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## ORIGINAL ARTICLE

# Knowing (with) the body: Sensory knowing in contraceptive self-tracking

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## Abstract

Scholars have criticised reproductive self-tracking software applications (apps) for reducing embodied experiences to objective quantifications and leading to user self-alienation. Building on scholarly work that underscores the sensory and affective dimension of self-tracking, this ethnographic study explores how users of contraceptive self-tracking apps come to know their bodies during their everyday tracking practices. By relating tracking data to embodied experiences and relating their experiences back to the data, users produce knowledge of their own lived hormonal physiology. Users learn to articulate how their body feels and acts, foregrounding their body as an instrument of knowing alongside technical devices used. Users also articulate how their body is affected by everyday factors such as personal behaviours, diet, sleep and stress, thereby enacting what I call situated health. By foregrounding people's sensory and affective engagements with their data and their bodies through self-tracking, this study contributes to understanding how reproductive self-tracking may be meaningful to users as well as encourages a move beyond the hierarchical opposition between 'objective' numerical data and embodied, lived experiences.

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**KEYWORDS**

contraceptive technologies, embodied knowing, knowledge practices, self-tracking, sensory knowing

## INTRODUCTION

Although smartphone self-tracking software applications (apps) to prevent pregnancy have become widely available, empirical studies on these technologies remain scant. Research on reproductive self-tracking apps, such as to track menstrual cycles or achieve pregnancy, has largely focussed on app design, privacy infringements and the way these apps are marketed while simultaneously stressing the negative effects of self-quantification (Kressbach, 2021; Lupton, 2015, 2016; Novotny & Hutchinson, 2019). These critiques argue that the apps lead to user self-alienation because they reinforce a hierarchical opposition between 'objective' numerical data and embodied, lived experiences (Kressbach, 2021; Lupton, 2015, 2016; Novotny & Hutchinson, 2019). These critiques, however, perpetuate the same opposition in reverse: while lived experiences are considered rich and complex, a quantified body is 'rendered flat and one-dimensional' (Lupton, 2015, p. 449). Following these critiques, quantifying the body would result in an oversimplified version of the complex reality that is embodiment, where bodies, selves and sexual activity 'become reduced to numbers' (Lupton, 2015, p. 446).<sup>1</sup>

While it is important to critically assess the effects of self-tracking technologies, these analyses tend to overlook ways that self-tracking is productive and meaningful for users. Empirical research on the use of reproductive self-tracking apps (Chen, 2017; Della Bianca, 2021; Grenfell et al., 2020; Hamper, 2020; Zampino, 2019) shows how users engage in knowledge practices relating to their menstrual cycles and hormonal health. Constructing understanding of how their menstrual cycle changes and evolves (Zampino, 2019), users' knowledge practices include numerical and/or statistical cycle data as well as sensory and affective practices, relating to bodily sensations and emotional states, while also involving practices of attunement (Della Bianca, 2021). This indicates that, in everyday practices, a hierarchical opposition between 'objective' numerical data and embodied, lived experiences may not be maintained.

Building on these studies, I approach the everyday practices of self-tracking app users as ways of producing knowledge relevant to the user. I ask: *How do users during their everyday self-tracking practices relate tracking data to embodied experiences and relate their experiences back to the data? What kind of knowledge of the body is produced through these practices?* To answer these questions, I draw from ethnographic research that I conducted through interviews and diary analysis of app users and in online user communities.

My analysis foregrounds how users relate data to experiences and experiences to data, producing knowledge of *their own lived hormonal physiology*. The known body is *physiological* in the sense that it is physiologically active; it produces hormones, releases ova, builds endometrium and sheds during menstruation. But the known body is also *lived*, as it is situated in and affected by daily life; personal behaviours, diet, sleep, stress and other everyday life factors can influence hormonal physiology. The known body is also the user's *own* body; it can be lived, felt, measured, sensed and understood as an individual, with unique needs and preferences.

Here, I build on the work of scholars underscoring the sensory and affective dimension of self-tracking (Lupton, 2018; Maslen, 2021; Ruckenstein, 2014; Weiner et al., 2020). By detailing how users relate and negotiate different types of data in reproductive self-tracking, my analysis

taps into a new field to explore sensory knowing. The daily and long-term self-tracking practices invite users to sense and cultivate awareness of how their body changes by, for example, feeling and noticing cervical fluids or ovulation cramps throughout the cycle. Users' digital-sensory work extends beyond simply feeling, sensing or diagnosing the body. Users learn to articulate how their body feels and acts, as well as how their body is affected by everyday factors such as personal behaviours, diet, sleep and stress. They enact what I call *situated health* by articulating and experimenting with the relation between these everyday factors and how their body feels and acts. This contributes to the understanding on how reproductive self-tracking may be meaningful to users as well as encourages a move beyond the hierarchical opposition between 'objective' numerical data and the embodied, lived experiences often predominant in critiques of reproductive tracking. It shows how sometimes the complexities of the reproductive body may be 'reduced to numbers' (Lupton, 2015, p. 446) and, at other times, engaging with numerical data may render the lived body 'rich' and 'articulate' (Latour, 2004, pp. 207–209) in specific ways.

### Self-tracking to prevent pregnancy today

Contraceptive tracking apps are mobile health technologies that can be used to identify on which menstrual cycle days pregnancy is likeliest to occur. They can range from simple calendar-based apps to complex algorithmic apps, combined with tracking devices such as thermometers, wearable devices or home testing kits to determine hormone levels. Today's digital contraceptive tracking tools evolved from what medical professionals call fertility awareness-based methods (FABMs). Fertility awareness-based methods determine the likelihood of pregnancy to occur on a given cycle day based on one or more parameters. Rhythm- and calendar-based FABMs use cycle length and statistical chances of conception on a given cycle day to determine a fertile window. Temperature-based FABMs hinge on the subtle basal body temperature rise around ovulation. FABMs that incorporate cervical fluid samples rely on information concerning changes in fluid viscosity and colour around ovulation. Those that involve testing comprise simple home kits, such as luteinising hormone urine tests, to determine if ovulation is imminent. To maximise effectiveness, some FABMs deploy multiple parameters, such as sympto-thermal methods that combine temperature measurements and cervical fluid samples.

For the user, contraceptive self-tracking using an FABM involves the daily input of data. This can include physiological data (e.g. basal body temperature, menstrual and/or cervical fluid) and a wide range of embodied experiences (e.g. headache, breast pain, ovulation cramping, energy level and mood). Apps differ in their extent of data interpretation. Some predict when a user can expect to menstruate or safely assume they are in an infertile phase. Others provide no data interpretation but allow users to determine fertile days according to their chosen FABM. Users can then adjust sexual behaviour in relation to the fertile window calculation.

The contraceptive effectiveness and thus use of self-tracking apps remain controversial. Medical professionals generally dismiss FABMs as ineffective for preventing pregnancy (Austad et al., 2016). The prevailing medical dismissal of these technologies' effectiveness is significant in situating their use: often prompted by advertisements or individually shared content on social media, the participants in this study employ their apps in a domestic setting, without the guidance of medical professionals but with peer support communicated through social media.

## Self-tracking as a sensory knowledge practice

In various popular discourses as well as some scholarship on self-tracking knowledge practices, tracking data is seen as providing access to objectivity about the self and the body, as per the quantified self movement adage of 'self-knowledge through numbers' (Heyen, 2016; Sharon, 2016). Heyen (2016) describes the 'knowledge and data-producing activities' of people who practise self-tracking as 'personal science' that 'attempts to produce verified knowledge' (p. 297). In these views, the measured numerical data collected through self-tracking is seen as objective and reliable, providing access to insights that users would otherwise lack.

In research on the sensory and embodied dimensions of self-tracking practices, some users contrast the measured numerical character of self-tracking data with their embodied sensations. For example, in Smith and Vonthehoff's (2016) analysis of data collection practices within the quantified self movement, users frame self-tracking data as more accurate than embodied modes of knowing. The authors conclude that in these practices, bodily intuition is 'being outsourced to, if not replaced by, the means of un-bodied data' (Smith & Vonthehoff, 2016, p. 19). Other times, the measured numerical tracking data is framed as disturbing embodied modes of sensing and knowing, as observed among athletes who criticise the use of fitness trackers, which may lead them to become 'overly dependent on numbers' and lose the 'ability to listen to our bodies and "go by feel"' (Mopas & Huybregts, 2020, p. 28).

Recent scholarly work on sensory knowing through self-tracking, however, problematises the opposition between tracked data and embodiment (Lupton & Maslen, 2018; Maslen, 2021; Mopas & Huybregts, 2020; Ruckenstein, 2014). These scholars emphasise the entanglement of body and device, showing how measuring and engaging with data are not disembodied activities. Ruckenstein's (2014) work on self-tracking shows how the visibility of data is crucial in providing (partial) insight into physiological processes, in some cases leading to a 'heightened awareness' of bodily reactions (p. 75). Here, '[o]ne learns how to feel one's body through the data' (Nafus & Sherman, 2014) Device and user thus 'work [...] together to configure a new sensory capacity' (Lupton & Maslen, 2018, p. 197). Lupton and Maslen (2018) call this a 'more-than-human sensorium'.

Scholarship on human-technology interaction in sensory practices similarly describes how people develop 'cultivated *awareness*' or 'articulate [...] perception' through sensory learning or 'feeling techniques' (Harris, 2020, p. 6; Latour, 2004, p. 201; Scholtes, 2022). This scholarship focuses on training kits and tools (comprising words, drawings, odour kits, foods, objects and digital devices) that help cultivate sensory attention and awareness. Through the use of these kits, bodies can get sensitised, 'learn to be affected' (Latour, 2004, p. 207) and acquire '(digital) sensory knowing' (Harris, 2020, p. 18; Maslen & Harris, 2021, p. 2).

Drawing on my own ethnographic research, I contribute to these discussions by presenting a case study of contraceptive self-tracking practices whereby users engage in complex negotiations with the measured numerical data and more embodied, sensory types of data and ways of knowing. I show how contraceptive self-tracking helps cultivate sensory attention and awareness by constructing physiological biofeedback about hormonal processes. Self-tracking technologies then function as a kind of training kit to learn to feel, sense or know (with) the body rather than merely a way to collect data about the body.

This taps into a new field to explore sensory knowing with digital self-tracking technology. Although case studies on long-term reproductive self-tracking indicate that users' sensory experience of their bodies can become increasingly intertwined with their devices (Chen, 2017; Della Bianca, 2021; Grenfell et al., 2020), we still lack an analysis of the techniques and processes

underlying this increasing intertwining in the case of contraceptive tracking. By considering the way users relate and negotiate different types of data, we can see how and in what way their daily practices are productive and meaningful to them.

## Methods of data collection and analysis

To collect data on app users' knowledge practices, I recruited participants through different local and international social media networks between January and April 2020. I myself was an active participant in these networks for several years.<sup>2</sup> Participants were approached via direct message, email or via a social media post. Of the 31 participants who responded, 8 chose not to participate, most often due to time constraints. I excluded 6 respondents, who did not use any cycle tracking app, or who used an app to track their cycle without the intention to prevent pregnancy with their tracking practices. The 17 participants who participated in an in-depth interview used or had used an app with the intention to prevent pregnancy for a period of time. After a first round of analysis, I chose to include only users who also collect temperature measurements as part of their daily self-tracking as these yielded data most relevant to this article focussing on knowledge practices involving numerical data.

The remaining 15 participants were between the ages 24 and 36 (average 30 years old), and all but one lived in The Netherlands at the time of the interview. Most resided in larger cities, and had finished or were in the course of obtaining a higher education. Five participants were born and raised in a country other than The Netherlands. Several participants mentioned having general or menstrual health conditions, such as irregular cycles or polycystic ovary syndrome (PCOS).

Ten participants used a sympto-thermal FABM app; four used a proprietary temperature-based app; one had switched from a temperature-based app to a sympto-thermal app (for a brief explanation of different FABMs, see Section 1.1). I chose to not systematically compare the practices of the different user groups as their knowledge practices showed semblance in most instances. When relevant, I do point out some salient differences between how users interact with their apps depending on their method.

My sampling methods yielded a group of highly engaged self-trackers. Recruiting users from online communities may have indexed for users who are highly involved in and committed to their tracking practices. High user engagement can be explained by my explicit focus on contraceptive tracking: to minimise contraceptive failure, users are required to track daily. Several users commented on the practices' importance as part of their life or lifestyle. These users gave me access to their long-term self-tracking practices and shared sometimes sophisticated knowledge practices that they themselves developed.

Interviews lasted between 33 and 114 min (median 52 min) and centred on the daily self-tracking practices of users. After some general background questions, I asked users to explain to me how they had come to use the app, which often prompted some general background information on contraceptive use. To focus on their daily self-tracking practices, I asked users to detail and show me what they do with their apps, on what occasions they open their apps, how they use it, what other devices they use and other practices relevant to their daily tracking, including their participation in online user communities. Interviews were semi-structured, allowing for other topics to arise relating to their contraceptive tracking practices.

Of 15 interviewees, seven accepted my invitation to keep a solicited diary (Bartlett & Milligan, 2015) of their daily self-tracking practices. I sent these participants a general prompt,



asking them to send me textual, visual and/or audio(-visual) material of their daily tracking practices as well as of things they deemed relevant or related to their practices. Sent via email or an instant messaging service, the diaries included personal writings, photos, screenshots and links. Participants' diaries varied in length, from just a few screenshots of recent cycle charts to a two-month-long series of several entries per week.

Interviews were transcribed verbatim. I anonymised the interviews as well as the diaries and coded them inductively with qualitative data analysis software (Atlas.ti). I coded users' everyday self-tracking practices as well as other salient themes that were generated (e.g. user activism, appreciating the body, looking for alternative contraceptive methods, taboos and stigmas). The codes were clustered in a code forest, and a paper code map was made to aid the praxiographic analysis (Mol, 2002). The last interview was conducted after the code forest was made, to ensure saturation was reached.

During data collection, my identity as someone who has been using apps to prevent pregnancy for several years likely contributed to rapport-building and the sense of a safe environment, where users felt invited to share their knowledge, practices and perspectives. The argument in this article is grounded in the interview and diary material I collected, yet it inevitably also bears the mark of my past personal engagements with these apps. Participants would sometimes address me as a (fellow) expert on app use or FABMs, as I had shared with them that my research project stemmed from my own self-tracking. Other times, I was confronted by differences between my self-tracking practices and those of my participants—something I stayed aware of in making choices in data analysis and writing.

The Ethics Advisory Board of the Amsterdam Institute for Social Science Research approved this study. Data were stored according to the research data management guidelines of the University of Amsterdam.

## RESULTS

In their daily self-tracking, contraceptive app users relate different elements to each other, such as their temperature measurements, embodied experiences, visual representation of the data, textbook renderings of cycle biology, their understanding of their cycle and their understanding of other bodies. From my interviews and analysis of digital diaries, I identified five techniques of knowing (with) the body that users employ:

- 1) constructing cycle patterns;
- 2) experimenting with lifestyle adjustments;
- 3) cultivating awareness though intimate monitoring;
- 4) sharing and comparing cycle visualisations in online communities;
- 5) crosschecking data, questioning interpretations and instruments.

Across these techniques, users relate their tracking data to embodied experiences and their experiences to data in various ways. In practice, these different techniques are intertwined and interdependent. I distinguished and ordered these techniques to make them accessible for analysis.

## Constructing cycle patterns

The most obvious way numerical data and embodied experiences come together is in a menstrual cycle visualisation. Apps help users aggregate the data that feeds the visualisation, which may take the form of a calendar or a chart. This visualisation is pivotal in users' knowledge practices, but it does not carry all the explanatory power in itself. Users make sense of and draw connections between the different elements in the visualisation. By drawing these connections, they mentally construct a cycle pattern that represents their body's hormonal changes. The visualisation thus comes to represent day-to-day hormonal fluctuations.

The diary shown below is a screenshot of a cycle visualisation with a variety of data (see Figure 1). Julia inputted the data and then her app aggregated and presented it as a cycle chart. Julia describes how she 'places' different embodied experiences in her chart and constructs a cycle pattern. The pattern is constructed by looking at the cycle visualisation, as Julia also invited me to do in the diary fragment ('In the chart you can see...'). She divides her cycle into several phases, referring to the pre-ovulatory phase as 'the first phase'.

Because Julia has inputted a variety of embodied experiences in her app, she can compare those that accompany 'the first phase' with those during the week before her menstruation. For example, as she notes in her diary, she feels more energetic in the first cycle phase. Situating their embodied experiences within their cycle pattern allows users to construct temporal relations. For example, Michelle says, 'a week before my period [I get] a certain kind of headache'; or 'I feel more energised in the first phase of my cycle,' says Julia.

Users, such as Julia and Michelle, understand the menstrual cycle as consisting of several phases, with menstruation and ovulation serving as two main points of reference. Users link ovulation and menstruation to temperature changes (i.e. a drop when menstruation sets in or a rise around or after ovulation) as well as related experiences or observations (i.e. feeling a certain kind of headache preceding menstruation or observing cervical fluid leading up to ovulation). The cycle visualisation is thus in itself a collection of different types of data, where measurements and embodied experiences are both understood as part of the cycle pattern.

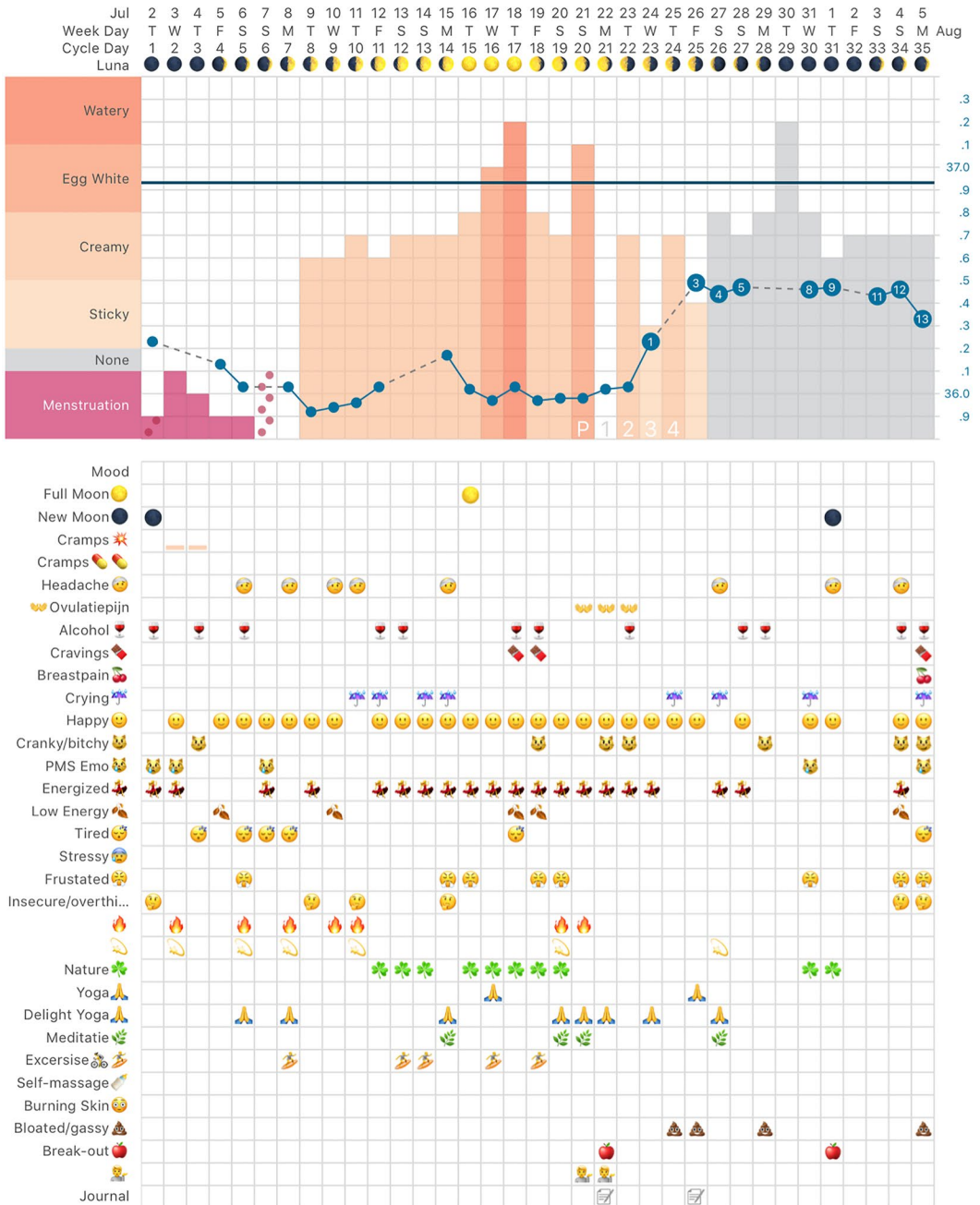
Once they have discerned patterns in their cycles, users say they compare or correlate their experiences with these cycle phases and patterns. Michelle says: 'It is pretty amusing to see if this can sort of be verified, that you yourself can see a sort of pattern. [...] That you can get more insight [into these patterns] is pretty remarkable.' Placing an embodied experience within a specific phase in the cycle pattern establishes for Michelle that physiological processes in her body associated with approaching menstruation are usually accompanied by 'a certain kind of headache'. Users thus explain the occurrence of particular embodied experiences in specific phases as a relation of influence: the hormones or hormonal fluctuations are thus understood as inducing specific bodily sensations and moods. Or, as Laura notes, users can gain 'more awareness about how hormones affect your body and your mood'.

These relations of influence may be co-shaped by the app's feedback about hormonal processes of the menstrual cycle. Katia, for example, cites understanding her body more because 'you're also getting little tips and [notifications] from the app here and there, like "this is happening, that is happening" [...] in your body'. Katia's inputted temperature measurements are translated by the app into notifications about physiological processes likely happening in her body as well as their effects. Users also reference other information sources (books, podcasts, blogs, social media posts and websites) that describe what may be summed up as the logic of the cycle. These sources present oestrogen and progesterone as the principal agents: when oestrogen is active, fertile cervical fluid appears and libido is activated. Progesterone, causing a temperature rise,





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**FIGURE 1** Cycle visualisation of one of Julia’s cycles. Julia writes: ‘As you can see I track different things, aside from my temperature and cervical fluid, such as my mood but also my physical condition. [...]’. For example, my energy level. In the chart you can see that in the first phase of the cycle (pre-ovulation) I have noted that I feel energized more often. In the week before my menstruation you see that I noted less “happy” and less energy, pain in my breasts.’ (Julia, visual diary).

indicates that ovulation has occurred. Progesterone may induce embodied experiences, such as moods, headaches or other pains. 'Placing' experiences in a cycle pattern also means understanding them as expressions of the hormonal changes in the menstrual cycle.

Users thus understand their body as active: it produces hormones, releases ova, secretes fluids, influences moods and other embodied experiences. Temperature changes, fluid samples, embodied experiences and app notifications function as messengers of hormonal processes that may otherwise be less articulate for users. Laura explains how she has come to understand her cervical fluid and sexual desire as 'signs' of fertility:

Before I used the app, it was a bit more amorph[ous]. [I noticed that] after I had my period, like the *day* after, I was completely horny and happy. And now [after using the app] I know that my cervical fluid *matches* that. [...] Quite literally, I can see the fertility [in the fluid]. [...] And before I figured that out, I had these like moments that I felt like: "Oh I am really horny, oh I am probably very fertile now." But I didn't *know*. And it didn't occur to me that it had this rhythm.

(Laura, interview, emphasis in original)<sup>3</sup>

With the help of her cycle chart, Laura correlates the embodied experience of sexual desire with the visual and tactile experience of bodily fluid. These two sensory and embodied experiences are taken as a sign from the body about its fertility. Their coincidence in the cycle phase during which Laura considers herself fertile within the pattern she has identified enables the triangulation of 'very fertile now'—'horny and happy'—'cervical fluid'. The 'rhythm' that Laura refers to reflects hormonal changes and phases her body goes through day by day.

Users thus co-construct cycle patterns together with their apps, thereby translating measurements and embodied experiences into 'signs' that indicate physiological processes happening in the body. The visualisation provides biofeedback to users about these processes, inviting sensitivity to and awareness of these processes, such as when Laura can 'see the fertility' in her cervical fluid. Numerical data and embodied experiences are thus taken together as indicators of how the body is affected by its own physiology. Body temperature may change, while headaches, moods and desires may be experienced due to the alternating cycle phases marked by progesterone and oestrogen. The cycle visualisation, with all the data it aggregates, thus allows users to see, sense and know their body 'rhythm' and how it is affected by hormones.

## Experimenting with lifestyle adjustments

The cycle visualisation, understood as a representation of the body's day-by-day hormonal changes, provides a starting point for a type of try-and-see experimenting. By adjusting factors that may influence their cycle, users identify which behavioural or environmental factors are at work. Measurements and embodied experiences provide biofeedback on the effects of their adjustments.

In experimenting, users first hypothesise relations of influence and then, based on their cycle patterns, expect or predict certain results. Hester, for example, constructs a pattern of influence between stress and ovulation:

I just very clearly see that stress has a very big influence on my cycle and that, the moment I ask too much of myself, so to speak, and push my limits, my cycle just

stops. It just stops in its tracks and nothing happens [no ovulation occurs]. And as soon as I relax and give myself space to recover from things, and not push myself too hard, my cycle more or less returns. So it's, it's become a very essential yardstick to measure how I am doing and, um, if I need to give myself more rest or space or if I can take it up a notch.

(Hester, interview)

Hester constructs a recurring pattern with negative outcomes: stress precludes ovulation and, as she noted in her visual diary, leads to mood swings and feeling unwell. Based on this pattern, Hester tries different adjustments. Hester may not be able to avoid all stressors in life, but she can try out ways to deal with stress, such as making 'space to recover from things' by taking breaks when confronted with stressful situations. Then, she looks to see how this affects her cycle and her wellbeing and if her adjustments have catalysed the changes she predicted. Other users adjust their sleep habits, diet, intake of nutritional supplements and exercise to see what effects ensue.

The measurements, samples and embodied experiences are significant in that they may or may not confirm the hypotheses that inspired their try-and-see experimenting. Hester did see a change in how her cycle pattern was visualised (an ovulatory pattern appeared). The visualisation thus functions as a 'yardstick to measure how I am doing' or a 'health map', as Nedelya, another participant, calls it. But, as Hester further explains, a change in how she feels also indicates a positive outcome of her try-and-see experimenting. She describes both relief from stress and an awareness of stress symptoms that she was previously unaware of:

Of course what I didn't pay attention to before, as I do now, is that I totally had symptoms of stress, you know—like neck pains, headaches, jaw clenching and general stiffness. Those things were so normal for me that I had no longer registered them.

(Hester, interview)

Hester has thus performed a type of 'digital-sensory work' (Maslen & Harris, 2021), whereby her cycle visualisation as well as sensory awareness help her register and interpret signs and symptoms with regard to her wellbeing. She has learnt to identify and become aware of bodily stress reactions by drawing connections between her cycle pattern, possible stressors and how well she feels. Through this digital-sensory work, Hester enacts a form of *situated health*: she identifies if—and if so, how—stress and rest affect her body in positive and negative ways.

## Intimate monitoring and cultivating awareness

The way users measure, sample and track their bodies on a daily basis is an enactment of intimacy. This intimate monitoring has different facets. Firstly, measuring and sampling fluid is an intimate engagement with the body, which users cite as their way to 'tune into my body' or 'check in with myself'. But, as I elaborate in this section, momentarily 'tuning into' may invite a more sustained awareness of physiology, a technique that may lead to 'sensory knowing' (Harris, 2020, p. 18). Tracked data and feeling and sensing the body are thus intertwined; measurements are always embodied practices, while feeling and being aware of the body is a way to know the body's physiology.

Marijn describes sampling her cervical fluid as an intimate tactile activity that requires the right space, both mentally and physically. To check her fluid while at work, she always chose the same spacious toilet stall:

It was a more comfortable space for me to take time for myself. [...] It was a conscious decision to [say] *this* is what I am going to do now. [...] In this way I, very clearly, got *out* of my work tasking mode. [...] That moment, sitting on the toilet, that [I] take time to check [my] fluid, that was very much about me. So I was going back to myself, to my private life and who I am as a female being on this planet, *my* fertility and all, and disconnected from all the crazy ways of the world.

(Marijn, interview, emphasis in original)

The physical task of touching her vaginal opening with her fingers, as well as touching and smelling the fluid sample to categorise it on a scale from less to more fertile, entails a ritual through which Marijn also creates a mental space to engage with her body. Taking time and making space to track her bodily fluids provide for Marijn a sense of 'going back to myself', as she put it. Other users describe it as 'asking how the body is doing' or 'listening to what the body is saying'.

'Asking how the body is doing' may take place during a temperature measurement, fluid check or in between these activities. Measuring or sampling is itself an embodied practice that invites a moment of awareness, as Marijn experiences. Although this awareness practice may take place at certain points throughout the day, its effects transcend any moment. Users describe increased 'alignment' or 'connection' with their body or self, including heightened awareness of the body and bodily processes. Femke, for example, feels ovulation occurring as cramping in an ovary:

I regularly find myself feeling really happy and telling my boyfriend or my best friend: "See how well I know my body." I know that if I'm feeling like this today, probably within a couple days, I will have ovulated. [...] It helps that I see the patterns and then I think: see, this is what I am feeling. I can just feel what's coming on or what's happening at this moment in my body.

(Femke, interview)

Femke also mentions that her cycle visualisation, and specifically the temperature curve depicted in it, may confirm that 'this is what I am feeling'. However, her understanding of her body is not simply mediated by measuring instruments or a cycle visualisation, but here emerges a more sustained being aware of 'what's happening at this moment in my body'. Two techniques of knowing are therefore intertwined and co-produced: a sustained heightened awareness of the body can be cultivated through meticulous and daily data collection; and simultaneously, cultivated awareness can be used as a technique to take note of moods, cramps or other experiences that may, in turn, be aggregated as data and represented in a cycle visualisation.

The intimate monitoring is hence a 'feeling technique' (Scholtes, 2022) that gives rise to a 'more-than-human sensorium' (Lupton & Maslen, 2018). Users are continuously relating measurements, samples and data in their cycle visualisation back to how their bodies feel and how their bodies feel is being inputted in the app. This technique enables users to 'cultivate awareness' or 'sensory knowing' (Harris, 2020, pp. 6, 18) of the processes happening in the body. Users thus cultivate awareness of the body as *physiologically active*. Additionally, users become aware of

how behavioural or environmental factors affect them, as in the case of Hester, who grew aware of the neck pains, headaches and jaw clenching as bodily stress reactions. Through practising awareness of her body, Hester can now feel when these stress reactions, which she was hitherto unaware of, occur. The body that emerges here is thus both physiologically active and *lived*, as it is situated in and affected by daily life.

## Sharing and comparing cycle visualisations in online communities

App users active in online communities describe social media as important in the equation of understanding their bodies. These communities function as learning spaces where users support each other, for example, by providing general information on apps, devices or FABMs used, tips on getting started, book suggestions and references to relevant scientific studies. Users also co-produce knowledge in online communities by discussing each other's cycles. Platforms that host user communities permit the sharing of visuals such as app screenshots or photos of cervical fluid, all while giving community members the chance to discuss them via linked comment threads. These discussions uncover the relationships between measurements, embodied experiences, cycle patterns and app predictions.

Michelle describes how she would post her cycle chart in a user community to understand what she was seeing. As a beginner, she could follow the app's instructions to prevent pregnancy based on an indication of so-called green and red days, which the app determines by algorithm. But she was unable to fully interpret the chart. It did not add up for her, as her menstruation did not start when the app predicted, leaving Michelle confused about her cycle visualisation. In her words: 'Well, what am I actually seeing? What does that really mean? Can I be pregnant?' Michelle shared her temperature chart and, through the online discussion, other users could help Michelle understand how the algorithm works and why it predicted her menstruation as such. In addition, other users pointed out that the temperature curve shows how 'ovulation may also fall on that [later] date'. Again, various elements, such as temperatures, fluids and algorithmic interpretation, are compared and any possible deviation to expectations is explained by experienced users.

In this case, Michelle can follow the app's simple prompts to consider herself fertile or infertile. She cannot, however, understand the visualisation as a representation of her cycle pattern, as the different elements—the app predictions and the absence of menstrual fluid—did not align. Users explain the misalignment by citing the algorithmic interpretation of temperatures. Other times, users refer to life events or other factors to explain the specific pattern in cycle visualisation. Ovulation may come early, not at all or be delayed by, for instance, stress. Some charts may reflect perimenopause, a postpartum period or a menstrual health condition, such as PCOS. As such, users understand bodies as diverse and individual while at the same time all sharing the fact that their bodies and their cycles may be, in one way or another, affected by various circumstances, such as approaching menopause, having a child or dealing with health conditions.

Users express the value of seeing and understanding others' cycle charts. A variety of cycle visualisations creates a diversity of input on 'what other people's bodies are doing', as Laura puts it. These online spaces show, as Jasmina says, 'the diversity among cycle charts of different people [and help in] getting a broader understanding' of the differences between individual cycles. As Jasmina explains, the 'standard graph' found in biology textbooks of a 28-day cycle with ovulation on day 14 does not apply to most cycles. Questioning the 28-day standard thus means that 'deviations' to the norm are no longer seen as deviations, but as normal within a

diversity of bodies. Users express the feeling of inclusion and, therefore, as Laura notes, 'feel normal' when exposed to a diversity of cycle visualisations, despite their own not matching the textbook standard.

Questioning the 28-day standard goes hand in hand with users' understanding of the body as individual as well as affected by behavioural and environmental factors. In the diversity of cycle visualisations, users see how cycles are different for different people in different situations. These differences are the normal consequences of an organism that is individual and can be affected by a variety of factors. By comparing many cycle visualisations through online sharing, users can still, however, construct general patterns concerning when, how and by what different cycles may be affected.

## Crosschecking data, questioning interpretations and instruments

The way users compare the types of data they collect is conducive to reflecting on and cross-checking an app's function, particularly noticeable among users of algorithmic apps that provide cycle interpretations. In a form of experimenter's regress (Collins, 1981), the mutual testing of 'fact' and instrument happens simultaneously: the body can be studied and understood in interaction with the app, while the app's workings are also crosschecked in relation to embodied experiences.

Katia mentions understanding her body better thanks to app notifications about her hormonal processes. The notifications provide narratives about the processes happening in the body, which create awareness of hormonal processes that Katia would otherwise be unaware of. Anna compares the app's notifications and predictions to the bodily processes she experiences, describing how her 'app[s] predictions were pretty much always right'. Users thus attempt to reconcile different types of data: the app's temperature interpretation and embodied experiences are compared and, when possible, aligned with each other.

By contrast, Michelle seeks online peer support when her menstruation does not start as the app predicted. As Michelle cannot reconcile the two, she attempts to sort out which is to be trusted: 'what the body is telling' versus what the app tells her. Other users help her attain a sense of reconciliation and reassurance once she can identify the app's prediction as inaccurate.

Some users voice scepticism towards apps that make automatic interpretations of their cycle in the form of predictions and notifications about their hormonal processes or their fertility status. Hester criticises two specific apps: one for making wrongful predictions about her cycle; and the other one for automatically producing interpretations of her temperature curve rather than allowing for her own interpretations. Julia decided to switch apps because she did not trust the algorithmic temperature-based cycle interpretations and felt more comfortable using a symptom-thermal app that let her determine her fertile window herself. Not only did she trust her own cycle interpretation over the algorithmic one, the app also allowed her to include more diverse embodied experiences in her tracking practice. Users thus assess, compare and sometimes reject the app's algorithmically produced interpretations of the user's cycle.

In another example of questioning tracking instruments, Laura expresses disbelief about a new fertility-tracking device on the market. To be inserted in the vagina, this device gives information based on the presence of cervical fluid:

What a weird thing. By paying attention a bit, you can keep track of this yourself  
I really don't get it, seriously.



Isn't it good that just by feeling and looking [at your cervical fluid] you can much more connect with your own body.

Instead of have some device do this for you. I can only imagine that it has the opposite effect (looking at a screen with abstract data supposed to display a representation of bodily processes)

You read that data [from the screen] and infer from there. Instead of just feeling.

(Laura, visual diary)

Laura's questioning of this device echoes a privileging of immediate, embodied experiences over mediated data. 'Just by feeling', Laura stresses, she has better access to what is going on in her body than a device inserted in the vagina. Feeling helps her 'connect to [her] own body'; it is itself a technique to determine fertility, while the body itself is the instrument with which she feels. However, as Laura emphasises in her interview, she learnt to become aware and 'just feel' her body precisely through daily self-tracking.

The digital-sensory work of users thus comprises processes of continuously and iteratively comparing different types of data (measurements, cycle interpretations and experiences) and data sources (devices, self-checks and body awareness) and attempting to reconcile them. They may sometimes accept and incorporate the apps' interpretation of their cycle in the context of other data and experiences, while other times an app's functions, operations or design are rejected as unreliable or ill-suited. The body therefore appears as both the object of knowledge and an instrument used to crosscheck the aptness of the self-tracking devices. Self-tracking practices, then, include technical devices as well as physical devices (bodies and feeling techniques) that co-produce knowledge.

## CONCLUSION

This study detailed how users relate tracking data to embodied experiences in order to produce knowledge of their own lived hormonal physiology. The physiological activity of their bodies is represented by a cycle visualisation that functions as biofeedback of the day-to-day patterned changes throughout the cycle. By experimenting with lifestyle adjustments and comparing their cycles with others' cycles online, users also come to know the body as affected by various factors such as stressful situations, life events, exercise and sleep. Both temperature measurements and embodied experiences serve as indicators of how the body is affected by its hormonal physiology as well as by other factors that may affect the cyclical body.

Users' self-tracking knowledge practices do not simply entail collecting 'objective' numerical data and constructing a visual representation of the menstrual cycle. Users are continuously relating measurements, samples and data visualised in their cycle chart back to how their bodies feel and how their bodies feel is being inputted in the app. Tracking data and embodied experiences thus blend into one another: users turn embodied experiences into tracking data, while sampling and measuring are embodied experiences whereby the body is always simultaneously felt. In their daily practices, users do not privilege numerical data over subjective embodied experiences, or vice versa. Rather, users critically compare different types of data, sometimes attaining reconciliation while at other times questioning a measurement, app prediction, interpretation or their own sensory experiences.

Through practising these 'feeling techniques' (Scholtes, 2022), users 'cultivate awareness' (Harris, 2020) of their own lived hormonal physiology. Here, body and app work together to

become a 'more-than-human sensorium' (Lupton & Maslen, 2018) to register subtle changes in their body. The heightened awareness produced by this 'digital-sensory work' (Maslen & Harris, 2021) is not so much a form of knowledge or expertise, but rather an embodied *skill*: to *feel* the body's reproductive physiology. In cultivating this skill, the body becomes an instrument of knowing alongside technical devices used. Users point to heightened bodily awareness as one of the key elements that makes contraceptive self-tracking meaningful to them.

With this, my analysis builds on existing work on digital sensory work in health (Maslen, 2017, 2021; Maslen & Harris, 2021). In health-related digital sensory work, devices and bodies become intimately entangled in the process of sensing and diagnosing (with) the body. My analysis shows, however, that the digital-sensory work of users of contraceptive self-tracking apps extends beyond interpreting symptoms, or sensing and diagnosing the body together with digital devices. By intimately monitoring it, users learn to articulate not only how their reproductive body feels and acts, but they also sense and understand their body as it is situated, related to and dependent on other elements, such as food, stressful situations or sleep. Rather than 'health by numbers' (Smith & Vonthehoff, 2016) or assessing health through digital sensory diagnosis (Maslen, 2017, 2021; Maslen & Harris, 2021), users enact a form of *situated health*, whereby 'external influences' such as certain foods and stressors are identified as potentially healthy or unhealthy.

The findings in this article contrast with those from earlier analyses of reproductive self-tracking, in which tracking apps were criticised for privileging quantification and digital data 'over people's own embodied knowledge of their body' (Lupton, 2015, p. 447). Often, users' uptake of self-tracking, including reproductive self-tracking, has been understood as a result of increasing pressures on the individual to discipline, monitor, manage and optimise their health and wellbeing (Della Bianca, 2021; Ford et al., 2021; Lupton, 2015, 2016). By focussing on sensory knowing, I have shown that users view the meaningfulness of their practices not mainly in terms of self-management and health optimisation, but in terms of *attunement* and *awareness* of the body. Contraceptive self-tracking, then, is not so much a way to objectify, quantify and/or control the reproductive body, but rather to feel, sense and know *with* the body.<sup>4</sup>

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## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are not shared due to privacy or ethical restrictions.

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## ENDNOTES

- <sup>1</sup> Criticisms about the reductionism of self-tracking can be viewed as the flipside to more enthusiastic data-centred discourse that frames self-tracking as a means to greater (objective) self-knowledge through data collection, while ‘subjective experience, intuition and haptic senses are [viewed as] lacking in comparison to the arithmetic precision of quantification’ (Sharon, 2016).
- <sup>2</sup> During my interaction in user communities on social media networks, I chose to not collect data in any formal way nor to store it due to privacy considerations and difficulties obtaining consent. To yield data on everyday social media interaction, I instead asked users during interviews to describe their practices in online user communities, and some users included their social media use in their solicited diary.
- <sup>3</sup> Laura’s conclusion may seem odd at first glance, as being very fertile right after menstruation is uncommon. However, her individual cycle pattern deviates from what may be considered a ‘normal cycle’ by being particularly short, with ovulation occurring earlier in the cycle. (See Section 2.4 on sharing and comparing cycles in online communities, where Laura notes, she ‘feel[s] normal’ after seeing a diversity of cycle patterns online, despite her short cycle pattern not matching textbook descriptions.)
- <sup>4</sup> Although beyond the scope of this article, users acknowledge this awareness as particularly valuable in the context of a culture that they see as disregarding the body and bodily needs. They refer to prevailing practices that they deem negative, such as shaming, ignoring or repressing the reproductive body, and frame their awareness practices as ways to counter a culture of negative body practices. User’s awareness practices as a form of self-care ‘against the grain’ deserves further attention in future research.

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