

Self-tracking Technologies and the Menstrual Cycle: Embodiment and Engagement with Lay and Expert Knowledge

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Abstract: The paper explores how humans intra-act with self-tracking technologies, reconfiguring the plurality of expert and lay knowledge. In particular, the current contribution presents an empirical analysis of the use of apps to manage menstrual periods. The article is positioned at the crossroad between three literatures: actor-network theory; new relational materialism; and a sociomaterial perspective on the medical field as relates to self-tracking practices. These approaches contribute to pay attention on the processes of embodiment and embodied knowing situated into sociomaterial practices. The aim is to explore how the body learns “to be affected” through the material entanglements between humans and apps, and how self-tracking technologies are engaged and provide support for processes of embodied knowledge. Research findings draw attention to how interviewees intra-act with apps for menstrual tracking, along an imaginary continuum at whose opposite points we can find – on the one hand – minimal engagement with the knowledge inscribed in the app and – on the other – an affective engagement with the knowledge *suggested* by the app. This continuum shows the overlapping intra-actions that perform embodied knowledge about how women fertility, subordinate to the various historical stereotypes, works.

Keywords: self-tracking practices; embodiment; body; engagement; humans and non-human actors; intra-actions.

Submitted: February 15, 2019 – **Accepted:** November 11, 2019

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I. Introduction

Digital technologies offer new possibilities for monitoring, measuring and visualising bodily and everyday wellbeing, potentially encouraging the development of new forms of engagement between human and non-human actors. The range of these technologies is vast: apps available for downloading to mobile devices such as smartphones; wearable technologies such as Google Glass and Fitbit; and sensors embedded in devices that can record both an individual's biometric information (e.g., body temperature, heart rate, blood glucose, etc.) and, in the smart city, various aspects pertaining to the health of that environment (e.g., air pollution, traffic, etc.) (Bianchieri *et al.* in Corbasiero and Ruspini 2016; Lupton 2013; 2015; 2016; Maturo and Setiffi 2016; Pantzar and Ruckenstein 2015). Self-tracking technologies allow users to monitor and document a great deal of daily information, practices and activities: calorie intake, fitness, weight, mood, sleep, reproductive health, chronic disease, healthy environment, and so on. Everyday practices and activities, as well as bodily functions, are transformed through these devices into data, with the potential to derive statistical analyses and graphical representations.

The aim of this paper is to explore how humans intra-act with self-tracking technologies, reconfiguring the plurality of expert and lay knowledge (Barad 2003; Latour 2005). In particular, the current contribution presents an exploratory empirical analysis of the use of apps to manage menstrual periods. Self-tracking apps for the menstrual cycle are intended to map and transform everyday symptoms, mood and body indicators into data – statistics and graphs – in order to visualise correlations and predict fertile moments, premenstrual syndrome and future menstrual windows (Lupton 2015).

Menstruation history is linked to a body of tacit knowledge (Polanyi 1967) based on myths, taboos and gender discrimination, often justified by medical research on hormonal biological changes (Delaney *et al.* 1988). In the sociological health literature, there has been extensive discussion on the transformation of symptoms and mood relating to menstruation into medical problems, with the emergence of the category 'premenstrual syndrome' (PMS).¹ Medicalisation is a complex and multidirectional process 'by which nonmedical problems become defined and treated as medical problems, usually in terms of illness and disorders' (Conrad 2007, 4). In many societies, for example, PMS does not exist. This implies that medical knowledge is socially constructed, because a disorder is not "ipso facto a medical problem" (Conrad 2007, 146). Moreover, feminist scholars have highlighted how medical knowledge is based on the assumption of male physiology as normative, with the consequence that women's bodies and experiences are particularly susceptible to the medicalisation process (Bird *et al.* 2010).

The paper is constructed around two concerns: (1) how the body learns “to be affected” through the material entanglements between humans and apps, and (2) how self-tracking technologies are engaged and provide support for processes of embodied knowledge.

First, this article outlines the theoretical-interpretative framework, drawing on actor-network theory (Latour 2005; Law 1992); new relational materialism, with particular reference to the feminist onto-epistemology of Barad (2003; 2007); and a sociomaterial perspective on the medical field as relates to self-tracking practices (Lupton 2018). These approaches have the common interest in the body, and together they contribute to pay attention on the processes of embodiment and embodied knowing through sociomaterial practices. Secondly, it reconstructs the debate around the use of digital data by second and third parties with the scope to surveillance and shape the habits and the bodily information of citizens.

Then, research findings draw attention to how women interviewed intra-act with apps for menstrual tracking, along an imaginary continuum at whose opposite points we can find – on the one hand – minimal engagement with the knowledge inscribed in the app and – on the other – an affective engagement with the knowledge suggested by the app.

Finally, the discussion of empirical findings highlights these two forms of engagement by which the embodied knowledge of the menstrual cycle is back through material engagements between humans and apps.

2. Embodiment and Self-Tracking Technologies

Self-tracking practices are reconfiguring our experience of embodiment, our relationships and our meanings of body through various practices of quantification. Self-tracking technologies have given rise to Quantified Self-movement (QSm), founded in 2007 by two editors of *Wired*, Gary Wolf and Kevin Kelly. The QSm motto is ‘self-knowledge through numbers’, to underscore the capacity of data to become a mirror reflecting imperceptible bodily functions, activities and practices otherwise taken for granted (Wolf 2009). According to Pantzar and Ruckenstein (2015), the voluntary self-tracker considers the data thereby derived to be more credible and objective than his or her own sensations and subjective experiences. Self-trackers experiment on their bodies through the emergence of ‘personal analytics’, i.e., practices that typically aim for self-optimisation (Moretti and Morsello 2017). Personal analytics practices transform human bodies into data with the purpose of reflecting in an objective way on themselves, others and on daily life.

Most particularly, self-tracking technologies are designed to be used in synergy with the body. This underlines the new intimacies of bodies and objects (Viseu and Suchman 2010). According to Knorr-Cetina (1997), objects take part in the co-constitution of social performances, in

which they have situated meanings and uses. The author posits an *object-centred* sociality, underlining a growing orientation towards objects as sources for thinking about Self, forms of relational intimacy, shared subjectivity and social integration.

Adopting a materialist perspective allows us to see the body as flows of heterogeneous sociomaterial elements that are relational and dynamics. The sociomaterial approach implies that the social and the material are co-constituted, namely that the nature and the culture are entangled. The humans are always situated in assemblages of heterogeneous elements, that have an agential capacity to affect producing power and resistance, tensions and ambivalences. A central aspect of the sociomaterial assemblages is that the matter is itself performed by the sensing and embodied knowing, showing the engagement of people with forces, things, bodies and other entities as entanglements of more-than human worlds (Barad 2003; Latour 2005; Law 1992)

We are immersed in assemblages where we learn to use the body to become sensitive to the materiality. As Latour (2004, 205) underscores, “to have a body *is to learn to be affected*, meaning ‘effectuated’, moved, put into motion by other entities, human or nonhuman” (original emphasis). The materiality is able to render the body sensitive to the differences of the world. The body feels and it moves. It is not finishing with the skin, but it encounters, tastes, hearings, smells other material elements. It is *affected* by the ‘effects’ of the knowledge, which is embedded and embodied within practices, by which we do experience of time and space. The body is enacted in various ways, continually being constructed through processes of incorporation and exclusion (Mol and Law 2004). Reciprocally, the body shapes how practices are done, and practices produce new responses across the process of producing sensible knowing in which body do not have determinate boundaries, rather it is co-constituted as an entanglements of relational and dynamics agency (Latour 2005; Lynch and Cohn 2016).

From a feminist materialist perspective, matter acts in assemblages in which human subjects are entangled with technologies (Lupton 2018). Boundaries between humans and non-human, as Barad (2003; 2007) argues, are not naturally given but rather historically co-constructed. The author proposes using the term ‘intra-action’ instead of ‘interaction’ in order to take into account the mutual constitution of humans and non-humans. This term is a way to reconsider the ability to act within relationships and not outside of them. In this regard, she uses the form “agential realism” to keep attention on the process in which the agency of subjects and objects acts symmetrically in the production of social and material worlds. The body emerges in ongoing discursive-material practices: “‘We’ are not outside observers of the world. Nor are we simply located at particular places *in* the world; rather, we are part *of* the world in its ongoing intra-activity [...] we know because we are *of* the world” (Barad 2003, 29-30).

Self-tracking technologies may be considered as objects of knowledge (Knorr-Cetina 1997) that are invested with expert and tacit knowledge related to embodied knowing that is multi-situated at the same time in materialities and discourses, but also in personal bodies and in their experiences. The intra-actions as bodily/materiality articulations perform various modalities of embodiment mediated by conventions and traditions. The term ‘embodiment’ enables a discussion of how the dichotomies mind/body and nature/culture are blurred in the materiality of the bodies. Adopting Scheldeman’s (2010, 145) definition of embodiment as “the way we live life ‘embodied’: with and through our bodies” allows us to regard embodiment as a process by which the lived body becomes a material-discursive phenomenon that comes to matter in the mutual constitution of entangled agencies. The aim is not to extend subjectivity to things. As Suchman (2008) emphasises, humans and non-humans are not necessarily constituted one another in the same way. Agency does not pre-exist separately, instead, “agency – and associated accountabilities – reside neither in us or nor in our artefacts, but in our intra-actions” (Suchman 2008, 8).

Digital is material itself that becomes part of ongoing entanglements across a range of everyday activities and practices that combine diverse types of knowledge and capture our everyday spatiality. Here, self-tracking practices help us see not only the entanglements amongst things, people and data, but also and how these come back through new sociomaterial forms embedded in the ongoing self-knowledge process (Pink and Fors 2017; Sumartojo et al. 2016).

Agency is relational and distributed through intra-actions and entanglements of people with technologies. Particularly, humans and apps work together in generating human-app assemblages (Lupton 2018), in which knowledge emerges as a doing situated and enacted within and across humans and nonhumans. In our case, apps for menstrual cycle inscribe assumptions about users and what they will do with the apps, that have been designed in order to suggest knowledge about how the body should be working. However, humans and nonhumans generate together agential capacities and forces that are continually reconfigured as part of the lived experience (Lupton 2018). Apps directed at monitoring the body inscribe knowledge that can be reconfigured through the daily-human-use of the app. The process of reconfiguration draws attention to how inscribed knowledge can suggest different ways to think about the body. People who do not meet the inscription associated with the imagined uses can activate different ways of tinkering with the ongoing process of embodiment and selfhood.

3. Surveillance in a Datafied Space

The use, online and offline, of digital technologies leaves traces of personal preferences, choices, habits and so on. These small data, generated with and through digital technologies, are often aggregated into big data, and thus become commercially profitable for second and third parties. Some scholars (Kitchin and Dodge 2007, 2011; Kitchin 2014) have highlighted several important implications and issues concerning access to and control of small data. Most designers and developers of apps are very unclear about how the data are gathered, analysed and then used in terms of becoming a kind of 'dataveillance' to generate predictive health scores for users as well as preferences and choices for shaping human behaviours (Beer and Burrows 2013; Bossewitch and Sinnreich 2013; Boyd and Crawford 2012; Kitchin 2014; Mann and Ferenbok 2013). The term 'dataveillance' is used to indicate the systematic employment of digital data to surveil and monitor the practices and activities of individuals or groups of people (van Dijck 2014). Thus, for example, a smartphone becomes an assemblage of personal information, algorithms, websites, platforms, manufacturers and retailers, policymakers, software and hardware developers, etc. It is a black box that renders invisible the process of dataveillance by which the personal information thereby gathered can easily be analysed and grouped into discrete categories (Lyon 2002).

When citizens voluntarily collect and share their personal data and evaluations of various aspects of their social life and urban environment, they contribute to various scientific research projects and policymaking. They become data gatherers from below with the emergence of a 'datafied space', that provides a set of possibilities for how and where things can (or cannot) materialise. Some persons choose to participate in scientific research projects, collecting data that are quite important for scientists. These initiatives directly involve citizens who collect health indicators from their local environment, themselves or a combination of both. Cities and bodies become expanded laboratories in which citizen-scientists take on a crucial role for scientific and governmental organisations in the empirical phase of collecting observations and measurements for free (Coletta et al. 2018; Kitchin 2014).

In particular, Jennifer Gabrys (2014) underscores the emergence of new practices of subjectification through various uses of digital technologies. Citizens can monitor and evaluate their own wellbeing and environment, becoming sensitive to various aspects of life. According to Gabrys, there is a distribution of relational power in the city, where citizens are not just surveilled: they can also control their spaces with the emergence of new practices of citizenship.

Dataveillance has become a salient topic for theoretical reflection about self-tracking practices. Herein, this theoretical framework is

presented in order to illustrate the complexity around the analysis of how digital data are embedded into more-than-human practices. However, the focus of this contribution is on the sociomaterial entanglements between humans and apps.

4. Methodological Issues

The development of Web 3.0 – the ‘intelligent Web’ that uses semantics, natural language, data-mining and machine learning in order to provide a more productive and intuitive user experience – is intensifying the production of data on different aspects of everyday life. Some authors refer to this explosion of digital data as a ‘data deluge’ (Savage and Burrows 2007) that brought the opportunity to rethink everyday practices and routines in a datafication process by which human behaviours, emotions and social relations are recorded and converted into numbers (Roberts et al. 2016).

Fifteen semi-structured interviews had been carried out with women who utilize the app to manage menstrual periods. The semi-structured interview is a performative research method that can produce knowledge through the relationship between interviewee and interviewer (Law 2009). During the sessions, the interviewee became an ally in the process of questioning and opening the black box of the knowledge inscribed in the app (De Vita et al. 2016, 510; Sciannamblo 2017). This follows the suggestion of Mazzei (2013) that the interview yields sociomaterialist insights that can be thought of as an assemblage in which participant voice “is produced in an enactment among researcher-data-participants-theory-analysis” (p. 739).

The interviews were conducted with fifteen Italian women aged between 15 and 46 years, three of which were done via Skype. Lasting between fifty and sixty minutes, they were audio recorded and verbatim transcribed in order to analyse how apps for the menstrual period are embedded in the user’s bodily knowledge. The interviews were intended to examine four principal concerns: (1) the choice of application; (2) the relationship between body and menstrual period; (3) the sharing of personal data with other users, parents, friends, partners; and (4) the sensibility about issues of privacy. The interviews were additionally enriched by using the app in real time in order to join the story of use at the practice of use.

Following an abductive approach, the analysis of the interviews aimed at generating creative, causal links and descriptions of particular empirical instances (Timmermans and Tavory 2012). Adopting an abductive analysis suggests entering the field with a theoretical framework that becomes the basis for developing creative and novel theoretical insights throughout the research process.

In other words, abduction is the form of reasoning through which we perceive the phenomenon as related to other observations either in the sense that there is a cause and effect hidden from view, in the sense that the phenomenon is seen as similar to other phenomena already experienced and explained in other situations, or in the sense of creating new general descriptions (Timmermans and Tavory 2012, 171).

The analysis captures two forms of engagement between human and non-human actors. The following sections draw attention to how interviewees intra-act with apps for menstrual tracking, along an imaginary continuum at whose opposite points we can find – on the one hand – minimal engagement with the knowledge inscribed in the app and – on the other – an affective engagement with the knowledge suggested by the app. This continuum shows the overlapping intra-actions that perform embodied knowledge about how reproductivity works.

5. Minimal Engagement

Women have to learn to control personal cyclical spotting that is different in duration and flow. Keeping track of the cycle's length through a diary and calendar, as tacit knowledge suggests, requires a certain amount of time and commitment (with the purpose of estimating future periods). The app translates the necessity of managing the beginning and the end of the period as a means of deriving an automatic prediction of future menstrual phases.

The example that appears through the various interviews relates to the need for an automatic memorandum that offers the possibility of eliminating thinking about the cycle from the daily agenda. This is the principal cause of engagement in the materiality of the app. For example, Adele explains how she has used it:

I started using it because I'm a big mess and I often forgot to mark it on the calendar... even with the app I'm a mess, but with the app I tend to be less [because] when I think that the period is coming, I open the app and check the previsions. So, I use it to know easily when the period is back. Let's say, so I can organize me... (Adele, age 46)

The app supports human organisation. It is easy to note the beginning and end of the period, because the smartphone is already incorporated in our lives. The app automatically organises the messy calendar to visualise the chronology of the cycle through 'objective data' that can be used to manage all the inconvenience linked with monthly spotting. For example,

Chiara recounts how she has decided to replace the paper agenda with a digital one:

It happened that I was at a conference and the cycle arrived unexpectedly. I mean, I did not remember it properly... but it was quite problematic because I had to present my research in public... hence, there were several factors of annoyance and then I thought that... I mean, if I note down in the diary then I forget to check, maybe I'm not looking. And I thought this thing of the app... that is, the thing that I find useful is that it has a calendar so if I click on the calendar, I visualize the whole chronology of my cycle since I downloaded it. (Chiara, age 38)

The diary needs to be fixed and the notes have to be checked. In contrast, the app easily creates statistics and provisional data on the basis of biological data collected by the woman. Self-tracking practices bring back the material aspects of menstrual cycle, rendering the body sensitive to the differences of biological changes. The body is translated in digital information, even if the woman does not record all the informational demands of the app. The following extracts pay attention to the different ways through which the women interviewees embed the app in their lives on the basis of different outlooks and necessities. It depends on their knowledge about how reproduction works, so on engagement with the knowledge inscribed in the materiality of the app.

For example, Jasmina does not understand why she should record her mood, symptoms and temperature, her cervical position or mucus amount. She does not know how this information can be useful to create a more reliable prediction of fertility and ovulation windows. It is interesting to underscore that she opens the black box of statistics and average menstrual and fertile windows only during the interview. Statistics and averages are produced on the basis of a chronological report of past menstruations. These functions produce data that can be visualised only if the user tinkers with the app in order to understand how it works. Before that, Jasmina had never tinkered with the app and she did not know that it could be used to record all that information. She says:

We can see it... that is, I don't really like this app, but I'm accustomed to use this one. See, you can record symptoms, mood, test results, contraceptives used... all these things, a little bit weird... maybe... let see, reports, predictions, chronology, sexual activities, temperature? Symptoms? Let's see, it tells you how many times you recorded this symptom in the past thirty days. I mean, it does graphs, too. But, I don't know... why I have to record all these data? Maybe I didn't invest time to understand why I should to collect these data... (Jasmina, age 27)

In this case, the interview becomes an ally in the intra-actions between the interviewee, knowledge of her fertility and the knowledge inscribed in the app. This extract shows the minimal engagement of Jasmina in the materiality of the app. She had not questioned the knowledge inscribed in it because she only needed a memorandum of the beginning and end of the menstrual window.

Minimal engagement with the knowledge inscribed in the app also depends on the gender stereotypes linked to menstruation. It emerges that menstruation is a 'thing' that needs to be made invisible through the materiality of the app. Chiara recounts that, when she downloaded the app, she looked for one that did not seem to be obviously a program to track periods:

The icon is violet with a drawing of the number twenty-eight. I think that is regarded as the menstrual period's length. By the way, I was looking for an app that didn't look like female stuff for menstrual period... I just felt weird that someone could see stuff for my period on my smartphone. So, when I chose it, I thought about the icon, too. (Chiara, age 38)

Another example that underlines the impact of gender stereotypes about use of the app is the consideration that reproductive knowledge becomes an issue only if a woman is seeking to become pregnant. Contraception is based on methods such as the pill and condoms that ensure protection without worry about the regular change that occurs in the female reproductive system. Each cycle can be divided into three phases: follicular phase, ovulation and luteal phase. These changes can be altered using hormonal birth control such as contraceptive pills. The use of these contraceptives is not linked to the need to think about hormonal changes. Acknowledgment of the ovulation phase is considered over-information because, as Palmira says, it is not necessary to know our hormonal changes when you can employ ready-for-use contraception:

I don't understand... I mean, there is written fertile and ovulation window. I mean, I know that in the ovulation period you could have some spotting. Or maybe... I remember that spotting should be between the two phases. However, since I don't want to get pregnant, I am not interested to understand these things. I mean, I don't want to get pregnant, so I am not interested if I am fertile or not. Maybe it is very useful for women who want to get pregnant. (Palmira, age 20)

The richness of this extract shows that the interviewee has not questioned the medical knowledge inscribed in the app. She has confused knowledge about fertility and ovulation and uses the interviewer's presence to tinker with the artefact. The materiality of the app provides the possibility of using it to better comprehend one's individual

sensibility. Palmira is subordinated at the historical stereotypes about menstruation seen as a reproductive business that can become an issue only while trying to get pregnant. Until that time, it is important to know cycle length to understand if it is regular or not and, consequently, to control it.

Here, it is possible to underscore that even minimal engagement in the intra-action with the app can produce knowledge reconfiguration. The knowledge reconfiguration gives rise, for example, to greater awareness of one's cycle length. Even if the app is used only for noting the beginning and the end of menstruation, its capacity to produce averages and predictions can enhance and extend knowledge of the user's own cycle, as Palmira explains:

I knew that my cycle was coming because that I had a traditional backache, so I didn't need the app. But I realized that my period was irregular, and I thought 'let me understand how much it is random'. Then I began to use the app in order to understand my irregularity. And I had realized through the average produced by the app that my period is about 35 days long. So, I utilized it just to understand my period's irregularity... my friends are so regular, they don't need the app. (Palmira, age 20)

This extract shows how minimal engagement produces minimal knowledge reconfiguration. The minimal reconfiguration knowledge is linked to awareness of the cycle's length. Now Palmira knows that her cycle is 35 days long. However, she is convinced that her period is irregular only because it is not 28 days long, even though medical knowledge affirms that menstruation is regular if it occurs anywhere along a 21- and 35-day cycle. In this sense, Palmira has not questioned her knowledge that is linked to the myth of regularity that defines a cycle as normal only if it is 28 days long.

Here, self-tracking practices show how the materiality and sociality act symmetrically producing different uses of the app in everyday spaces. The materiality of statistics and graphs produces different means embedded in the knowledge about one's own cycle, which at the same time act in the ways in which the app is used.

6. Affective Engagement

This section shows how the entangled agency between humans and non-humans can produce overlapping forms of intra-action by which both personal and expert knowledge are reconfigured. Here, attention is directed to the form of engagement embedded within reflexive tinkering with the expert knowledge suggested by the app. The agency of the app emerges through its capacity to make visible how fertility should work on

the basis of the data recorded by women. The body is broken down into a series of symptoms such as acne, back pain, headache, change in mood, identifying traces of sociomateriality left by statistics and graph.

The principal characteristic of affective engagement is recognising that the working of the app depends on biological knowledge that becomes visible in the concrete daily experience. The body is 'learning to be affected' through tracking some symptoms. The interviewees are becoming more sensitive to recognising various changes in their bodies as linked to menstrual phases. Even if they know their menstrual symptoms and mood, the app provides proof of such connections. In this regard, Maia says:

At first, I recorded symptoms and other things because I wanted to understand. I mean, I thought: 'Maybe these symptoms such as headache and back pain are regular, maybe they reappear in the same way'. So, I kept a note. But now, I'm sick of recording this information. I just don't really have time for the app, either. But sometimes I record it if I have a bad headache or particularly strong pain. Then if it occurs again, I can say: 'Well! It was because of my cycle!' [...] I mean, I like to know when I am in the max period of fertility because I know that it is linked to some symptoms, like spotting, etc. I like to know if they are linked to my cycle or not. (Maia, age 26)

Here, Maia collides with the suggestion to recognise PMS in some symptoms in her daily mood. She uses the app to track her symptoms and emotion, but this does not mean that she records all the information suggested by the app. To the contrary, she just tests her bodily knowledge to confirm some connections. After that, she embeds the app in a reflexive underutilisation, because she recognises when her mood or various symptoms are linked to her cycle; for this reason, she does not always feel the need to record that information. We can note how interactions between humans and non-humans translate agential capacities and forces by a setting of uses that take into account the materiality and sociality of the lived experience.

As a counterpoint, Adele monitors symptoms to confirm that she is on the threshold of menopause. In this case, the app is a repository of traces that make it possible to join to demonstrate an assumed awareness. She recounts:

...seeing how much time, how many days my periods last, the amount of flow, on which days it is concentrated. Those are data I come back to. In fact, it is through the app that I have understood that my cycle has become shorter—for example, from 28 days to 25 or 26 days. When you can visualize this through statistics, you have a different awareness and possibly you are surer about your body. Indeed, among other things, it is more useful for giving me

knowledge about my body. Because I have a coil, I have no problem controlling my cycle from that point of view, to control my fertility or not, or rather to become pregnant or not. Let's say, I'm quite... Yes, the app gives me further knowledge of my body, how it changes and how it is changing. (Adele, age 46)

This extract shows the agential relationship between humans and non-humans. The agency of the non-human actor lies in its capacity to produce personalised statistics that are reconfigured through self-tracking practices embedded in everyday activities. Some interview extracts show that women often play with the app even just for short periods or for some needs, such as when Ada was trying to get pregnant:

It helped me because I more or less knew my fertile days. Obviously, it's not one hundred per cent sure! There must also be some luck. We succeeded immediately. I was pregnant by the second month! So, I don't know if it was the accuracy of the app or luck [...] I recorded the times we had sex, so I could see more or less the two days in which I got pregnant, which were the two days close to my ovulation day. (Ada, age 31)

Ada knows how fertility works, pointing out that she is not sure about the accuracy of the information the app provides her. Maybe, if she had not used the app she would have obtained the same result. However, it gives her support in determining when she is in the fertile window, becoming an ally in her aim of getting pregnant.

If, in the previous extract, attention is on the possibility of visualising ovulation days, in the next the app can help to visualise how fertility works; as such, it can organise dates and thereby play an active part in contraception dynamics based on the use of a condom. Ofelia explains:

I mean, before using the app, I didn't have exact control over at-risk days for having sex. I mean, I know that there are other ways of knowing that, because [name of app] doesn't discover anything. However, it's so much simpler with it. The cycle comes, and I just sign in, that usually it's already foreseen. Moreover, there is the possibility to track symptoms and... Look how beautiful! You can track everything, even acne. But, when I have a partner, I often need to know if I will be in my period or not in order to organize, you know... I mean, it's simpler to organize. Obviously, if you use a contraceptive method, you don't stop using it. But, I mean, it can be useful, that is, it's better to know. So, you are even more aware of your body than your relationships. (Ofelia, age 25)

Ofelia has biological knowledge about how a woman's body works, and she recognises this knowledge in the app's materiality. She knows that the prediction of fertility and ovulation windows depends on

biological mechanisms that could be calculated manually with the use of a calendar; however, she had never calculated her ovulation days prior to obtaining the app. Ofelia's affective engagement is embedded in her reproduction experience of a 25-year-old university student who thinks about her reproduction only in order to avoid pregnancy. The app is considered an enhancement to the use of the condom, becoming a contraceptive itself.

The same function can be used in different ways, as suggested by Chiara's experience. Chiara is 38 years old with high investment in her academic career. She has postponed having a child, thinking that one day she will satisfy her need for motherhood. But now that her reproductive life is approaching the menopause phase, she knows there is a high probability that she will fail in her desire to have a child. Here, the function of visualising the ovulation window becomes a way of reflecting on the body in relation to reproductive and sexual life, as Chiara explains:

My awareness has changed regarding a whole series of things! For example, since I was not trying to get pregnant – at this precise moment, I don't even have a partner [...]. I never even thought about using the Knaus-Ogino method as a contraceptive. The whole story of when I'm ovulating, I mean, awareness of when I was ovulating, I would have preferred not to have this awareness. [...] I don't know how to explain... the app doesn't produce any kind of changes. It's not that... It's the fact that displaying certain types of information makes it hard not to think about it. So, for example, since I've been using this app, every time it tells me 'today is a fertile day' I'm thinking, 'another day of my life that hasn't been used'. I don't change my mind or do different things, but... (Chiara, age 38)

Here, Chiara embeds the visualisation of ovulation windows materialised through statistics and graphs in her ideas about motherhood. She sees the averages and the forecasts as unfertilised eggs. In this sense, the use of the app is embedded in her thoughts about fertility, ovulation, motherhood and gender discrimination regarding PMS definition. She says:

For example, when I take the pill and the app tells me 'You're ovulating', I think 'What a fool!', I mean, it's not very rational [...]. Then it says 'PMS', which I imagine means premenstrual symptoms. But I think this is a sexist thing, as it never occurred to me to record whether I had symptoms. (Chiara, age 38)

It is interesting that Chiara uses human language to make fun of the app. She tinkers with the non-human actor with complaints about the definition itself of PMS, since recording symptoms and mood reproduces and thereby keeps alive sexism and taboos around the female period.

In this second engagement form, the body comes to matter within an effective engagement between human and non-human actors. The agency of the app performs the recognition of some bodily elements otherwise taken for granted. On the other hand, the women interviewed tinker with the suggested knowledge about how the body should work. The result is an affective engagement of apps and bodies, which become more sensitive to understanding menstrual phases.

7. Discussion and Conclusion

The two forms of engagement analysed in previous sections are considered as a continuum whereon overlapping intra-actions can produce different experiences of embodiment.

Tracking menstrual cycles can bring back the materiality of hormonal changes. Analyses of these engagements illustrate how bodies learn into dynamic assemblages in which, reciprocally, body shapes how practices are done, and practices produce new responses performing the body in both social and material ways (Lynch and Cohn 2016). The result is that self-tracking practices emerge as part of ongoing process across a range of everyday activities, combining diverse types of knowledge.

The first form of engagement embeds the necessity to control the beginning and the end of menses on the basis of biological knowledge that, inscribed in the materiality of the app, provides an algorithmic memorandum. The second implies a reordering of the knowledge suggested by the app, rendering alterations within the body affected at the various meanings that could express hormonal changes. This interpretation is sustained by the difference that emerges from the interviews between inscribed knowledge and suggested knowledge. In the first case, interviewees recount how they use the app, describing it as a black box that produces predictions about the next menses. They have not questioned how tracking menstruations could be the result of a materiality that incorporates biological knowledge about how the menstrual cycle should work and, as well, developers' assumptions about users and how they should use the app. Self-tracking practices replace the use of pen and calendar, becoming part of the women's tacit knowledge about bodies and menstruation (Polanyi 1967; Scheldeman 2010). In the second case, women tell about how they tinker with the device, seen as a repository of inscribed knowledge that suggests different ways to think about their relationships and, further, meanings of their own body-as-lived. Here, menstrual tracking becomes part of the process by which body 'learns to be affected' by entanglements of humans and nonhumans (Latour 2004).

The two forms of engagement assume diverse nuances in thinking about the body. The extracts of the first form analysed describe a

confused knowledge about fertility subordinate to the various historical stereotypes. Here, it is important to know cycle length to understand if is regular or not (and thereby control it). Some of the interviewees do not care about how the app works, since they do not know all its functions; they use the interviewer's presence as an ally to understand the knowledge inscribed in it. The extracts of the second form describe the process by which knowledge inscribed in the app becomes a way to think about fertility, ovulation, motherhood, PMS and gender stereotypes. In this case, the visualisation of ovulation and fertility windows is embedded into daily experience whereupon the body is continually reconfigured as part of the lived experience (Lupton et al. 2018).

Regarding this point, it is important to note that the interviewees emphasise the difficulty of trusting in the suggested knowledge. The dynamics of ovulation remain invisible, and for them a graph or an average cannot represent the reality of the biological mechanism. The interviewees underscore the challenge of recording all the information requested by the app, even though it allows them to reflect on some connections otherwise taken for granted. Here, we can see how the boundaries between humans and non-humans are co-constructed and tied to heterogeneous elements. So, rather than delineate what capacities are human or technological, analysing self-tracking practices as embodied knowing helps capture how humans and app act together in the construction of entangled agencies.

This interpretation is also sustained by the examples presented in the section on affective engagement with the materiality of the app. Even though the application suggests knowledge and practices, women play with it even for just a few moments or periods or, alternatively, for specific necessities, such as when Ada was trying to become pregnant. She knows that she would maybe have obtained the same result without the app's use, but it becomes an ally in the acknowledgement of her ovulation phase. In particular, even though self-tracking technologies are designed to act in synergy with the body in order to produce reliable data, the extracts analysed reveal the mutual translation between what the app suggests monitoring and what the woman actually tracks. It is important to draw attention to the constant renegotiation between how the app should be utilised and how it is used in real-life experience. As we have seen, agency is relational since the app enacts expert knowledge that acts to produce graphs and statistics. At the same time, women record only that information considered useful in the economy of their everyday lives. Here, we can see the process by which the agency of subjects and objects act symmetrically, producing data that are co-constructed into human-app assemblages (Barad 2007; Law and Mol 1995; Lupton 2018).

The intra-actions between interviewees and apps standardize symptoms as acne, tender breasts, bloating, feeling tired, mood changes across the materiality of graphs and statistics. The affective engagement

with the materiality is able to render the body sensitive to recognise some menstrual signs, which emerge as the result of intra-actions between knowledge inscribed in the app and tacit knowledge embedded in human corporeality. As Maia said, knowledge inscribed in the app suggests that tracking symptoms and signs can derive demonstrable proof of the connection with one's upcoming menstruation. In addition, the affective engagement in one's cycle and its fulsome implications can be embedded into not using of some functions in order to contrast, as Chiara explains, the assumptions inscribed in the app. She tracks just the beginning and the end of menstruation because she complains about the definition of PMS, since recording symptoms and mood is a way of sustaining sexism and taboos around the female period.

Even if self-tracking practices produce data that women voluntarily collect in a fragmented way contrary to the real developers' design, they can be a resource for governments and markets (Kitchin and Dodge 2011; Kitchin 2014). The body is transformed into digital data through practices that people enact within power relations that exist into assemblages of humans and nonhumans.

Power is based on surveillance, incorporated in the governance of citizenry and internalised by actors. Analysing self-tracking practices means observing how policymakers and health authorities alike could gather personal information and create discrete categories (Lyon 2002). In our case, data on fertility, ovulation and the menstrual cycle, produced through an app, can be used not only by employers, but also by governments, to monitor the state of pregnancy and, further, estimate the duration of maternity leaves for female workers².

However, subjects are not just surveilled, they also respond and reconfigure the dominant ideas and norms of environment. The spaces of everyday life become expanded laboratories in which individuals take part in the dynamic of power relations through a range of different practices (Gabrys 2014; Coletta et al. 2018). Here, self-tracking practices emerge as a way to enact different meanings of the body's engagement in the ongoing process of subjectification. This engagement comes back into diverse materiality ways as the product of overlapping intra-actions between humans and nonhumans, in which digital technologies are situated into practices that enact a knowing embodied.

Adopting a sociomaterial lens suggests analysing the self-tracking practices as part of entanglement of people and technologies, showing how the experience of menstrual cycle tracking is an embodied, more-than-human practice. This allows to pay attention on the complexity and heterogeneity of uses that often differ from their expected utilization, rather than trapping such experiences within discourses that emphasise a range of issues relating to data surveillance.

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¹ Even if the focus of this contribution is not on the constitution of PMS as a medical syndrome, it is interesting to note that this term is frequently used, especially in the public debate, to report or justify a mixture of somatic and

psychological symptoms related to changes in the ovarian hormone levels that, notwithstanding an understanding of its exact etiology is still poorly described and documented. In some cases, PMS ends up being used as a means of questioning the capacity of women to manage and participate as co-equals to men in prestigious economic and political positions (Rittenhouse 1991). Symptoms are categorized as physical, psychological and behavioral. Physical symptoms include fatigue, edematous sensation, sinus sensitivity, headache, weight gain, muscle pain; behavioral and psychological symptoms include irritability, nervousness, mood swings, sadness, depression, hypersomnia or insomnia, decreased concentration.

² Particularly the press is beginning to emphasise that app's developers could sell data to second and third parties. For an overview, it is interesting to quote the articles available on the subject: https://www.washingtonpost.com/technology/2019/04/10/tracking-your-pregnancy-an-app-may-be-more-public-than-you-think/?noredirect=on&utm_term=.7833e7e2ec3f; <https://www.internazionale.it/video/2019/07/23/app-mestruazioni-marketing>.

