Entangled Pregnancies: Expectants' Experiences of Using Pregnancy Apps

Beatrice Tylstedt
Uppsala University
Uppsala, Sweden
beatrice.tylstedt@im.uu.se

Helga Sadowski
Uppsala University
Uppsala, Sweden
helga.sadowski@im.uu.se

Caroline Eliasson
Uppsala University
Uppsala, Sweden
car.eliasson@gmail.com

Lina Eklund
Uppsala University
Uppsala, Sweden
lina.eklund@im.uu.se

Abstract

Digital applications for tracking pregnancy and fetal development are increasingly popular, yet we know little of how these technologies shape individual pregnancy experiences. This empirical study investigates how 17 expectants in Sweden use such apps to make sense of their pregnancies. It is grounded in feminist perspectives, highlighting the need to focus on women's health. Drawing on entanglement and flat ontology, we show how apps are part of socio-material configurations where they contribute to pregnancy meaning-making. We show how users experience a gradual realization that apps model ideal pregnancies and not the participants' own, how the app's commercial nature conflicts with many participants' ideals of pregnancy, and how participants continue to use apps despite this but engage in selective use. All to support ways of making pregnancy in desired ways. Finally, we outline how users engage with pregnancy apps and the resulting natureculture arrangements where bodies and technology are intertwined and co-constructed. We argue that entanglement should be seen as a process, not a state, as users continually negotiate their use, engaging in what could be called processes of untangling.

CCS Concepts

• **Human-centered computing** → Human computer interaction (HCI).

Keywords

Pregnancy, HCI, user studies, reproductive health, entanglement theory

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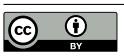

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1 Introduction

Pregnant people increasingly turn to mobile apps for health information, support and guidance throughout their pregnancy [15, 29]. Today, there are more pregnancy apps on the global market than apps about any other medical topic [35]. Pregnancy apps are part of a broader industry of female health technologies and innovation–FemTech–that aims to empower female health through data and innovation [3]. By giving users the opportunity to track menstrual cycles, detect fertile phases, or virtually follow an unborn's development, smartphone applications such as *PregLife*, and *Natural Cycles* are entering reproductive health arenas and seemingly allow users to take fertility matters into their own hands.

However, there remains a limited understanding of how reproductive health apps (RHAs) influence personal experiences of reproductive health. For reproductive health apps in general, previous studies have highlighted the apps' tendencies to quantify embodied perceptions, and explain individual experiences with standardized averages that often are far from the range of lived experiences, this has led scholars to question the self-knowledge possible to gain from such apps (e.g. [45]). Studies, such as [25], suggest that the use of pregnancy apps has become an integral part of daily mobile routines, and stress the apps potential agency in profoundly shaping the pregnancy experience. Yet current work in human-computer interaction suggests that the relationship between humans and technology is performative, meaning that both continuously shape and influence each other [14]. This entangled [14] perspective adds potential for studies on pregnancy as the apps come into play for experiences of pregnancy, an embodied but nonetheless socio-cultural life event. Drawing on socio-materialism and Donna Haraway's natureculture concept we aim to explore the intimate and interdependent connections between the apps and the pregnant individuals contributing with knowledge on the ways these designed, technological artefacts co-construct users' experiences and behaviors to explore both benefits and risk of these apps. Applying this perspective we must recognize that technology does not merely reflect reproductive experiences but actively participates in shaping them. For pregnancy apps, this understanding prompts us to ask: *How do expectants experience their use of pregnancy apps, and how are the natureculture entanglement of pregnancy enacted in and with everyday app use?*

We situate our work within the broader context of feminist HCI and its growing focus on (digital) women's health, following calls

from scholars like Almeida et al. [2] to prioritize women's health in studies of technology. While much previous research critically examines the consequences of reproductive technologies on a broad scale (e.g. [27, 28]) we zoom in to the micro level of users' everyday interactions, highlighting both risks with these technologies but also how users appropriate the technology. We interview pregnant individuals using pregnancy apps, to examine the ways these apps, through their various design features, actively participate in shaping the experience of pregnancy, the body, relationships with the fetus, and the surrounding political landscape of pregnancy and data privacy. We show how the design of popular pregnancy apps can create tension and conflict, as users navigate the challenge of aligning the performance of pregnancy with their wishes and desires. We discuss, how users, through selective engagement strategies, negotiate entanglement, attempting to direct the experience of pregnancy in ways that resonate with their own needs while navigating notions of the good and healthy body as communicated by these apps. Taken together, we contribute to understandings of how health narratives are designed and consumed in the digital health sector, and to critical perspectives on the design of (gendered) commercial health and wellness apps developed and used outside established public health care systems.

2 Background

2.1 The rise of reproductive health apps

Early research from the 70s-80s on reproductive health and its technologies primarily focused on medical technologies controlled and provided by healthcare professionals [43]. Traditionally, such reproductive technology was divided into four categories: fertility control (e.g., contraceptives and techniques for terminating a pregnancy), management of labour and childbirth (e.g., Cesarean section), antenatal technologies (e.g., ultrasound), and conceptive technologies (e.g. IVF). Reproductive health apps differ from these technologies in crucial ways, warranting their classification as a fifth category of reproductive technologies: Unlike traditional medical technologies, RHAs are autonomously chosen, downloaded, and used by individuals who want to avoid or induce a pregnancy, by expecting parents, by parents who want to monitor their newborn's health and development, and by IVF patients who wish to digitally track their treatment plans.

In Sweden, like in other (Western) countries, pregnancy apps are popular. In app stores, users can choose between a number of apps, both international ones, and ones developed in Sweden (e.g. Babyjourney, One Million Babies, and Preglife). Pregnancy apps generally include functions that allow users to follow the development of the fetus both through visualizations and through written information about what is happening in the fetus' development, and in the body of the pregnant person. The apps often also contain one or several of the following features: self-tracking functions which allow users to track symptoms, information about aspects such as dietary recommendations and possible alerting symptoms to seek health care for, kick-counter functions, journaling functions, community functions, checklists, and codes and discounts for baby-related purchases.

Maternity care in Sweden is part of the public health care system, although the popularity of pregnancy-related apps could indicate a shift towards patient self-governing within maternity care [44]. On one hand, pregnancy apps provide informational support to enhance a sense of confidence when it comes to interactions with healthcare, on the other hand, pregnant people may become less dependent on guidance and help from medical providers. However, patient control is not without consequences, as it also places burdens and demands on individuals to manage their own health [25].

2.2 Previous research

The recent development of RHAs over the last few years has gained scholarly attention (and critique) in relation to questions such as self-quantification, data surveillance, neoliberal imperatives, commodification, gender norms, and female empowerment [1, 17, 27, 28, 32–34]. In the field of Feminist HCI, reproductive health has gained increasing attention with studies exploring questions such as menstruation [4, 9, 10, 12, 31, 42] and pregnancy [11, 13, 19, 26, 39] largely from design perspectives. We situate our study in Feminist HCI and its presumption of the gendered nature of technology [5, 40], providing knowledge of how pregnancy apps and users are entangled, and how apps and users co-create experiences of pregnancy in daily interaction.

Pregnancy apps have become an integral part of the pregnancy experience for many pregnant people [29]. Although pregnancy apps primarily rely on standardized information and average values, women generally find them useful for gaining information about bodily changes and fetal development during pregnancy [21, 25, 29, 38]. However, some studies indicate that the easy access and vast amount of information available through these apps can contribute to a feeling of never knowing enough amongst users, and cause pregnant people to obsessively compare their symptoms and experiences with those presented in the app [25]. When it comes to emotional support, pregnancy apps have been suggested to foster a sense of connection between the pregnant person and the unborn, and are experienced as providing emotional support to users [22, 29]. Socially, the apps are often used together with partners and family members to cooperate around practical preparation, create a connection to the unborn, and to bond with each other and share excitement around the pregnancy [26].

This body of research has in common the view of pregnancy apps as active agents in profoundly shaping the experience of pregnancy (e.g. [25]). In this study we build on this research and elevate the understanding of pregnancy as a situated socio-material experience and practice by applying the lens of entanglement. Thus, while previous research centers the agency of apps in shaping embodied experiences such as pregnancy, we bring a theoretical perspective that challenges the very distinction between technology and embodiment, and contribute an empirical account of how commercial health apps are intimately entangled with lived embodied experiences.

2.3 Entangling pregnancy

Drawing inspiration from Blackwell's [6] notion of technology as a lens for HCI "through which to understand being human in a changing world" (p. 511), we argue that understanding the use of pregnancy apps is key to understanding what it means to be

pregnant in today's digital world. As Christopher Frauenberger has identified, theories of entanglement are increasingly entering HCI [14]. This family of theories reframes human-computer interactions as performative acts and sees technology as one actor in socio-material configurations. In socio-material perspectives, technology is viewed as inherently social, shaped by the contexts in which it is designed, developed, and used [37]. Socio-materialism sees the interconnectedness of social and material elements like technology in shaping human experience, behavior, and society [37]. The social and the material are mutually constitutive and interact in complex ways to shape the world. This perspective challenges traditional paradigms in HCI that focus predominantly on usability and functionality, proposing instead that the deeply entangled, situated nature of technology in everyday life must be acknowledged. By doing so, it foregrounds the social, cultural, and ethical dimensions of human-technology relationships, recognizing the complex interplay between users and technologies [14].

Drawing on this perspective when studying pregnancy allows us to see pregnancy as a socio-material practice that is performed with technology. Pregnancy can be understood as an 'ultimate' example of what Donna Haraway calls "natureculture," in that it is both a clear "animal" biological experience of human reproduction and embodied processes, and a "human" socio-cultural one. The concept of natureculture also rejects the notion of a pure, pre-technological existence [16]. Haraway argues that there is no state "before" entanglement; bodies and technologies are always already interconnected. Studying pregnancy as an example of entanglement is particularly interesting because of its "pureness" as natureculture experience and its historical, as well as contemporary, entanglement with technology. Pregnancy allows us to explore the fuzzy borders between humans and technology that have been increasingly exemplified in contemporary and personal technologies leading HCI to questions of "where the human ends and the technology starts" [14](p. 2:2) and vice versa, ultimately leading to philosophical questions of "desirable technological futures and who 'homo digitalis' should be in those futures" [14] (p. 2:2). Pregnancy realizes these existential questions of what it means to be human with technology [6] but also questions of desirable futures [14] both by asking how we want to go through pregnancy experiences with technology, but also as it literally involves bringing about the future generation.

In our work we engage with pregnancy as a natureculture and through this seeing pregnancy as coming to be through interconnections between human and non-human entities, as a sociomaterial configuration that also considers the biological and embodied nature of pregnancy as natureculture.

3 Method

This qualitative study is part of a larger research project which aim to study the use of pregnancy apps in Sweden by both expectants, their partners and the apps' role in meeting with midwives. Sweden as a context for studying pregnancy apps provides an "extreme" case in the sense that the country has a well-established public health care system that offers health care to all its residents close to free of charge, but also in the sense that it is often considered one of the most gender equal countries in the world. Yet, the popularity of pregnancy apps indicates that commercially developed apps that specifically cater to female health needs, contribute something to female health and pregnancy care that public health care does not. Using Sweden as a case helps us understand how users engage with commercial health and wellness apps as a complement to public health care rather than as an alternative to it, and how they navigate the commercial character of the apps in relation to publicly available non-commercial alternatives.

With our feminist approach, we aimed to acknowledge womens' lived, embodied experiences by collecting rich, and in-depth descriptions of how pregnant individuals engage with pregnancy apps. We thus performed semi-structured interviews where participants were able to influence the direction of the discussion [20]. This allowed us to allow the participant's experiences to shape the direction of the data gathering but we still could focus on apps and app use. We initially focused on first-time pregnant because studies have indicated that they are the ones most likely to use RHAs [21]. However, after the first ten interviews, we broadened our sampling to also include second-time pregnant as preliminary analyses indicated the potential for differences between first and subsequent pregnancies. The interviews dealt with detailed and personal experiences of pregnancy and RHAs, as well as user experience and perception of app design, data governance and privacy.

The interviews were carried out in 2023 and 2024 and were mostly conducted via Zoom. Most participants chose zoom interviews, even though all were first given the option of a face-to-face interview. We believe that the mediated interaction made it both easier to schedule and to agree to talk to a stranger. Each interview lasted between 35-60 minutes. The interviews deal with detailed and personal experiences of pregnancy and RHAs, as well as user experience and perception of app design, data governance and privacy.

3.1 Ethics

The project has received ethical approval from *anon. for review* Ethical Review Board, *number anon. for review.*

We worked from the principle of informed consent. Before each interview, the participants were sent information about the study, their participation, and their right to withdraw at any time and without stating a reason. We followed the GDPR concerning data handling and all information provided from and about the participants has been handled accordingly. No identifying information about the participants has been included in the transcriptions, data analysis, or results.

Quotations are used with the participants' permission. Quotes are translated from Swedish to English by the researchers since most of the interviews were conducted in Swedish.

3.2 Recruitment and sample

We used a combination of sampling strategies. First, we recruited through posts in ten Facebook groups for pregnant people (after permission from group admins), based on due dates and specific cities (the names of the groups are left out due to anonymity reasons). We chose groups connected to large, medium, and small cities in Sweden, aiming for a sample of expectant participants with varying backgrounds, education levels, and experiences of

the public health care system, as these points often vary across the country and between larger and smaller cities. The intention was not a representative sample of the population, but to capture a variety of experiences of pregnancy and a multiplicity of perspectives. We complemented our advertisement with snowball sampling and convenience sampling by reaching out through private and work networks. The combination of sampling strategies was necessary to gain enough participants for the study.

The seventeen participants are 23-40 years old and live mostly in large cities but also medium, and small cities in Sweden. Thirteen were expecting their first child, several had experienced miscarriage(s), four participants were pregnant with their second child during the time of the interview. All of the pregnant participants were expecting their child together with a male partner. Two of the participants had migratory experiences and were born outside of Sweden. Fourteen of the participants had a higher education (university degree or, 'university college' degree, or equivalent).

It should be added that the Swedish pregnancy care system is free of cost and follows a 'natural' model, where midwives manage routine care and doctors intervene only in high-risk cases, minimizing unnecessary medical interventions. This approach contrasts with more medicalized models, like in the United States, where obstetricians lead care and interventions are more frequent. While the Swedish model provides a personalized and less invasive experience, it may create discomfort for those used to constant medical oversight by doctors [24].

3.3 Analysis

All interviews were audio recorded and transcribed *in verbatim*. They were uploaded to the qualitative analysis software NVivo. We followed a thematic qualitative analysis [23] approach. The first step involved becoming deeply familiar with the data. Each researcher read and re-read the transcripts multiple times to immerse in the data, making preliminary notes on emerging ideas, patterns, and notable points inductively. Building on this, we jointly developed initial codes within NVivo. This involved systematically identifying and labelling segments of data of relevance. Each feature or insight within the data was coded, and related excerpts grouped under these codes to create a comprehensive overview of the data's key points.

After the initial coding, all authors moved to the phase of identifying broader themes. This involved clustering generated codes into broader, more encompassing themes that captured patterns of meaning across the data. We collated all data relevant to each theme, ensuring a thorough and nuanced understanding of the underlying patterns and how they interrelated. We did this with the help of a digital whiteboard that illustrated the relationships between themes and provided a clearer understanding of the data structure. In this step, we used the theoretical framework to think with entanglement as a concept to understand the interplay between users and the app.

4 Results

Most participants used several apps to track their pregnancy. They turned to different apps for different purposes: to combine certain features and shape use to fit their needs, and they describe selecting apps based on recommendations from friends and midwives, the designerly look and feel, and the specific characteristics and functions of the apps. Several, for example, explain that they chose the app *One Million Babies* as it is supposed to be more 'scientific' than other apps, and *Liberoklubben* because of its discounts on diapers and other products.

The apps used by the participants were: *Baby Journey, Liberoklubben, Natural Cycles, One Million Babies, Preggers, Preggo, Preglife, and Pregnancy Plus* (also listed with additional info about the developer, release year, country of origin and cost, in the appendix). Some participants also used the wearables *Garmin* and *Apple Watch* to track their pregnancy, and many participants used the *1177 web service* (the Swedish Healthcare Guide for medical advice) in addition to apps. Many participants used menstrual or fertility tracking apps and wearables before the pregnancy (*Natural Cycles, Flo, Premom, Period Tracker by GP apps, Garmin,* and *Cycles*).

Just like pregnancy is an individual experience, so do our participants tell personal stories and anecdotes about their pregnancies. While some embrace the apps to co-construct their pregnancy experience whole-heartedly, others are more critical towards all or particular aspects of the entangled experience, and in particular when the apps attempt to make pregnancy in a way that runs contrary to their own ideals or desires about what pregnancy should be.

We have structured the result of our analysis under the headings; embodied entanglement, fetal entanglement, and political entanglement, to show the entangled nature of pregnancy and the role of apps in this on a physical, social, and political level. Under these headings, we explore the relations between the apps, users, and other human and non-human elements and the entanglements these are engaged in.

4.1 Embodied entanglement

4.1.1 Making pregnancy timelines. For most participants, with the confirmation of pregnancy, a new timeline or perspective of how to count time begins. A novel terminology structures the expectant's time and immediate future: Is it trimester one, two, or three? What happens in week 16, when is my due date and how accurate is it in the first place? What complicates things is that many phases along the pregnancy journey are associated with different medical risks and developmental steps. The first trimester, for instance, is often considered the insecure one: Here, miscarriages are most likely to occur. For many, particularly this early period can be accompanied by anxieties. Thus, participants use the apps to keep track of the important 'milestones' of the pregnancy and the fetus' development. One participant (20) describe feeling a relief when the app informed her that the fetus' heart had started beating. When being asked what kind of information she takes part of in the app, she says:

> P20: I mean first of all it's a lot about the child's development which I thought was very interesting in the beginning when so much is happening each week, some organ has been created or something like that haha. . . and then there is also information about the mum, so that's about me, which was also very interesting especially in the beginning when there were so many hormones and yeah. So, in the beginning I

> thought it was nice to feel like now the heart starts beating, I mean these milestones to feel–I was quite worried about miscarriage–and then I thought it was comforting to see that it was moving forward and that the child was developing.

The quote illustrates how the participant uses apps to count important milestones of the fetus' development, and how the apps keep users calm, even though they do not say anything about the particular fetus. No matter how advanced their visualizations or predictions, they are not diagnostic devices but give average values. The apps and the users co-create a timeline of pregnancy where the 'progression of the pregnancy' is possible to divide into milestones, and count up or down:

> P17: it says how many days you have been pregnant and how many days that are left. And then it also says in percent. For example, now when I open the app it says 95% [...] you can really count down!

Participants check the time-progress regularly, some describe checking several times a week, while others describe checking once a week, on the day before entering a new week, to see how the fetus will develop during the upcoming week. Some of the participants describe doing this together with their partners, almost like a weekly ritual. Other participants describe using it to look for what is coming up further ahead in the pregnancy:

> P1: This is the page [showing the app] I'm most frequently in, where you can check week by week and read about what information they recommend then. . . and of course I've checked upcoming weeks too, especially in the beginning when I was pregnant, I examined this app and everything that's in there. So actually I've probably read everything.

The participant describes a curiosity to know 'everything' about the pregnancy, and to inform herself about upcoming weeks. Rather than focusing only on the current week, expectants use the apps to make time pass during the pregnancy, counting down the weeks until the estimated birth date, sometimes impatiently. The pregnancy is experienced as a long time period and a line towards a clear goal–the estimated birth date–that the apps help the users visualize. The calendar year – a time interval most people would think in – becomes irrelevant. In this way, the pregnancy-app entanglement contributes to a different perception of time.

In sum, it can be said that the participants' use of apps reflects a co-creation of a pregnancy timeline, where they track, count down, or look ahead to upcoming weeks, managing the time of the pregnancy through the app. The apps provide a sense of control and calm by offering average developmental benchmarks, even though they cannot provide specific diagnostic information about the individual fetus. This usage creates a new temporal experience distinct from the ordinary calendar, focusing instead on the countdown to the due date. Overall, for many of our informants, pregnancy apps help reframe time, creating a structured way to manage the uncertainties and anticipation of pregnancy by turning it into a series of measurable and predictable events.

4.1.2 Experiencing the body with the app. In our data, we found a focus on embodiment and embodied experiences. A second-time pregnant user (participant 14) discusses how reading about what is happening during a pregnancy makes her able to see the corresponding events in her own body. This contributes to a sense of her body working as "supposed", which results in a sense of trust and pride.

> P14: My relationship with my body has been complicated in general throughout my life. I was also sick as a child, so I haven't had much trust that everything will work as it should, ehm, and being pregnant and going through a pregnancy, like I already did, and now doing it again, it always triggers a bit of that too. . . but what I think is so nice about it is that it [the body] still can, and that it actually does everything it's supposed to, and reading about "now this and that is happening," okay, my body is actually doing it. I don't even know how to describe it. It makes you kind of proud.

For her, this is a relearning of what her body is and can do, as she from a young age has not had confidence in her body. While the embodied experience itself has a positive effect on the previously "complicated" relationship, the app and the knowledge it provides, its ability to report "now this and that is happening", is part of this making of the pregnant body that she feels proud of. Participant 11, explores the same process similarly:

> P11: I actually think I've noticed certain things about my body that I wouldn't have seen if I didn't have the app. I think it was something... some app, I don't remember which one it was, maybe Preggers or another one, where they described that you might start seeing visible veins on your breasts. I didn't see it that week, but then I saw it, and then I noticed that, yeah, now they're starting to get a bit veiny. I probably wouldn't have noticed that at all if I hadn't had that information from the app.

She was excited that the app provided interesting information about her body that she might have missed otherwise. In this way, it increased her awareness and became entangled in the making of the pregnant body. However, this process is not always as uncomplicated as for our participants above. Participant 7 is critical of the entanglement with the apps, yet relies on them as a confirmation of 'normality'.

> Interviewer: You mentioned that you're more in tune with your body now. How do you feel about relying on that instead of looking at the app?
>
> P7: Yeah, I think it's good. I believe it's healthier in some way, ehm, to, yeah, not... not get symptoms that you maybe don't even have [laughs].
>
> Interviewer: Have you experienced that during the pregnancy, like you've checked the app and then felt symptoms that you didn't really have?
>
> P7: Well, maybe not symptoms exactly, but of course, it's been a confirmation, like, I feel nauseous, and it's

> natural to feel nauseous, so it has kind of confirmed the self-image of how I'm feeling.

This confirmation is a significant part of the interviews, as in the quote above. She is critical of relying too much on the app, yet still takes comfort in being able to double-check that everything is progressing 'as it should' according to the 'natural' pregnancy progression framed by the app. While referring to more restrictive app use as 'healthier,' the participant leans on the app to confirm both the healthiness of her pregnancy, and her own self-perception, by interpreting her experience with the app.

We also interviewed pregnant individuals who were more critical or ambivalent towards app use and wondered if this type of entanglement with the embodied experience does not take away something from it. One participant describes having grown more and more critical towards the technologies and the mechanisms behind them, during her second pregnancy:

> P4: I get more information out of, actually, paying attention to myself which is actually increasingly difficult where the digital is so prevalent [...]. I think I simply believe in other sources of knowledge, for example intuition. And I think now, especially with the difficulties and complexities at the beginning of my pregnancy, where I completely ignored my own limits for so long and obviously I crashed at some point, it was a reminder to trust in other things than institutional frameworks such as data.

In other words, this participant argues that, instead of being a seamless nature-culture [16] entanglement, she rather feels disturbed by the technology's entanglement, disturbing her alternative ways of knowledge production through the body– "paying attention to myself", and "intuition". She is very critical towards, what she calls, "a disconnection from the self". In her case, this led to a critical situation at the beginning of her first pregnancy (she reported earlier in the interview how she did not take enough rest and overworked into a state of complete exhaustion), resulting in distrust of institutional frameworks. Ultimately, in the course of the interview, she wondered to herself why she used the app in the first place.

Other participants mention similar, yet less critical, views, arguing that the excessive information consumption promoted by the apps is causing them to feel they are 'too much in the head' rather than 'listening to the body.' Such moments disrupt the seamless integration of the app with the user's bodily experience, resulting in an undesirable shift for many—from a grounded, embodied understanding of pregnancy to a more detached, cognitive one. This dualism underscores a tension between technological mediation and the desire for authentic, bodily awareness.

However, some participants describe having come up with strategies for how to consume information through the apps in a way that fits their desired pregnancy experience. Participant 3, for example, describes how she chooses to not take part of all the information that comes up in the app:

> P3: I, who have a tendency to worry easily, have practiced to not press on everything that comes up, there are questions that appear in the app... Coffee and energy-drinks came up here [scrolls the app] and I have already made a decision to drink one cup [of coffee] a day so maybe I don't need to read more about that. So, it also comes down to being selective when you consume information, what type of information.

This user feels like information irrelevant to her is bothering her over and over again. She has made the decision to limit her caffeine intake to a particular norm (that stays in the lines of recommended guidelines in Sweden). For her, this is now a topic that is 'done'. However, since her app does not know about her caffeine consumption levels or works on the assumption that expectants might not know guidelines or willingly ignore them, she keeps getting notifications to curb her consumption. While this, on the one hand, might be experienced as patronizing, for this particular user it has another bothersome dimension, namely that she tends to worry a lot and frequent messages make her nervous. Thus, she had to "train" herself not to react to each and every single message, reflecting frictions in the app-pregnancy entanglement. Said differently, she has to take a step back and distance herself from the pregnancy experience created in tandem with the app, has to make a conscious effort, and has to unlearn reacting to the app to some degree.

In sum, the users describe both positive and negative sides of experiencing the pregnant body with the app. The app, for some users, give them a sense of pride in their own body and what it is capable of, and leads the user's attention to changes in the body that they would not have noticed without the app. For other users, the app disrupts their sense of bodily integrity and knowledge, and cause worries due to excess information consumption, which motivates users to creatively adjust use to avoid these negative aspects, and to make pregnancy in a way that fit their ideals of a desired pregnancy. Interestingly enough, while some users are very critical of the apps, they do not discontinue use altogether, which supports the understanding of pregnancy as natureculture ultimately entangled with technology.

4.2 Fetal entanglement

Visualizations of the fetus, which practically all of the apps our interviewees discussed offered, are easily one of the most popular features. Visualization comes in two forms, either as metaphors for size such as fruits (see image 1), or as more realistic illustrations of the fetus (see image 2).

In Image 1, the size of the fetus is illustrated by a drawn green lime against a pastel pink colour. The app screen communicates to the user that "your" baby is now the size of a lime–contributing to the experience of the app describing the user's actual fetus rather than an average estimation of the fetus' size at this time of the pregnancy–and that it is 35% developed. The app (*Preglife*) uses the word "baby", rather than "fetus" or a similar word, to describe the fetus in week 14, contributing to the personification of the fetus, which at this point, is far from a "baby". This is interesting in light of the Swedish context where abortion is legal until week 18 (and after week 18 with a certain permission), especially since *Preglife* is developed in Sweden and supposedly the most popular pregnancy app in Scandinavia (according to their webpage www.preglife.se). These types of visualizations, as we show in the next few paragraphs, contribute to users relating to the fetus as "human".

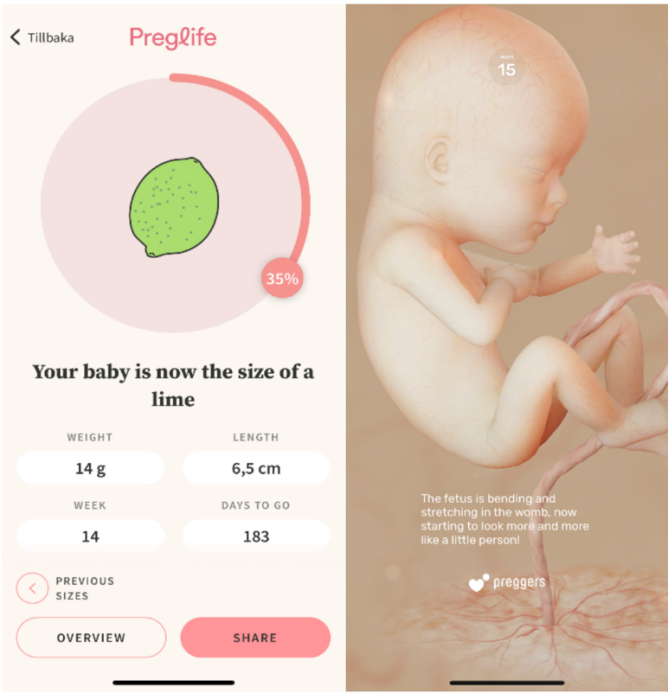

Figure 1: Left, Image 1: Screenshot from the app Preglife. Right, Image 2: Screenshot from the app Preggers: 3D animation of a fetus.

In *Preggers* (Image 2) the user can interact with the animation of "the fetus" by moving it around and looking closer at different parts. The fetus skin color is customizable in the app, and has what can be interpreted as a peaceful look, floating around in a beige vacuum. It is illustrated in a "realistic" style, and has an umbilical cord, indicating that it is part of the pregnant user's body–and thus mediates a relation to the expectant.

Most of our participants enjoy the visualizations:

> P13: With the first child, it was really exciting to see which fruit the baby was compared to in each week, and we'd sit there counting down like, "What week are we in now? Oh, it's going to be so exciting, how fun!" [...]. Back then, we'd even go to the store, find the fruit that matched the app, buy it, and take pictures of the belly with it.

The fruit illustrations are part of materializing the fetus, making it real. In Sweden, one ultrasound per pregnancy is normally offered in the second trimester. Thus, there are relatively few opportunities to 'see' the fetus. For that reason, ways of 'making' the fetus with the help of the apps' visualizations are welcomed by a majority of participants. In this particular example, the couple even did an extra step by purchasing the respective fruit to be able to make something that felt inaccessible and hard to grasp, as the fetus in the womb, not only visible but also more 'tangible'. Participant 12, in a similar way, explains that the visualizations, while a bit silly and non-realistic, still contribute to making a connection:

> P12: I think it's cute, to think that now it's this big or like a blueberry or similar, and it's cute because you get more attached.

In other words, getting a better understanding of the unborn's size and the 'fruitiness' equates to a certain 'cuteness' which in turn increases a feeling of attachment. Other users embraced the more realistic types of visualization, such as the one illustrated in Image 2.

> P16: You get to see the journey from almost an embryo, to a human, and that does something with you that I think makes it easier to, like, feel and relate to it being a real person and human that is growing.

In other words, it is not the abstract idea of a fruit substituting for an unborn, but showing the 'humanness' and becoming human in more concrete ways. While this early humanization of embryos has been criticized in much of early feminist theorizing on the topic, and is currently problematized the context of a post Roe v Wade US, for this participant it becomes a selling point of the app and its visualizations to be able to "relate to it being a real person and human that is growing."

Although the visualizations and updates on the fetus' development increases the sense of connection between the expectant and the fetus, ultimately, they do not say anything about the *actual* health status of the fetus, which some users reflect upon. Participant 3, for example, describes a 'realization' that the development status of the fetus as described in the app does not necessarily equate the status of her baby:

> P3: The thing is that both the weight and length that it says here [referring to the app], I have understood since quite a while back, that that does not have to do anything at all with me. So 35cm, like it says now, has nothing to do with my baby. It's like an average [...] so it's not really connected to me... for good and for bad of course. Maybe it would have been strange too, to have it more accurate here, I mean it's pretty... It's not exactly something I've missed, but you realize that it doesn't give you that much, in terms of what is happening specifically in my belly.

The participant talks about how this came as a sober realization: "it's not really connected to me", followed by some disappointment: "it doesn't give you that much". So the illusion carefully fostered by many of the apps that this is a more or less accurate depiction of what is happening within the uterus, is failing.

In sum, one key socio-material configuration is the entanglement with apps, expecting parents, and the unborn. Through visualizations that compare fetal size to everyday objects and detailed descriptions of fetal development, these apps provide a "window to the womb" [7], allowing users to engage with the fetus in new ways. This entanglement is especially significant in early pregnancy, when the fetus is not yet felt through movement. For many, particularly first-time mothers, this period is marked by uncertainty and a lack of control over the pregnancy outcome. By offering visual cues–such as comparing the fetus to a piece of fruit–these apps become intertwined with the process of pregnancy, helping to fill this gap and facilitate a sense of connection to the developing baby.

4.3 Political entanglement

In the interviews, some examples of what we here call political entanglements, came up. That is, users navigating the social and political context in which they use the apps, and the implications of this. The political entanglement that was most clearly criticized by the users, was the commercial character of the apps.

Several participants were outspokenly critical to the commercial character of the apps, and that they are developed and run by private companies as opposed to being part of the public health care system. For example, participant 2 says:

> P2: Now it's so clear that these apps are driven by advertisement. All the time, you get different suggestions and that makes you, ah. . . Some suggestions you get, like get pregnancy insurance, or other suggestions that you can do... I mean the question becomes if it's really necessary or if they're just trying to sell you products and services that you don't really need? So yeah, [I would prefer] an app that was not commercial.

Participant 2 talks about advertisements and how they become a sign that the apps might not have the best interest of the pregnant person in mind, but rather try to get her to buy things. Later in the interview, she connects the app developers' commercial interests to concerns of credibility, implying that the commercial interests could conflict with trustworthiness. Other participants raise the same concerns. Participant 15, for example, argues that there should be a quality regulation of the apps to make sure the information they provide are medically accurate. The skepticism towards the apps being private commercial actors developed outside of the Swedish public health system can be contextualized by the institutional trust being high amongst the Swedish population, like in other Nordic countries [30]. Interestingly enough, participants share some of the same concerns that have been highlighted in previous research, e.g. that self-tracking apps are part of a neo-liberal shift moving responsibility for public health from the state to the individual citizens [27, 28], turn users into objects of commodification [17, 41], and that apps for reproductive health need to be regulated [32].

Another main criticism against RHAs have been their lack of data security. When asked about what data the user inputs in the app, and data security concerns, participant 5 says:

> Interviewer: And what do you think about data security? Do you think about that, or...?
>
> P5: No, I'm the type who thinks it's a lost cause. You have Facebook and Instagram and all that. So, this feels like just a drop in the ocean compared to everything else.

This statement is a bit contradictory: On the one hand, the user sees data security as "a lost cause". On the other hand, she is still conscious and careful about the amount of data she is sharing, adding: "I've only entered my last period date, basically". While one could argue that this is, nevertheless, a rather intimate piece of data, she is not taking into account that she is leaving other kinds of footprints when using the apps, which also generate data for the producers, e.g. which links the user clicks, how much time they spend with particular visualizations, if they open sales links of business partners, etc. [46].

Another participant is more critical and embeds the question of data security and reproductive health apps with (at that time) ongoing debates about tightening abortion laws in the US and potential misuse of tracked data:

> P10: I haven't logged anything super sensitive so far. I mean, I haven't logged any abortions, I haven't logged any medications, I haven't–of course, it's sensitive information [the due date]–but maybe it's not the kind of information that's dangerous if it gets out, at least that's what I think right now.

Here again, we see a bit of a being-torn: On the one hand, being very critical of the horrible, potential pitfalls as they have been discussed mainly in US-American context and its restrictive abortion laws, on the other hand a shrugging of shoulders and thinking that one is not affected by such pitfalls because one has only logged 'harmless' information. In the end of the quote, the participant suggests that her view might change in the future. Yet, she limits her judgement of the potential harm of the data, as we interpret it, in relation to the current legal and political landscape of her use. As the right to abortion lacks constitutional protection in Sweden, the American case still sheds light on potential future risk of this type of data.

In sum, users somewhat navigate political questions of data commodification and data privacy by not tracking data, while they at the same time express little concern over the potential harm of pregnancy apps in comparison to social media apps. While some users downplay privacy concerns by focusing on minimal data sharing, others remain uneasy about potential risks, especially in light of ongoing debates about data misuse. This highlights a broader tension between awareness of political entanglements, with questions such as data privacy issues, and practical engagement with digital tools. It is striking, however, that the participants, in consequence, do not engage with or try to avoid one of the main intended functions of the apps: To track data.

5 Discussion

In this study, we explore how the specific natureculture [16] entanglement of pregnancy is experienced and enacted in and with everyday app use. We have shown how expectants engage in complex navigations of technological arrangements in and with the apps, social and personal expectations and norms around what a "good" pregnancy is, and political dimensions of data tracking and privacy when co-constructing pregnancy through everyday interactions, and thus contribute with knowledge about how this technology comes to matter in everyday life on both a personal, and political level.

Our results show how users explore and understand both the fetus and the body with the app, and how the app and the user are intimately entangled in the knowledge production of pregnancy. This contribute to the use of entanglement theory for shedding light on user's interaction with technology [14], and support what previous studies have shown about pregnancy apps' impact on facilitating users' information consumption and connection with the unborn during pregnancy [21, 25, 29, 38]. The apps contribute

to users' conceptions of pregnancy time, are part of shaping perceptions and relations to the fetus, make users pay attention to bodily changes that might otherwise have gone unnoticed, and contribute to sometimes conflicting user experiences of being "in the head" while wanting the pregnancy to be an embodied experience, of experiencing both reassurance and increased worries through the app use, and of navigating standardized information and norms in contrast to the perceived uniqueness of their pregnancy. By showing how users hold space for multiple and contradicting perspectives on apps' functionalities, we show how users relate to apps as a given part of embodied experiences like pregnancy, while at the same time problematizing the app-presence when it overshadows their embodied experiences. While our study only studies experiences of pregnancy, we suggest that this–the holding space for multiple and contradicting perspectives–largely mirrors what it means to live with technology also in other parts of live. Making our results useful in opening up avenues for future studies.

Our results also add to previous knowledge by shedding light on how users actively shape use to navigate negative experiences with the apps. Several design features in the apps are experienced as conflicting with their visions of how pregnancy should be. Foremost it is the gradual realization that the apps, while at first glance appearing to provide highly personalized experiences, in reality are derived from general knowledge, statistical averages, and norms. The various representations of pregnancy in the apps model ideal pregnancies and not the participants' own pregnancies. Secondly, the commercial nature of the apps conflicts with many participants' ideals of pregnancy. These features are e.g. ads within the apps, or the business models visible through advanced tracking options for personal data that can be monetized or sold onward. The expectants desire pregnancy to be non-exploited and in cases where the commercial nature of the apps becomes visible, it contributes in constructing pregnancy in non-desired ways. Thirdly, we discuss how participants continue to use these apps despite their critique against them but do by enacting the agency they have by shaping their use patterns. They engage in selective use, using some features and not others, using multiple apps to combine features across designs, limits information shared, all to support ways of making pregnancy in ways they desire and limit ways of making pregnancy that run contrary to their ideals. Thus, our results show that users navigate and actively resist, to the degree possible while remaining users, some of the exploitation that scholars have criticized reproductive health apps for [17, 27, 28, 33, 34]. This highlights user agency within restrictive systems but could also guide ways that this type of technology could be redesigned, to respect and meet users' needs. Future research could explore this by continuously centering the lived experiences of expectants in design.

Despite the users' sometimes critical perspectives on these apps, our participants are still users. This is partly a consequence of our sample where we target active users. Yet, considering the extremely high penetration these apps have among first-time pregnant [8, 29, 36] it also indicates the pervasiveness and impact of this technology as an actor in the socio-material configuration of pregnancy. This also confirms results from previous studies which show that once the user has started using reproductive health apps, they are unlikely to want to quit use [18].

It is clear from our results that the entangled making of pregnancy is not an either or, or ever finished project. Pregnancy, as performative, is constantly made and in this making the apps have a role in shaping pregnancy but also as a framework that the expectant struggle with in their making. We thus see processes of entanglement, where certain features of the apps are drawn on and enact influence on the making process, but we also see resistance and conflict. As some features of the apps push how pregnancy is made in certain directions that are undesirable by our participants, they actively go in to reshape their use, engaging in what could be called processes of *untangling* how pregnancy is made from the agency of the app design. Our participants stress the uniqueness of their experience, thereby arguing for their right of interpretation and definition. Entanglement, we argue, is a process, not a state.

6 Conclusions

Finally, digital applications are part of how physical, embodied experiences come to be, while at the same time, the political and social realities of pregnancy influence how the technology is engaged with and used. For the participants in this study, reproductive health apps are important social actors in a socio-material web of meaning-making around pregnancy. The experience of pregnancy is shaped and comes into being as pregnant individuals interact with these apps. Digital interfaces shape the physical experience of pregnancy, while at the same time, the physical realities of pregnancy influence how the technology is engaged with and used. Drawing on the concepts of entanglement and natureculture allowed us to pinpoint how design is enacted. We cannot understand what interfaces do to people, unless we also understand what people do to interfaces.

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