool *Ambient Cycle* supports exploration and negotiation of subjective meaning making. They suggest that design strategies for reproductive tracking should be more open-ended and non-prescriptive but without "being so open [...] that they are deemed inaccurate or obsolete in comparison with [other] self-tracking apps" [26:1842]. Similar to our findings, the authors suggest that users compare tracking technologies to others that offer more prescriptive and Cartesian ways to turn the body into an object of measurement (such as the case with Drip above). We agree with previous work and suggest that, rather than imagining that design could break free from normativities, we might **expand design approaches to include a greater plurality of data-objective structures.** Instead of attempting to design against dominant narratives of the reproductive body as cis-gendered, cis-hetero and able-bodied, we might instead seek **to design for a plurality of reproductive bodies by acknowledging and engaging with a multiplicity of normativities that comprise underrepresented experiences of fertility and reproductive health.**

We propose inclusive design of MFTAs should not completely abandon or eliminate data-objectivities but engage with them through intersectional and multiple perspectives, accounting for different contexts, users, and types/durée of engagement [5]. As Leahu et al. [30] point out by building on Haraway's work: objectivity can be engaged with from a feminist standpoint as "a temporary, networked negotiation among multiple, situated subjectivities." [30:427]. This aligns with our findings that the kinds of data-objectivities sought by users are situated within subjective experiences of navigation among MFTAs to find apps that support objective sense making about the reproductive body in relation to others with non-normative experiences. **Seeking objectivities is always non-innocent [19] and therefore it is important that design considers data-objectivities from intersectional and multiple perspectives.**

Through our work we have explored a different approach to unpacking the entanglements of the lived experience of reproductive bodies, technology, and sociocultural surroundings of MFTAs, contributing to similar calls for this (e.g. [25]). Through combining first-person reflections with the walkthrough method, we created a frame that explores relations of cultural, technological, and scientific understandings of reproduction on the one hand, and practices of tracking and self(care) on the other hand [33]. This enabled us to reflect more deeply on ideas of reproductive bodies, normativities and moments of usage/non-usage, which we highlighted in our findings. We explored how emerging norms are configured with and through apps that aim to challenge existing norms or are created for underrepresented groups. We thus follow Suchman's [44] call for attention to (app) interfaces and Bardzell's [7] call to critically engage with interactions as they offer a site for novel forms of connection and interaction, both with and through computational devices. We also build on the recent call for uncovering how intimate technologies might restrict the knowledge users can have of their bodies and often employ normative understandings of bodies and gender [16, 21]. By deploying the walkthrough method to this context and by expanding it with first-person accounts, we have unpacked emerging forms of interaction and experiences of one's body and intimate data. This research approach helped us to understand first, and then suggest what the walkthrough method can offer to this research space (i.e., studying existing technologies for tracking the body) and especially to how designers and researchers working in such domains can study intimate data tracking apps, aiming to ultimately design such apps.

5.2 Reflections on the Walkthrough Method - Gains and Limitations

We found that the walkthrough method helped us to critically engage with infrastructures and interfaces. As previously sketched out, the walkthrough method offered us a means to examine MFTAs that differs from other methods employed within HCI studies of reproductive health apps, in terms of the empirical material it draws forward for analysis, its commitments and scope, and the reflexive and critical mode of analysis it supports. Empirically, the method draws out different materials for analysis such as reflexive notes that go beyond the app's functionality, compared to e.g., the cognitive walkthrough where it is being evaluated if the users can follow the intended flow of activities. Rather than only focusing on *how* interaction flows, we attended to the socio cultural ecologies these apps are part of [32] to determine *why* interaction is being imagined to flow in a certain way. Methodologically, the method allows for a shorter or longer commitment, depending on individual approaches. In our case, we extended the everyday use phase to last approximately six months. However, shorter engagement could be possible with this method, which allows for a comparison between multiple apps, broadening the scope of how many apps can be researched simultaneously yet thoroughly. When considering prior work conducted in this area, we can see how this compares in terms of time commitment, depth, and breadth of study. While Mehrnezhad and Almeida's approach enabled them to examine 30 apps, this was limited in scope to an analysis of the data demands and collection prior to user consent [33]. On the other hand, the analysis by Fox

et al. [15] was more open ended in its examination but required a long-term investment of nine months and first-person use of the apps studied. The walkthrough offers a middle ground in the sense that its analytical aims can be very open ended and inductive (we did not know what questions we would exactly answer other than an interest in understanding norms) while also being structured in a way that readily enables comparison in a relatively short time frame.

Compared with participatory methods, the walkthrough does not require recruitment of users as it relies upon the media analyst to navigate their own relations to use, whether or not they are the intended user, although there are limitations shaped by the analyst's positionality, as we discuss. Analytically, the method allows for a type of critical and reflexive approach, understanding apps as cultural artifacts. The method thus enabled us to view the MFTAs as cultural artifacts and trace where cultural ideas of reproduction are reconfigured within the apps. This adds a layer of reflexive analysis compared to e.g., the cognitive walkthrough or diary studies, where there might be a bigger focus on users. Rather than focusing on how users might utilize the app, we investigated the apps as objects and artefacts embedded within cultural systems, exploring which interactions they afford and govern and via these which norms of bodies they reproduce and/or resist. This resembles in many ways the reflexive analysis available in first-person methods (e.g.,[48]) or the critical analysis of interaction criticism [7]. However, the methodical and exhaustive procedure of conducting the walkthrough is highly repeatable across several apps supporting comparison as the unit of analysis chosen by the researchers (in our case gendered and bodily norms). When compared to user studies, it produces a coherent analysis situated within the researchers' perspectives rather than producing dispersed personal accounts of different apps as might arise e.g., in a diary study. There are trade-offs, of course, with each of these methods as, e.g., user studies can draw upon a much wider range of intersectional positionalities and lived experiences. We do not argue that this is the best or even a better suited method, but rather see it as a method that can add to the repertoire of HCI methods in this space. Based on our experience we would recommend it particularly as an early-stage method that can be used to guide further research design that could e.g., be more participatory.

While we gained a variety of insights employing the walkthrough method, we also encountered limitations in investigating the MFTAs Drip, Clue, and Tilly through this method that we find important to highlight. In the following, we therefore discuss the limits of the walkthrough method to extend beyond or challenge our own positionalities in understanding normativities of data tracking practices within these app environments.

Limitations were encountered for example, when collectively analyzing the data. Here it became visible, that A1 and A3 had significantly different understandings of the affordances of the MFTA Tilly, which is specifically targeted for users with fertility concerns. In their initial discussion of the walkthrough method, Light et al. [32] understood the method as a starting point for engaging with apps, that can be expanded through other methods [ibid], such as interviews. However, the authors also suggest that researchers can *"make explicit the otherwise implicit and (by design) apparently seamless process of engaging with a digital media object – and they can give away hidden affordances and tricks*" [ibid:885] when solely deploying the walkthrough method. Yet, when trying to further understand the affordances of the MFTA Tilly, A1 encountered the limitations of her situated knowledge. While she could account for and describe the data users are prompted to track, she had little understanding of the emotional and invisible labor that is entangled in this data. When engaging with the MFTAs Clue and Drip, A1 could relate to the data they are requesting. She could account for the physical and invisible labor it takes to 'listen to one's body,' to explore it through touching and by making sense of pain and symptoms. But as A1 is not in fertility treatment, she had trouble understanding what it may mean to be in treatment and use the Tilly app. As A3 has navigated infertility, her personal experience allowed for different access to the app and different understandings of how an app such as Tilly addresses the experience of infertility. In section 4.3.3 we sketched out how different learning materials in the learning space discuss possible causes for infertility offering material for users at different stages in their fertility journey. A1 could understand how some material is freely available while some is beyond a paywall besides the fact that the learning space carries the message 'knowledge is power', withholding some of that knowledge felt disempowering to A1. But only through collectively analyzing the material, we could make sense of the way the app is structured to promote the users' journey into more specialized knowledge, as A3's personal experience with infertility made her sensible to understanding how the paid and unpaid material is targeted towards different users.

We therefore suggest that researcher's positionality matters when employing the walkthrough method, as it guides the researcher's attention and restricts what knowledge they can produce. Especially spaces that relate to intimate bodily processes and potentially speak to some aspect of disability require a sensitivity to positionality. Moreover, while much of the research into reproductive health in HCI is an attempt to correct a gap or the lack of it, it is also often conducted by researchers whose own positionality might shape their research and create new gaps. Therefore, one's positionality should not only be made visible, but actively explored and engaged with. This leads us to ask what methods can help us better attend to the power dynamics of positionalities even within marginalized spaces.

These considerations about positionality are not new to feminist research agendas [19, 45]. However, we propose this as an expansion for a method already being used to identify underlying socio-cultural structures, intended user, and intended use. We thereby found that we were limited by our positionality in some cases, but in other cases it allowed us a deeper understanding of what is at stake. It would be interesting to see further work employing this method to MFTAs to see and compare what analysis different positionalities draw out.

6 CONCLUSION

We employed the walkthrough method on the three MFTAs Clue, Drip and Tilly. We found this method to be useful to understand the apps in relation to a wider ecology of apps pertaining to tracking intimate bodily data. The method allowed for an entry to understand the different ideas of bodies that are present in the apps and who

is assumed to be the primary intended user. We mapped out the boundaries of the intended user, showing the kinds of uses that are marginalized or only partially included. This became particularly visible when scrutinizing Tilly as an app that is specifically designed for people that have (medical) fertility issues. While this speaks to one marginalized group, it leaves out other perspectives of e.g., non-cis female bodies or social infertility, as it assumes the female body in relation to the male body when exploring infertility causes. Using the walkthrough method furthermore allowed us to understand how rather new apps that are entering the *femtech* market (i.e., Drip and Tilly) seeking out to be alternatives to primary apps on the market (i.e., Clue), by addressing their shortcomings in e.g., data security or aspects of reproductive health.

However, what was more difficult to obtain with this method, was an understanding of how our positionality affects our ability to analyze these apps. It was therefore useful to analyze data obtained from the walkthroughs in collaboration, to see how distinct positions draw out different understandings and meanings of the data. By 'walking with' the apps, we combined the walkthrough method with first-person reflections of our experiences with the apps. This was useful for developing insights about how the apps address further opting in, opting out, or adaptations of the apps in use.

Overall, we suggest that the walkthrough method is a useful addition to the repertoire of (feminist) methods for understanding tracking data and its relation to the body as well as for conducting critical interaction analysis, particularly for initial research. The method, combined with first-person reflections allowed for a critical engagement with the affordances of interactions within contemporary MFTAs and to suggest ways forward in designing for and with a plurality of reproductive bodies.

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PAPER 2

Fertile Becoming: Reproductive Temporalities with/in Tracking Technologies

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4

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Lara Reime, Marisa Cohn, and Vasiliki Tsaknaki

Introduction

If only we had known earlier…

This was a common phrase we encountered during our research on reproductive technologies and how they enable sense-making about fertility and reproductive potentials through data. *If only we had known earlier, we would have started earlier. If only we had known earlier, we would have frozen sperm (or eggs). If only we had known earlier, our future would look different as we could have acted accordingly*. These recurrent 'if only' narratives are just one example of how people who are concerned with infertility negotiate their present in relation to the past. They reveal what Barad (2010) refers to as lingering thoughts of the past and possible futures of what might yet be/have been.

In this chapter, we explore the multiple entangled temporalities of navigating fertility that we encountered in our research on menstruation

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and fertility tracking applications (MFTAs) and how their users share and make sense of intimate bodily data tracked by these devices. In examining such apps and how people discuss their use in online forums, we observed many complex temporal relations such as rethinking and reencountering the past, managing expectations related to diagnosis and predictions in the present, and desires for the future. We are interested in understanding how such temporalities become structured through everyday engagements with technologies. We particularly investigate MFTAs and how they shape rhythms and relations to time and bodies. This includes how they embed particular biopolitical structures of reproduction through the ways they visually and narratively represent time, such as menstrual cycles, to the user; how they orient the user temporally in relation to their lived bodily experience of fertility and reproduction over time; and also, how users negotiate time through collective sense-making regarding data about their bodies within an ecology of apps and technologies aimed to assist with reproduction.

MFTAs make up a large part of the FemTech market with currently around 300 apps (both iOS and Android) available and the number is continuously increasing. Such apps prompt users to track their bodily sensations, activities, and practices. Through rendering this information into quantifiable data (Lupton, 2015a), they provide predictions on future beginnings of menstrual bleeding and fertile phases.

We scrutinize which particular temporalities are embedded into current MFTAs through how they represent, organize, and narrate time for the user. For example, they tend to capture data related to the present 'where am I in this cycle?' and display data related to the future—'when am I ovulating?'. We argue that the temporality of reproduction in these apps is reduced to linear, progressive narratives, as we will show through concrete examples. Overall, bodily experiences of the present (e.g. menstrual bleeding and ovulation) become translated into data archives of the *past* that serve as basis for action in the *present* (e.g. intercourse) to produce an anticipated *future* (becoming pregnant).

We ask how people navigate within the limitations and normativities of these apps, to understand how the complexity of reproductive temporalities often exceeds what these apps can represent. We find that people make sense of their data and the linear as well as progressive notions of time with others through in-app or online forums. We therefore examine extended discussions around reproductive self-tracking data in online forums where people share their tracking data and experiences with MFTAs more broadly or create alternative practices of data sharing. We analyze discussions of people encountering these apps from intersecting, and non-fixed relations to reproductive health, for example from infertile, queer, or non-binary positions. Such narratives reveal how reproductive temporalities are not only experienced in the present but also over the long durée and via retrospection.

Thus, this chapter offers an entry point into understanding the role MFTAs play in the narration of reproductive temporalities. At this point we briefly want to clarify our understanding of *reproductive time* and *temporality*. Reproductive time attends to moments where reproduction is biologically possible, i.e. ovulation and fertile years. Whereas temporality encompasses phenomenological modes focused on lived experiences of time (Freeman, 2010). In other words, with temporalities we refer to the lived and embodied experiences of reproductive time and the entanglements of past and future that form actions in the present. Temporality further entails social constructions of reproductive time, for example, through narratives of good time in one's life to become a parent. Thus, temporality, as opposed to time, is defined by multiplicity, entanglements, and relations.

To understand how temporalities are embedded in MFTAs and to map the interactions such self-tracking applications afford, we analyze data obtained from the walkthrough method (Light et al., 2018) and

autoethnographic engagements with the MFTAs Drip, Clue, and Tilly.[1] The walkthrough method was employed to attentively and meticulously walk through an app's interface to unpack the social and cultural understandings of reproduction and reproductive bodies embedded in those. A1 expanded the 2nd phase (everyday use) of the walkthrough method with a longer autoethnographic engagement over a period of six months. Here, the author engaged daily with the tracking prompts of the three different MFTAs, taking screenshots, and writing down reflection notes when deemed necessary (see also Reime et al., 2023). To understand how people navigate reproductive temporalities and complexities, we also built on data conducted through digital ethnography in three online spaces on Reddit where infertility is being discussed.[2] Through these multiple data sources, we explore how time and temporalities are being understood and narrated in MFTAs and how these understandings bring

[1] Clue is one of the most used apps on the market for fertility and menstruation tracking, with a total of 12 million active users. Clue therefore builds part of the 'status quo' that some newer apps, like Drip, are positioning themselves against. Clue allows users to track bodily symptoms (e.g., bleeding, pain), activities (e.g., intercourse, exercise), emotions, as well as means of birth control (pills, IUD). The data is then analyzed and visualized by the app to predict future fertile windows and menstrual bleeding. Drip is a rather new app (first available for download since 2022), open source, and embodies ideals of inviting users to be in control of their data. Additionally, it is developed by women, and its creators communicate explicitly that this app departs from current MFTAs, by having addressed and improved particular aspects, such as transparency, data privacy, and bodily sensemaking. In Drip, users are actively encouraged to explore their bodies through touch, as the consistency of the cervical mucus is one of the markers Drip uses to make fertility predictions. Tilly is specifically targeted on tracking when in fertility treatment, which adds a different dimension and medicalization to menstruation and fertility tracking. Apart from tracking bodily sensations (e.g., cramps, bleeding, temperature), emotions (e.g., happy, calm), and activities (e.g., intercourse, exercise), Tilly also offers the possibility to track one's fertility protocol and medication. Tilly is conceptually developed by two women who have gone through fertility treatment themselves—a 'stressful journey' that they now want to support others with through data-driven personalization (see also Reime et al., 2023).

[2] We understand these as vulnerable spaces, despite their online availability. We have used quotes that are paraphrased in a way that they should not be traced easily. To further ensure anonymity, we refrain from naming the exact subreddits we are investigating. We are exploring three different forums which are freely accessible on Reddit, whereas one is addressing fertility more broadly, the second one is specifically geared towards aspects of queer reproduction, and the third one is used for picture sharing and comparison of fertility-related tests.

reproductive bodies into being.[3] Not only do lived experiences of reproductive temporality exceed these reductive temporalities presented by MFTAs, but the apps and their temporal frames are now part of the entangled experience of reproductive health.

MFTAs, while focused only on data collection and prediction, reshape and reconfigure experiences of reproduction. In that, they join other reproductive technologies, such as ultrasound or in vitro fertilization, taken up in prior critical Feminist STS work (e.g. Franklin, 2022) and are also entering the space of the socio-material making of reproduction. Recent technological advancement within reproductive health promises 'pregnancy for everyone' as the 'broken reproductive body' can (partly) be fixed through processes of assisted reproduction or IVF (Welsh, 2019). Prior 'infertile' bodies (either medically or socially) now have the possibility to become fertile and pregnant (Mamo, 2007; Welsh, 2019). Within this technoscientific development (some), queer bodies become fertility patients, not (or not only) because of their physical conditions but because of their sexuality (Mamo, 2007). Consequently, such technologies are entangled into broader cultural structures, carrying the potential to challenge heteronormative ideas of parenthood and family, while at the same time running the risk of reproducing such structures by reinforcing normativities of reproduction (ibid). These technologies are also part of complex temporal narratives of reproduction, as they (potentially) extend reproductive time by prolonging 'biological clocks' (Bach, 2022; Kroløkke, 2021; Wahlberg & Gammeltoft, 2017). Through egg or sperm freezing at a young age, reproductive futures are being secured, to realize one's reproductive potential, once the 'timing' is right, independent from bodily temporalities. Reproductive temporalities are thereby

[3] To situate our work and the ways we have surfaced the following analytical contributions, we find it important to spend some words on our own positionality. Each of us identifies as a woman, who, to different degrees, have been engaged with our own menstruating bodies and their fertile potential. One author has navigated infertility and participated as a subject of medical research on infertility as well as participating in data sharing among LBGTQ* groups related to fertility, while the other two authors previously tried to make sense of their fertile potential in order to avoid pregnancy. Therefore, our lived experiences in this regard are varied.

disconnected from bodily temporalities of aging and decreasing reproductive potential.

However, not only assisted reproduction and IVF are redefining reproductive time and temporalities; MFTAs are also suggesting timelines to act upon reproductive potentials through rendering intimate data archives into objective data outputs in forms of notifications and representations of 'fertile windows'. MFTAs, through such suggestive timings, shape what is 'good timing' for reproduction both at a moment in a particular cycle as well as throughout one's life course. They shape experiences of time through the habits of logging and calculation and people managing their expectations of such calculations. All in all, these apps and the data collecting and sharing they enable become tied up in processes of becoming (in)fertile, we argue.

In what follows, we first situate our work within existing research and theories on reproductive temporalities and self-tracking. We further hone into the processes of becoming fertile through and with technologies, particularly MFTAs. We attend to the temporal norms that are reinforced through MFTAs and how they become part of reproductive sense-making ecologies. Our research shows that people experience fertility through a complex entanglement of data tracking and sharing where MFTAs and their modes of embedding time are taken up by users to critically engage with their possibilities and limitations by employing an array of fertility sense-making practices.

Reproductive Temporalities

Theoretically, we anchor this chapter in feminist, crip, and queer theories of time and temporality. Donna Haraway's (2016) work, for instance, offers us vocabulary to talk about different temporalities as *ongoing pasts, thick presents*, and *still possible futures* pointing to the mutual entanglement of different temporal frames. In her words, 'there is nothing in times of beginnings that insists on wiping out what has come before, or, indeed, wiping out what comes after. Kainos ["new" in the Greek] can be full of inheritances, of remembering, and full of comings, of nurturing what might still be' (Haraway, 2016, p. 2). With ongoing pasts, Haraway

refers to how our own pasts, but also worldly pasts, are still shaping our presents and the futures we can have. Thick presents capture the multiplicity of experiences of the present, which are always shaped by the past and the future. Still possible futures are nurturing what might still be, imagining futures not only for us but the world that comes after us and how that affects our being in the present.

This entanglement of temporal frames becomes crucial in understanding how reproductive time is being made, understood, and imagined, as we will point to throughout our analysis. In that, time is not only linear and forward oriented but always also entangled in the past: 'in our now lays the future […] we're always coming into ourselves entangled in the past' (Gammeltoft, 2013). In her research of pregnancy in Vietnam, Gammeltoft (2013) highlights how past experiences of war and chemical pollution impact present approaches and concerns to reproduction. Here, pregnant bodies carry past traumas that might affect the future of their unborn child. Recent work also shows how not only a pregnant future is being negotiated but also how the future of the child is being imagined and how that becomes impacted by current issues of, i.e. climate change (see e.g. Lautrup, 2022). Further research argues that a pregnant person is already understood as 'a mother embarked on a life trajectory of mothering' (Browne, 2022), thereby not only entailing gendered ideas of pregnancy and parenthood but also pointing towards a 'future temporal horizon with pregnancy framed as a one-way passage to birth (when are you due?) and a forward time of teleological progress and being-toward' (Browne, 2022). Reproductive time becomes the means towards this future horizon of becoming a parent.

We further draw on the concept of *crip time* (Kafer, 2013) which allows us to view (reproductive) time as individual and multiple. In 'Feminist, Queer, Crip', Alison Kafer (2013) brings forward understandings of crip bodily temporalities as always already out of rhythm. Kafer (ibid.) argues that socially, time is seen as productive, and bodies that cannot reach a certain threshold of productivity are seen out of sync or, rather, experience their lived experience of time as out of sync with the world around them. In a similar vein, Freeman's (2010) notion of *chrononormativity* makes sense of the relationships between norms and time and

builds on the 'use of time to organize individual human bodies towards maximum productivity'.

More specifically, Luciano's (2007) notion of *chronobiopolitics* tries to make sense of how lifespans become organized through 'teleological schemes […] such as marriage, accumulation of health and wealth for the future, reproduction, childrearing, and death and its attendant rituals' (Luciano, 2007 in Freeman, 2010, p. 4). In other words, chronobiopolitics moves beyond individual temporalities towards understanding how entire populations are managed through such schemes, synchronizing and relating bodies not only with each other but bigger temporal and social schemes, and rituals. For example, Martin's (2001) work shows how ideas of reproductive time, i.e. when a body is able to reproduce, is deeply entangled in gendered and social narratives of reproduction. Her work also highlights how narratives of reproduction are closely tied to ideas of citizenship and how such narratives cast the female body as a machine-like reproductive body 'producing' children (ibid). Thus, reproductive 'efficiency' takes on new meaning when it now becomes entangled in everyday practices of datafying reproductive bodies. In such teleological schemes, some bodies are always already outside of these normative temporalities through their positions in the world. This helps us to understand how MFTAs are remaking or reproducing such schemas and how the feeling body becomes an alternate collection of time (Luciano, 2007).

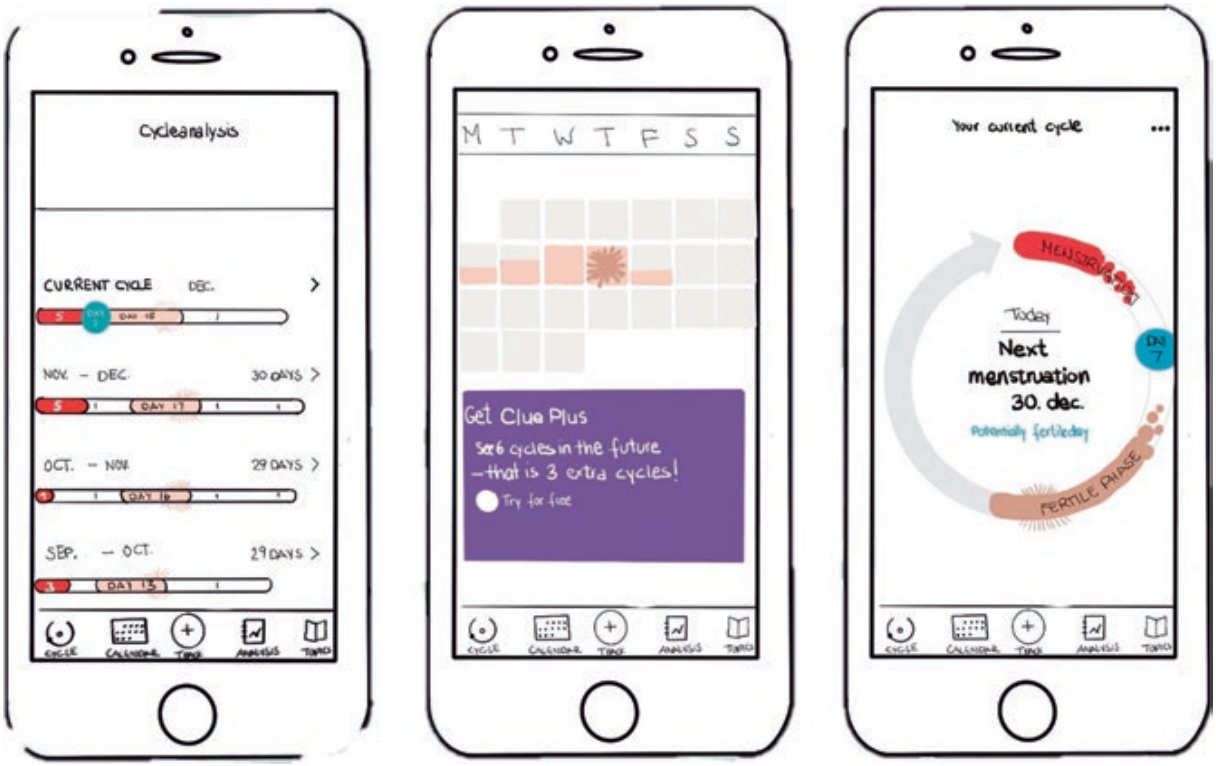
We draw on these theories of time and reproductive temporalities to frame questions for our analysis such as: How do people navigate their temporal schemes and make sense of them in relation to lived bodily experiences? How are crip and queer temporalities of being out of synch mediated by these apps? What are the 'thick' presents of becoming fertile? This allows us to surface moments where temporalities become visible, structured, and entangled, as well as to bring forward understandings of reproductive time which exceed biological terms, but rather asks how people make sense of their own reproductive time and temporality in becoming fertile.

Before moving into the analysis, we want to briefly situate practices of self-tracking within current research on MFTAs. Work in this field suggests that these apps are mainly designed for fertile,

reproductive—willing and—able cis women in heterosexual relationships (Epstein et al., 2017; Lupton, 2015a), thereby neglecting the reality that not all women and not only women menstruate and excluding those who do not equate menstruating with being female (Homewood, 2018). Thus, critical and feminist scholarship argues that such technologies reproduce what it means to be sexed and gendered, as they are a product of entanglements with social structures, practices, and norms around reproduction (Cifor & Garcia, 2019; Homewood, 2018; Roberts et al., 2019). Other critiques from contemporary feminist research show how most reproductive health technologies still equate women's health with reproductive health, neglecting intersectional standpoints of women and gender as non-fixed categories (Keyes et al., 2020). Further critique attends to how those systems create issues of surveillance and data sovereignty (Mehrnezhad & Almeida, 2021). But research also points to their empowering potential of creating more self-knowledge and awareness (Andelsman, 2021; Homewood et al., 2020). For example, Hamper's (2020, 2022) work shows how women in the UK use MFTAs to make sense of their fertile window by learning about their bodies through tracking data. Further, Lupton's work (Lupton, 2015a, 2015b) offers a broad research scope on various socially entangled practices of self-tracking, bodies, and data. Specifically, her work on reproductive self-tracking points to the reconfigurations of bodies, as data is not only extracted from bodies but also shapes these bodies in return (Lupton, 2019). We build on this work by offering a critical engagement with normative temporal frames reinforced through engagements with MFTAs and an analysis of how reproductive bodies navigate these spaces.

Making and Understanding Temporalities Within MFTAs

The following analysis exemplifies different entangled modes of making and understanding time within reproductive sense-making. We move from analytical points of how we see temporality imagined within tracking applications towards practices through which these temporalities are



Figs. 4.1–4.3 Cycleanalysis, Calendar view, and Current Cycle

being made-sense-of through community practices. We present the first examples through data conducted from the walkthrough method and autoethnographic engagements, while the latter point is exemplified by community chats in reddit forums. We begin by presenting findings specifically on temporalities within MFTAs. Here, we surface how time is being represented and configured through such apps. Further, we look into which temporalities users become oriented towards, how datafied relations are built in the present towards the past and future, and how such apps are embedded in broader social schemas (chronobiopolitics) of reproduction.

The apps represent the reproductive journey as temporal linear and cyclical. For example, Clue uses three different representations of cyclic time. The visualization in 'Cycle history' (Fig. 4.1) views cycles in comparison, it individualizes each cycle—they have a distinct start and end. The calendar overview (Fig. 4.2) puts the reproductive cycle in connection with time around it (meaning days and dates). Figure 4.3 is probably the most used visualization for reproductive time, starting with the first day of menstruation, prediction of the fertile phase and locating one's current

position on this cyclic trajectory that ends with the first day of menstruation and at the same time starts all over again. The idea of cyclic time stabilizes forward movement, promises renewal rather than rapture (Freeman, 2010). What all visualizations have in common is that they highlight and center fertile time (ovulation).

Apart from different modes of visualizing and representing time, they also afford the building of datafied relations to pasts and possible futures. Through fertility tracking in the present, data is being created that builds a 'digital archive of the body', which is then being used to calculate and predict fertile times. Thereby, MFTAs engage with different temporalities of the reproductive body (tracking data in the present to build an archive [past] that can predict future ovulations). 'The future' becomes the commodity of the app. The user shares their present and their past and the app predicts the future in return. In Clue, for example, the non-premium user only gets 3 months of prediction, whereas a longer prediction horizon of 6 months is available for users paying a monthly fee. If one has a 'regular' cycle, the difference between knowing 3 or 6 months in advance seems minor, as one could easily do the calculations oneself. Where it might be more meaningful for people with irregular cycles to make sense of their future reproductive times, as it might be harder to predict oneself, the apps fail to do these predictions, as they can only calculate with regularity. Thereby these apps are geared towards an ableist understanding of bodies and their regularity which makes them predictable.

Not only is the future being withheld from the non-premium user, so too is the analysis of their past. For example, Clue has A1's tracking data since January 2019 (more than 3 years of, more or less, consistent tracking data), but because A1 has not created an account, Clue does not give her any analysis on her past cycle data, other than providing the dates. This creates an imbalance, where the user loses their data sovereignty (Prainsack, 2019). The app now has more insights on the user than the user themself and is not sharing these insights with the user. By reading through the privacy statement of Clue and Tilly, we learn that both apps potentially share anonymized data with researchers for the purpose to 'create more knowledge around reproduction to help people with fertility issues' (Clue, 2022; Tilly, 2022). This help, however, does not directly reach the user, as they are not aware of the analysis that is being done

about them based on their data. Creating a meaningful archive is also only possible by tracking consistently, which most people either do not do or where the apps do not allow for tracking, as they are only geared towards a certain life situation (getting pregnant/avoiding to) but do not encompass a more holistic view of reproductive life (Kumar et al., 2020), thus not allowing for consistent tracking throughout the life course. The user becomes part of an unknown future, a future where infertility supposedly can be better understood.

MFTAs orient[4] the user towards different temporalities such as rhythms, rituals, and durations, in multiple ways. Through notifications, the researched MFTAs structure daily engagements by sending reminders to track data, measure temperature, and even give suggestions for good timing of intercourse based on the data inputs. For example, 'mornings' become such a temporal orientation, as this is the moment where temperature measurements should take place. Though mornings should be understood as the time when bodies are waking up, not necessarily the temporal frame of morning (i.e. sunrise to noon). Through framings of 'mornings' rather than for example wake-up time, some bodies are already out of sync, as different work- and lifestyles allow for different moments of 'mornings'.

The researched MFTAs do not only structure users' time and engagement but also prompt them to 'make time' for taking self-care actions. For instance, Tilly has dedicated a whole section on self-care, including guides for meditation and yoga, as well as online courses regarding mental health, such as a 6-weeks course on dealing with miscarriage. While this might be helpful for some, it also assumes that users have time and can make time for taking care of themselves through meditation and have the capacity to become fertility experts of their own body by taking the courses they offer and engaging in tracking practices as well as community exchanges. Thus, tracking technologies 'bind' us (Freeman, 2010)

[4] To ask about orientation is to consider, how we arrive to the app as a designed object, what kind of attending to it requires of us and our body, and how it directs us along the 'well trodden paths'. 'Lines are both created by being followed and are followed by being created. The lines that direct us, as lines of thought as well as lines of motion, are in this way performative: they depend upon the repetition of norms and conventions, of routes and paths taken, but they are also created as an effect of this repetition' (Ahmed, 2006, p. 16). This allows us to ask about what an app 'affords' in terms of how it orients the user to particular temporal experiences such as the menstrual cycle.

into specifically patterned lives, intimately linked to national narratives and timelines of reproduction (when is the right time and space to reproduce). That is to say, MFTAs do not only build on normative temporalities in the sense of cyclic temporalities (e.g. how long is a cycle, which day ovulation happens) but also on social temporalities of when it is socially acceptable to become pregnant. This becomes visible as the researched MFTAs are mainly addressing heterosexual couples in their late 20's early 30's. In the community space of Tilly, for example, most stories from people that are trying to conceive are from people in heterosexual relationships in their 30's. For example, one story recalls the experience of how a couple started to try to conceive when they were in their early 30's. After a few 'natural' tries, they took a consultation with a doctor who diagnosed the woman with fertility issues. She started treatment and eventually gave up trying, as she was getting too old. Throughout her narrative, we see the spell of the past lingering: 'if only I had known earlier, I might have had a chance'.

The past does not only become important on an individual level. As a campaign from the Copenhagen Municipality shows, potentially reproductive bodies are geared to take action in the present to ensure their ability to have children in the future (Copenhagen Municipality, 2015). This campaign illustrates that, in contemporary western societies, especially in bigger cities, people tend to have children at a later age, thus acknowledging, if not enforcing, a temporal shift in the chronobiopolitics of reproduction. Reproduction at a later age might lead to fertility issues as suggested by the campaign: 'your chance at becoming a mother is double as high when you are 25 than 35', or '40% have a low sperm quality. It can take time to become a father'. Such narratives not only reinforce gendered reproductive bodies but also fertile bodies; in other words, a younger body is more fertile than an older one. To battle a dwindling birthing rate, this Danish campaign suggests, for example, egg-freezing at a young age in order to ensure a reproductive future. Despite this campaign being critiqued for their involvement in citizens' reproduction, it thus points to entangled temporal relations. Rather than time being linear, it is nurturing of a future of what might still be, remembering a past where chances have been missed and ongoing presents infused with multiple temporalities and materialities (Haraway, 2016).

Collective Practices of Becoming Fertile

So far, we have shown, through data collected via the walkthrough method, the ways that MFTAs embed and represent temporality and temporal norms, not accounting for complex and individual temporalities. We now shift to these complexities of lived experiences of reproductive temporalities. In this section, we focus on the ways people make sense of these multiple and assembled temporalities in MFTAs in relation to their own experiences. We explore online forums, as we see these spaces as sites where people come to fill gaps encountered through the mismatch of lived experiences and engagement with the apps and reproductive health more generally. Here is also where alternative ways to share tracked data together beyond what the apps can offer are being developed and engaged with. Thus, these spaces also exemplify practices of knowledge and data exchange with others in similar situations. We are interested in understanding how people navigate these apps when they do not conform to their lived experiences. We look particularly at forums where people discuss queer experiences with fertility and experiences with infertility (these are also intersecting as we will discuss). We focus on how these forums are used to share experiences with the apps or reflect together on data tracking collection and analysis.

Generally, these online forums are spaces where information is being shared to make sense of one's own body and data. People share data regarding their reproductive experiences to varying degrees. Some have details such as diagnosis, age, gender, relationship status, miscarriages, and more in their 'flair' (a little information box behind their usernames, e.g. username1 [38F | Unexplained | Single | 1MC]). Some users actively seek help by posing questions while others provide help through sharing their own experiences or opinions, while another set of users might find it helpful to read discussions without actively engaging in them. Questions users ask relate to sharing frustrations and other emotions, but also to making sense of symptoms, cyclic stages, IVF treatment processes, pregnancy tests, or of doctors' advice. Users frequently share their diagnosis and the treatment doctors suggested, apparently trying to verify with the community if this is the 'correct' process. In that, time becomes an

important normative horizon that can be oriented towards (e.g. duration of treatment). Within community chats for people in fertility treatment, normativities are a source for hope in that people tend to relate their own experience to someone else in the same situation. This becomes visible as people often answer with phrases like 'when I was at this stage', 'it looked the same for me', or 'I had the same diagnosis and treatment, and this happened to me'. Normativities of time are being used to make sense of one's situation. Where should I be at this stage of my pregnancy or at this stage of my IVF treatment? What did others do? How many tries did others have? What is normal?

These conversations could already be understood as data-sharing practices, where users share intimate information about their treatment, relationships, and diagnosis. But we also encounter examples where data sharing is approached in a more organized manner through, for instance, a spreadsheet. Whereas the forum entries are tied to experiences, emotions, and worries, the spreadsheet offers a collection of 'purer' data. Here, users can enter information including their reddit username, infertility diagnosis, age (at egg retrieval), cycle date, treatment protocol, the number of eggs retrieved, medication taken, whether sperm or egg donor were used, the costs, and much more.

Contrary to earlier examples, where MFTAs built data archives of users' data and share them with researcher beyond their control, this example can be understood as a bottom-up practice of creating a database that is accessible for everyone—a crowd-sourced resource from the community to the community people are engaged in. Such data sheets also fill another role, namely making sense of one's body in relation to others. The spreadsheet can be filtered in/excluding certain diagnosis or treatments. Consequently, users can find other users with similar parameters such as age, diagnosis, treatment, and from this information make assumptions about their own body, such as the amount of IVF procedures they will most likely need. What becomes visible when looking at the forum and the spreadsheet is that most users are in heterosexual relationships, and thus focus primarily on the female body for tracking and intervention. In that, social infertility is not specifically included though also not excluded, as the forum guidelines make clear that everyone

concerned with infertility is welcome in the forum. However, there are different temporalities and relations at stake, depending on medical or social infertility (or an intersection of both), as we elaborate further.

Temporal and Bodily Pluralities

Medically, heterosexual couples are understood as infertile after one year of trying (having unprotected sex during the ovulation period), unless any affecting illness is known prior to that. Queer temporalities differ, as there is never a 'trying' period. From the beginning, queer bodies are entangled in multiple structures such as medical examinations, law, technology, hormones, and data. During this process, not only identities as parents become negotiated but also gender identities are being negotiated, gained, and lost. For example, Dahl's (2018) work illustrates how gay identities are being reshaped through pregnancy and parenthood, but also through national, in this case Swedish, narratives of reproduction. Focused on reproductive technologies and queer bodies, Mamo (2007) shows how wombs that have been previously outside of reproductive time are through technological and legal advancement embraced into this space: 'Becoming fertile, a process that involves a desire to reproduce through pregnancy, is a rather queer phenomenon; it is profoundly shaped by effects of and access to fertility medicine itself' (van Balen & Inhorn, 2002).

In the forums, we see people discussing their plans of becoming fertile in advance before even starting any treatment. For example, one user started planning treatment four years in advance, as processes such as sperm donor quarantine result in a longer temporal frame for conception. In response to this thread, most users share that they planned at least one year before they started trying to conceive. This includes finding a doctor, finding a donor, maybe even doing transitions, reducing/increasing hormones before the 'actual' trying can start. 'Queer Conception: The Complete Fertility Guide for Queer & Trans Parents-to-be' (Kali, 2022) is a book most frequently discussed and shared as an invaluable source for starting the journey. Here the 'pre-starting process', which includes making decisions and creating a timeline is the first

chapter. This indicates how important planning is being understood and how the present is being planned towards the future. Knowing the exact time of ovulation becomes even more relevant in this process as not only the desire to get pregnant is involved but also different stakeholders (doctors, donors) and infrastructures, as well as financial resources (depending on location), and extended emotional labor.

Once a body has entered AR or IVF, their temporalities become more vulnerable due to repeated delays and disruptions. Users share their concerns with missing the 'perfect cycle' due to sickness or doctor office opening hours. 'What would have been if we would have been able to use this cycle?'—is a question we frequently encounter in the forums. The stories of several users show, for example, how they are affected by the COVID-19 pandemic, not only in terms of closing/opening hours of doctor offices but—in the longer perspective—shortages on sperm donations and resulting waiting lists. Answers to these posts are trying to see the positive, that they now have one more month of tracked data, which will make it easier for them in the future to determine 'good timing'. Other advice suggests zooming in and out of life, thinking about the decades of life staging. Instead of being upset about this moment, zooming out to realize that there is a whole 'family making decade' (20-40), so one month will not affect this. Another suggestion is to group cycles in 3-months blocks, which should help to minimize the disappointment of one failed cycle, making each cycle in itself less vulnerable.

Significantly, none of this can be represented in how MFTAs are currently designed. There is no possibility to think of/group cycles differently, as the apps offer a cycle-to-cycle thinking and set of representations. There is no such representation of a 'pre' phase, though apps might be mainly useful in the 'pre' phase, where users are learning about their bodies, and 'becoming fertile' in order to be 'ready' once they actually start trying. Moreover, the MFTAs we explored do not allow for adding insemination—only intercourse. Even though Tilly is an app developed for people concerned with infertility, the treatment categories only include treatment start date, egg retrieval, embryo transfer, follicle check, pregnancy test, ovulation injection, start of stimulation, appointment but not specifically insemination. This potentially indicates that most MFTAs are specifically designed for a certain part of the reproductive

process. In this case, the 'becoming fertile' phase, adding medication and treatments, but once insemination happened it seems to transgress into a 'pregnant' body who cannot be tracked through this app anymore.

Ecologies of Becoming Fertile

Through research into MFTAs and online communities, we explored how temporalities of reproductive bodies are represented, configured, and navigated. We pointed towards complex temporalities of (in)fertile becoming. We now shift towards discussing the ecologies of reproductive bodies and how they come to matter through MFTAs and social narratives of reproduction.

MFTAs and other means of digital tracking have a linear understanding of reproductive time in the sense that they cannot deal with disruption of the linear forward movement towards pregnancy which ultimately results in the birth of a child. Thereby, MFTAs cater towards an ableist view of reproductive bodies. That is, through sufficient self-knowledge and observation, bodies can be moved, or progressed, into fertility. Reproductive time becomes the means towards this future horizon of becoming a parent, anticipating the right moment to establish this horizon by tracking and making sense of data. Miscarriages, abortions, and illness, however, destabilize the linearity and one-way nature of it. Pregnancy might end without becoming a parent. Miscarriages, for example, cannot be understood through most tracking applications, as there is no option of tracking pregnancy or miscarriage in the researched MFTAs. Once the body becomes pregnant, tracking through these apps is not possible anymore. This leaves a lack of possibilities for tracking the multiplicity of imaginary, sexualized, gendered, and technologically augmented bodies (Kroker, 2012). Even in a merit of apps that are specifically geared towards pregnancy tracking, pregnancy loss cannot be accounted for (Andalibi, 2021). This means that users need to delete their app to avoid the continuation of visualization of their lost pregnancy and to stop receiving notifications on the progress of growth. In the few cases where it is possible to add the loss, previous pregnancy data just becomes deleted, rather than offering a possibility to acknowledge

and engage with the loss (Andalibi, 2021). Andalibi (2021) suggests that this reflects the cultural and social ecologies these apps are part of, namely ecologies in which miscarriages become individualized and tabooed rather than actively engaged with.

MFTAs are further part of shaping cultural and sociotechnical understandings of reproduction and bodies, for example, by embedding teleological schemas (Luciano, 2007) of reproduction. Thus, bringing reproductive bodies into matter through, for example, narrating when the right time to have children is not only in a particular cycle but at which stage in life. Expectations on how reproductive bodies should be acted upon and materialized are tied to cultural ideas about 'time and progression' (Franklin, 2022). When is it the right time to become a parent? What stage or life situation is best? Temporalities of reproductive bodies do not only bring norms into being in terms of which moments in one's life reproductive potential should be acted upon; it also brings into being very normative ideas of reproductive cycles that everyday life becomes acted upon and structured around. MFTAs thereby introduce a more normative and formalized temporal frame to reproductive bodies (Hamper, 2020).

In Barad's terms, coming into matter is a 'condensation of dispersed and multiple beings- times, where the future and past are diffracted into now, into each moment'. (Barad, 2015). Following that thought, reproductive bodies come into matter through MFTAs, where the past (bodily archive) and the future (becoming pregnant) are diffracted into actions in the now. Reproductive technologies are bringing reproductive bodies into being and altering reproductive temporalities. Tracking applications do not make people more or less fertile. But they create anticipation and visualize fertile moments, thereby making fertile bodies that can be acted upon. They are also remaking what a reproductive body is and moving bodies towards a reproductive future. Through collecting data in the present, predictions about future fertile potential are being made and anticipated by the user, affecting actions in the present (e.g. diet, sex, and doctor visits). Through MFTAs, these futures are visualized and acted upon, as bodies are becoming known as reproductive (Hamper, 2022).

In our exploration of the relationships between bodies, apps, data, and reproduction, we understand MFTAs not as singular way of making

sense of fertility but as used together with other technologies, such as tests, thermometers, online forums, and analog notes. MFTAs are thereby part of an ecology of technologies that are used to make sense of one's fertility. Thus, reproductive bodies are complexly entangled in technologies, self-knowledge, and reproductive labour (Hamper, 2022). Within these entanglements of temporalities and technologies, we see reproductive bodies becoming fertile.

For example, through broader 'FemTech' developments, possible futures become intertwined with medical practices, in which reproductive bodies become spaces for constant repairs (Welsh, 2019). Infertile bodies are only temporarily 'broken' as, through technological intervention, everybody can get pregnant (Welsh, 2019)—in theory. In practice, however, some bodies will never become pregnant, partly by their own choice, but also due to the social and local situation they are moving within. Do they have access to healthcare? To inclusive healthcare? And in some cases, even technological advancement cannot make up for the historical medical neglect of the (female) reproductive organs that still leads to misconceptions and treatment errors. That is to say, the past lingers in the reproductive body in multiple ways. Not only our own past, and the decisions that we have made throughout our life course that might make it harder or easier for us to become fertile, but also decisions of the past that were not ours. The body inherits how reproduction has been studied in the past, especially how the uterus has been *understudied* in the past still affects the knowledge we (do not) have today. Fertility tracking gears us towards a hopeful future by contributing with our data in the present, to make future research more attuned and inclusive to the needs of diverse bodies and reproductive scenarios, and filling this historical research gap. However, we should remain cautious of the harm designs that are based on normative and under-researched understandings of embodied reproductive temporalities might do, even with the good intent of filling knowledge gaps.

Conclusion

This chapter has shown how specific FemTech developments, such as MFTAs, are entangled in a broader ecology of fertility sense-making. Empirically, we have engaged with the three tracking applications: Clue, Tilly, and Drip, as well as online forums in which users are making sense of their data and experiences together. We have shown how MFTAs represent and organize reproductive time, how they build datafied relations to pasts and futures, and how users become oriented towards temporalities that are embedded within broader social and cultural narratives of reproduction. We have further explored how people engage in collective practices to make sense of their fertile potential and find ways of 'queering' their temporalities.

Based on these explorations, we propose that future MFTAs should be designed with a more holistic purpose in mind: inclusive and accounting for a plurality of bodies, experiences, and temporalities. But as Barad (2015) pointed out: it is not about making 'trans or queer into universal features […]. The point is to make plain the undoing of universality'. In other words, the question might not be about embracing other marginalized groups into these tracking spaces, but the mere idea that reproductive bodies can universally be tracked, categorized, and predicted is to be debated. However, we also want to take seriously users' need for objective sense-making about their reproductive bodies. We therefore propose that inclusive design might not completely abandon normative representations of temporalities but engage with them through intersectional and multiple perspectives. Thus, allowing to make sense of reproductive temporalities as entangled and non-linear.

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PAPER 3

Orienting towards (Non)Reproductive Futures: Anticipating Infertility

Lara Reime

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Orienting towards (Non)Reproductive Futures: Anticipating Infertility

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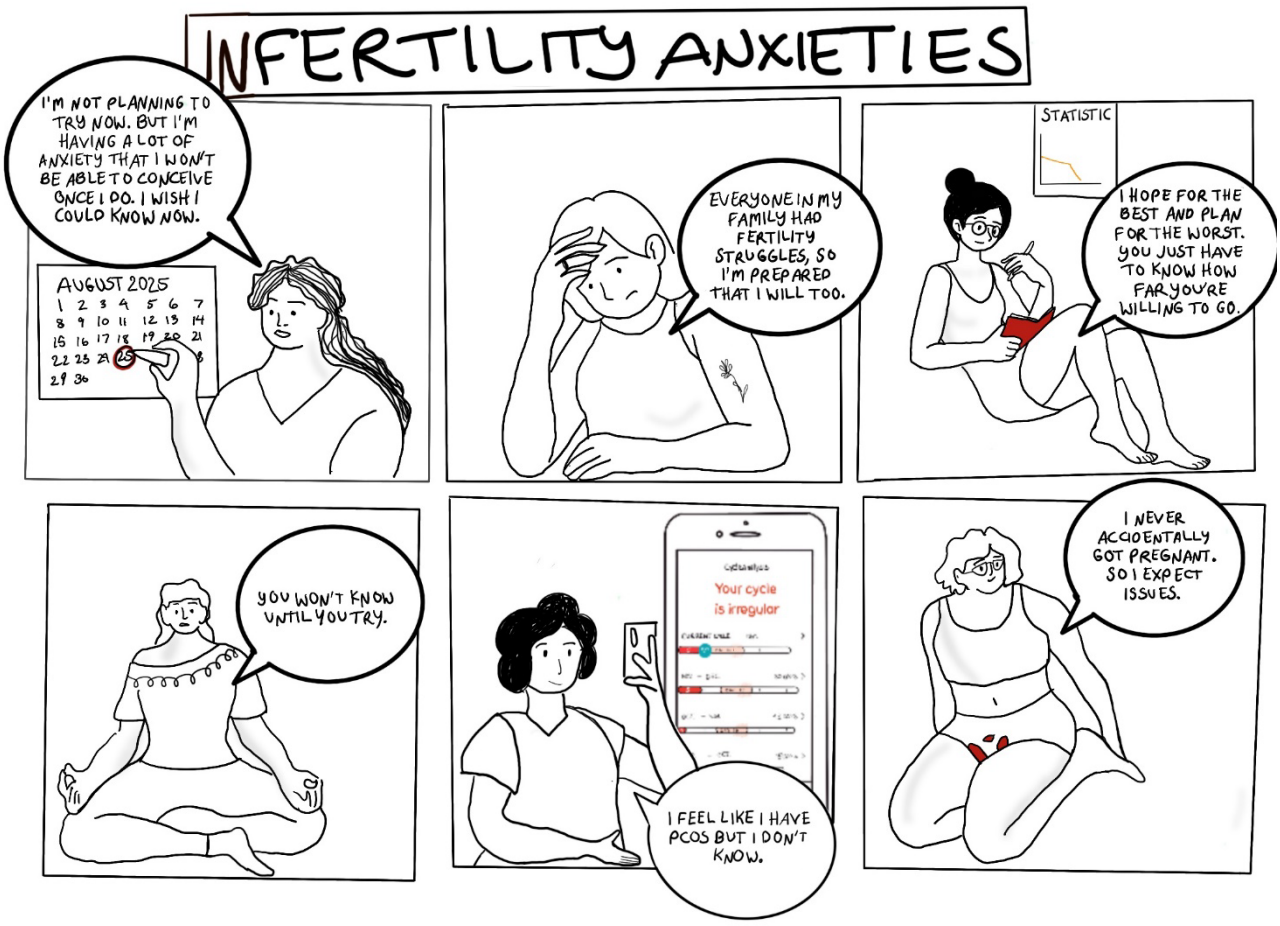
ABSTRACT

With the rise and availability of data producers around reproductive bodies, such as Menstruation and Fertility Tracking Applications (MFTAs) as well as Fertility awareness counseling (FAC), forms of control and preparedness through datafication are offered while at the same time ideas of fertility precarity are further distributed. This paper investigates the ways datafication of fertility takes form as people become oriented towards data as means of control over their reproductive potentials, while at the same time such data might orient people towards anticipating infertile futures. They thus behave and take actions as if infertility was already here, rather than something that is liminal in the future. By anticipating infertile futures people are moving timelines of reproduction and preemptively synchronize with healthcare services and legal requirements. Furthermore, reproductive labor becomes cast onto pre-conception bodies moving behaviors of a future reproductive body into the present.

Keywords: fertility, reproductive health, anticipation, orientations, temporalities

INTRODUCTION



The comic-strip like sketch[i] above shows six people navigating their thoughts and worries about their reproductive futures. It portrays black and white sketches of people making sense of their future fertile potential by relating to experiences of family members (everyone in my family had fertility struggles), to their own reproductive pasts (never got pregnant accidentally) or the uncertainty around potential diagnoses of Polycystic Ovary Syndrome (PCOS) or endometriosis. These considerations result in insecurities and uncertainties about their reproductive future and show how infertility, or at least struggles to conceive, are anticipated, and preemptively navigated: "I hope for the best and plan for the worst".

This paper considers people that are in the liminal space of biological fertility, where bodies fluidly move between fertility and infertility as neither is 'finally' constituted: "you don't know until you

try", as the intro sketch showed. Most of the people participating in this space are navigating fertility in the absence of current attempts to conceive but based on the wish for conception in the future.

I created this sketch to convey how discussions in online forums around infertility are picking up and feeding into contemporary social anxieties around fertility decline. Through narratives of fertility decline, particularly "women's fertility is being refigured as precious and vulnerable, something to be tracked, documented, and attended […]" (Roberts and Waldby 2021, 1). They become encouraged to track and understand their cyclic patterns, as well as to be aware of their ovarian reserve to protect and ensure their reproductive futures (ibid), as their fertility becomes understood as precarious (Van De Wiel 2020).

An understanding of fertility as precarious allows for technologies to enter reproductive spaces by offering tech-solutions to combat dwindling fertility rates as they ought to provide control and foresight over reproductive processes. These reproductive technologies include, for example, Invitro Fertilization (IVF) and Artificial Insemination (AR) (Thompson 2005; Franklin 2022; Mamo 2007), gamete freezing (Van De Wiel 2015; Martin 2010) or cryofreezing of cell material (Bach 2022; Lemke 2021; Kroløkke et al. 2019).

These numerous and continuously evolving technologies also offer possibilities for collecting data on reproductive bodies. Such datafication practices create new forms of data work and practices for bodies as they try to make sense of their fertility and reproductive futures through data. There is a need to further understand empirically how such data practices both result from and contribute to an orientation to infertility. *This paper thus asks in what ways the availability and promotion of datafication technologies (re)shape orientations towards fertility.*

This paper builds on an analysis of discussions in online forums on the planning of reproductive futures, and semi-structured interviews around the technologies people use to make sense of their fertile potential. I take Menstruation and Fertility Tracking Applications (MFTAs), as well as the

almost national rollout of Fertility Awareness Counselling (FAC) in Denmark as exemplary objects of datafication as they are being employed by my interlocutors to understand their fertile potentials.[ii]

ORIENTATIONS TO OBJECTS, SPACES, AND TEMPORALITIES

In this section I first sketch out Sarah Ahmed's (2006; 2010) notion of *orientation* before turning to Vincanne Adams, Michelle Murphy, and Adele Clarke's (2009) notion of *anticipation*, as a temporal orientation towards the future. I bring these two readings together to show, through an analysis of fertility datafication practices, how anticipation is not only an orientation towards the future, but also towards objects and spatiality of reproduction.

Orientation, following Ahmed, does not only shape the world around, but bodies and objects "take shape through being orientated toward each other" (2010, 245). Orientation is the act in which an initial subject (a body) and an object (e.g., MFTA) fluently move between the subject and object position and take shape through each other. Orientations are not neutral; they are influenced by social norms, power dynamics, and cultural expectations (Ahmed 2006). In this paper, I use orientations to analyze how the body, the spatial, and the social come together in practices of fertility datafication.

Furthermore, Ahmed brings to the fore how orientations are affective. To be affectively oriented is to follow objects of happiness and turning away from fear and pain, as Ahmed argues in *Promise of Happiness* (2010b) and *The Cultural Politics of Emotions* (2014), for example. Ahmed (2010b, 2020) discusses the 'family' as such a happy object that people move towards to or turn away from. When tending towards the familiarity of the family, one becomes oriented towards maintaining such structures (i.e., through 'providing' the next generation). One becomes oriented towards reproductive futures, by "imagining one's futurity in terms of reaching certain points along a life course" (Ahmed 2010b, 71). Thus, following the formation of life through socially given order of events, such as birth, education marriage[iii].

Other research has also discussed how people affectively turn towards reproductive technologies such as IVF (Franklin 2022), cryofreezing of cell material (Bach 2022; Lemke 2021), or oocyte freezing (Van De Wiel 2020) as they become understood as 'hope technologies' in the pursuit of happiness, in these cases the possibility of a biological family (as a point to reach along the life course).

To live in *reproductive orientation* (Van De Wiel 2020) then means to be oriented towards a future as biological parent. By being oriented towards such a future in the present, one *anticipates* it. *Anticipation* is a temporal orientation towards the future that requires action in the present (Adams, Murphy, and Clarke 2009). Thereby, the future becomes shaped in the present: "is not just betting on the future; it is a moral economy in which the future sets the conditions of possibility for action in the present. Through anticipation, the future arrives as already formed in the present" (ibid., 249). In other words, through anticipation the future has already arrived in the present, as actions are required in order for such futures to materialize or to avoid the materialization of unwanted futures.

Following an anticipatory logic in terms of reproduction would mean for example, changing practices and habits such as exercises or alcohol consumption in the present to ensure a 'healthy body' ready for conception in the future (Waggoner 2015). Public campaigns that advertise egg freezing at a young age, make use of this anticipatory logic by anticipating future infertility at a later age (you are never as fertile as you are now) on the one hand and on the other hand anticipating future reproduction, that is a timeframe in which citizens want to reproduce later in life, as I will expand later in this paper.

Such anticipatory logics *orient* people and health care systems towards risk management and prevention rather than reactive treatment (Bach 2022). The idea of acting now in the name of the future has become inscribed into clinical care of reproduction (Bock von Wülfingen et al. 2015). As such, anticipation (similar to orientation) is highly affective, as it is conceptualized and produced through hope (Clarke 2015).

In the analysis of this paper, I explore how hope and fear for a reproductive future are the affective motor that promote datafication of reproductive bodies. In doing so, I follow the five dimensions of anticipation as proposed by Adams, Murphy, and Clarke (2009): *injunction, abduction, optimization, preparation* and *possibility*.

RELATED WORKS

Critical and feminist scholars have inquired into reproductive technologies as both an object stemming from anticipatory practices of infertility as well as a subject producing them. For example, the work of Lucy Van de Wiel (2015) shows how the availability of relevant technology and the public discourses around reproductive aging foster practices of social egg freezing, in which future fertility is managed in the present by freezing one's eggs at a young age. Van de Wiel (2022) argues that through such practices, fertility treatment has become proactive, rather than reactive. The work of Anna Sofie Bach (2022) further illustrates how technologies of cryofreezing foster hope for cancer patients, as they not only allow for the anticipation of a future family but also a life after cancer treatment, making such practices highly affective and embodied on multiple levels. Celia Roberts and Catherine Waldby (2021) more generally examine how fertility has become a subject to management throughout people's lives afforded by the rapid development of new reproductive technologies. Particularly female fertility becomes cast as precarious, allowing for such practices of monitoring to unfold, shaping expectations and implications for reproductive temporalities. By drawing on the concept of *reproductive citizenship*, Katherine Carroll and Charolotte Kroløkke (2018) investigate how egg freezing becomes cast as an enactment of such as the risk of future reproductive failure is anticipated and preemptively managed through egg freezing.

Charis Thompson (2005), Sarah Franklin (2022) and Chia-Ling Wu (2023) are, for example, concerned with the affective and entangled practices of IVF treatment and assisted reproduction. They are investigating how people are living with and managing the medicalization of their fertility, making

an argument for the social organization of reproduction, and situating the logics of assisted conception within wider cultural narratives of reproduction.

Work in this space has further investigated the dynamics and temporalities of technologically mediated anticipatory regimes. For example, Wu argues, that the feeling of needing fertility datafication and prediction stem on the one hand from our ability to calculate probabilities and potentials, on the other hand by health services mobilizing our need of certainty by "riskiz[ing] the normal" (Wu 2023, 8). This results in "anticipatory medicalization" (ibid), in which 'normal' conditions become preemptively medicalized. For example, through narratives of a national fertility crisis and a national rollout of fertility awareness counseling, people become enrolled in what Moira Kyweluk (2020) calls the *(in)fertility pipeline* in which engagements with reproductive technologies become encouraged throughout the lifespan starting earlier and earlier. Within this pipeline, fertility treatment is rationalized for people that are (not yet) experiencing infertility (Van de Wiel 2022).

This work is relevant for my research as it illustrates how reproductive technologies orient people towards different reproductive timeframes. They have argued how data-driven, medicalized, and technology-centered practices around fertility remake reproductive temporalities by disrupting them (Franklin 2022), potentially slowing them down, or prolonging them (van de Wiel 2022).

In this paper I want to discuss what happens if people become oriented towards their reproductive futures at earlier stages in their lives, enrolling them in anticipatory practices and preemptive navigating of such future. Instead of waiting for an uncertain future to arrive, the data promises of e.g., FAC or MFTAs promote anticipatory logics, in which the future can be understood and shaped in the present. Through anticipating infertility, people become enrolled in technologically mediated *pre-conception health behavior* (Waggoner 2015). I offer empirical examples of data practices, and by extension reproductive technologies such as MFTAs and FAC, as actors and objects of anticipation. I analyze how data promises, technological progress, and public narratives *orient* people

towards such objects. Through this I show how anticipation is not only a temporal orientation towards the future, but in doing so, one becomes oriented towards objects and spaces as the materiality and spatiality of anticipation.

FERTILITY (AND) DATA IN DENMARK (BACKGROUND)

Alongside these more medicalized reproductive technologies, such as IVF and gamete freezing, various forms of collecting data around reproductive bodies have increasingly gained value for people in the liminal space of fertility as a means of control and clarity in this speculative space of reproductive futurity and thus become enrolled in multiple ways. For example, data is collected to achieve aims such as predicting future menstrual bleedings or ovulation, calculating chances for successful IVF treatment, or estimating how much fertile time remains. This data is often sourced through medical examinations in the form ovarian reserve and sperm testing (fertility testing) (see e.g., Roberts and Waldby 2021; Kyweluk 2020) or through self-tracking practices which have become increasingly supported through menstruation and fertility tracking apps (MFTAs) (see e.g., Hamper 2020; Homewood, Karlsson, and Vallgårda 2020; Roberts et al. 2019). In this paper, I focus on MFTAs and the FAC as technologies and practices that generate forms of fertility data. This section provides a brief background on these technologies, as well as more general narratives around data and fertility as they shape such practices in contemporary Denmark.

Denmark is defined by an ongoing digitalization of health services, which includes extensive data collection practices, interconnected data infrastructures, and personal identification numbers that allow for the tracking of citizens and sharing of their data across different sectors (Hoeyer 2023). In this context, fertility datafication is not an exception but rather one of many examples of data-driven governance and practices. This data-centric approach has made fertility datafication (through self-tracking and medicalized examinations) a routine aspect of infertility treatment provided by the public healthcare system (Dahlman et al. 2023).

This general datafication of the public healthcare sector (see e.g., Hoeyer 2023), ideas of responsibilization and self-reliance of individual citizens (see e.g., Carreras and Finken 2022), along with circulations of paradoxical narratives of fertility decline and overpopulation (Bach and Breengaard 2024), as well as normativities of family formations (see e.g., Dahl 2018; Adrian, Kroløkke, and Herrmann 2021; Andreassen 2018) make Denmark an interesting case for researching fertility data practices. Charlotte Kroløkke points out how the Danish welfare state is essential for understanding practices around reproductive technologies, as they are not only state sanctioned but "the making of children is also encouraged and seen as a state matter, and as essential in the continuation of the Danish welfare state" (2018, 11). The continuation of the welfare state has been put into question in more recent political debates, where 'underpopulation' and fertility decline have been discussed as a threat for the welfare state (ibid). Citizens are being once more encouraged to take control of their reproductive future to ensure the future of the state. The rollout of FAC (as I discuss in the next paragraph) is just one example of wider political projects and regulations relating to fertility awareness and preservation. It takes and gives form alongside initiatives such as fertility campaigns of the Copenhagen Municipality in 2015 and 2018, urging its citizens to become aware of their fertile potential and consider gamete freezing (see e.g., Kroløkke 2021) or recent changes in regulations of reproductive technologies.[iv]

In 2011 Rigshospital, the state sanction hospital in capital region of Copenhagen, Denmark, launched a research project called *fertilitetsrådgivning*, or in their own translation: fertility awareness counselling (FAC) (Hvidman et al. 2015). This 10-year pilot project created a 'fertility awareness clinic' in which citizens of the capital region could receive a free fertility test without prior suspicion of infertility. This offer was novel in that it offered fertility testing as part of government subsidized healthcare service which was previously only accessible through private healthcare or after 'one year of unsuccessful trying' (for heterosexual couples). This new offer as part of the healthcare system

predicts fertile potentials through ovarian reserve and sperm testing. Everyone who has turned 18 can participate in the testing. However, there is an age limit for women (41 years), and they should not have any prior diagnosis of for example PCOS or endometriosis. During the trial run of this project, it was only possible to get this examination when living in the capital region Copenhagen. During these 10 years, the meaningfulness of this examination was established (Hvidman et al. 2015) resulting in the further rollout of the offer in other municipalities across Denmark in 2023 (yet still not available in all of the country). Even though the FAC is being implemented in more municipalities, it is still scarce as waiting times can be up to three years. Consequently, the public healthcare system encourages people to generate data on their reproductive bodies themselves, for example through MFTAs (see e.g. sundhed.dk; Dahlman et al. 2023).

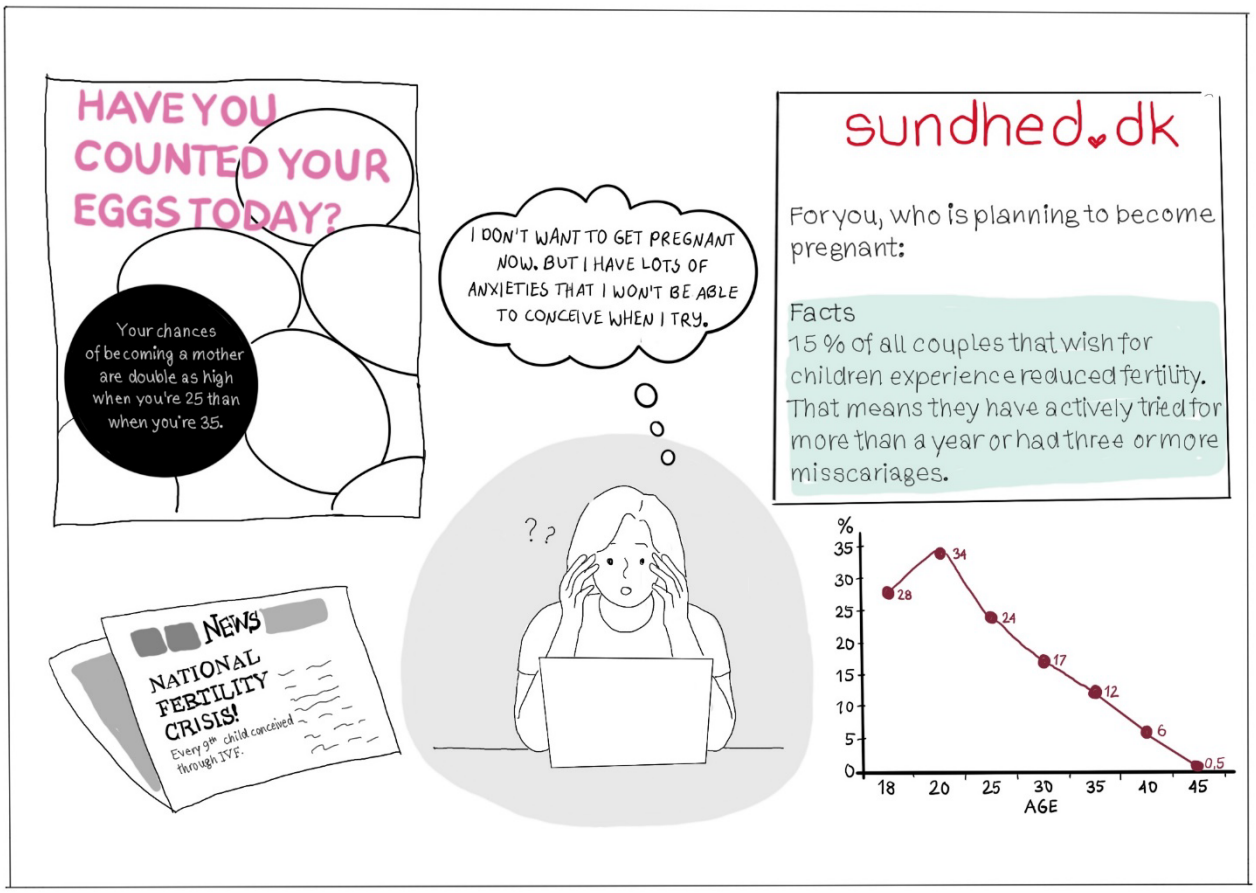
In the liminal space of future reproduction MFTAs have become a tool to foster awareness of one's fertile potential. App-supported self-tracking practices aim to generate data on bodily processes such as menstrual bleeding or temperature (see e.g., Lupton 2015; Hamper 2020; Homewood 2018). Such data then gets utilized to make sense of one's future fertility based on regularity and signs of ovulation. Most MFTAs[v] promote the promise that fertility calculations and objectifications can aid the user to make sense of uncertainties by "slicing life into controllable and actionable units" (Ruckenstein 2023) that can be acted upon and thus allowing users to 'master their bodies'. Tracking then, might become a form of care for future possibilities of reproduction, making sure to 'possess' a body most suitable for reproduction.

LIVING IN ANTICIPATORY REGIMES OF INFERTILITY

I utilize the five dimensions (injunction, abduction, optimization, preparation, possibility) of anticipation as laid out by Adams, Murphy and Clarke (2009) to structure my empirical material and to draw out how people become oriented towards objects and temporalities of reproduction. In the following section I show how these dimensions intersect, and anticipatory regimes of infertility

develop and come to be throughout them. Each section is introduced by a fabrication sketch to illustrate different situations that were shared with me in interviews and online discussions.

INJUNCTION: CREATING THE DUTY TO KNOW



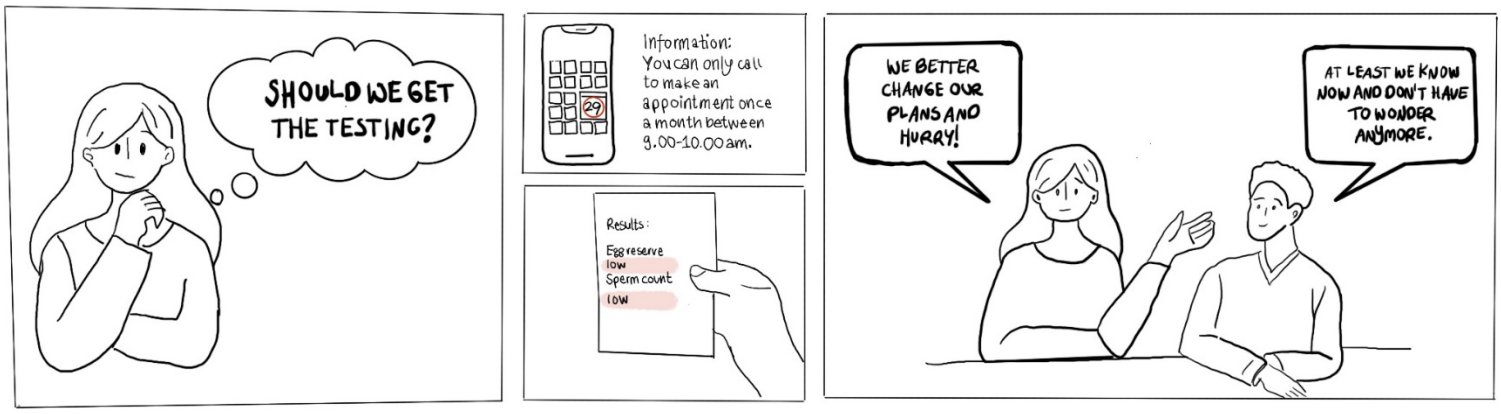
People increasingly 'come across' information on fertility decline and 'troubles to conceive' in the sense that they are not actively seeking it out but encounter it, for example, through fertility campaigns in public spaces, targeted advertisement for fertility treatment on their social media feed, or numerous newspaper articles on national fertility decline. For some of my interlocutors this abundance of information lead to questioning their own reproductive potential. As the sketch illustrates, one's own reproductive potential becomes negotiated in light of such public campaigns, statistics and public health information. "I don't want to get pregnant now, but I am anxious if I'll able to in the future" many people reflect in online discussions and during interviews.

These narratives of increasingly uncertain futures, due to 'ticking clocks' (you have higher chances of becoming a mother with 25 than 35) and national fertility decline open up space for anticipatory regimes to flourish, as they *injunct* citizens to "stay informed about possible futures" (Adams, Murphy, and Clarke 2009, 254). People then become oriented towards objects such as MFTAs and FAC as a means to become aware of and maintain their fertile potential. Injunction, following the authors, has become "mandatory for good citizenship" (ibid, 254). Particularly the progress logics of neoliberal contexts, as well as technoscientific innovations (which allows for a heightened predictability) promote regimes in which individuals are obliged to foresee and manage future (reproductive) risks while cultivating reproductive futures (Van de Wiel, 2015; Waggoner 2015). Preservative actions, such as egg-freezing or fertility testing, can be understood as such an act of responsible citizenship (Carroll and Kroløkke 2018).

Making fertility testing publicly available and promoting it through campaigns *injuncts* citizens to be responsible to turn their fertility into a quantifiable resource in order to "reconcile [it] with the processes of planning, management, and decision, and with economic, algorithmic, and clock-time logics more broadly." (Roberts and Waldby 2021, 17). Research published about the initial trial highlights the need for women in particular to be able to 'manage and plan' their reproductive futures. Building on the idea of the 'family clock', they argue that women often cannot build the families they imagined, as they are becoming aware of fertility issues too late (Koert et al. 2022). The testing, so they argue, helps them to become aware earlier, so they still have the chance to build the families they imagined, or at least can adapt their 'imaginations' sooner (ibid). These findings are part of justifying the expansion of the testing into other municipalities following the 10-year trial period in the capital region. They make the underlying narratives of the roll-out visible: 'people need to know as early as possible so they can act and plan accordingly'.

This shows, for example, how discourses and practices around technologies such as FAC not only answer to but also actively create an urgency (e.g., national fertility decline) that calls for such anticipatory practices (preserving fertility in the present). By mobilizing hope and desires for futures as affective dimensions individuals become temporally oriented towards the present as space for action (Wu 2023).

ABDUCTION: TRYING TO KNOW



When various tools and technologies to 'control' the future become available and promoted, people must first navigate these possibilities and then the results of such datafications. Even if people feel compelled to care for their reproductive futures through those previously described injunctions, they do not automatically become enrolled in such processes. Rather, they are going back and forth between their own past experiences and hopes for their futures and the role data can play within that. However, in the stories I have encountered, people generally seem to think that "it's good to know, no matter the outcome". For some people who have participated in the testing, the results required additional action, bringing their reproductive futures even further into the present. This can be seen in the accounts of people sharing their testing experiences. As the sketch illustrates, people online discuss how the testing made them aware of their low fertile potential, moving them into a space where quick action was needed. Rather than imagining childbearing as something of the future (after

a job and a home are procured as well as time spend on self-exploration and travelling), they are being oriented towards the present to avoid even further decline of their potential. Media coverage around the rollout of the testing share similar stories of couples that got a 'reality check' through the testing and got surprised by their relatively 'low' fertile potential.

But even through a 'positive' result, future fertility is moved into the present, as future decline is being pointed out and ways to preserve that potential discussed during the counselling. Through fertility testing, people might be moved into fertility treatment and preservation, as a high result might be used to rationalize egg freezing (you will never be as fertile again) as will a low reserve to preserve the 'little' potential that is left (Van de Wiel 2015).

While *induction* describes how anticipatory regimes create a "duty to know" as part of responsible citizenship, *abduction* refers to "the lived experiencing of trying to know" (Adams, Murphy, and Clarke 2009, 254). Within such orientation, it is not only the past that becomes mobilized (as a reference for future predictions, e.g., when did you mother enter menopause), but also the present that becomes altered, when results of testing and predictions need to be navigated. Even when people are not planning to become pregnant in the present, abduction requires action in the present, as datafication, simulations and probabilities (ibid) cast people preemptively infertile.

OPTIMIZATION: RUNNING OUT OF TIME

Out of time refers to practices through which bodies become oriented towards being out of reproductive time and consequently aiming to optimize the time that is left. In an interview, Lisa tells how she and her partner did not want to "waste any more time" once they started trying to become pregnant. "We better get the process started, the 'worst' that can happen is that I am getting pregnant in the meanwhile", she told me. At this point, Lisa and her partner have not encountered any fertility issues yet. But through information found online, exchanges with friends and family, and engagements with tracking technologies, they have been oriented towards conception as a difficult process due to their 'advanced' age (both are in their late thirties).

Such stories, for example, can be found in-app forums in which people share their experiences of being diagnosed with infertility when they thought 'they still had time'. Such out of time narratives are also amplified through media coverage of the FAC, where people are sharing their experiences of getting the testing. Governmental-issued advertisement (as I discuss in the first section) orients citizens to freeze their eggs or sperm in their mid-twenties, 'before running out of time' and information found on the national health platform (sundhed.dk) states that women should know about their fertile potential before turning 35, as enrolling in IVF or AR processes after that age will only lower their chances. Further, legal limits of IVF and AR place bodies as out of time, as they are legally governing 'when the clock stops ticking', which might be in disjuncture to people's bodily capacities to conceive. [vi]

Furthermore, their previous experiences of encountering healthcare services also orient Lisa and her partner towards longer timeframes: "it'll take some time until we get it all started anyways". Due to

long waiting times, they want to get started now, so they 'are ready' and enrolled in the respective systems, when 'it is actually time'. I understand this as a preemptive synchronization, in which bodies are already being placed in synchronization with the bureaucratic structures of healthcare services, so they are already synchronized once it matters, instead of further loosing time in this initial synchronization. Here, I am building on Thompson's (2005) work on the *ontological choreography of reproductive technologies,* where she brings forward how different (bodily) temporalities must be placed into synchronization during IVF treatment: the cyclical and repetitive menstrual and treatment cycle, with the bureaucratic time of working hours and clinic opening hours, with the linear and unidirectional of the biological clock. Through technologies such as MFTAs and FAC, people partake in preemptive synchronization, where bodies are being placed in synchronization before even entering processes of IVF or AR. These forms of fertility prediction technologies, health narratives and legal frames generate new temporalities and "ontological categories of 'anticipated infertility' - capturing women who have no reason to suspect they are infertile but who foresee a future diagnosis of infertility or a struggle to conceive" (Kyweluk 2020, 2). Through preemptive synchronization, 'best possible futures' within anticipatory regimes are being secured.

PREPARATION: MANAGING RISKS OF REPRODUCTIVE FAILURE

People do not only try to optimize their remaining reproductive time within anticipatory regimes of infertility by preemptively synchronizing with healthcare services, but also prepare themselves by preemptively managing the potential risks of reproductive 'failures'.

They do this by preparing their bodies for a future pregnancy but also by preparing themselves for future infertility treatment. For example, people online discuss how they want to achieve certain weight loss goals, have a more healthy and nutritious diet, stop drinking alcohol and/or smoking, as well as taking various vitamin supplements. But this time is also used to understand one's body better, particularly trough the datafication of menstrual cycles. This idea is amplified through the narratives of MFTA providers, as they promise to be 'in sync' with one's fertility and have control over it by means of datafication. These in sync, controlled and understood bodies can then be progressed into fertility (Hamper 2022), as users can 'know' when the right moment for conception is: "the promise of knowledge is the control it offers over the reproductive process" (Franklin 2022, 157).

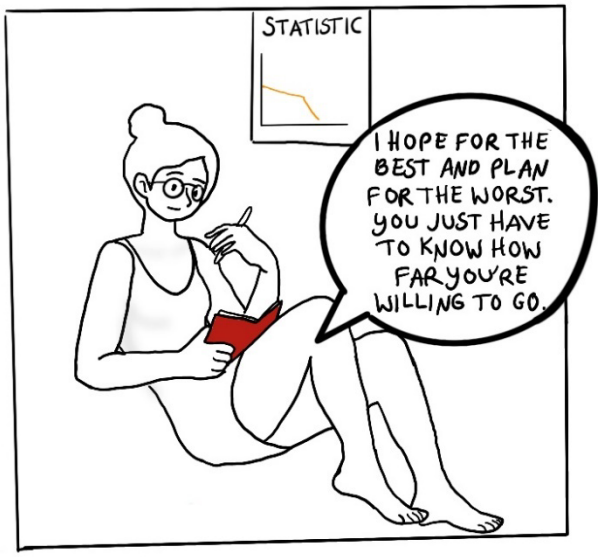
Through preemptively synchronizing to the potential of IVF processes, as I also discuss in the previous section, timelines of reproduction become reconfigured. The sketch in the beginning of this section is fabricated based on several discussions I followed. Here, people calculate their latest starting date (the age at which they want to begin trying for conception). They calculate it based on information they find online (how long it takes on average to get pregnant), the regularity of their cycle, the average duration of IVF as well as national legal limits of treatment. This is to ensure that

they have 'enough time' left in case they need extra treatment or encounter waiting times to enroll in fertility clinics.

Preparing for a future infertility makes people on the one hand consider "how far they are willing to go", by considering possibilities of e.g., IVF treatment or use of gamete donation and on the other hand striving towards 'healthy bodies' to try their best to avoid future fertility treatment. While for some the possibility of IVF treatment offers (the only) hope, for others it is seen as a last resort that should be avoided due to the strenuous process. This shows how this sphere is not only a space for anticipating and reconfiguring technoscientific and biomedical progress (i.e., avoiding the inevitable national fertility decline by rising the amount of state financed IVF treatment or supporting the invention of new technologies), but also creates *pre-conception health behavior* (Waggoner 2015). That is, by living towards reproductive futures, present health behavior becomes altered in order "to provide for a future other" (ibid, 942).

In this preparation phase, anticipatory regimes generate "new and better means of dealing with inevitable disasters rather than actually preventing them" (Adams, Murphy, and Clarke 2009, 258). In other words, FAC and tracking do not actually prevent infertility as such but produce preparatory actions. Instead of preparing for parenthood, people prepare for the potential of not becoming biological parents and preemptively navigate the potential consequences.

POSSIBILITY: PROMISES AND LOSS



When people are preemptively synchronizing with medical processes to manage the potential of future reproductive 'failures', they are creating the possibility of their reproductive future despite the apparent odds of an infertile future. A multiplicity of outcomes is being imagined when speculating on reproductive futures, as the sketch illustrates. When everything is already imagined and preemptively navigated, decisions on 'how far one is willing to go' can already be made, and the hope that everything "will be (all) right" preserved, as they were properly anticipated (Adams, Murphy, and Clarke 2009).

Through anticipatory regimes, possibility becomes reconfigured as it is no longer measured against the impossible thus opens up new spaces for investment and progress (ibid). For example, anticipatory regimes of infertility create possibilities for scientific progress and new political legislations, as funding is being mobilized to further the research of reproductive technologies. Changes in legislation then seize the possibility of such reproductive technologies to combat national fertility declines, this includes for example regulations regarding abortion, supported IVF treatment or how long gametes can be frozen. Legislations create the possibility of objects and reconfigures our orientation towards them as their availability had previously been impossible. We might think for example of Franklin's (2022) early accounts of IVF treatment receivers, in which IVF was a novel technology only accessible by a few. In the last forty years, the availability of the technology itself and how it has been made available through legislation has changed our understanding of IVF today. In

contemporary discourses in Denmark IVF treatment has become such a normalized practice that it is preemptively navigated and negotiated, as the previous sections show.

Anticipatory regimes of infertility also open spaces and create value for data promises, legitimizing an increased collection and sharing of reproductive data. Data promises, following Klaus Hoyer, are the "paradoxical drivers of intensified data sourcing. They are justified by a need for—and promise a future of—decisions based on some sort of 'evidence', but they are not themselves supported by evidence" (2023, 31). In other words, data promises are creating an urgency for data to be collected in the present based on speculations on their possibilities in and for the future. In this case, data promises build the argumentation to construct new data infrastructures and subsidize data providers, such as the FAC. Here, data is being collected in the name of preventing further fertility decline, both on a national and individual level. On a national level, data promises circulate the idea that with sufficient data on citizens' reproductive potentials further fertility decline can be better understood. For example, a recent report on infertility stressed the importance of more data to combat the infertility epidemic (Eliasen et al. 2024). Institutionalizing data providers such the FAC then opens the possibility to collect data from a broader category of the population as everybody, theoretically, can get tested thus diversifying the collected data. Consequently, the possibility to collect data from a younger and 'healthier' population is being fostered, in comparison with previous data collections that mainly entailed the data of people already in fertility treatment.

An individual might collect data around their reproductive body to make sense of their reproductive future, predicting its possibility, so they know what 'the worst' will be they have to expect. However, individuals can also lose the possibility of a reproductive future through anticipatory practices. For example, other research shows how some people would not want to participate in FAC as it would be like "knowing when you'll die" (Bodin et al. 2021). A negative test result might put in question the

very possibility of a future reproduction thus making one grief one's reproductive future before that loss is finally constituted (ibid).

ORIENTING TOWARDS REPRODUCTIVE FUTURES THROUGH PAST EXPERIENCES

In the previous analysis I have shown how fertility becomes cast as something fleeting and precarious which needs constant protection, prediction, and care. This understanding offers spaces for technologies to enter as solutions in the form of control (e.g., MFTAs) and prediction for planning purposes (e.g., FAC). I have drawn out how anticipatory regimes of infertility orient people towards the possibility of reproductive futures, its demise, and objects of reproduction. In this section I further discuss how anticipation is not just a 'simple' orientation towards the future, but a continuous tending towards the "not-yet" (Ahmed 2006). I structure this discussion around three points: the more-than-future temporal orientations involved when living towards the future, the background on which bodies and objects materialize, and the labor involved in living for the future.

Firstly, an orientation towards the future entails more temporal entanglements than the future. When we orient towards a (specific) future, the present becomes reoriented based on that future orientation. This has been captured by the previously laid out idea of anticipation in which the present becomes

abducted by the future, as life takes shape as if the future was already here (Adams, Murphy, and Clarke 2009). Reading this with Ahmed's work, we can understand that the future not only changing the present but is also always based on our past experiences, which determine how and what we can imagine for the future. This becomes visible, as people are mobilizing their past in order to predict their fertile future. For example, fertility struggles of a family member, miscarriages, or the lack of accidental pregnancies in the past are being used as indicators for fertile potentials in the future. The past then becomes what orients people towards reproductive 'failures' in the future, and consequently creating an openness for anticipatory regimes to injunct management and preservation efforts. Anticipation then is not only a temporal orientation towards the future, but also a retrospective orientation in which the past is latent in the imagination of possible futures.

Secondly, Ahmed (2006) argues that the objects we become oriented towards are not the cause of our orientation towards the future but the effects of the repetition of such orientations. In other words, it is not objects that orient but when oriented "in a certain way is how certain things come to be significant, come to be objects *for me*" (Ahmed 2010a, 235). Through certain orientation, such as towards reproductive futures, and tending towards these futures, some objects become nearer than others and available within one's bodily horizon. The existence of objects such as FAC or MFTAs are not necessarily the cause for our orientation towards the future, but by tending towards the not-yet of reproductive futures, we come across and near such objects. So, while the injunction dimension might make it seem like objects just appear in the world that people then need to make sense of as they are being injunct to manage their fertile potential, they are 'not just found there'. They need to be in proximity to the body, and they come into proximity on a path that is already taken towards future reproduction. In other words, bodies that are not on this path might not be injuncted or further oriented towards these objects and spaces of reproduction. Drawing for example on the idea of the family as happy object, Ahmed (2020) argues how some people become oriented towards different

life points that ensure the reproduction of this happy object, while other people become disoriented when following such objects or do not come near them in the first place. However, orientation both shapes how "subjects and objects materialize or come to take shape in the way that they do" (Ahmed 2010a, 235). For example, if the FAC came to matter within an orientation of self-knowledge and bodily understanding, rather than ensuring of a reproductive future, then bodies might form around it differently.

Thirdly, when bodies (and objects) materialize it "involves forms of labor that disappear in the familiarity or 'givenness'" (Ahmed 2010a, 235). FAC and MFTAs are not just given, but they materialized within anticipatory regimes of infertility. Their materialization and that of anticipatory regimes themselves require labor, which is often invisibilized. For example, I have shown how people navigate and live within anticipations of infertility, reorienting their presents and making sense of data around their reproductive futures. This exemplified, how much labor is needed to "to 'optimize', to 'live in preparation', to anticipate – to gather information calculate, consider, plan, foresee, decide, act, and so on" (Clarke 2015, 90). Through the availability of MFTAs and offers such as the FAC, reproductive labor becomes cast onto pre-conception bodies (Waggoner 2015). Anticipatory practices locate reproductive labor much earlier in people's life, fostering what I call preemptive synchronization in which bodies become already synchronized with medical institutions and multiple timeframes even though they are not yet enrolled in fertility treatment. Anticipation thus "reterritorializes and expands the domains and sites – not only in space, but also in time – that are called into the future" (Adams, Murphy, and Clarke 2009, 253). As established throughout this section, orientation includes the repetition of the tending towards. It is thus not a single act to participate in the FAC, but a repetitive tending towards a reproductive future of which the FAC becomes one 'point on the line'. Reproduction too is not a single moment but a continuous process (Wu, 2023), which becomes visible through the previous analysis.

CONCLUSION

The paper set out to ask how the availability and debates around datafication technologies (re)shape orientations towards fertility. Through empirical examples and qualitative analysis, I have shown how some people in liminal states of fertility become oriented towards anticipating infertility, rather than fertility. Building on the work of Adams, Murphy and Clarke (2009), I have utilized the five dimensions of anticipation (injunction, abduction, optimization, preparation and possibility) to investigate how people become affectively oriented towards objects, such as MFTAs and FAC as a means to predict future fertile potential.

Here, I have shown how public narratives around fertility precarity, and decline foster normative narratives that value foresight and preparedness. Responsibility for such preparedness becomes recast and individualized by giving citizens the tools to make sense of their reproductive futures as early as possible. Through the availability and narratives around such technologies, infertility is being produced as a "possible future that should be *preemptively* considered, acted upon and engaged in the present" (Clarke 2015, 101). Knowing about one's fertility then becomes a duty of responsible citizenship (Sänger, Langer, and Carstensen 2024; Van De Wiel 2015).

Anticipating infertility orients people towards objects, such as reproductive technologies that can potentially provide such foresight and preparedness. My analysis showed how people participate in preemptive synchronization in which bodies are already placed in sync with bureaucratic rhythms of healthcare systems and legal requirements in the absence of constituted infertility. I have shown how the potential risk of reproductive failure (not being able to conceive), is preemptively encountered and managed.

I then discussed these findings by bringing in my reading of Ahmed's (2006) notion of orientation. By reading ideas of orientation and anticipation with and against each other, I argued that anticipation is not only an orientation towards the future but an entanglement of different temporal orientations.

The (im)possibility of reproductive futures becomes based on past experiences, which affect how the present is understood as a space of intervention and preparation. Drawing on the theoretical notion of orientation has helped to show how subjects and objects materialize with each other. Here I argued that rather than FAC and MFTAs orient people towards infertility, people need to anticipate infertility first in order to become oriented towards and into proximity of objects such as MFTAs and FAC.

Lastly, I discussed the labor it takes to orient and live in anticipatory regimes of infertility. Particularly, through such regimes, labor becomes cast onto pre-conception bodies moving behaviors of a future reproductive body into the present.

Further, anticipatory regimes of infertility are not only focused on the loss of future reproduction but materialize alongside hope for the future. In the presented cases anticipation works as a way of "hoping for the best and preparing for the worst". Considering the rapid development and availability of various technologies, future research could explore their emerging relations. This could include a focus on more recent social media sites such as TikTok and the ways they possibly contribute to the injunction and experience of anticipatory regimes of infertility, as an example.

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[i] These situations are fabricated based on my empirical material collected through interviews and digital ethnography. Here, I build on Markham's work (2012) on fabrication as ethical practice when doing internet research, as an attempt to ensure anonymity.

[ii] I am doing this research from certain (bodily) positions in the world. My access to and understanding of reproductive technologies, as well as my relations to reproductive futures, are shaped by my position as a white, heterosexual, cis-woman with a higher education.

[iii] See also Elizabeth Freeman's (2010) notion of *chrononormativities.*

[iv] In 2024, new legislation raised the number of IVF treatments paid by public healthcare from three to six tries, as well as offering treatment for a second child (previously only singles/couples without previous children could receive state financed AR/IVF treatment). Further, the freezing limit of 5 years for oocytes was suspended, allowing for eggs to be frozen until the respective woman reaches the legal age limit of IVF treatment (46).

[v] The landscape of MFTAs is vast and affords different engagements. As such, it is difficult to talk about this variety as if it were one object. However, while I cannot pay attention to the ways individual MFTAs govern reproductive bodies in very specific ways, I include more broad experiences of datafication and self-tracking.

[vi] In Denmark, government supported IVF treatment is only provided for women until they are 41 years old, (they must have gotten the transferal to the clinic before they turn 40). Against payment, women can receive IVF treatment until they are 46 years old, though sundhed.dk informs that only 5-10% get pregnant between the age of 40-43, and that almost no one achieves pregnancy after they are 43 years old ('Fertilitetsbehandling - Sundhed.Dk', n.d.).