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Tracking the Female Body: Femtech, Biosensors, and the Enactment of Computerized Fertility

Della Bianca Laetitia

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Tracking the Female Body:
Femtech, Biosensors, and the Enactment of Computerized Fertility

THÈSE DE DOCTORAT

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Docteure ès Sciences Sociales

par

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Faculté des sciences sociales et politiques

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Le Décanat de la Faculté des sciences sociales et politiques de l'Université de Lausanne, au nom du Conseil et sur proposition d'un jury formé des professeurs

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- Tamar SHARON, Professeure à l'Université de Radboud

autorise, sans se prononcer sur les opinions de la candidate, l'impression de la thèse de Madame Laetitia DELLA BIANCA, intitulée :

« Tracking the Female Body:
Femtech, Biosensors, and the Enactment of Computerized Fertility »

Nicky LE FEUVRE
Doyenne

Lausanne, le 8 septembre 2022

Abstract

This dissertation develops a praxiographic approach (Mol, 2002, p. 158) to uncover different aspects associated with the shaping of the "modern woman" through fertility-tracking practices. Focusing on relational practices, the research follows an artifact (i.e., computerized fertility) through different times and locations, in places where its "coming into being and passing away" are disputed (Daston, 2000, p. ix). The empirical observations lead to a twofold argument: first, the "enactments" of the fertility-tracking subject via computerized biosensors are intrinsically multiple (Mol, 2002, p. vii); second, taking part in different "assemblages" (Murphy, 2006, p. 12) and materialized within specific "configurations" (Suchman, 2013) of bodies, technical artifacts, knowledges, and values, fertility-tracking practices not only shape (modern) tracking subjects but the particular conditions of their acceptability, which are deeply embedded in the historical and political contexts in which they operate. Drawing on ethnographic research conducted between 2017 and 2020 in (and out of) a company commercializing menstrual cycle tracking biosensors, I present an analysis of the complex and sometimes conflicting relations through which menstrual cycle tracking biosensors are "enacted in practices" (Mol, 2002, p. vii). Following some apps and their ancestors in different temporal and spatial situations, I question how the *tracked female fertile body* emerges as a historically situated version of contemporary womanhood. The dissertation is organized into four thematic parts. Each part is concerned with specific dimensions of the life of fertility biosensors, namely, their distribution, promotion, use, and regulation, and contributes to the constitution of an analytical toolkit aimed at challenging common oppositions tendentially taken for granted in digital health, and self-tracking literature.

Résumé

Cette thèse développe une approche praxiographique (Mol, 2002, p. 158) pour questionner différents aspects associés à la construction de la « femme moderne » à travers des pratiques de suivi de la fertilité. L'enquête suit un artefact – la fertilité informatisée – à travers différentes époques et espaces, dans des lieux où sa « naissance et sa disparition » sont contestées (Daston, 2000, p. ix). Un double argument émerge de cette enquête empirique : d'une part, les pratiques de suivi de la fertilité féminine via des biocapteurs informatisés sont intrinsèquement multiples (Mol, 2002, p. vii) ; d'autre part, les pratiques de suivi de la fertilité non seulement façonnent l'identité de sujets (des « femmes modernes ») mais aussi les conditions particulières d'acceptabilité des biocapteurs, profondément ancrées dans les contextes historiques et politiques dans lesquels ils évoluent. S'appuyant sur une recherche ethnographique menée entre 2017 et 2020 dans (et hors) d'une entreprise commercialisant un biocapteur de suivi du cycle menstruel, je présente une analyse des relations complexes et parfois conflictuelles à travers lesquelles des biocapteurs de suivi du cycle menstruel sont « réalisés en pratique » (*enacted*) (Mol, 2002, p.vii). En suivant des biocapteurs dans différentes espaces et époques, j'interroge la façon dont le suivi du corps féminin fertile émerge comme une version historiquement située de la féminité contemporaine. La thèse est organisée en quatre parties thématiques. Chaque partie concerne une dimension spécifique de la vie des biocapteurs de fertilité, à savoir leur distribution, promotion, utilisation et évaluation. La thèse contribue à la constitution d'une boîte à outils analytique visant à remettre en question des oppositions tendanciellement prises pour acquises dans la littérature sur la santé numérique et le *self-tracking*.

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Introduction

> We are tailored to you. The first FDA[1] cleared birth control app, [is] putting power in the palm of your hand. Skip the pharmacy, no prescription… Natural Cycles is … powered by an algorithm that determines your fertility status based on basal body temperature. Just measure with your NC° thermometer, enter it into the app, and let our algorithm do the work.
> – Natural Cycles, official company website, 2022.

The Swedish company Natural Cycles promises to set women free from the burdens of contraception by providing a "natural," "non-hormonal," and "side-effect-free" alternative to traditional contraceptive methods. In the last decade, hundreds of mobile apps like this have been developed to track women's menstrual cycles and offer digital solutions for their so-called biological 'problems.' Ranking just second behind highly popular health activity-tracking apps, menstrual trackers are now among the most downloaded mobile health apps worldwide (Fact.MR, 2018). Ida Tin, founder of the Berlin-based menstrual tracking app called Clue, first coined the term *femtech* (or, "female health technologies") to sum up their rapid proliferation and economic position as a "new business category on the rise" (Tin, 2016). The term, now widely used,

[1] FDA stands for Food and Drug Administration, the American federal agency responsible for certifying food, drug, biological, medical, electromagnetic, cosmetic, veterinary, and tobacco-related products (FDA, 2022).

encompasses a variety of consumer products centered on reproductive, sexual, and maternal health (CB Insights, 2017).

Despite their popularity, femtech and fertility-tracking apps have aroused critical reactions in the media[2]. While companies advertise the benefits of the menstrual cycle's digital revolution (Tin, 2015), many in the press view such claims with caution. Some commentators acknowledge the potential of certain apps to contribute to users' well-being (Luz Henning Santiago, 2018), but others insist that users be warned about privacy risks surrounding their personal data (Gupta & Singer, 2021; Hamilton, 2021; Marsh, 2020; Molteni, 2018; Rosato, 2020). When it comes to their use for pregnancy prevention, reporters typically cite medical experts who either advise using alternative methods (Altman, 2018; Brigham & Farr, 2018; Chaudhuri, 2018) or refraining from their use until there is greater evidence for efficacy (Wetsman, 2018). In sum, although menstrual cycle tracking apps may offer some benefits to users, skepticism in the media centers on concerns about data privacy and limited evidence about their effectiveness.

Ambivalence toward self-tracking apps abound in the scientific literature as well. Academic discourses at times stimulate a polarizing debate that juxtaposes techno-enthusiastic positions about the uses of health monitoring apps against techno-pessimistic ones (del Rio Carral et al., 2016; Sharon, 2017). However, a review of social science literature by Ruckenstein and Schüll (2017) reveals that scholarship does not consist of "debates or disagreements so much as [it] represent[s] parallel conversations that place weight on different themes, sites of inquiry, and

[2] For example, in a 2019 BBC News article entitled "Femtech: Right time, wrong term?," Carolina Milanesi, founder of a technology consultancy firm, exposed her skepticism towards the framing, by femtech innovators, of fertility as an issue. More specifically, Milanesi regretted the framing as a *women's* issue. She sarcastically pointed out the gendered framing of the terminology: "When it's about men and men's health, it's not mentech, right?" (Milanesi cit. in Kleinman, 2019).

analytical frameworks" (p. 263). While each of these areas of analysis offer unique contributions about the role of these new technologies, the compartmentalization of research limits understanding of the complex dynamics in which self-tracking practices unfold. Therefore, scholars are now calling for a move beyond limited debate (del Rio Carral et al., 2016; Sharon, 2017) and a widening of the frame to achieve less-traveled research paths (Ruckenstein & Schüll, 2017, p. 270) that explore the specific contexts in which self-tracking occurs (Fors & Pink, 2017; Henwood & Marent, 2019; Rich & Miah, 2014; Weiner et al., 2020).

In my dissertation, I take up the call to provide an empirical investigation of self-tracking technologies in practice. Drawing on ethnographic research conducted between 2017 and 2020 both within a company marketing a menstrual cycle tracking biosensor[3] and more broadly in related sites, such as tech fairs and users' homes, I present an analysis of the complex and at times conflicting relations through which menstrual cycle tracking subjects are "enacted in practices" (Mol, 2002, p. vii). Following specific menstrual tracking biosensors over time and in different contexts, I explore how the *tracked female fertile body* emerges as a historically situated version of contemporary womanhood. The remainder of this chapter will problematize the emerging femtech market in relation to feminist research on reproductive technologies. Then, it will outline and synthesize the social science literature on menstrual cycle tracking apps. Finally, it will present my dissertation approach and the chapters that lie ahead.

[3] Following anthropologist Dawn Nafus, I use a definition of biosensors as sociotechnical artifacts that do not only transform things into electronic data, but also "mediate uncertain, sometimes fraught relations between medical practice and self-care, between scientific knowledge and lay knowledge, between community and commercial impulses, and between aesthetic production and instrumentality" (Nafus 2016, xi).

The "FEM" in Femtech – Problematizing the Gendered Rhetoric of Fixing Women's Biology with Technology

Ida Tin coined the term *femtech* while participating in the 2016 TechCrunch Disrupt conference in San Francisco. On the entrepreneurs' network website *We Are Tech Women,* she explained that "while all other available technologies [at the Disrupt conference] were grouped together in a logical way, the products aimed at women were scattered all over the exhibition hall, looking lost and out of place" (Tin, 2019). Tin thought that these products were distinct from the others in the exhibit hall in that they were intended for women's bodies and biology, understood to be uniquely different from those of men. Thus, for Tin, these products deserved to be showcased in a clearly demarcated and cohesive space. Tin made clear that the "fem" in femtech stood for "female" and that the tech involved was aimed specifically at female health (Tin, 2016).

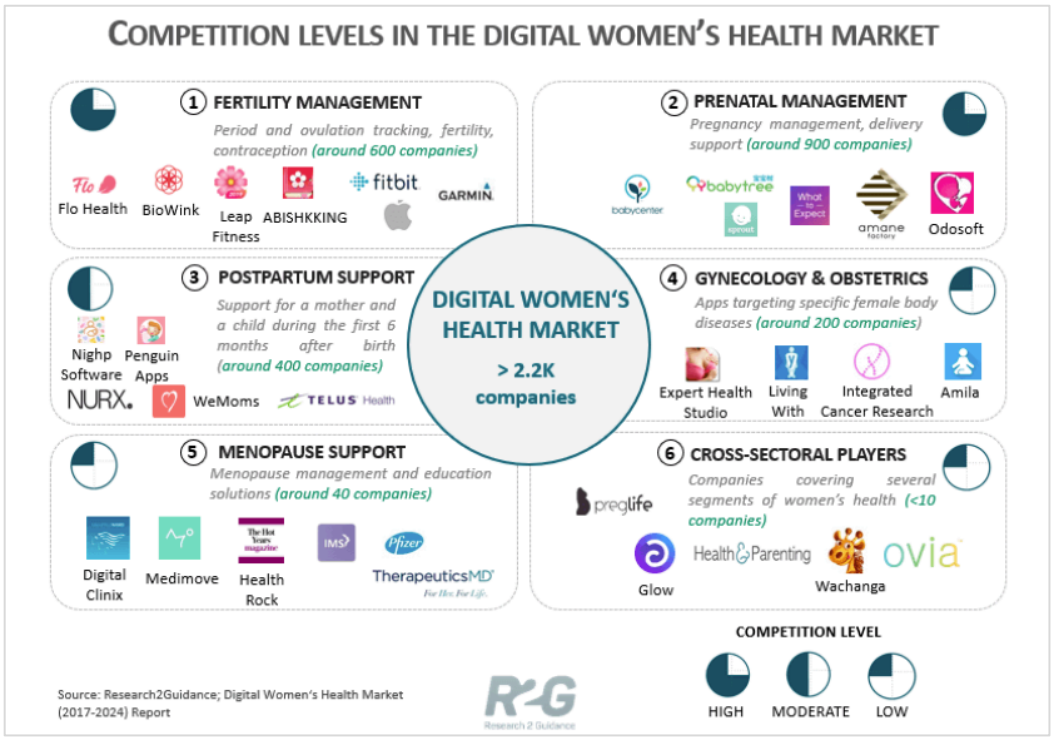

Figure 1: Femtech's Segments and Competition Levels; Reproduced from Danilin (2020).

Box 1: Mapping Femtech From a Business Perspective

According to market research firms, the newly coined *femtech* niche is expected to generate important revenues for investors. As a sign of expansion, major tech companies such as Alphabet and Apple have recently joined the innovation pathway.[4] Research2Guidance describes the femtech market as populated with "around 2,200 providers of women's health app-based solutions who operate in six different segments" (Danilin, 2020). Among these, fertility management is presented as "the largest and most competitive of the digital women's health market" (Danilin, 2020), ahead of prenatal management, postpartum support, gynecology and obstetrics, menopause support, and cross-sectoral players (Danilin, 2020). Though marketed as a "holistic" response to woman's health, femtech innovators usually operate within a single sector. Research2Guidance estimates about 600 companies within the fertility management sector (see figure 1).

Whereas the "fem" in femtech more often conveys female tech than it does feminist tech, the market rhetoric often suggests a "neoliberal feminist" agenda (Rottenberg, 2014).[5] In fact, innovators like Tin deplore what they view as the health-care industry's long-standing ignorance of women's health and biological needs. For them, femtech is a new market category intended to

[4] Research2Guidance's report announces an "increasing competitive pressure" imposed on fertility companies "from tech giants like Apple and Alphabet," with the introduction of menstrual cycle tracking in April 2018 by Fitbit (Alphabet) and in June 2019 by Apple (Danilin, 2020).

[5] Catherine Rottenberg describes neoliberal feminism as a new form of North American contemporary feminism, "displacing… mainstream liberal feminism" (Rottenberg, 2014, p. 419), and "predominantly concerned with instating a feminist subject who epitomizes 'self-responsibility,' and who no longer demands anything from the state or the government, or even from men as a group" (Rottenberg, 2014, p. 428).

correct what they perceive to be a lack of research and consumer products specific to women's health.

Within the femtech sector, fertility-tracking products promise potential customers a twofold benefit. First, they should receive a solution (or, at least the alleviation) of a biological problem. Second, the personal use of digital technology promises added value in the form of scientific knowledge that is expected to result from their individual contributions to big data science[6].

Femtech rhetoric presents science and industry as allies. As the industry mobilizes the scientific expertise to assess product accuracy and efficacy, it grants the industry privileged access to personal data. The return on customers' investment (through turning over their biological data) takes the form of scientific knowledge generation[7] that has potential to benefit the public good[8]. By legitimizing business opportunity itself, the new femtech market frames itself as a means to rectify gendered imbalances in science, research, and development.

[6] In a scientific article entitled "Is Female Health Cyclical? Evolutionary Perspectives on Menstruation," authors Alexandra Alvergne and Vedrana Högqvist Tabor expect "[m]obile phone apps [to] offer a unique potential to document previously unknown phenotypic diversity" (Alvergne & Högqvist Tabor, 2018, pp. 410, 412).

[7] Menstrual cycle tracking apps are hoped to promote research on endometriosis and polycystic ovary syndrome, which is seen as understudied due to the stigma surrounding women's bodies (Tin, 2019).

[8] For a critique of the solidaristic framing of data sharing for the public good in medical research, see Ajana (2017)

Figure 2: Gendered imbalance in scientific research: Women's health as understudied

Popular covers of *Scientific American* illustrate the femtech narrative circulating in the public sphere (see figure 2). In fact, three issues of *Scientific American* during the past four years were specifically aimed at redressing gender bias in biomedical science[9]. An issue in 2017 featured an article arguing that "Doctors Must Dig into Gender Difference to Improve Women's Health Care" (Scientific American, 2017). A 2019 issue was dedicated to bringing awareness to women's reproductive health and its "huge gaps" (Scientific American, 2019). And in 2020, the magazine highlighted "sex-specific risks" associated with certain illnesses as well as the "slothful pace of innovation" in birth control (Scientific American, 2020).

The commodification of fertility: A brief review of social science literature

While the narrative about gender bias in science raises critical issues for both women and science, it highlights several other concerns. First, it neglects the production and distribution of biomedical

[9] Another example of the framing of the hidden biases in sciences as a public interest can be found in the bestseller, by science journalist Angela Saini, *Inferior: How Science Got Women Wrong – and the New Research That's Rewriting the Story* (Saini, 2017).

knowledge throughout the last century: framing the "missing parts" on women's sides ignores that men's reproductive health has long flown under the radar (Oudshoorn, 2003; Gardey, 2005; Almeling, 2020; Johnson, 2021).

By associating women with fertility and reproductive capacities through new consumer products, femtech discourses have the potential to reinforce the historically unequal treatment of gendered bodies in medicine, one in which women's bodies (traditionally cast as reproductive entities) have been situated against men's bodies, seen as the standard, non-reproductive entities (Almeling, 2020, p. 13). We can therefore question the extent to which such endeavor may help correct gender asymmetries in the production of biomedical knowledge or, on the contrary, reinforce existing ones concerning the missing science of men's reproductive health (Almeling, 2020, p. 165)[10].

The dichotomous framing of women's/men's health in femtech discourse also reinforces a dualistic perspective in which male/female are positioned as cohesive, "non-overlapping categories" (Almeling, 2020, p. 6). However, scholar France Winddance Twine challenges the monolithic category woman with the concept of a "fertility continuum," emphasizing that reproductive rights may be defined quite differently by women from diverse socio-economic, racial, and ethnic backgrounds who vary in terms of cultural and economic resources (Twine, 2017). Technological innovations sold as solutions to women's biological problems tend to reify this dualism without taking diverse experiences into account.

[10] Another example from an innovator who will present at the next Femtech Summit which is to be held at the Federal Polytechnic School at Zürich, in June 2022: "There are things that the female body does uniquely that could be incredible measurements of women's health: biomarkers that could help us predict, diagnose, treat or stratify the risk of disease as it manifests differently in the female body. The problem is we don't typically use any of those biomarkers–like the vaginal microbiome–because they don't exist in men so we just never studied them" (ETH Femtech Summit Newsletter, received by email on January 26, 2022).

The notion of commodification helps understand the increasing valuation of women's fertility as an asset. Communication scholar Vincent Mosco defines commodification as "the process of transforming things valued for their use into marketable products that are valued for what they can bring in exchange" (Mosco, 2009, p. 127). Similarly, sociologist Laura Mamo described the increasing commodification of the body in the reproductive sciences during the late twentieth century in the United States as "Fertility Inc." (Mamo, 2007b). In Mamo's iteration, the body no longer needs to be pathologized to be subjected to medical interventions. Indeed, the body (and its parts) has become the focus of a double imperative: (1) to be healthy, and (2) to exercise its consumer choice "through processes of maximizing health, minimizing risk, and producing oneself anew" (Mamo, 2010, p. 175). With a focus on the desire for procreation among lesbians, Mamo's study investigates how gametes and sperm have been transformed into commodities.

The commodification of the body occurs along as a form of what Clarke et al. (2021, p. 125) call *biomedicalization*, "the increasing reliance of medical organization, practices and treatments on technoscientific innovations (e.g. MRIs, CAT scans, new pharmaceuticals) and the reorganization of biomedicine itself from the inside out through application of computer and information sciences (e.g. computerized patient records)." Clarke et al. further characterize the process of biomedicalization with five key components, that I synthetize as follow: 1) "a new biopolitical economy of medicine" (p. 126), 2) "a new and intensifying focus on health" (p. 126), 3) an increasing reliance on higher technologies for treatments rather than "lower tech and less costly alternatives" (p. 126), 4) "transformations of biomedical knowledge…through applications of computer" (p. 127), 5) "transformations of bodies…and identities" (p. 127). Menstrual cycle tracking for pregnancy prevention presents an intriguing case of biomedicalization; while fitting most of the characteristics identified by Clarke et al., it nonetheless challenges the third dimension,

by promoting lower tech (such as mobile apps) rather than expensive, higher ones. Additionally, as we will see in chapter three, menstrual cycle tracking appears as a way to resist a related concept of biomedicalization, *pharmaceuticalization*, "the redefinition of health 'problems' as having pharmaceutical solutions" (Clarke et al., 2021, p. 129). When using a fertility biosensor as an alternative to the birth control pill, many users resist the process of pharmaceuticalization; and as I will show, in turning to plants and alternative medicine, some users also resist contemporary trends of biomedicalization towards women's bodies.

Feminist scholars Celia Roberts and Catherine Waldby (2021) describe further how biomedical innovations construct fertility itself to be an asset, "separable from reproduction per se, in which women should invest if they are not to fall prey to incipient infertility" (Roberts & Waldby, 2021, p. 1). Menstrual tracking apps fall squarely within the biomedical shift to further position fertility as an asset. Instead of locating its worth in sperm or gametes however, the latest technological innovations place its value in digital data. Embedded in a broader "digital knowledge economy" (Lupton, 2016a, p. 90), practices of digital fertility-tracking "bring together the private with the public spheres in new ways" (p. 91).

The next section problematizes menstrual cycle tracking biosensors as presented in different approaches to social science research.

Social Scientists and Menstrual Cycle Tracking: From Apprehension to Intervention Through Comprehension

> Two years ago, when my body went to hell and I spent months in a whirlwind of migraines, vertigo, fatigue, and all-around misery that doctors couldn't diagnose, I turned to tools and techniques coming out of the quantified self movement in an effort to get some form of insight…As I explored different services and tools…I found myself resisting two classes of quantified practices: 1) anything that got framed around "dieting" and calories; and 2) anything that got described as being about fertility. In short, I wanted nothing to do with the practices that were gendered feminine (…) or other activities that position the female body in an objectifiable state…Completely unfairly, I associated fertility tracking with aging women desperate to get pregnant and I didn't want to frame myself as such.
>
> (boyd, blog post, October 1, 2012)

danah boyd (lowercase intended) is a renowned scholar and advocate working on social issues related to digital technology, youth, and privacy. Readers familiar with critical data studies may have encountered boyd's writing in other contexts. Her writing here is representative of an approach to menstrual cycle tracking that is at first apprehensive, not of technology *per se,* but of the objectification of women's bodies. The 2012 above blog post that opens this section speaks to an embodied experience—that of a painful body, a body that doctors did not understand and that necessitated an in-depth knowledge-seeking endeavor. In this case, boyd's journey of self-discovery as it related to her body involved fertility-tracking. Yet her choice of self-tracking tools was not automatic. She recalled a strong initial aversion to these apps and acknowledged having

perhaps "unfair" assumptions towards them. Nonetheless, she resisted engaging in practices (such as fertility tracking) that would objectify the female body and cater to a type of consumer who did not reflect her identity, namely "aging women desperate to get pregnant."

When boyd published her blog in 2012, social science research on menstrual cycle tracking was absent. Although anthropologists had been discussing the culture surrounding menstruation for decades, the technologization of the menstrual cycle via tools and techniques had not yet become a valued research object. Ten years later, social scientist studies on menstrual cycle tracking apps are proliferating. In what follows, I identify three dominant clusters in the emerging literature on menstrual cycle-tracking technologies: (1) critical and apprehensive approaches, (2) comprehensive approaches, and (3) interventionist and interdisciplinary approaches.

Cluster one: Critical and apprehensive approaches

In 2015, two publications by sociologist Deborah Lupton contributed to the legitimization of menstrual cycle-tracking apps as valuable sociological research objects and opened the way for a growing research domain. Lupton first critically evaluated the norms embedded within sexual and reproductive self-tracking and their potential as privacy threats (Lupton, 2015). Lupton then analyzed how period and pregnancy monitoring apps specifically target women and intensify an ethos of self-responsibility and self-surveillance (Lupton, 2016a).

Social scientists built upon Lupton's line of inquiry in critically theorizing the ways menstrual cycle-tracking apps frame users' understandings of their bodies and lives, promote idealized reproductive subjects, and examined issues related to data reliability, security, and transparency (Healy, 2020; Hendl & Jansky, 2021; Kressbach, 2021; Lavoie-Moore, 2017; Light et al., 2016; Mishra & Suresh, 2021). Taken together, these studies offer a rather homogeneous set of conclusions framed within a narrative of alienation vs. liberation. Although users may have

positive outcomes from use of tracking apps such as feelings of empowerment (Hendl & Kansky, 2021, p. 22), the biosensors may also be regarded as "disciplinary" vis-à-vis elements of heterosexism and gender oppression embedded within them (Lupton, 2015, p. 449).

Cluster two: Comprehensive approaches

Another body of literature has started to investigate why and how some people turn to menstrual cycle-tracking apps[11]. Findings to date provide qualitative evidence that, far from being unified, user engagement exists on a continuum (Zampino, 2020, p. 33). In addition to providing documention of the various reasons users track their menstrual cycle with apps (Amelang, 2021; Gambier-Ross et al., 2018; Levy, 2020; Levy & Romo-Avilés, 2019)[12], specific themes center on menstrual management and stereotypes (Levy, 2018b; Lutz & Sivakumar, 2020), self-knowledge and self-care (Ford et al., 2021; Grenfell et al., 2021; Zampino, 2020), pregnancy planning (French et al., 2022; Hamper, 2020; Wilkinson, 2020; Wilkinson et al., 2015), couples' relationships (Hamper, 2021), and users' perspectives on privacy (Amelang, 2021; Karlsson, 2019).

Besides the emphasis on users' heterogeneous engagements with menstrual cycle-tracking apps, important finding from this cluster demonstrate that users are not passive "surveilled" subjects. Different from the alienation-liberation narrative commonly found in previous literature, this body of research suggests that users "respond and reconfigure the dominant ideas and norms of [their] environment" (Zampino, 2020, p. 47).

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[11] Some of these studies used online survey methods (Lutz & Sivakumar, 2020), mixed methods (Gambier-Ross et al., 2018), or auto-ethnographic methods (Gaybor, 2022; Levy, 2018a).

[12] Levy and Romo-Avilés (2019, p. 1) distinguished the following motivations: "1) tracking menstrual cycle dates and regularities, 2) preparing for upcoming periods, 3) getting to know menstrual cycles and bodies, 4) verifying menstrual experiences and sensations, 5) informing healthcare professionals, 6) tracking health, 7) contraception and pregnancy, and 8) changes in tracking."

Additionally, it illuminates how users' relations to privacy are more complex than simply a desire to protect their personal data from being shared with third parties. Users understand privacy issues in relation to ongoing stigma surrounding menstruation (Karlsson, 2019; Lutz & Sivakumar, 2020) or personal data insecurities (Amelang, 2021). In an explorative study, I have explored various enactments of privacy through the analysis of menstrual cycle-tracking app users' narratives (Della Bianca, 2021a). I found that users draw different boundaries between what they perceive as private. While for some users, a menstrual cycle-tracking app granted them the privacy they had not experienced before (e.g., by allowing them to record their menstruation dates on their smartphone rather than on the kitchen calendar), for others, it would represent a serious incursion in their privacy (e.g., when receiving an unprompted smartphone notification from their tracking app) [13].

Cluster three: Interventionist and interdisciplinary approaches

Interdisciplinary studies on human-computer interactions (HCI) have found an intermediate space between the apprehensive-critical cluster and the comprehensive cluster mentioned earlier. A growing HCI literature has started to explore issues surrounding representations of women, built-in assumptions about sexual orientation and gender, and the call for apps to address user diversity. By focusing on app content, users' experiences, or the mediated user-app process, these studies have identified new developments in app design (Fox & Epstein, 2020; Homewood et al., 2019; Homewood & Vallgårda, 2020; McKillop et al., 2018), given comprehensive accounts of user

[13] Other examples included the case of private Facebook groups, which some users perceived as the perfect place to collectively share confidential information about their bodies. On the contrary, other users had the unpleasant experience of seeing their privacy eroded when they discovered an unfriendly acquaintance being also a member of the "private" group (Della Bianca, 2021a, p. 62-64). This explorative study prompted me not to problematize the research with a normative perspective on privacy issues.

interactions with data (Costa Figueiredo et al., 2018), or offered recommendations for app developers, potential users, health-care professionals, and regulatory agencies (D. A. Epstein et al., 2017; Hendl et al., 2019).[14]

In sum, my review of menstrual cycle-tracking literature echoes the approach taken by Ruckenstein and Schüll (2017) in describing research on the datafication of health. In their literature review of social sciences contributions to the datafication of health, Ruckenstein and Schüll found three dominant themes: a) datafied power, b) living with data, and data-human mediations (p. 263). Similarly, in fertility tracking studies, cluster one on the apprehensive-critical approaches is concerned with the power of data (or datafied power) in shaping people's lives and its unintended consequences; cluster two, on comprehensive approaches, takes a different perspective and looks at how users live with data, making visible the ambivalence that characterizes users' engagements with biosensing technologies; finally, cluster three on interventionist and interdisciplinary approaches focuses on mediations between human, non-human, data infrastructures, and the performativity of design on individuals.

In fertility tracking studies, scholars from cluster one on apprehensive-critical approaches usually "cut the network" (Strathern, 1996) via app stores and produce analyses within the confines of a selection of apps; the selection criteria are usually not discussed. In cluster two on users' experiences, scholars usually construct their study sample by geography and tend to investigate users' practices delimited within a single country[15]; a few studies further tightened their scope to

[14] Several studies in the second cluster offer recommendations as well (framed as research implications) intended for health-care professionals, regulators, or other implicated actors (Gambier-Ross et al., 2018; Levy & Romo-Avilés, 2019).

[15] For example, the Netherlands (Andelsman, 2021), the United Kingdom (Blair et al., 2021; French et al., 2022; Grenfell et al., 2021), Germany (Amelang, 2021), Italy (Zampino, 2020), the United States (Ford et al., 2021), Denmark (Karlsson, 2019), and Austria and Spain (Levy, 2018b; Levy & Romo-Avilés, 2019).

users of a single app in a single country (French et al., 2022; Grenfell et al., 2021). Research objects in cluster three on design interventions are usually constructed focusing on app-user interactions.

The social science literature on menstrual cycle-tracking apps reflects a compartmentalized research field that offers little insight into the contrasting findings of the dominant clusters identified above. Rather, the primary focus has been to investigate either apps content or user's practices.

A New Approach to the Study of Menstrual Cycle-Tracking Apps

In response to the field's segmentation in separate clusters—what I see as an "unhelpful compartmentalization of research" (Hyysalo, 2010, p. xxiii)—I developed my dissertation in close discussion with self-tracking scholars[16]. With the specific aim of attending to the role of gender and embodied differences in menstrual cycle-tracking, I conducted a multi-site ethnographic fieldwork, which I describe in the next subsections. I present the roadmap to my dissertation theoretical perspectives by first introducing readers to the ontological and epistemological approach underpinning this research: Annemarie Mol's praxiography. Second, I describe another approach, the biographies of artifacts and practices methodology, which I combined with the praxiographic inquiry. I conclude by highlighting the contributions of these associated frameworks to the study of fertility biosensors and mHealth apps.

[16] See, for example, my contribution article, "The Cyclic Self: Menstrual Cycle Tracking as Body Politics," to the Catalyst special issue on "Self-Tracking, Embodied Differences, and the Politics and Ethics of Health," edited by Dolezal & Oikkonen (2021) (Della Bianca, 2021b).

Conducting a praxiography of menstrual cycle-tracking biosensors

My dissertation draws upon a *praxiographic* approach—or, the study of "objects-in-practice" as theorized by Annemarie Mol (2002, p. 149)—to write an analysis of menstrual cycle-tracking biosensors *in practice*. For Mol (2021), a praxiographic approach is a form of empirical philosophy that brings "philosophy down to earth" (p. 15)[17] and enables an accounting of the ways in which objects are "enacted" in a variety of practices. This approach is characterized by the explicit ontological assumption that reality is *performed* through practices, rather than "discovered."[18]

A praxiographic approach is useful for the study of menstrual cycle-tracking biosensors, as it allows for "cutting the network" differently to better account for the diversity of practices and assumptions behind them (Strathern, 1996). It fosters a rethinking of common frameworks and assumptions prevalent in self-tracking literature. In addition, praxiography does not take *culture* (ethno) as a unit of analysis but *practices* (praxio) (Bueger, 2020). As this is a crucial difference between a praxiography and more classical ethnography, my dissertation methodology relies upon the former.

The praxiographic approach may be more easily understood with an illustration. In an essay entitled "Who knows what a woman is?" Mol explained that although different scientific disciplines use the same word when talking about *women*, they are not talking about the same "thing" (2015, originally published in Dutch in 1985). Using an intentionally simplistic narrative, Mol argued that, in genetics, a woman is characterized by two X chromosomes; in anatomy, it is

[17] I was first introduced to Mol's praxiography in 2016, during an interdisciplinary course I took while spending a year in exchange during my master studies at the Universität Bremen. The course, "STS for All!", was given by Katrin Amelang, Michi Knecht, Juliane Jarke, Hennig Laux, Anna-Lisa Müller, and Frederike Gesing.

[18] The praxiographic approach also corresponds with specific works in science and technology studies, including the writings of Foucault, Haraway, Latour, and Strathern.

the organs, their shapes, and their arrangements in the body; in endocrinology, it is the specific levels of certain hormones; and in sociology, it is a set of attitudes, traits, and behaviors resulting from socialization. Mol explains further:

> The term empirical does not call up a univocal reality that the sciences represent in complementary ways. Instead, different knowledge practices interfere with reality in contrasting ways. Disciplines like anatomy and endocrinology may well share the term woman, but the term evokes different realities. Between these realities there are both tensions and interdependencies—in other words, reality is multiple.
>
> (Mol, 2021, p. 23)

Drawing upon Mol's work, my dissertation centers on the empirical notion of "woman-as-a-body" (Mol, 2015, p. 65). Mol argued that scientific disciplines work to stabilize a definition of an object (e.g., woman) in an attempt to make it "singular" and something to be acted upon. Likewise, my dissertation research on menstrual cycle-tracking biosensors describes how different entities (not limited to scientific disciplines) work to stabilize a definition of the app user as a good "fertility tracker." In doing so, the *fertile female body* emerges as a relational effect of fertility-tracking practices.

Mol's praxiographic approach has a normative dimension that is crucial to understanding the methodology and its potential findings. In Mol's example, each scientific discipline produces and justifies a "right" way of understanding (and intervening with) reality according to its own definitions. This process is not necessarily to predetermine what *should be* but to manifest how actors *justify* what seems right *to them*. Actors themselves may be more or less aware of their

assumptions or the degree to which their assumptions are shared by others. Thus, it is the praxiographer who makes visible an object's various enactments and the relations between them.[19]

Various iterations of an object, even discipline-specific ones, may share both similarities and differences that overlap. At times, these may be compatible and/or mutually reinforcing. However, there may be instances when a particular iteration overrides or contradicts another resulting in confusion or interdisciplinary disagreements. Most often, disciplines work with "multiple possible truths" to achieve deeper understanding (Law, 2004, p. 52). Working across relevant disciplines to explore menstrual cycle-tracking biosensors, two central questions guided the inquiry of my dissertation research: (1) How are menstrual cycle-tracking biosensors done in practice?[20]; and (2) How, do they materialize the "fertile female body" and the values associated with it?

Identifying key literature for practicing a praxiography: The biographies of artifacts and practices (BOAP)

Although prolific on its premises concerning the ontological status of reality, Mol's praxiographic approach is rather elusive when it comes to the methods to use to produce praxiographic accounts. To address this lack of method explicitation, I have found useful guidance in literature theorizing the "Biographies of Artifacts and Practices" (BOAP) (Hyysalo, 2010, 2021; Hyysalo et al., 2019).

The BOAP methodology was developed in part to address the perceived "weakness of many studies of technology and work…particularly the dominance of relatively short-term, often single

[19] Selected analyses of objects include medical conditions such as anemia (Mol et al., 1995), atherosclerosis (Mol, 2002), and epilepsy (Soler & Trompette, 2010); values such as autonomy, solidarity, and authenticity (Sharon, 2017); and units of measurement such as the calorie (de Laet, 2017).

[20] Rather than essentializing artifacts, the verb "to do" functions to characterize the situations in which they are "enacted," thereby contributing to how individuals, institutions, objects, techniques, sense of time, values, and morals produce different versions of reality, in this case of the tracked female fertile body.

site studies of technology implementation" (Pollock & Williams, 2010, p. 1). In relation to eHealth infrastructures in particular, BOAP scholars elaborated a set of eight core principles in a seminal article in *Science & Technology Studies* to provide methodological guidance for the study of sociotechnical systems (see box 2 below).

I first learned about the BOAP approach from the Bochum Autumn School on data infrastructures, organized by Estrid Sørensen and Laura Kocksch in October 201. During this doctoral school, we read and discussed an inspiring article by Helena Karasti and Jeanette Blomberg, "Studying Infrastructuring Ethnographically" (2018). Although I had already considerably undertaken my fieldwork at that time, I found in the BOAP core principles an explicitation and clarification of what I was undertaking. Mainly, these principles convinced me that, when constructing my field, it was scientifically valid to "leave the walls" of the company and go to different sites to study my artifact: computerized fertility.

The identification of my artifact was not obvious from the beginning of the investigation: was I following a company, a tool, or an epistemic notion? After some time, I identified "computerized fertility" as the most fruitful artifact for this research. The interest of this choice is that the notion of "computerized fertility" enables to grasp with various biosensors from different period of times and spaces (instead of focusing on apps as artifacts). It does not limit the inquiry to a single app, company, or practice, and, therefore, offers a greater generalization potential for the study of sociotechnical innovations in femtech.

Box 2: BOAP Core Principles

1. "The studies must encompass the multiple loci and times wherein sociotechnical change is shaped and move beyond singular 'snap-shot' accounts" (p. 6)
2. "The shaping of technology and practices must be viewed as taking place within *ecologies of interconnected actors*, and not only study the actors only with respect to how they affect the studied technology" (p. 7)
3. "It may be particularly fruitful to identify and research *interstices*, the moments and sites in which the various focal actors in the ecology interlink and affect each other and the evolving technology" (p. 7)
4. "Pursue research at multiple temporal and spatial *scales*" (p. 7)
5. "Different temporalities and spans of change are seen as *multiple enacted contexts* (Hyysalo, 2004, 2010)" (p. 7)
6. "Investigate the shaping and shape of technology in the process" (p. 8)
7. "Create *balanced and empirically adequate* accounts of the different actors in the ecology phenomena, rather than assume, for instance, that key design decisions would be made by designers" (p. 8)
8. "Attend to the *detailed dynamics of sociotechnical change* both empirically and theoretically" (p. 8)

From Hyysalo, Pollock, and Williams. 2019. "Method Matters in the Social Study of Technology: Investigating the Biographies of Artifacts and Practices." *Science & Technology Studies* 32(3):2–25. doi: 10.23987/sts.65532.

Box 3: Biographies of Artifacts in Sociology of Health and Medicine

The field of sociology of health and medicine has used biographical approaches to analyze technoscientific objects in terms of their "conditions [of] production," "use," and "actual effects in the world" (Dumit & de Laet, 2014, p. 86). In viewing sociotechnical objects as historically, culturally, socially, and politically constructed[21], this approach invites documentation of "how phenomena… come into being and pass away as objects of scientific inquiry" (Daston, 2000, p. 1).[22] These include: clinical instruments such as brain scans (Dumit, 2004) and growth charts (Dumit & de Laet, 2014), pharmacological agents such as the male contraceptive pill (Oudshoorn, 2003) and antiretroviral medications (Genre & Panese, 2021), body parts such as the clitoris (Gardey, 2019/2021) or the prostate (Johnson, 2021), and contraceptive devices such as intrauterine devices (Takeshita, 2012). Like collecting testimonies about a person to write their biography, biographic approaches of objects assemble multiple "stories" to describe what an artifact is or was. Following this line of inquiry for my dissertation, I understand self-tracking biosensors to be *bio-graphing* devices that require biographies.[23]

[21] This scholarship differs from strictly "social constructionism," in that it is based on the assumption that social and technical are mutually constitutive; in other words, they are co-constructed, rather than uniquely socially constructed. For a discussion on the debates related to social constructionism, see Hacking (2000).

[22] Writing more than 20 years ago, Lorraine Daston contrasted "scientific objects" from "quotidian objects"; she considered the former "elusive and hard-won," a property she did not recognized in the latter (Daston, 2000, p. 2). Menstrual cycle-tracking apps, as we shall see, tend to continuously blur such distinction.

[23] I borrowed this formulation from Dumit and de Laet's (2014) pedagogical chapter on the "material life of graph," in which they entitled their conclusion "bio-graphs need biographies" (p. 85).

Contributions of combining a praxiographic-BOAP approach to mHealth apps studies

For this dissertation, praxiography enables an investigation that goes beyond user-app interactions and examines the "development-use nexus" (Hyysalo, 2010, p. xxiii). It uses a broad definition of "promoter" to describe anyone advocating for the development of menstrual cycle-tracking biosensors. By using this definition, it counters the social construction of the professional designer as a unique and autonomous actor in the shaping of technologies and acknowledges the blurred boundaries between "designer" and "user" (Suchman, 2002, p. 94). Many actors besides technology developers intervene with the configuration of self-tracking technologies, including "policymakers, designers, producers, marketers, journalists, and test users" (Oudshoorn et al., 2004, p. 37).

Within the praxiographic-BOAP approach, I paid close attention to "the situated practice of comparison" undertaken by different actors across sites (Deville et al., 2016, p. 20). Rather than considering comparisons as an epistemic practice by which researchers classify social phenomena, this approach "treat[s] comparisons as objects of analysis" (p. 19), which Deville et al. (2016) encourage as a "creative" dimension of comparison (p. 27). Focusing on "how comparability and comparable phenomena are co-produced," or "emic comparisons" (Sørensen et al., 2018, p. 161), makes visible the characteristics, criteria, values, and entities mobilized by actors while they explain and justify the relevance of menstrual cycle-tracking biosensors and configure their use in practice. Making actors' comparisons visible offers a different set of potential findings about fertility tracking practices; rather than portraying biosensors, designers, or users as unified categories, it makes room for ambivalence within these simplified positions.

Outline of Chapters

This dissertation is organized into four parts. Each is concerned with specific dimensions of the life of fertility biosensors, namely, their distribution, promotion, use, and regulation.

Chapter 1: ASSEMBLING

This chapter delves into the forgotten lives (i.e., biographies) of the ancestors of modern menstrual cycle-tracking apps. Drawing from archives acquired during fieldwork, it investigates selected aspects of fertility biosensors, also called "fertility computers," developed and promoted at the turn of the twenty-first century. It uses the concept of "assemblage" (as developed by Murphy) to describe "an arrangement of discourses, objects, practices, and subject positions that work together within a particular discipline or knowledge tradition." In doing so, it exposes different assemblages shaping the construction of the temporarily (in)fertile female body through specific articulations of binaries such as North/South, traditional/computerized, medical/subjective, natural/artificial, fertile/infertile, and others. The chapter illuminates how the materialization of cultural conceptions shapes and configures practices relating to the management of bodies, knowledge production, and sexuality. Doing so helps to place the novelty typically associated with femtech as an emergent market into a broader yet concretized context.

Chapter 2: CONFIGURING

This chapter describes the promotion and marketing of contemporary fertility-tracking apps. It deploys the concepts of "figuration," "configuration," and "reconfiguration" (Suchman, 2007a, 2013) to build upon and extend prior research on the empowerment

potential of self-tracking apps. First, it uses the concept of "figuration" to "zoom out to a wider view" of self-tracking biosensors (Suchman, 2007a, p. 283) to better account for the fluidity and multiplicity of ways that "humans and machines are figured together—or *con*figured—in contemporary technological discourses and practices" (Suchman, 2013, p. 49). Second, it adopts the concept of "configuration" to unpack how different self-tracking bodies emerge as "ongoing consequences of specific socio-technical encounters" (Suchman, 2013, p. 50). Third, it uses these multiple configurations to develop an analytic matrix that enables (a) evaluation of the power relations constituted through self-tracking biosensors and (b) illustration of the "material-semiotic reconfigurations required for their transformation" (Suchman, 2013, p. 58).

Chapter 3: EXPERIENCING

This chapter attends to the mechanisms and processes co-produced during biosensor-user encounters in their own private spaces. It explores the extent and conditions under which practices of fertility self-tracking shape, and are shaped by, particular power relations. Based upon interviews with users of Daysy, a fertility tracking biosensor developed by Valley Electronics AG, it investigates how users receive biomedical facts through their tracker and how they incorporate these facts into their lives. Adapting Dumit's (2004) notion of "objective self-fashioning" (p. 7), it argues that through these self-tracking practices, users shape a relationship with their body, which I call "cyclic self-fashioning"—a process through which the *datafied body* becomes a catalyst for understanding and intervening with the self. It then presents an analysis of the ways these technologies contribute to users' relationships with what emerges as the "fertile female body" and what makes it axiomatic. While at first glance the process of cyclic self-fashioning may be

perceived as simply a reinforcement of biologism, this chapter shows how normative expectations in/of/from Western biomedicine about the fertile female body are received, challenged, and/or creatively mobilized by users themselves for purposes that extend beyond optimization of an idealized reproductive body.

Chapter 4: ASSESSING

This chapter investigates the assesment of fertility biosensors for pregnancy prevention. Building upon Murphy's (2006) concept of "regime of perceptibility" (p. 10), it develops the concept of "regimes of *acceptability*" to distinguish the specific rules, standards, discourses, and values that actors produce and mobilize in order to assess for themselves whether a biosensor is *acceptable enough* to achieve a particular purpose in certain contexts. It describes two case studies to illustrate controversies surrounding the *conditions of acceptability* of two fertility biosensors. The first case study underscores a debate surrounding the publication and, ultimately, the retraction of a research article presenting findings to suggest improved usability of a hardware biosensor (Daysy) through the addition of an app. The second case study highlights accusations against the app Natural Cycles for misleading customers with claims that their app is "highly accurate." Three consumer protection agencies came to different regulatory positions toward the app after separate investigations. For both case studies, this chapter presents the different regimes of acceptability mobilized by the actors involved (i.e., scientists, users, midwives, sex educators, and regulatory agencies) and compares the elements mobilized, their articulation, and their effects.

The dissertation includes "anchoring" sections between each chapter in the form of ethnographic vignettes (Hyysalo, 2021, p. 33). These sections provide background information on the relations

between myself as the researcher and my informants from Valley Electronics AG. They are purposefully written in a less academic style and offer to attend to what anthropologist Nick Seaver calls "the texture of access" of fieldwork (Seaver, 2017, p. 7). The formulation, developed in algorithmic studies, is particularly relevant for a praxiography in and out of companies commercializing fertility algorithms, where corporate concerns about secrecy are always present. By documenting the textures of access of this research, I aim, in these sections, to describe how I "constructed the field," an inevitable aspect of every empirical study, especially information infrastructure studies, although quite rarely presented by scholars (Karasti, Blomberg, 2018, p. 234).

Anchoring 1

Constructing the Field

One of the significant legacies of feminist studies has been acknowledging the impact of researchers' positionality on the knowledge they produce (Haraway 1988). Indeed, my knower perspective—as a Swiss cis-gender highly educated woman—and prior knowledge shaped my interest in this research. In 2016, my attention is drawn to the unexpected resemblance, in terms of data-driven visualization, between an armband for *step-tracking* (that I had been researching for my Master thesis) and an armband for fertility-tracking (the Ava fertility tracker that I discover in a local newspaper[24]). In contrast, steps and fertility seem to me to not have much in common.

Furthermore, I am surprised by the unequal attention that both kinds of tracking receive in academic publications. While period-tracking apps are almost as much downloaded as step-tracking apps among female teenagers (Wartella et al. 2015), it is difficult to find scientific publications on them; this is a striking difference compared to the numerous academic books that have just been published on activity-tracking (Nafus 2016; Lupton 2016; Neff and Nafus 2016; Selke 2016).

But most radically, I [a]m surprised on discovering that the traditional method of natural family planning valorized in my Catholic upbringing—which, as an agnostic, I had refused as a sign of emancipation—was co-opted by corporate start-ups. A new market category for the datafied

[24] https://www.letemps.ch/economie/2016/11/15/bracelet-fertilite-dava-leve-10-millions-dollars

method is given the name femtech and promoted as a lucrative business opportunity for innovators addressing women's health through digital consumer products (Tin 2016).

In the autumn of 2016, while I am writing my research project, I use these surprises as heuristic tools (Wade 2020; Muller 2014; Aronova 2019), and start looking for a field that will allow me to explore computerized fertility-tracking artifacts ethnographically. I am hoping for an entry point that will facilitate an investigation of the different forms of "situated knowledge" associated with these devices (Haraway, 1988). Entering this field through the doors of app designers seems to represent a privileged terrain, as it will allow for a transversal approach to investigating the development, promotion, use, and contestation of these fertility-tracking biosensors. Furthermore, apps' designers environments remain an underresearched area in self-tracking studies (Lupton 2014, 618; Schüll 2016, 5).

We cannot open our doors to you: Facing refusal

However, access to app designers is not immediate. In February 2017, a first attempt at establishing a contact at a Swiss startup, Ava, results in a negotiation failure[25]: "*You understand the universe of startups is tough, we have few resources, and unfortunately, we cannot open our doors to you*."

Therefore, I opt for a step-by-step approach and try to avoid formalizing the relationship of inquiry from the outset. Assuming that gaining access to a company might become a long process, I create an Excel file to list potential fieldwork companies. I inscribe on the list any companies

[25] I attribute part of this failure to the position of naivety from which I contacted the company. I first received an answer to my email from the CEO asking me to elaborate on what it would mean for their company for my sociological dissertation to be written on their technology. I replied that I had imagined, for example, conducting interviews with users, and that collaborating with a social scientist could provide the company with an original perspective on its products, customers, environment, and other uncertainties that it may encounter during the development process. This response did not generate my interlocutor's interest.

producing computerized fertility-tracking biosensors, their locations (if available), whether they operate with an additional device (hardware), the kind of biosensor, and some comments[26]. Arbitrarily, I decide that I will focus on companies selling fertility-tracking hardware, and, pragmatically, I plan to concentrate my efforts on companies headquartered in Switzerland or neighboring countries.

Sure, come in, our doors are open! Openings and negociations

A second attempt in May 2017 proves successful. I send an email to the Swiss-based company Valley Electronics AG, asking for an interview with a representative to learn more about the history and development of their innovation[27]. Valley Electronics replies the next day, inquiring about my questions and suggesting that they could respond by email. I explain my interest in having a conversation, rather than an email exchange, and this time, I am able to meet the head of the company. Two weeks later, I am in Valley Electronics's office to interview the CEO. After an hour and a half of an incredibly rich interview, she tells me that their "*door remains open if it can be useful for research. We've had Ph.D. students here before. You could see how the work is going in customer service or other areas, for example*." I thank her and confirm my interest in continuing the investigation. This first visit will be decisive for the rest of the investigation, Valley Electronics being a pioneer in the field of software-assisted menstrual cycle tracking (see figure 3).

[26] I kept updating the file during the first two years of the research and came up with a list of 113 companies, including 42 selling hardware tracking devices and 69 selling only apps. Among the marketed hardware devices, some were hormone kits, others were sperm "smart" analyzers (5), and the others tracked basal body temperature or menstruation (see appendix A).

[27] At the same time, I sent emails to other companies identified in the list, but I did not receive any replies.

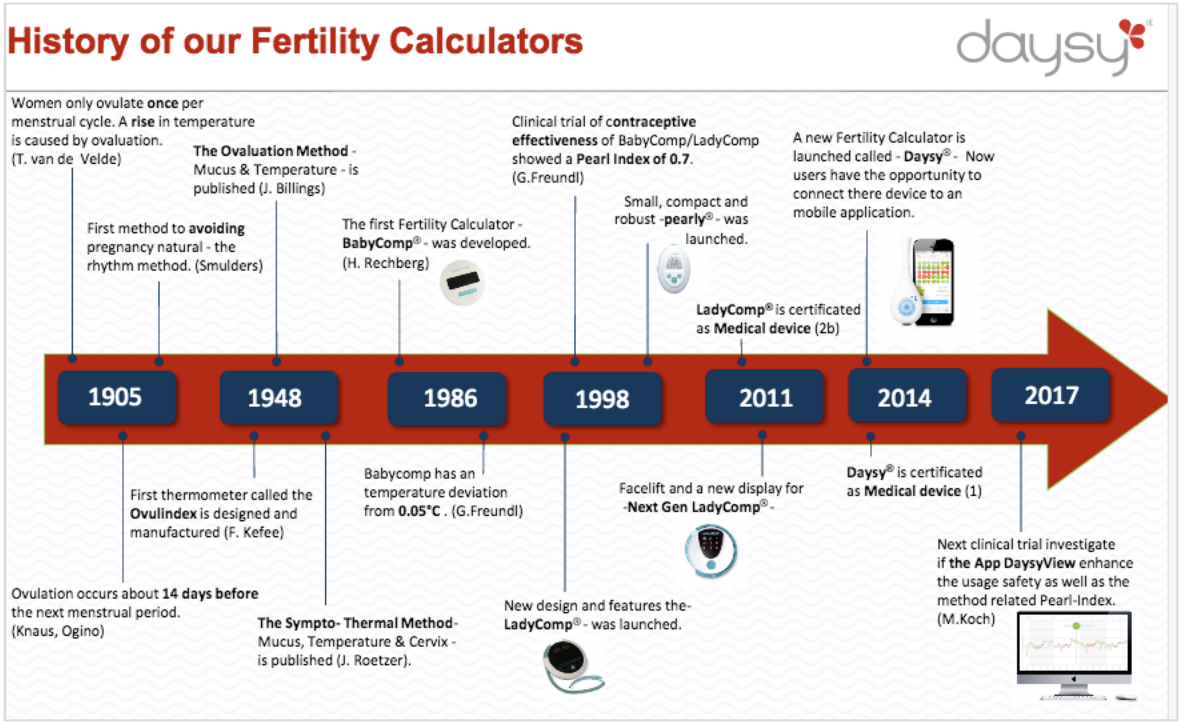


Figure 3: History of Valley Electronics Fertility Trackers, reproduced with permission of Valley Electronics AG

Negociating a researcher's position in business organization: Problem and resolution

On October 9, 2017, during my second visit to Valley Electronics Swiss office, I am handed a form by the Chief Operating Officer (COO): "*We have each employee sign it; it is a simple non-disclosure agreement*." Problem: The contract I am being handed stipulates that, whereas I am authorized to take part in the company's life, I must obtain prior written authorization from the company to communicate anything about my observations. As it stands, the document is essentially intended to protect the company's trade secrets (i.e., technical or commercial information, computer data and codes, drawings, diagrams, and general know-how). The company uses this mutual non-disclosure agreement in situations where it is required to share confidential information with a third party (e.g., employees, commercial partners, etc.) with the aim of facilitating discussions, meetings, and the conduct of business in a mutual interest. Therefore, the

type of relationships governed by the standardized document differs significantly from those specific to socioanthropological inquiry.

After being advised by a professor who is an expert in the sociology of innovation, and with the help of the legal department of my institution, we reformulate the contract so that I am authorized to communicate my research. During my following visit to the Swiss office on November 20, 2017, I propose my suggested modification to the COO to modify the document by adding the following paragraph:

> Laetitia Della Bianca will submit to Valley Electronics AG, in writing, details of any Results and any of Valley Electronics AG's Background that she intends to publish or communicate. Valley Electronics AG may, by giving written notice to Laetitia Della Bianca (a "Confidentiality Notice") require her to correct or hide factual data, within 30 days after Valley Electronics AG receives details of the proposed publication or communication. Valley Electronics AG is also invited to comment on the analyses produced by Laetitia Della Bianca, who will take them into account, but remains free in her interpretations. If Laetitia Della Bianca does not receive a Confidentiality Notice within that period, she may proceed with the proposed publication or communication provided that, whether or not she has received a Confidentiality Notice, any of Valley Electronics AG's Background that is Confidential Information may not be published.

The modification is well received by the COO, who declares, "*No problem!*" The contract is updated, the sheet is immediately reprinted, and we sign it.

Bringing Back to Life Some Ancestors of Apps

On Thursday, December 14, 2017, I knock on the door of the office of Dr. Hubertus Rechberg, Valley Electronics's founder, and father of the CEO. This is my second visit to the company's German office, located in the small town of Murnau-am-Staffelsee[28].

THE INNOVATOR: Yes, come in!

THE RESEARCHER: Hello, I'm a researcher from Switzerland…

THE INNOVATOR: I remember you.[29] Please, sit down.

(*I take a seat opposite the innovator, and as I try to find where to place my notebook among the mass of objects cluttering the desk, I explain to him how I became interested in this topic.*)

THE RESEARCHER: My parents used a fertility indicator, the Bioself, to plan their pregnancies in the 1990s. Personally, I have never been interested in such methods, but I am intrigued by their return with the rise of femtech…

The innovator *grabs a piece of paper, writes a few words on it*, and begins to tell me about how the commercialization of the company's first biosensor took place in 1986. In his narrative, a panoply of instruments (e.g., calendars, thermometers, and conductometers) was utilized by a number of scientists (e.g., Knaus, Ogino, Billings, Freundl and Loewit) who sought to reveal a

[28] Valley Electronics has offices in Switzerland (Zürich), Germany (Murnau-am-Staffelsee), and the United States (Centreville, PA).

[29] We met briefly during my first visit in September 2017.

temporarily infertile female body. Gradually, the discussion narrowed down to controversies in the 1980s that revolved around the "best" indicator of fertility.

> THE INNOVATOR: The NFP [i.e., Natural Family Planning] movement is not to the taste of the modern woman. The rules of the NFP are not a problem in themselves. The problem is the handling. With the NFP, the optimal detection of the fertile phase relies on three different parameters: luteinizing hormone, temperature, and cervical mucus. However, these three parameters don't manifest themselves all at the same time, which can lead to three different results. Which one is correct? How should one measure the parameters? Who establishes the correlation?

The innovator stands up, rummages in the library behind him, and pulls out a thick file simply entitled "*Konkurrenzprodukte*" [Competing Products]. He places it on the desk and leafs through it (figure 4). He then begins to talk about "Fertil-a-chron," which no longer exists, and "Bioself," which has also disappeared. In this file, he had collected, over the span of twenty years, "any document, found or reported by acquaintances, concerning the competition." The file includes scientific articles, press clippings, medical and pharmaceutical journals, comparative tables, technical information files, correspondence with certain companies, instructions for use, and promotional material. As such, it is a treasure for anyone interested in the little-known history of fertility-tracking biosensors. I cannot hide my wonder.

> THE RESEARCHER: Incredible! I didn't know that there was already such a variety of sensors in the 1980s!
>
> THE INNOVATOR: There sure was. You find it interesting?

THE RESEARCHER: Of course! It is fascinating.

THE INNOVATOR: Well, you can have it if you wish. If it can help your research, so much the better!

Figure 4: Narrating the life of apps' ancestors. Office of the Founder-Innovator of Valley Electronics, Dr Hubertus Rechberg (1948-2019), Dec 14, 2017.

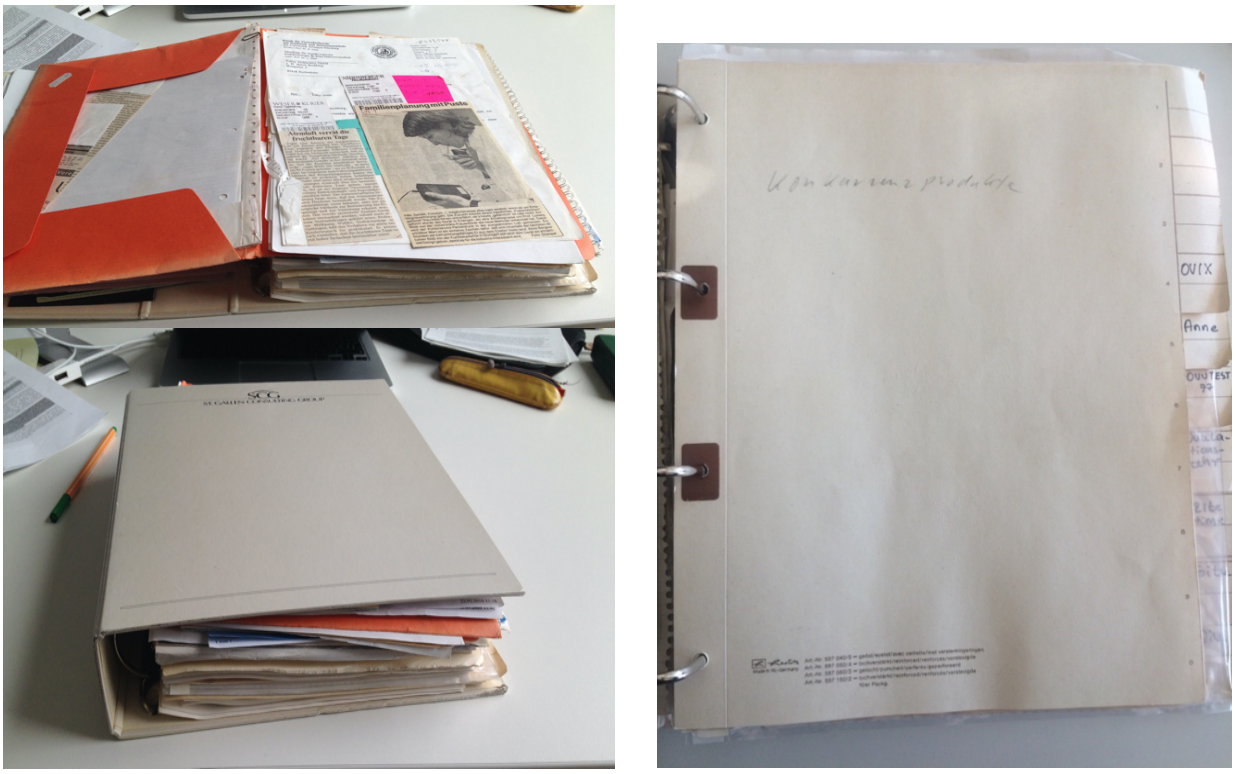


Figure 5: The innovators' file, University of Lausanne, January 15, 2019

A note on the research backstage

Spanning over more than three decades of business operation, Valley Electronics has witnessed a variety of technological innovations in the field of fertility tracking. These observations were mostly collected by its founder Hubertus Rechberg, and long-term employee Klaus Puchinger. A positive and unexpected consequence of my inquiry within Valley Electronics has been to create bridges between the knowledge of the older team (The Ladycomp Team) and the more recent one (The Daysy Team). These bridges occurred when I was invited to give presentations to the Daysy Teams in the German, Swiss, and American office, or during more informal moments of observations within the company. The following extract of my ethnographic journal (in French)

and the accompanying pictures illustrates one of such bridges where employees from the Daysy Team discovered with me the older team's fertility trackers collection (cf. figures 6 and 7).

Box 4: Ethnographic Notes on Computer (Extract), Thursday December 14, 2017

15h35. Je vais aux toilettes et traverse la grande pièce. En revenant Klaus me demande pour quand est prévue la fin de ma thèse… où j'en suis. Je dis que je dis toujours que je suis au début, mais en fait c'est déjà la deuxième année. Il me demande si c'était intéressant la discussion avec H. Rechberg. Je dis oui, très, je dis qu'il m'a montré des vieux flyers, super intéressants. Il dit que lui aussi a des anciens Geräten. Wouah. Je demande si je pourrais les voir, une fois ou l'autre…(silence). Klaus dit peut-être la prochaine fois que je reviens… (silence). Il me demande si je suis là demain. Je dis non, je pars demain à Düsseldorf, pour rencontrer Prof.x. Alors il me dit, attends, je vais les chercher à la cave. Il revient avec une dizaine de boîtes contenant des moniteurs de fertilité.
Quelqu'un de l'équipe Daysy qui était dans la salle de conférence passe dans la grande pièce pour aller aux toilettes. Je ne sais plus qui, NR peut-être. Elle voit les appareils et dit wouha, est-ce que Nik est au courant? K dit je ne crois pas. Alors elle va chercher Nik et les autres qui étaient dans la salle de conférence. Tout le monde vient, touche les appareils, ambiance très excitée, bon enfant, wouha regarde ça, et ça c'est quoi? Quelqu'un dit (NR?) qui a dit que les femtech était a new things? C'est génial. Non seulement de voir ces différents appareils, mais aussi pour l'ambiance de réunion. On passe au moins 20 minutes à prendre des photos, rigoler. Ensuite les autres retournent dans la salle de réunion.
Je reste et Klaus m'explique encore un peu… Pour lui le problème d'inclure le mucus c'est vraiment l'interprétation, c'est subjectif, c'est pas possible de dire pour sûr…Parmi les devices, un mesure probablement dans l'oreille, mais K dit qu'il n'est sûrement jamais sorti sur le marché. Il me montre des graphes, des beaux graphes. On voit le graphe imprimé à la verticale. Il me dit qu'eux les regardent toujours comme ça, mais les autres à l'horizontal. {peut-être proposer de les montrer aussi à la verticale sur l'app… ça correspondrait mieux au format des écrans…}. Je l'interroge un peu sur différence avec nfp, je dis que pour nfp phase entre menstruation et ovulation est rouge, alors que pour eux, un peu vert. Je lui parle un peu de mes observations des autres apps. Rien de trop spécial. Je demande s'ils continuent d'ajouter des choses à la collection ? Il dit oui. Par exemple, ils ont un ava. Et un ??, mais la boîte est vide parce qu'ils le décortiquent et observent. Il me dit qu'ils aiment bien voir aussi comment font les autres. 16h51

Figure 6: Members of Valley Electronics AG discovering the “Trackers Museum,” Valley Electronics Office, Murnau. Image by LDB

Figure 7: The Trackers Museum, Valley Electronics Office, Murnau. Image by LDB

1 Assembling

> What gets to count as "nature"? For whom? And when?
> And how much does it cost to produce nature,
> at a particular moment in history,
> for a particular group of people?
> – Donna Haraway, Paper Tiger TV, 1987

When I was presented the file by the innovator, I was amazed by the variety of biosensors. I was also surprised never to have heard of their existence before (except for "Bioself")[30]. As the innovator told me, some of these biosensors either never made it to market production, had been retracted, discontinued, or replaced. But a few pursued their life until today: "OvaCue," "Clearblue Fertility monitor," "Persona," "Sophia," or the innovator's products, "Babycomp," and "Ladycomp."

As I began analyzing the file in November 2020 (figure 5), it quickly became apparent that this corpus was problematic for socio-anthropological analysis. Several documents had neither a date nor a source, and some images – which had been faxed or photocopied – were of poor quality. Although heterogeneous in terms of types of data, authors, target populations, and languages, the corpus had been constituted with a precise and coherent aim, i.e., to investigate products

[30] This chapter presents a revised and extended version of a forthcoming article to appear in *Techniques and Culture*, "'In/fertility by design' : Enquête sur des biocapteurs de fertilité féminine."

considered sufficiently similar to the company's innovation to collect them, carefully observe them, and file them as part of an entrepreneurial technoscience project.

I first tried to create my own database to overcome the lack of information in the innovators' file. I used Google's online search engine and Google patents search engine to find similar biosensors and complementary information on the biosensors in the file (see appendix B, file "Autres"). But as the studied biosensors pre-existed massive datafication (Cukier & Mayer-Schoenberger, 2013), the search attempt returned only poor results.

I found a useful conceptual tool in Michelle Murphy's use of "assemblage." Murphy mobilizes this notion to describe "an arrangement of discourses, objects, practices, and subject positions that work together within a particular discipline or knowledge tradition"[31] (Murphy, 2006, p. 12). It has further been used similarly to Murphy by Waidzunas and Epstein (2015) to produce a history of a measuring device, the phallometric test. Here, from a close reading of the ethnographic file material, I trace different assemblages in which the computerized fertile body was enacted. My use of this concept follows Waidzunas and Epsteins' work, by considering performative effects in terms of the "bodily truthing" of a technological object that is expected to reveal bodies (Waidzunas and Epstein, 2015, p. 191). I combine the analytical lens of the assemblage with a

[31] Michelle Murphy (2006) draws on the studies by Foucault, Deleuze, and Guattari to develop the concept of assemblage during a historic American study in the 1980s on Sick Building Syndrome (SBS). She used this concept to highlight the link between racial privileges and toxic chemical exposures. While Murphy's methodology is largely inspired from Deleuze and Guattari's concepts, her argument differs from theirs; as Murphy explains: "Many Deleuze scholars interested in science have followed Deleuze's lead and used scientific and mathematical concepts to formulate their own philosophies of ontology. This book, in contrast, seeks to historicize science and seeks to contribute to analytic approaches in science studies, environmental history, the history of health, and the history of knowledge production" (Murphy, 2006, p. 183).

"mapping the sites" approach (Mol, 2002; Mol & Law, 2002, p. 16; Law, 2004, pp. 74–75), in order to describe how the elements, in each assemblage, are articulated.

Box 5: Making Sense of Messy Material – A Two Steps Analytical Approach

A) Producing digital copies, skimming through and organizing the content

I digitalized all the paper sheets with optical character recognition software and imported them into a folder on my computer. I structured the content in different folders (Technologies > Other parameters; Temperature / Press clippings / Mail / Printed internet copies, et cetera (see appendix B). On an additional file, I listed every document presenting a biosensor. I indicated which files belonged together (see appendix C).

B) Reading closely, analyzing and interpreting the structured content

I copy pasted the folder content on a word document, grouped the text by biosensors names, and started reading it, highlighting some extracts and taking notes. During this process, I reflected on the notion of the fertile body as a "relational effect" (M'charek, 2010). Anthropologist Amade M'charek developed this analytical notion in the context of analyses:

> "aimed at denaturing difference by focusing on the kind of differences that emerge and vanish in a split second, namely fragile differences. What are these differences made of? And what kind of relations help to make or unmake them?" (M'charek, 2010, p. 310).

Therefore, the analysis aimed at observing which systems of differences – such as culture, gender, class, and sexuality – were mobilized in the texts to make sense of how fertility tracking biosensors were part of specific assemblages. More precisely, the analysis aimed at identifying the "regularities" among the assemblages (Murphy 2006, 13).

Four assemblages emerged from my interpretation of the corpus, based on what the biosensors were expected to achieve according to the discourses (Table 1). In these assemblages, biosensors not only identify fertility statuses, but mostly articulate relations among a series of actors, including scientists, medical doctors, men, women, patients, future parents and child, as well as physiological biomarkers, moral values, and specific temporalities. With the assemblages, I distinguish biosensors perceived as tools aimed at: *a)* improving demographic forecasts considered to be of alarming concern (*public health assemblage*); *b)* assisting doctors in diagnosing and treating their patients supposed infertility (*clinical assemblage*); *c)* allowing couple to avoid pregnancies and improve their sex life (*self-management assemblage*); *d)* planning the sex of a desired child (*sex prediction assemblage*).

Table 1. Assemblages within which the biosensors operate

Assemblage	**Population**	**Clinic**	**Life-enhancement**	**Sex prediction**
Envisioned performativity	Reduce population growth	Solve infertility problems	Enhance sexuality/relationship; prevent or plan pregnancy	Plan family composition
Envisioned users	All women, but differently	Doctors	Women, couples	Women, couples, parents
Process	Separation	Hierarchisation	Opposition	Anticipation
Systems of differences	Developed vs. developing countries	Experts vs. non-experts	Pharmacological vs. natural	Boy vs. girl
Technological artifact	A futuristic solution	A diagnostic aid	An erotic tool	A bonus

These assemblages are not meant to represent a chronological history. Instead, they are used as a means – although partial due to the specific status of the empirical material – to start uncovering some aspects of the materialization of the fertile female body as a differently situated social "problem" to which technology is expected to provide a solution. By engaging in the characterization of these forgotten artifacts in the trajectory of computerized fertility tracking, I aim, in this first chapter, to contribute to the understanding of the ways historically specific technocultural conceptions of science, technique, and biology, shape and configure practices relating to the management of bodies, knowledge production, and sexuality.

Taken within the broader dissertation narrative, this chapter puts into perspective the attributes of novelty associated with the emergence of computerized fertility tracking. By placing the use of menstrual cycle tracking techniques "at a particular moment in history" (Haraway 1987, in epigraph), it allows for the exploration of the connections between fertility-tracking apps and their ancestors, also called fertility computers.

Technosolutionism or How to Solve the Fertility Crisis with Computers

"Ovulation clock could solve third world problems"[32]

Figure 8: Philip Morris Forschungspreis, colored copy obtained from the German National Library, Leipzig.

Four white men stand proudly in front of the camera. They are all wearing suits and ties and present big confident smiles. Above them, the page is entitled: "The 1983 Philip Morris Research Prize 'Challenge Future,'" followed by presentations of "The Award Winners," who are lauded for having developed "Four excellent ideas for a better future" (figure 8). On the right side of the page,

[32] Philip Morris, Press release, undated.

the journal addresses all researchers and inventors to already request the 1984 competition documentation and further explains:

> Innovative thinking needs encouragement and incentive. That is why the Philip Morris research prize "Challenge Future" was created. It endowed new technical solutions with DM 30,000 each. With the expert support of the Verein Deutscher Ingenieure e. V.[33] (VDI) under the patronage of the Deutschen Aktionsgemeinschaft für Bildung, Erfindung und Innovation e. V. (DABEI) [German Action Group for Education Invention and Innovation]
>
> (*VDI Nachrichten*, Nr. 25/24, June 1983, translated from German).

On the left, among the four laureates, Werner Weiland is congratulated for his invention:

> Family planning by wristwatch: Werner Weiland, awarded 30,000. DM for his "ovulation watch" idea: A microprocessor in the clock uses a temperature sensor to measure the body temperature continuously. In this way, the readiness [Empfängnisbereitschaft] for conception can be precisely determined. This method could simplify family planning in industrialized nations in the future and be used for birth control in the Third World.
>
> (*VDI* Nachrichten, Nr. 25/24, June 1983, translated from German).

The innovator's product, the Ovulation Watch (*Ovulationsuhr*), developed in Germany, must be worn by a woman at night and will automatically record her basal temperature during her sleep. When the temperature rises approximately 0.5°C, an ovulation indication appears on the watch:

[33] In Germany, e.V. stands for an "*eingetragener Verein*" meaning registered association or incorporated association. It confers "a legal status for a registered voluntary association in Germany" (Wikipedia source, accessed February 22, 2022, https://en.wikipedia.org/wiki/Registered_association_(Germany).

"At the push of a button, the ovulation watch shows the body temperature using LEDs. Next to it either a red field lights up (fertile days) or a green field (infertile days)" (*VDI Nachrichten*, Nr. 25/24, June 1983, translated from German). The watch is announced to be sold for approximatively 50 DM in Germany[34], and with "a cheaper version…considered (e.g. for developing countries)"[35].

> By 2010, UN forecasts predict that the world's population will reach the unbelievably large number of seven billion people. So far, no birth control method has slowed growth. The Ovulation-Watch could be a game-changer… [as] an alternative to all the family planning methods previously used, especially in the third world.
>
> (*VDI Nachrichten*, June 24, 1983, my translation from German)

[34] *Bild*, June 24, 1983

[35] Rheintechnik documentation, "Basic structure of the ovulation indicator (woman's ovulation clock) according to German patent application P 32 37 565.4 of October 9, 1982."

Figure 9: Ovulation Watch

Mit Hilfe der Mikroelektronik ist jetzt möglich geworden, was konventionelle Temperaturmessung nicht leisten kann: *Ein Mikroprozessor vermag die normalen Schwankungen der Körpertemperatur und die Eisprungtemperatur zu unterscheiden.* Auf der Ovulationsuhr kann der Zeitpunkt des Eisprungs einfach und sicher wie die Uhrzeit abgelesen werden.

DAS SYSTEM VERWENDET BEWÄHRTE BAUSTEINE.

Das Meßsystem besteht aus einem *Temperaturfühler* auf der Haut, einem damit verbundenen *Mikroprozessor* und einer *sensorgekoppelten Anzeige.* Der Mikroprozessor mißt die Temperaturen, speichert sie und vergleicht sie mit anderen eingegebenen Werten. *Auf Knopfdruck zeigt die Ovulationsuhr per Leuchtdioden die Körpertemperatur an.* Daneben leuchtet entweder ein rotes Feld auf (fruchtbare Tage) oder ein grünes Feld (unfruchtbare Tage).

WISSENSCHAFTLICHE BASIS IST KNAUS-OGINO.

Die vom österreichischen Gynäkologen H. Knaus und dem japanischen Gynäkologen K. Ogino aufgestellte Lehre von den fruchtbaren Tagen der Frau ist wissenschaftlich unumstritten. Unzulänglich waren jedoch bisher die Methoden, nach Knaus-Ogino Familienplanung zu machen. Weder die Kalender-Methode noch das Fieberthermometer sind besonders sicher.

FAMILIENPLANUNG OHNE PROBLEME.

Der eine große Vorteil der Ovulationsuhr ist, *daß sie nicht in die natürlichen Abläufe des Körpers eingreift,* sondern sie nur aufspürt. Deshalb gibt es gegen dieses System weder medizinische noch ethische oder religiöse Bedenken. *Die Ovulationsuhr hilft, sowohl den Wunsch nach einem Kind erfüllen als auch eine ungewollte Schwangerschaft verhüten.*

Der zweite Vorteil ist die einfache und sichere Handhabung: *Die Zeit der Ovulation zu erkennen, wird ebenso leicht gemacht wie das Ablesen der Uhrzeit.*

EINE HOFFNUNG FÜR DIE DRITTE WELT?

Bis zum Jahr 2010 wird nach Proghosen der UNO die Erdbevölkerung auf unvorstellbare 7 Milliarden Menschen anwachsen. Keine Geburtenregelung konnte das Wachstum bislang bremsen.

Die Ovulationsuhr könnte erfolgreicher sein. Dazu müßte jedoch die Temperaturmessung vereinfacht werden: *Als "Tiefentemperatur" vom Armpuls direkt in die Uhr.* Ein niedriger Preis des gesamten Systems ist bei großen Stückzahlen schon heute möglich.

Damit wäre die Ovulationsuhr speziell in der Dritten Welt eine Alternative zu allen bisher praktizierten Methoden der Familienplanung.

Figure 10: Ovulation Watch

In this assemblage, the discourses place the Ovulation Watch within an anticipated fertility crisis. After an evocative subtitle, "When you put the cart before the horse" (*Wenn der Storch schneller bleibt als der Pflug*) (figure 9, my translation), the text described why this innovation offered "hope for the third world" (figure 10, my translation): as an automatic device, it could slow down demographic growth in the areas where this growth was considered to be alarming and to boost it where it was considered to be insufficient. In geographic areas where curbing growth are seen as concerning, women are referred to as a population, unlike in the opposite case where they are presented as consumers expected to make rational consumption choices.

This framing of a population crisis was common at the end of the XXth century. Concerning the matter of concern here, this rhetoric was present in several scientific events that occurred in

the 1980s decade in Germany[36]. At that time, the World Health Organization was undergoing efficiency trials on so-called natural family planning (NFP) methods in different countries (Obelenienė et al., 2021, p. 2). Computerized biosensors were envisioned in this context as promissory means for the promotion of NFP methods in poor countries (Rabe et al., 1985, p. 31), not without a certain sense "culturalism" (Fassin, 2001). For example:

> The main problem in the developing countries is that those wishing to use NFP might nevertheless be hampered by living conditions which make temperature taking or even observing and recording changes in cervical mucus, or storing charts, difficult. There may be no place to keep thermometers, the woman may not get up at the same time each morning, and she may be unable to learn to read a thermometer or keep or interpret a temperature chart. Also, in very poor families even the small cost involved may be too much to payout. Persistent ill-health may also make both temperature and mucus findings difficult to interpret.
>
> (Schenker & Mor-Yosef, 1985, pp. 10–11)[37]

Coming back to the Ovulation Watch, in an additional document from the innovator's company, Rheintechnik, accompanying a patent application, we learn that the watch comes from the innovator's background in veterinary sciences:

---

[36] As examples of the scientific events occuring at that time, I can mention the conference on the "Future aspects in Contraception," September 5-8, 1984, Heidelberg, "The Symposium on Sperm-Mucus interaction," September 22-24, 1985, Düsseldorf, "Second International Symposium," Female Contraception: Updates and Trends," June 13-16, 1987, Heidelberg, and the "8th World Congress for Sexology," June 14-20, 1987, Heidelberg. I learned about these events thanks to a document in the innovators' file presenting the 1985 Symposium on Sperm-Mucus interaction and my research in online scientific databases looking for similar events based on the names of the scientists mentioned during this Symposium.

[37] I found this source through the literature review I performed outside the file (cf. previous footnote).

> The thought-provoking impulse for the ovulation clock idea comes from animal husbandry, as there are parallels to the temperature behavior of women in certain animal species. The basic research conducted in cooperation with veterinary science has shown that the minimum of the body temperature curve in the early morning hours (the exact point in time varies from person to person) is largely constant during sleep and shows the characteristic temperature rise according to Knau-Ogino after ovulation.
>
> (Rheintechnik document for patent application 09.10.1982, translated from German)

I see this assemblage as produced by a *separation* process; the discourses present and promote the watch by creating boundaries. It distinguishes how the watch would be used: planning births in the North and controlling and minimizing them in the South. This assemblage relating to an unevenly distributed fertility crisis can be seen as encompassing the other assemblages that I present below.

"A useful first step approach to fertility problems"[38]

Another problem that fertility computers are meant to address is the "infertility crisis" in so-called developed countries:

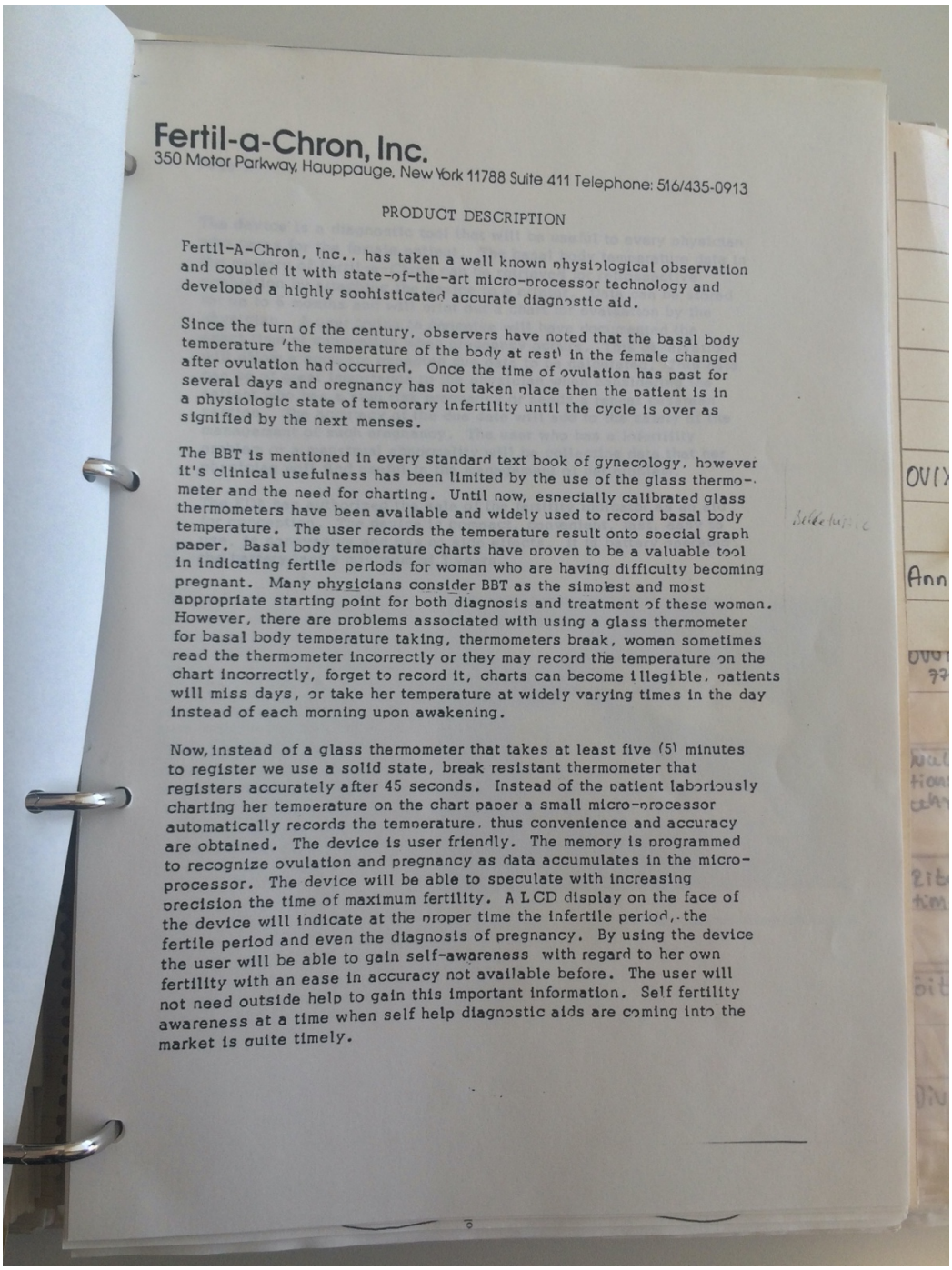
> Between 4 mln and 5 mln couples face the problem of infertility each year. (…) Causes of infertility are equally attributed to both males and females. (…) One of the first steps in the infertility workup is the daily charting of basal body temperatures (BBT) based on the fact that a woman's temperature shifts slightly after ovulation has occurred. The traditional BBT glass thermometer is gradually being replaced by an electronic fertility analyzer: a "computerized" electronic thermometer that measures daily BBT, detects

[38] Ovix, marketing document.

> certain BBT shifts, and stores the user's personal BBT pattern in its microprocessor memory. A new hand-held device is made by FERTIL-A-CHRON (Hauppage, NY) and retails for only $95[39]. (…) FERTIL-A-CHRON's microprocessor BBT is one of several products used to assist couples before more time-consuming and costlier methods –such as controlled administration and monitoring of fertility drugs or one of various in vitro/in vivo fertilization methods– are tried
>
> (Biomedical Business international, 1987, Vol. X No. 16/17).

Instead of spending a lot of money and time on long treatments, biosensors in this assemblage are hoped to provide couples with a gain of both (money and time) by intervening earlier on their conception journey.

[39] A business memorandum announces a higher price: "The Fertil-A-Chron marketing plan is to sell the device to physicians in lots of 10. plus one chart reader (modem). The price would be $850. The physician in turn would sell the devices to patients for approximately $125.00 each. The modem would enable the physician to receive the chart information directly by telephone from the patient" (December 16, 1986). The memorandum is a private exchange between two individuals whose function or business affiliation I could not identify. As there might be some business secrecy associated with such exchange, even though time has passed, and because I do not think that their names would add much to the point, I will keep them anonymous.



Fertil-a-Chron, Inc.
350 Motor Parkway, Hauppauge, New York 11788 Suite 411 Telephone: 516/435-0913

PRODUCT DESCRIPTION

Fertil-A-Chron, Inc., has taken a well known physiological observation and coupled it with state-of-the-art micro-processor technology and developed a highly sophisticated accurate diagnostic aid.

Since the turn of the century, observers have noted that the basal body temperature 'the temperature of the body at rest' in the female changed after ovulation had occurred. Once the time of ovulation has past for several days and pregnancy has not taken place then the patient is in a physiologic state of temporary infertility until the cycle is over as signified by the next menses.

The BBT is mentioned in every standard text book of gynecology, however it's clinical usefulness has been limited by the use of the glass thermo-meter and the need for charting. Until now, especially calibrated glass thermometers have been available and widely used to record basal body temperature. The user records the temperature result onto special graph paper. Basal body temperature charts have proven to be a valuable tool in indicating fertile periods for woman who are having difficulty becoming pregnant. Many physicians consider BBT as the simplest and most appropriate starting point for both diagnosis and treatment of these women. However, there are problems associated with using a glass thermometer for basal body temperature taking, thermometers break, woman sometimes read the thermometer incorrectly or they may record the temperature on the chart incorrectly, forget to record it, charts can become illegible, patients will miss days, or take her temperature at widely varying times in the day instead of each morning upon awakening.

Now, instead of a glass thermometer that takes at least five (5) minutes to register we use a solid state, break resistant thermometer that registers accurately after 45 seconds. Instead of the patient laboriously charting her temperature on the chart paper a small micro-processor automatically records the temperature, thus convenience and accuracy are obtained. The device is user friendly. The memory is programmed to recognize ovulation and pregnancy as data accumulates in the micro-processor. The device will be able to speculate with increasing precision the time of maximum fertility. A LCD display on the face of the device will indicate at the proper time the infertile period, the fertile period and even the diagnosis of pregnancy. By using the device the user will be able to gain self-awareness with regard to her own fertility with an ease in accuracy not available before. The user will not need outside help to gain this important information. Self fertility awareness at a time when self help diagnostic aids are coming into the market is quite timely.

Figure 11: Fertil-a-Chron, Inc. Product Description

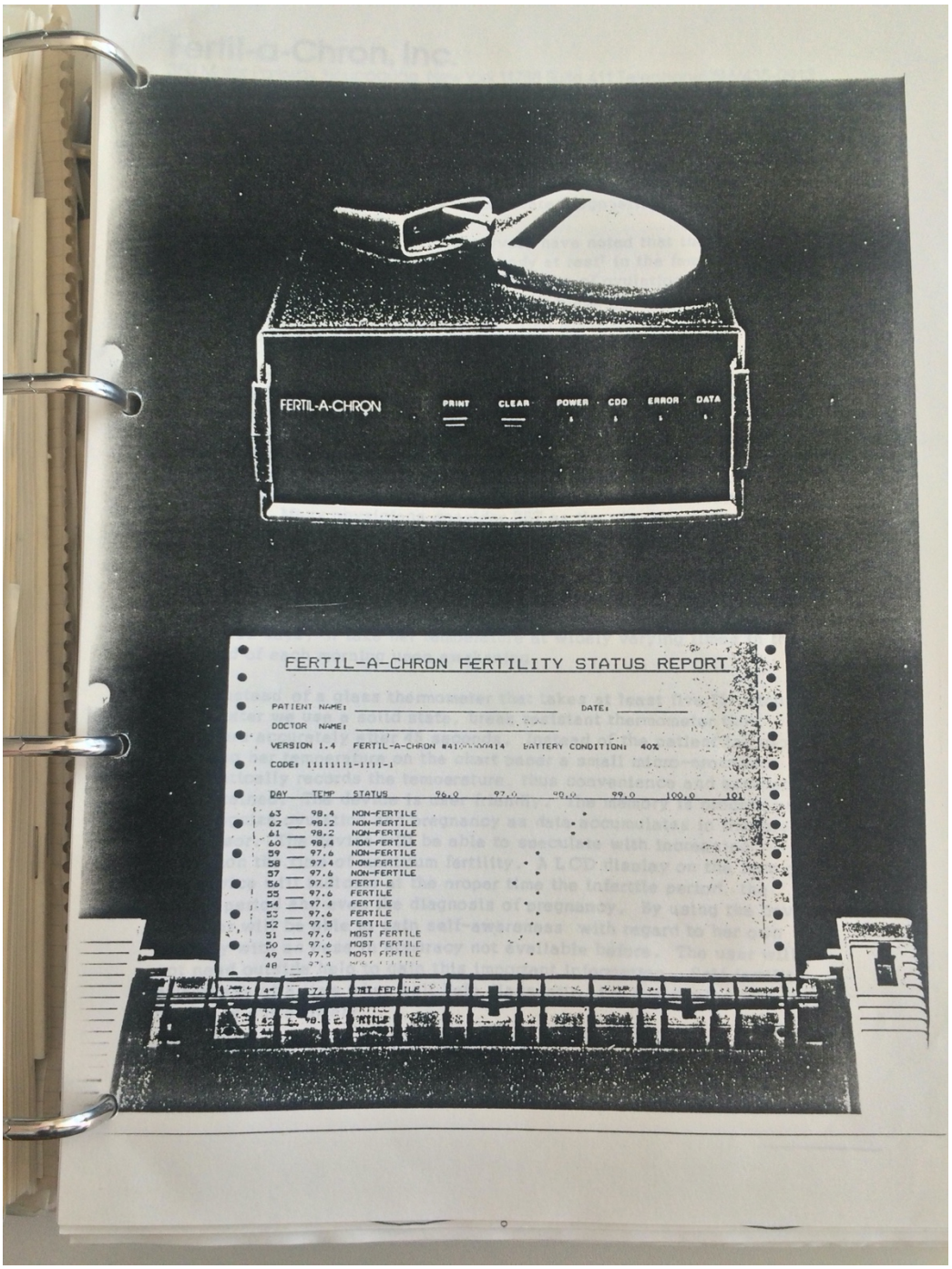


Figure 12: Fertil-a-chron

In Fertil-a-chron product description (figure 11), several elements are listed are constructed in opposition in the first and second paragraph: among them, on the one side, gynecological textbooks, glass thermometers, users, basal body temperature charts, paper, woman, physicians,

diagnosis and treatments; on the other side, micro-processed data, LCD display, programmed memory, user friendliness, convenience, precision, and self-awareness. The biosensor is configured as a facilitator of more convenient measurements and data interpretation. On the next page of the product description, the biosensors is presented as a "diagnostic tool that will be useful to every physician who cares for the female patient" (Fertil-a-Chron, Inc. Product Description).

In the clinical assemblage, biosensors are promoted based on a process that seeks to compare them with traditional thermometers – perceived as clinically useful but not practical. At the same time, these comparisons occur along a process of hierarchization. Biosensors, in this assemblage, are envisioned to contribute *more* to the properties already offered by analog thermometers, or by former Knaus-Ogino method[40]. Fertility computers promotion highlights how they produce more reliable data because they are less dependent on women when taking the measurements. Instead of the laboriously charting woman emerges the "smart" tracking patient. This clinical assemblage configured female fertility as something that could be treated within the framework of a clinical relationship[41].

In the file, concurrent products that do not track temperature but other biomarkers are also included. One can mention, for example, the Discretest or the Ovucheck[42] (see the exhibit section),

[40] Although Knaus' et Ogino's methods were slighty different from each other (Pérez, 1998, p. 78), they are usually referred to as a single method.

[41] Other biosensors in the file are similarly presented as diagnostic tools. For example, Ovix (see exhibit), a device developed in Somerville, Massachusetts (US), is given as a "Fertility Computer [that] will help you get the best possible information about your own fertility cycle. It's like a daily consultation with your gynecologist" (Ovix, marketing material, undated). Although the device is compared with a gynecologist, it does not seem to replace them. Still, it is posited as a "Useful First Step Approach to Fertility Problems" that "will help you and your doctor find out more about your fertility cycle" (Ovix, marketing material, undated).

[42] The Ovucheck was distributed by Röhm Pharma GmbH and the Discretest by the Deutsche Chefaro Pharma GmbH. The latter group belonged to Chefaro Proprietaries Limited, which according to a CB insights web article, was founded in 1967 and "was the OTC [over the counter] division of the Dutch multinational Akzo Nobel, until it was acquired

which aim at detecting luteinizing hormone (LH) in urine. LH is presented a more suitable parameter for detecting the beginning of the fertile phase, contrary to temperature rise, which occurs *after* (supposed) ovulation.

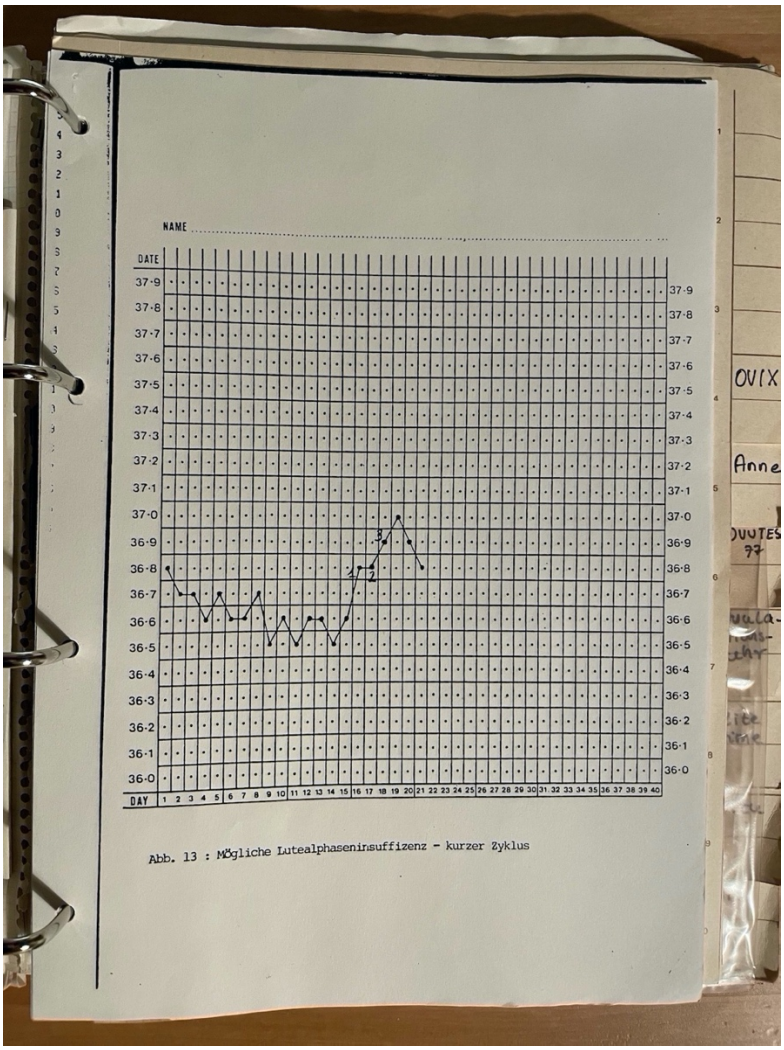


Figure 13: Bioself (chart)

by the Belgian pharma company Omega Pharma in 2000" (https://www.cbinsights.com/company/chefaro-proprietaries). A test kit marketed under the name Ovucheck is manufactured today by the veterinary and agri-food biotech company, Biovet Inc. Funded in Canada, in 1991, Biovet sells Ovucheck tests for progesterone detection in cows, dogs, and porks (https://www.biovet-inc.com/en/about-us/). While a business connection between these innovations is possible, I could not trace whether nor how the trajectory of the veterinary tests were related to the one intended for human medicine.

Figure 14: Bioself

A note on computerized charts

In this assemblage, many documents extolled the beneficial properties – for physicians, which is a significant difference compared with other assemblages – of biosensors compared with traditional tools such as the mercury thermometer or paper and pencil. The simplification announced concerned the production of data, more straightforward measurement, and the automation of the graphic recording of temperature values and their translation[43] into fertility[44]

[43] For a study investigating the knowledge translation process enabled by self-monitoring devices, see for example (Danesi et al., 2020).

[44] It might be more appropriate to speak of fecundity than of fertility, that said, the notion of fertility is systematically used in the corpus (unlike that of fecundity which does not appear, or very little).

status (figure 12). In a file presenting the Bioself – a device developed in Switzerland – entitled "Notes for the doctor" (my translation from German), a series of graphs shows menstrual cycles produced by the sensor. These charts are presented with evaluative labels, such as "typical long cycle," "sudden [temperature] rise," "slow rise," "monophasic temperature pattern," "short cycle – potential insufficiency of the luteal phase" (figure 13, my translation from German). These graphs, used in clinical practice, are meant to differentiate between typical and atypical menstrual cycles and identify the interventions that could be necessary to counteract supposed infertility. By observing the variations in the temperature curves, these biosensors transform the idea of the perfect cycle. Rather than locating normality in the cycle length – such as the stereotypical 28-day menstrual cycle[45] – it is moved *within* a cycle expected temperature shift. In the case of Bioself, the production of graphics requires a specific infrastructure; they can be produced either in a Bioself center equipped with a suitable printer (figure 14), or at a doctor's office:

> With a printer, the doctor can decrypt this information and obtain a temperature curve, the date of the last period, the length of the cycles, etc. The doctor can thus identify the fertility or infertility problems of his/her patient.
>
> (Bioself, *Journal de Genève*, August 26, 1987, translated from French)

[45] The reference to the 28-day cycle is not entirely absent in the file, as evidenced by a document promoting *Rovumeter*. This non-electric biosensor proposed to detect ovulation using a disposable pipette, making it possible to measure the amount of cervical fluid daily. Aimed at, among others, women with irregular cycles, the product was delivered in packs containing 28 pieces (Rovumeter, promotional leaflet, my translation from German).

I see this assemblage as produced by a process of hierarchisation of data, instruments, and methods. Biosensors promise an addition[46] to former assemblage that involves the adaptation and personalization of the so-called calendar methods.

Its positioning as being superior to traditional tools occurred alongside a justification, but also controversies, relating to the identification of the best biophysical parameter to measure. In the majority of cases, body temperature was selected as the main parameter. However, some biosensors opted for other parameters, such as saliva, cervical fluid, or urine, from which they sought different fertility indicators. Depending on the parameter measured, the biosensors revealed variations in the fertile female body, within different boundaries (skin, mouth, vagina). Depending on the substance measured, and on how the body must be arranged to this end, the data are perceived as being more or less reliable of the individual user action. The electrical biosensors in this assemblage are therefore positioned as tools for infertility diagnostic, mostly promoted for the doctor as user, and configure women as more reliable producers of data than they would be with traditional instruments.

Enhancing People's Life With Fertility Computers

Scholars have started to use the notion of "lifestyle drug" to talk about "medications that are designed to improve a person's quality of life by treating less serious conditions" (Watkins, 2012, p. 1464). For example, the marketing of the oral contraceptive pill Seasonale as a tool for menstrual suppression has led scholars to call it a lifestyle drug (Mamo & Fosket, 2009, p. 925; Watkins, 2012, p. 1470). What I find interesting with this notion is the idea that a drug (therefore, a

[46] Thus the added value of electronic biosensors lies in their supposed better suitability to the material measured; in other words, they are promoted as better "inscription devices" than traditional tools, in the sense that they would more accurately turn a substance into a graphic (Latour & Woolgar, 1987/1986, p. 51)

pharmacological substance), by acting on the *body*, also acts on the person's *life*. As feminist scholar Takeshita puts it, "[b]y changing the material body, lifestyle drugs transform life from the inside out (Takeshita, 2012, p. 138)".

Although fertility biosensors are substantially different from the contraceptive pill (biosensors aim at intervening in the body *with information* rather than *pharmacological substance*), I tend to believe that their marketing also contributed to shifting their use from a contraception assemblage into a lifestyle one; in other words, although the methods they are relying on were developed for specific conception outcomes, biosensors are marketed as *life enhancers*. I present in the following section some of the discourses typical of this assemblage. While discourses presenting the first assemblage were expressed for the attention of researchers and innovation-promoting agencies, and the second for clinicians, the two following assemblages address consumers more directly.

Figure 15: Anne

"It gives you a beautiful sex life"[47]

A slim, white woman with long blond hair, only wearing panties, holds a strange console in her hand (figure 15). She bites a little stick in her teeth and looks at the readers with a mischievous smile. At the bottom of the photography, a text details: "A laughing blond girl, an electric thermometer in her mouth, a small computer in her hand. The computer (345 marks) measures the body temperature and calculates the woman's fertile and infertile days. Chief Physician Dr. Döring (64) from Munich: 'The computer is as safe as the pill.'"

This picture covers a significant portion of the front page of the *Bild* journal, published on March 1, 1985. We can see the biosensor "Anne" eroticized in a photographic setting. Primarily intended to seduce potential customers, rather than explain the instructions for use (the temperature has to be taken with the fertility computer immediately after waking up, before standing), the biosensor is compared to the oral contraceptive pill, *deemed to be similarly* safe.

The biosensor Anne, developed by Micro Idea Instrument Co. LTD in, Taiwan, is the winner of the Gold Medal at the Brussel World Fair for Innovation 1982[48].

Several newspaper clippings present the Anne biosensor as a "heat computer" that can replace the pill. A *Bild* article, published on May 10, 1983, states that "women who quit the pill can still control love" because Anne, the heat computer, will calculate their "safe" days for them. In this model of sexuality, heterosexual and monogamous relations are the norm and are often euphemized by the term "love."

By presenting ovulation monitoring as a method comparable to the pill, the descriptions of biosensors promise their users they will be able to quit contraception when they are temporarily

[47] This quote verbatim comes from a document promoting the biosensors Ann. The complete sentence reads "It gives you a beautiful sex life and aid for family planning."

[48] Anne, Marketing document, undated.

infertile. These phases are distinguished, symbolically, with a red light on the screen of many biosensors, as opposed to green light, for infertile days. Through this traffic light metaphor, biosensors represent subjects whose sexual activity is assumed to be programmed as desired, according to prior indications.

Through another set of comparisons, biological temporality is associated with a clock. For example, a newspaper clipping from the *Berliner Zeitung* dated January 4, 1985[49], reads: "The computer says: now I can! 'Anne' makes an old method of contraception much safer and more precise" (my translation from German) (exhibit, figure 19). How users must relate to permission (*now I can*) implies that, at other times, *they cannot*;" these other times are therefore promoted as abstinence.

[49] I attribute this copy to the *Berliner Zeitung* published on January 4, 1985, page 25, because of the following accompanying annotation in the sheet: "BZ. 4.1.85 S.25."

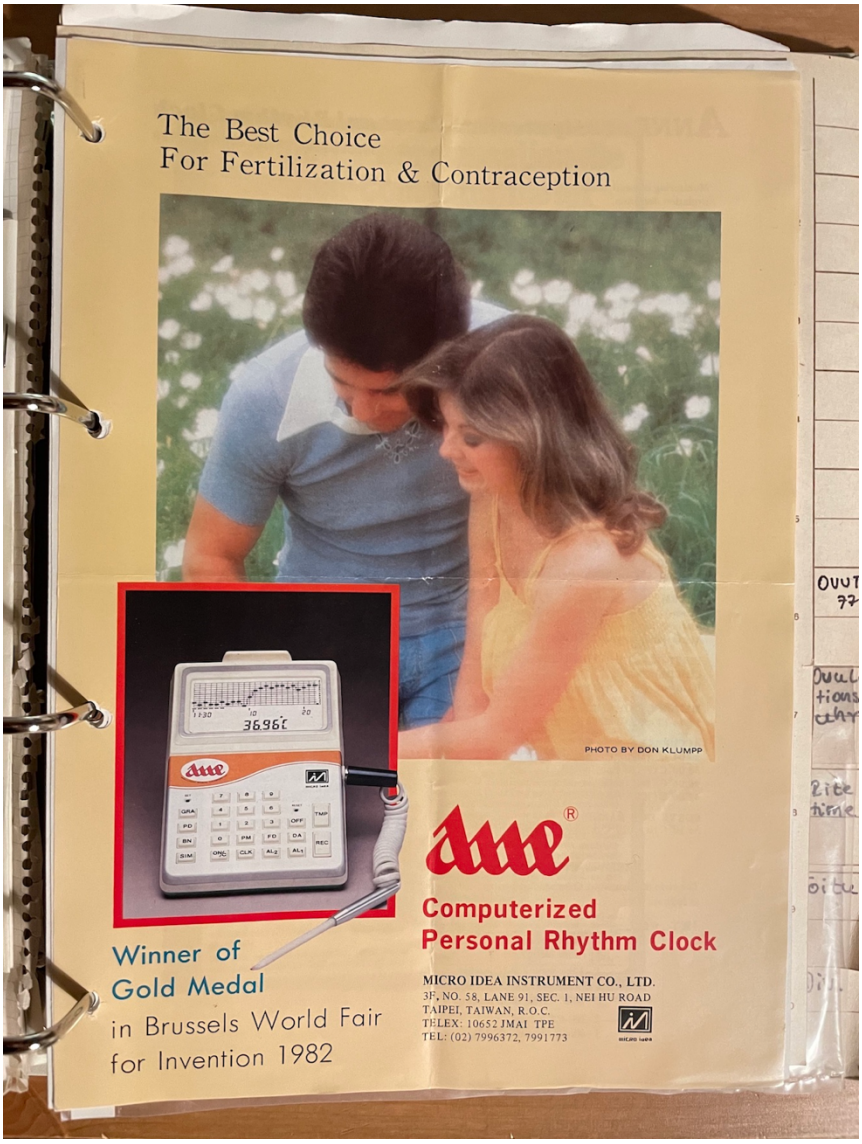


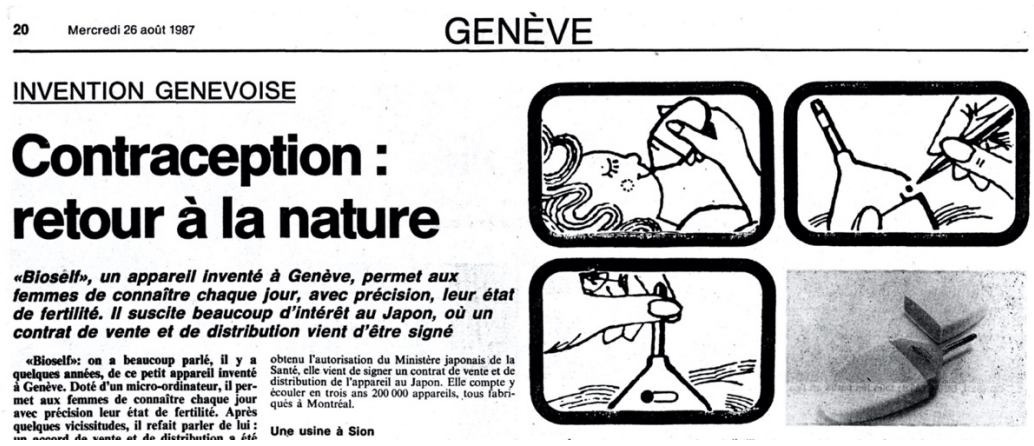
Figure 16: Anne

Besides the tracking woman, her partner tends to disappear in linguistic ellipses. Further comparisons occur between women's bodies and watches or clocks. For example, a marketing brochure presents the Anne biosensor as a "Computerized Personal Rhythm Clock," "Known as…..(sic) Intelligent Woman Thermometer," "The Best Choice For Fertilization & Contraception" (figure 16). Biological time (ovulation) and social time (sexuality) are

synchronized. Another newspaper clipping from the *Abendzeitung* in Munich, published on July 16, 1991, reads: "The sex watch ticks to woman's rhythm. When the needle is on the green, no offspring." The association between a woman's body, calendar, biological rhythm, and social rhythm is present in several documents, such as those presenting the Ovulation Watch (*Ovulationsuhr* seen in the first assemblage) or the Swiss Lady Watch[50].

The association between menstrual cycle rhythm and sexual practices also appears with different moral beliefs. For example, in an interview Bioself's innovator describes the adequacy between the purpose of his innovation and his philosophy of life:

> The purpose of life is love, it's love to have children. (…) My device is not intended to prevent births. Rather, it serves to "schedule" them according to the parents' wishes. (…) Moreover, Bioself is not a means of contraception. A simple fertility indicator, it can be used to prevent unwanted births, but also to increase the chances of their occurring.
>
> (*Journal de Genève*, August 26, 1987)



20 Mercredi 26 août 1987 GENÈVE

INVENTION GENEVOISE

Contraception : retour à la nature

«Bioself», un appareil inventé à Genève, permet aux femmes de connaître chaque jour, avec précision, leur état de fertilité. Il suscite beaucoup d'intérêt au Japon, où un contrat de vente et de distribution vient d'être signé

«Bioself»: on a beaucoup parlé, il y a quelques années, de ce petit appareil inventé à Genève. Doté d'un micro-ordinateur, il permet aux femmes de connaître chaque jour avec précision leur état de fertilité. Après quelques vicissitudes, il refait parler de lui :

obtenu l'autorisation du Ministère japonais de la Santé, elle vient de signer un contrat de vente et de distribution de l'appareil au Japon. Elle compte y écouler en trois ans 200 000 appareils, tous fabriqués à Montréal.

Une usine à Sion

Figure 17: Bioself

[50] Developed in Switzerland by the Watch firm Pointer, this watch was presented at the 18th Watches and Jewellery Fair in Basel in 1990 and relies on calendar-based methods for fertility tracking (Dätsch, *Schwäbisches Tagblatt*, April 28, 1990).

The fertility-tracking subject is also enacted through opposition. For example, journalist and Bioself's innovator, taking religious norms as a pivot, oppose natural and artificial means of contraception. Biosensors are ranged on the natural side:

> Journalist: [The innovator's] interest in natural contraception must be sought in his religious convictions: a practicing Catholic, he is opposed to artificial means of contraception. "When Rome condemned the use of the pill, I initially thought that they had taken a complete step backward. But when I thought about it, I realized that they were right: even today, little is known about the long-term consequences of the pill on health. It's like environmental degradation: for far too long, we ignored the serious consequences that this could have."
>
> (Bioself's innovator interviewed in the *Journal de Genève*, August 26, 1987)

Additionally, in the above excerpt, other associations emerge. Religious institutions (Rome), natural,[51] environmental concerns ("environmental degradation"), and a technological solution (Bioself) come together to produce fertility tracking as a life-enhancing practice.

Sexual morals are not necessarily associated with religion in the file. While the heteronormativity which accompanies these technological objects is not inherent in the artifacts themselves, it is nonetheless a (silent) characteristic of their promotion in this corpus. A rare example in which a potential user includes single women appears on the back of a brochure for

[51] While Natural Family Planning was used as a name for fertility tracking methods in general, the wording began to change after a World Health Organization (WHO) workshop on NFP, held in August 1986. At this workshop, participants recommended "that the term 'natural family planning' should be replaced with the term 'fertility awareness methods' in order not to imply that other contraceptive methods were unnatural and bad" (Obelenienė et al., 2021, p. 3).

Anne. One can read, “ANNE is perfect for both single and married women, both contraception and fertilization. It gives you a beautiful sexual life and aid for family planning”. Although the text is aimed at a woman (“if you want a baby and take your basal body temperature every day...”), the brochure is one of the few that visually represents a picture of a couples.

As seen in the previous assemblage, temperature-tracking biosensors compete in the file with other biosensors tracking other biomarkers (such as urine, saliva, cervical mucus). For example, the marketing flyer of the biosensor Ovulator presents a microscope to analyze fertile signs in saliva; other newspapers articles show surprising devices such as the Antibaby Lupe, the Antibaby Papier, Fertimeter, or Ovutest-77[52].

The Ovutest-77 causes quite a lot of stir in the achival file. The device is manufactured in Germany by Medical Electronics Trading Company and sold for 384 DM in German pharmacies[53]. In an undated marketing document, the device is promoted as revolutionary for tracking a new fertility indicator, uteroglobin. The biosensor takes the form of a vaginal probe and a measuring and display part. On the same marekting document, Ovutest-77 is said to measure “the electrolytic behavior of the cervical mucosa in the presence of uteroglobin”[54]. Uteroglobin is described as “a protein found in humans only since 1974 [and] formed when the pregnancy hormone progesterone increases.” A press article, published in the weekly German-speaking magazine Bunte on June 9, 1983, presents the biosensor as “the first hormone computer in the world for natural and side-

[52] Visual representations of these biosensors can be found in the exhibit section following this chapter.

[53] Markus Medizintechnik, June 17, 1986, letter addressed to Valley Electronics.

[54] Ovutest-77, marketing document, undated, translated from German.

effect-free conception control"[55]. The author, Renate Scholz describes the device's color-coded fertility statuses display:

> On the infertile days, the pointer stops in the green field: This means a green light for safe love. The following area marked in yellow shows the ovulation phase: So now is the time to be careful when having sex—or if you want to have children, a very favorable date for conception. On the far right of the picture is the red scale—a clear warning signal for an increased willingness to conceive.
>
> (Renate Scholz, *Bunte*, Nr 24, June 9, 1983)

Like other descriptions in the file, the love euphemism is combined with the traffic light metaphor in this enactment of the life-enhancing assemblage. *Love* is meant for sexual relations, and *safe*, contrary to other discourses about sexuality[56], is used for not at risk of pregnancy; green means go, yellow means start to break (or be careful), and red means stop (or go, if you have other conception intentions).

Shortly after publication, Bunte press article is vehemently critized in the 1983, July issue 7, of Gyne, Specialist journal for practical gynecology and general medicine [Fachzeitung für praktische Frauenheilkunde und allgemeine Medizin], and in the German publisher Medical Tribune, Nr. 31, August 5, 1983. The Gyne article calls the Bunte article "a scandal," and comments:

> BUNTE editors don't have to be experts in the field of medicine, but they should be experts in journalism and know that research comes before "imprimatur." And they

[55] This naming of the biosensor as a *hormone computer* (Renate Scholz, *Bunte*, Nr 24, June 9, 1983) contrasts with the naming of temperature-tracking biosensors, often referred to as *hormone-free* devices.

[56] This meaning differs drastically from "safe sex" prevention discourses, in which "safe" means not at risk of STDs.

> should distinguish between pure information and (paid) advertising…. It is doubtful whether a new active substance is measured in cervical mucus (you write something about uteroglobin). It's more likely that the Ovutest is a simple potentiometer that measures voltage fluctuations between the uterus and the vaginal wall.
>
> (*Gyne*, July 1983, translated from German)

> The uncritical advertising article cheers a placebo instrument! The gynecologists quoted as witnesses for its suitability are pissed off and outraged: They fear for their reputation, and for the BUNTE readers who have been taken in by clever profiteers, they fear numerous unwanted pregnancies.
>
> (Medical Tribune*,* Nr. 31, August 5, 1983, translated from German)

The constitutive elements in this assemblage are articulated in the construction of what I call *technico-moral compatibilities*. These compatibilities take the form of ontological oppositions and constituent negations. There are ontological oppositions between a so-called natural body (which can be measured) and a body whose essence has been altered by pharmacological hormones (and measurement does not allow the detection of hormonal changes during the menstrual cycle). I refer to these oppositions as ontological and constituent, because they touch on what constitutes the essence of "woman-as-body" (Mol, 2015, p. 67). Through a process of constituent negation, the infertile body is produced. Whether it is positive (fertile) or negative (infertile), the assumed degree of fertility remains the primary (and sought-after) reference and categorization of the self-tracking woman in this assemblage.

"It is possible to determine the sex of a desired child with a certain probability"[57]

Another promised performativity of electronic biosensors is to predict a baby's sex, depending on when sexual intercourse occurs. Several biosensors in the file (Babycomp, Cyclotest, OvuTest-77, ProCare, Swiss Lady Watch) promise their consumers this functionality[58]. Therefore, the biosensor's manual recommends having sex one or two days before the suspected ovulation, on the day of ovulation, or the following days, to conceive either a boy or a girl. The common theories beyond such ideas usually are that a female-carrier sperm is slower than a male-carrier one; therefore, it the female-carrier is less likely to reach the egg if the partners have sex at a distant date from ovulation.

The association of different elements within this assemblage (sperm, egg, ovulation, time, sciences, anticipation, man, woman, sex, hope) is imagined to configure a child's identity. Indeed, this identity is produced through a system of difference structured by binary biological variables (XX versus XY chromosomes) that are imagined to be predictable and producible thanks to the biosensor.

The sex prediction is often presented as bonus to other performativities from the device (for example, infertility of self-management, as previously seen). On a promotional document for the Anne biosensor, the manufacturer states that:

> Anne tells you exactly when the unfertile days are, if you don't want a child. But Anne also tells you when the fertile days are if you do want a child, on which specific days a girl is most likely to be conceived and when a boy will be conceived, and much more.

[57] Anne

[58] See exhibit section.

(Anne, promting material, undated, translated from German).

A few documents within the file also present biosensors that offer this function, although not being about electronic biosensors: for example, the PROCARE Gender Choice kit or a "GENDER-TEST" distributed by the wholesaler Pharma Wolf. Among other documents, a New York Times article from February 1, 1987, is entitled: "Deception Charged on Choosing Sex of Babies." It reports an announcement by the FDA: "The Food and Drug Administration has called a company's contentions that its Gender Choice kit can help couples choose the sex of babies a 'gross deception of the consumer.'…The company says it sold 50,000 of the kits from their introduction last September to December, and ProCare offers to refund the purchase price to customers who have a girl when they are trying for a boy, or vice versa, Ms. Henry [of the Colorado public relations concern that represents ProCare] said."

By promoting this functionality, the assemblage reinforces the boy/girl gender binary and stereotypical imaginaries according to which male characteristics equate to power, whereas female ones correlate with passivity. It also stresses that the sex of a child is an important matter of personal choice. These estimations are based on often contradictory scientific theories[59], or

[59] I mentioned, in the clinical assemblage, that the hormone computer OvuTest-77 had been causing controversies. In the sex prediction assemblage, however, its performativity is explicitly ignored by experts; in a clinical study assessing its innacuracy, denoting a polite amount of disdain, the authors conclude their article with the following comment: "The original instruction manual for OvuTest indicates that it might be used to influence a baby's sex! We quote: 'If you conceive when the indicator indicates yellow, the probability of getting a girl is very high. If you conceive when the indicator indicates O-red, the probability of getting a boy is very high.' The functional failure of the device to correlate with ovulation in the tests reported here spares us the obligation of responding to this claim" (Daniel et al., 1987, p. 596).

"scientific fairy tale" as anthropologist Emily Martin would call it (Martin, 1991, p. 486), that have long been subject to controversy[60] .

Reading Feminist Criticisms on Fertility Tracking Devices

During the 1980s and 1990s, fertility biosensors have been discussed in feminist writings, whose criticisms reveal other assemblages connected to different articulations of normative and political concerns. I present two occurrences of such critique, the first one by feminists from an American self-help group, the second by Tia DeNora, sociologist at the University of Exeter, at the time of the publication.

In the 1980 article "Reclaiming Reproductive Control: A Feminist Approach to Fertility Consciousness" published in the journal *Science for the People,* the authors, who are members of the Fertility Consciousness Group of the Cambridge Community Health Center, categorically reject the idea of resorting to "mechanical devices" for the monitoring of ovulation. Such techniques are deemed "unnecessary and likely ineffective" (Bell *et al.*, 1980, p. 32):

> It is unlikely that any device to measure mucus changes will increase the effectiveness of the Ovulation Method in preventing pregnancy. In fact, there are reasons to predict the opposite. No machine can take into account the wide range or variation from woman to woman; in contrast, each woman making her own mucus observations can concentrate on her own individual cycle. The rules of the Ovulation Method allow for special circumstances and unpredictability from one cycle to the next. (…) In addition, a mechanical device is subject to errors in manufacture as well as operational failure during

[60] See, for example, Andrea Bertotti Metoyer and Regina Rust (2011), Burcu Mutlu (2017), and Rajani Bhatia (2018).

> use. But mechanical devices can be used to generate profits and discourage women from becoming autonomous in controlling our reproduction.
>
> (Bell *et al.*, 1980, p. 32)

In the above-mentioned article, the authors call for the emancipatory potential of menstrual cycle tracking for all women, i.e., "lesbian and celibate women, as well as heterosexually active women who use non-natural birth control" or "women reaching menopause" (Bell *et al.*, 1980, p. 34). They celebrate such tracking practices as a way for women to emancipate themselves from the medical establishment and reclaim power over their bodies collectively. They, however, are opposed to the instrumentalization of knowledge of the menstrual cycle by certain actors.

> Widespread practice of effective birth control through knowledge of our own bodies threatens some of the profits reaped by drug companies, doctors, and medical facilities. In addition, it challenges the belief that doctors must "take care of women's reproductive capacity.
>
> In response to these threats, many doctors and family planning programs refuse to inform themselves about the Ovulation Method.
>
> (Bell et al., 1980, p. 31)

The authors considered especially that the delegation of the interpretation of the technological device to medical doctors would make it difficult to overturn the asymmetric power relationships in the clinical relationships between objects and subjects of knowledge. The encouragement of abstinence as the only acceptable principle is also strongly contested. In another publication, in the edited book *Birth Control and Controlling Birth: Women-centered Perspectives* (1980), the same collective explains:

> For people whose sexual expression includes activities other than penile/vaginal intercourse, the meaning of the word abstinence may become unclear. Also, the word abstinence perpetuates sexist assumptions that penile/vaginal penetration is the most desirable sexual activity and anything else must be somehow inferior.
>
> (Women's Community Health Center, 1980, p. 76).

In these texts, cycle monitoring is presented in a dimension that goes "beyond contraception" (Bell et al., 1980, p. 34) and therefore aligns with cycle tracking from the life-enhancing assemblage. However, here the tracking body is situated in feminist writings within social practices that are referred to as structured by systems of differences shaped by gender, class, race, abilities, and I would add, moral beliefs. The benefit of tracking is presented in its reliance on collective learning processes rather than mechanical devices[61].

In 1996, Tia DeNora published an article entitled "From Physiology to Feminism: Reconfiguring body, gender and expertise in natural fertility control." DeNora feared that new fertility monitoring technologies would exert power over the female tracking subject for male observers such as doctors or partners (DeNora, 1996, p. 371). More specifically, DeNora feared that ovulation kits risk reinforcement of traditional gender binaries, as the kits deliver fertility status via "external and more authoritative confirmation to male observers" such as male partners or clinicians, whereas women are framed as passive, inexperienced objects upon which "modern Western" medicine is exerted (DeNora, 1996, p. 375).

[61] I will come back to some tensions related to the learning dimension of self-tracking in the next chapter.

Mobilizing what she calls "ethno-technologies"[62] and their body "as an instrument in its own right" rather than objectifying technologies –such as dipsticks for ovulation detection– women once trained, become "the 'real experts' on their own bodies" (DeNora, 1996, p. 370). Training women to become aware of their physiology was therefore considered key for the method to work.

Assemblages' Overlaps and Versatility

The assemblages analyzed are characterized by their overlapping. Non-exclusive, they operate at different entangled levels: the population, the clinics, the couple, the family, the individual. While articulating, they separate, prioritize, make compatible, and anticipate various elements and, in doing so, participate in different constructions of the fertility tracking subject. In the analysis, I have emphasized the major processes through which the promised performativity is articulated along with different binaries:

- *separating* (North/South; developed/developing)
- *hierarchizing* (traditional/computerized; medical/subjective)
- *opposing* (natural/artificial; fertile/infertile; sexual/abstinent; religious/non-religious; masculine/feminine)
- *anticipating* (knowing/non-knowing)

Sometimes, certain binaries are challenged, as seen for example, with the emphasis on broader meanings of sexual activities, in the narrative of the Boston feminist self-help group.

[62] Francesco Panese aptly suggested the term "ego-technologies" to frame the use of the body as an instrument in fertility-tracking configurations.

Computerized biosensors, especially in the narratives shaping the first and third assemblages, can be seen as "politically versatile technology" (Takeshita, 2012, p. 3). Feminist scholar Chikako Takeshita has introduced this notion, studying intrauterine devices (IUD). By politically versatile technology, she means "a technology…adaptable to both feminist and nonfeminist reproductive politics, the result of the manifold efforts that its researchers undertook in order to maintain the suitability of the device as a contraceptive method for women in both the global South and North" (Takeshita, 2012, p. 3). This endeavor to keep a device adaptable to different contexts of use is explicit in the first assemblage, with the Ovulation watch. However, it does not necessarily come from researchers but innovators and promoters.

In addition to their *political versatility*, I observe that computerized fertility is enacted through *practical versatility*. This aspect is often valorized in marketing: not only can a fertility biosensor be used to prevent pregnancy, but it can also be used to plan one. This dimension is especially visible in Bioself marketing and Anne or Sophia. For example, the L Sophia, developed in Japan, is presented as "An Amazing Device!! No need to chart. L Sophia is a versatile Woman's Thermometer in a class by itself." In a bullet point list, the versatility of the biosensor is explicited:

> L Sophia is for you, if: you quit because it was too much bother ; you want to time a pregnancy ; you're hoping to become pregnant; cycles are irregular; you want to stop having children; you have premenstrual tension; you want to monitor your health; menopause is approaching; you're keeping tab on gynecological indications; you are under stress.
>
> (L Sophia, undated)

With this list of uses, L Sophia suggests broader meanings of the menstrual cycle beyond fertility (as seen with the L Sophia biosensor). This emphasis on the will to monitor health (rather than

fertility, conception or contraception) as a reason to use it is not common within the file. I could not find the launch date of this device. Still, outside of the file, L Sophia is mentioned, among other tracking devices, in a 1998 scientific publication on the history of Natural family planning method (Pérez, 1998, p. 87). It is possible that the marketing and development of the devices produced by the end of the nineties were more clearly shaped than the ones developed in the eighties by the increasing imperative of health in which fertility was framed (Lupton, 1995; Mamo, 2010).

Conclusion: Assembling People, Instruments, Data, and Values

By the end of the 1980s, fertility computers were making their entrance as potentially legitimate actors in the field of reproduction/contraception. Imagined as tools to reduce population growth in so-called developing countries, they were meant, in so-called developed countries, to facilitate clinical practices for infertility treatment, provide women and couples with "easy-to-use" non-pharmacological contraception, and offer them to choose the sex of a desired baby. Promoted for different uses, they contributed to the construction of different envisioned users.

Feminist scholars in the 1980s-1990s were particularly critical of the marketing of any clinical instrument for ovulation prediction and detection. Although envisioned and promoted with hope, they were also received and analyzed with apprehension. Feminists activists and scholars criticized their use in terms of empowerment and control; in these criticisms, different kinds of reductionisms – such as sociodeterminism, technodeterminism, and biologism – were mobilized to talk about interventions on the female body with technological artifacts. At the core of the feminist critique was the challenge of the predominant figure, in conventional Western epistemologies, of the ideal

subject of knowledge, usually figured as a neutral observer (man), separated from his object of study (women).

Along with the datafication of earlier menstrual cycle tracking practices, fertility computers also brought new issues. With the introduction of computerized fertility, users' bodies and their relations have been technically objectified and morally governed in ways not possible before. This new system of semi-automated classification has positioned tracking individuals in new sets of infrastructures, introducing further consequences (Bowker & Star, 1999).

The mutual embeddedness of bodies and technical artifacts within broader economies of knowledge took a significant turn at the beginning of the XXIst century, with the connection of tracking devices to cloud computing services with the addition of mobile apps in the assemblages. I will turn to these new assemblages in the next chapter, in which I offer to unpack and situate the multiple ontologies of the body in contemporary fertility-tracking apps.

Exhibit

Figure 18: Anne[63]

[63] The biosensors are ordered alphabetically

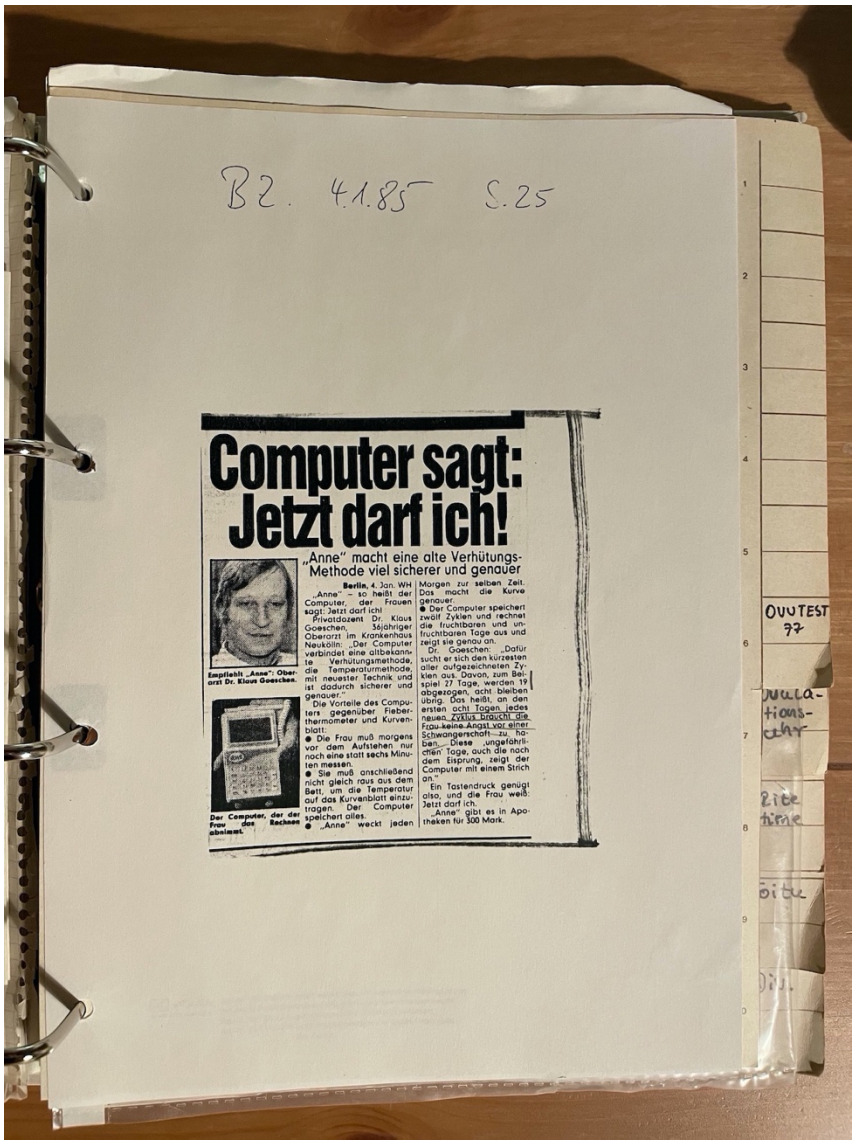


Figure 19: Anne

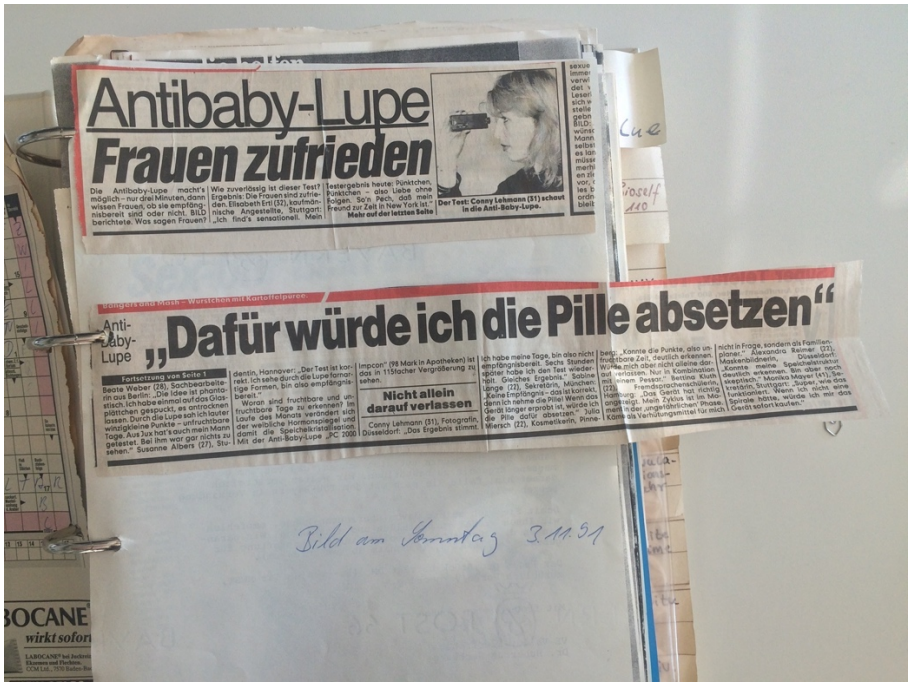


Figure 20: Antibaby Lupe

frau aktuell

40211 DUESSELDORF NW
Verk.Aufl.woechtl. 394,911
Gedruckte Auflage 651,177
23.12.97 2636
Nr. 1/98

DMA Deutsche Medienbeobachtungs Agentur
10117 Berlin, Tel. 030-203 98 70

Mediziner der Universität Erlangen haben eine neue Form der Verhütung entwickelt: Ein Puste-Röhrchen soll Pille, Kondom oder Spirale ersetzen. Einmal täglich wird der Atem der Frau gemessen. Der Kohlendioxid-Gehalt zeigt an, wann der Eisprung bevorsteht. „Das System

O.: Mit diesem Puste-Röhrchen kann die Frau ihren Atem messen

Verhütung

Pusten statt Pille

beruht auf der gleichen Methode wie die Messung der Temperatur", so Professor Ludwig Wildt, der das Gerät in dreijähriger Arbeit entwickelte. „Wenn der Wert von 40 auf der Anzeige rapide sinkt, steht ein Eisprung bevor. Dann sollte auf Geschlechtsverkehr verzichtet werden – es sei denn, Sie möchten schwanger werden." Pendelt sich der Wert dagegen zwischen 30 und 34 ein, bleibt der Geschlechtsverkehr ohne Folgen.

Das neue System wurde bereits von 100 Frauen getestet. Es hatte eine Sicherheit von 95 Prozent. Anfang 1998 soll das Puste-Röhrchen auf den Markt kommen, zum Preis von 200 Mark.

Die Sicherheit der Anti-Baby-Pille liegt bei 99 Prozent. Etwa jede dritte Frau verhütet damit. Nachteil: Das tägliche Schlucken von Hormonen belastet manche Frauen seelisch.

Figure 21: Breathing device, frau aktuel, bought on December 23,1997.

For a contemporary version of breath fertility tracking, see the "Breathe ILO", a device manufactured by Carbomed Medical Solutions Gmbh, https://www.breatheilo.com/

BERLINER MORGENPOST

10969 BERLIN B
Verk.Auf.t.a.egl. 184,098
Gedruckte Auflage 215,271
26.11.97 1234 S

Atemluft-Methode soll Frauen „kritische Tage" anzeigen

BM/dpa Erlangen – Eine Analyse der ausgeatmeten Luft soll Frauen künftig ihre fruchtbaren Tage anzeigen. Der Erlanger Frauenarzt und Hormon-Fachmann Prof. Ludwig Wildt hat in zweijähriger Arbeit ein Meßgerät entwickelt, das angeblich die Temperatur-Methode überflüssig macht.

„Ein deutliches Abfallen des Kohlendioxidgehalts in der Atemluft zeigt an, daß der Eisprung unmittelbar bevorsteht", sagte Wildt gestern. Die Methode – an mehr als 100 Frauen getestet – sei zu 95 Prozent sicher, bestätigte Wildt einen Bericht der Münchner „Abendzeitung".

Im Gegensatz zum frühmorgendlichen Messen der Körpertemperatur könne die Atemluft zu praktisch jedem beliebigen Zeitpunkt und unter allen möglichen Streßbedingungen Auskunft über die bevorstehenden kritischen Tage geben, meinte Wildt.

Figure 22: Breath fertility tracking, Berliner Morgenpost, bought on November 26,1997

Süddeutsche Zeitung

80331 MUENCHEN BA
Verk.Auf.1.taegl. 414,135
Gedruckte Auflage 512,249
04.12.97 1120 M

DMA Deutsche Medienbeobachtungs Agentur
10117 Berlin, Tel. 030-803 98 70

MEDIZIN

Atemtest ist nicht das „Ende der Pille“

Schon hatten Medien das Ende der Anti-Baby-Pille verkündet: „Pusten statt Pille“– eine einfache Verhütungsmethode, hieß es, ein Puderdosen-großes Meßgerat, mit dem die Atemluft der Frau analysiert werde, verspreche eine Sicherheit von 95 Prozent. Demnach würde die „Versagerquote“ fünf Prozent betragen „Völliger Quatsch“, kommentiert Elisabeth Rait-Paula, von der Arbeitsgruppe Natürliche Familienplaung (NFP) an der Universität Düsseldorf. Allein der Zeitpunkt des Eisprungs stimme in 95 Prozent der Fälle mit dem Absinken des Kohlendioxid-Gehalts (pCO_2) der ausgeatmeten Luft überein, sagt die Ärztin. Nur bei einem Kinderwunsch, wenn die fruchtbaren Tage ermittelt werden sollen, eigne sich das Gerat wirklich. Der Entwickler, Ludwig Wildt von der Universität Erlangen, hatte nach einer Studie an 15 Frauen lediglich in Aussicht gestellt, daß die Methode im Zusammenhang mit der Verhütung – durch bereits bekannte natürliche Methoden – „Bedeutung gewinnen konnte“ (*Geburtshilfe und Frauenheilkunde*, Bd. 57, S. 549, 1997).

Seit langem ist bekannt, daß der Kohlendioxidgehalt der Atemluft über den Zykluastand Auskunft gibt. Dies liegt daran, daß die Frau zum Zeitpunkt des Eisprungs aufgrund hormoneller Effekte stärker atmet und somit pro Atemzug weniger Kohlendioxid ausatmet. Gegenüber der Konkurrenz-Methode, der morgendlichen Messung der Körpertemperatur, hat die pCO_2-Bestimmung den Vorteil, daß sie den Eisprung ankündigt. Diesen erfährt die Frau mit der Temperaturmessung erst im nachhinein, woraus sie dann ihren nächsten Eisprung berechnen kann. Auch soll die Atemluft-Analyse zu jeder Zeit verläßlich sein, selbst bei Streß und körperlicher Aktivität, wenn die Körpertemperatur keine Schlüsse auf den Zyklusstand zuläßt. roe

Figure 23: Breath fertility tracking, 1997

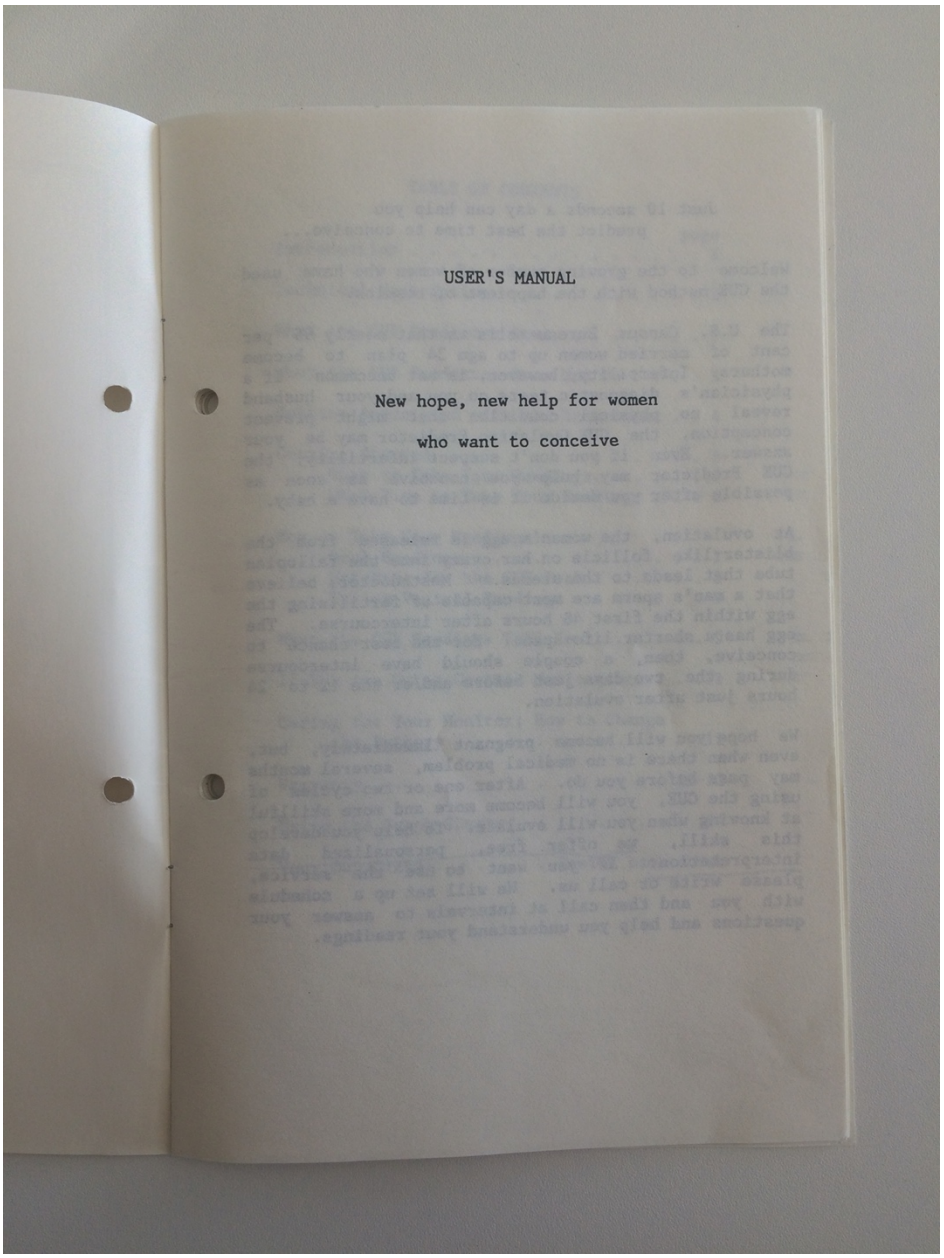
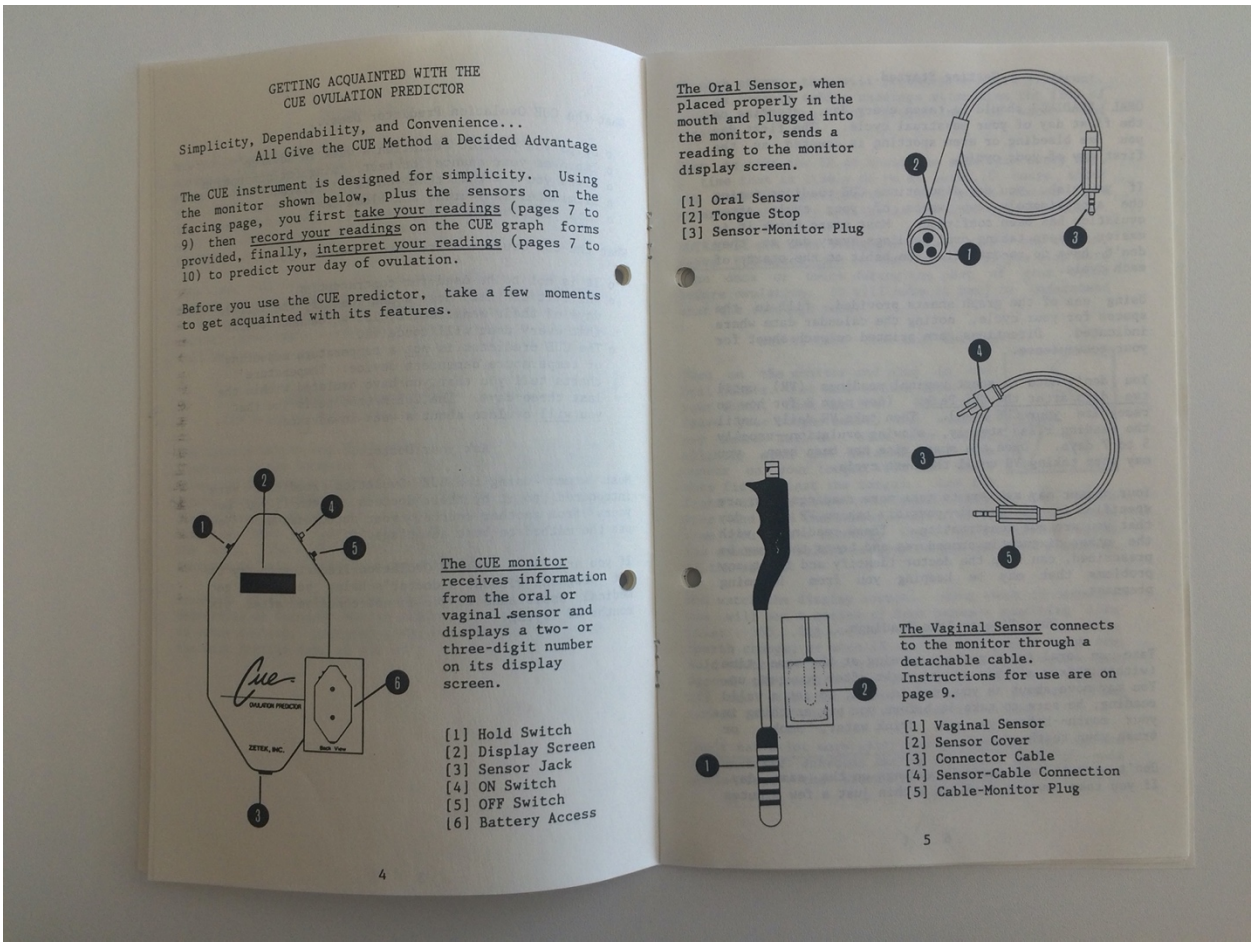


Figure 24: Cue, user's manual

For a contemporary version of Cue fertility tracking, see the OvaCue Fertility Monitor, https://www.ovacue.com/



GETTING ACQUAINTED WITH THE
CUE OVULATION PREDICTOR

Simplicity, Dependability, and Convenience...
All Give the CUE Method a Decided Advantage

The CUE instrument is designed for simplicity. Using the monitor shown below, plus the sensors on the facing page, you first take your readings (pages 7 to 9) then record your readings on the CUE graph forms provided, finally, interpret your readings (pages 7 to 10) to predict your day of ovulation.

Before you use the CUE predictor, take a few moments to get acquainted with its features.

The CUE monitor receives information from the oral or vaginal sensor and displays a two- or three-digit number on its display screen.

[1] Hold Switch
[2] Display Screen
[3] Sensor Jack
[4] ON Switch
[5] OFF Switch
[6] Battery Access

4

The Oral Sensor, when placed properly in the mouth and plugged into the monitor, sends a reading to the monitor display screen.

[1] Oral Sensor
[2] Tongue Stop
[3] Sensor-Monitor Plug

The Vaginal Sensor connects to the monitor through a detachable cable. Instructions for use are on page 9.

[1] Vaginal Sensor
[2] Sensor Cover
[3] Connector Cable
[4] Sensor-Cable Connection
[5] Cable-Monitor Plug

5

Figure 25: Cue, user's manual

pta APOTHEKENPRAXIS

Innovationspreis 1991

für Minicomputer zur natürlichen Schwangerschaftsverhütung/Familienplanung

Der baden-württembergische Wirtschaftsminister Hermann Schaufler übergab höchstpersönlich den „Dr.-Rudolf-Eberle-Innovationspreis 1991" an den Geschäftsführer der Uebe-Thermometer GmbH aus Wertheim-Reicholzheim für die erfolgreiche Entwicklung eines erst vor kurzem auf den Markt gebrachten neuen Minicomputers zur natürlichen Schwangerschaftsverhütung/Familienplanung (Cyclotest®-D, Abb. 1).

Dieser „Dr.-Rudolf-Eberle-Innovationspreis" wird jährlich für besonders innovative und nutzbringende Entwicklungen verliehen. Gewürdigt wird damit auch die Risikobereitschaft mittelständischer Unternehmen. Die Jury bestand aus kompetenten Vertretern der Großindustrie (u. a. Entwicklungsleiter IBM), der Steinbeis-Stiftung und der Handwerkskammer.

Anzeige der fruchtbaren und unfruchtbaren Tage

Der neue Minicomputer ist die innovative Weiterentwicklung der herkömmlichen Glas- und einfachen elektronischen Thermometer. Mit dem biegsamen, schnell reagierenden Meßfühler wird ganz einfach unter der Zunge die Morgentemperatur gemessen; ein Tastendruck genügt und der handliche Minicomputer speichert die Daten, wertet sie aus und zeigt in sekundenschnelle fruchtbare und unfruchtbare Tage sowie eine eingetretene Schwangerschaft an. Unregelmäßigkeiten wie Schlafmangel, Streß, Erkältung, Fieber etc. erkennt das Mikrochip und führt sie nicht der Auswertung zu.

Grundlage des Auswertemodus beim neuen Gerät ist der wissenschaftlich gesicherte Nachweis, daß die Temperatur-Methode (Abb. 2) sowohl absolut natürlich als auch sicher verhütet (sie gilt als die sicherste Verhütungsart nach der Pille). Und sie gilt zugleich als die geeignete Methode, den Kinderwunsch nach Wunsch zu erfüllen. Häufig ist sie unersetzlich für den Arzt als Ratgeber bei Behandlung beispielsweise von Zyklusstörungen.

Drei Paten

Der neue Minicomputer hat drei prominente Paten. Bei der Konzeption stand quasi die Weltgesundheitsorganisation (WHO) Pate. Denn nach ihren Richtlinien ist das Gerät programmiert. Ähnliches gilt für den Münchner Temperatur-Methode-Spezialisten Prof. Dr. Döring, dessen Erfahrung das Projekt maßgeblich beeinflußte. Die Entwicklungsarbeit wurde darüber hinaus vom Bundesministerium für Forschung und Technologie als förderungswürdig anerkannt und finanziell unterstützt.

Abb. 1: Der mit dem „Dr.-Rudolf-Eberle-Innovationspreis 1991" ausgezeichnete Minicomputer zur natürlichen Schwangerschaftsverhütung/Familienplanung

Abb. 2: Temperaturkurve, deutlich ist der Temperaturanstieg nach dem Eisprung zu erkennen.

Neuartige Meßtechnik

Mit einer neuartigen, bereits durch Patent geschützten Meßtechnik arbeitet der neue Minicomputer. Man bezeichnet sie als Relativ-Meßtechnik. Sie ermittelt nämlich die Abweichung der gemessenen Temperatur zur Normaltemperatur (Bezugswert) der Anwenderin, und zwar auf 1/100 Grad genau. Dabei handelt es sich nicht um Grad Celsius, sondern um die ganz persönlichen Temperaturgrade der Anwenderin. Aus diesen individuellen Temperaturgraden ermittelt das Gerät bei jedem Zyklusstart einen neuen Bezugswert. Dies bedeutet: Etwa alle vier Wochen justiert sich das Gerät selbsttätig neu. Die Genauigkeit unterliegt deshalb nicht den üblichen Abnutzungserscheinungen, sondern bleibt über Jahre hinweg gleichbleibend.

Ein weiteres Ziel der Entwicklung war es, das Gerät zu einem Preis, der für jedermann (Frau) erschwinglich ist, anbieten zu können. Auch diese Zielsetzung wurde erfüllt. Der empfohlene Verkaufspreis für das Gerät beträgt weniger als 200 DM, was schon dem jährlichen Kostenvergleich mit allen anderen Verhütungsmitteln standhalten kann. p/r

Figure 26: Cyclotest

Figure 27: Cyclotest

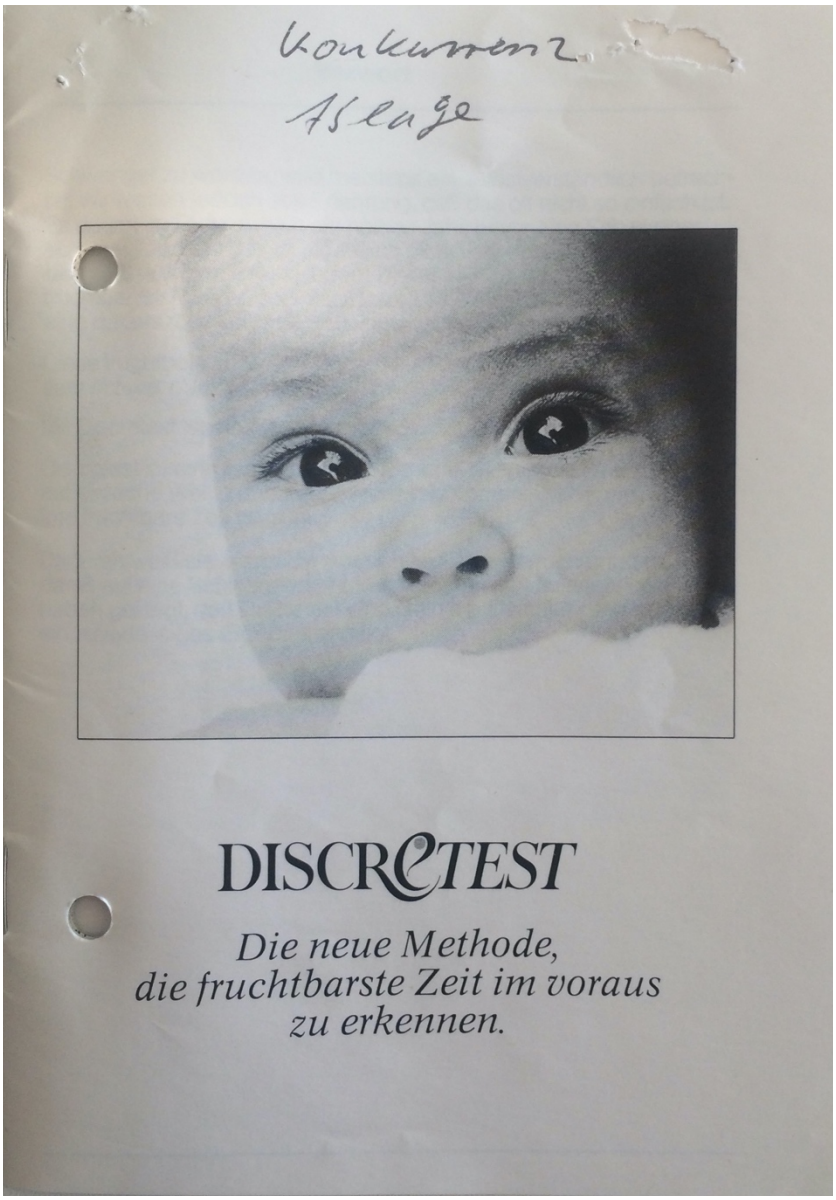


Figure 28: Discretest

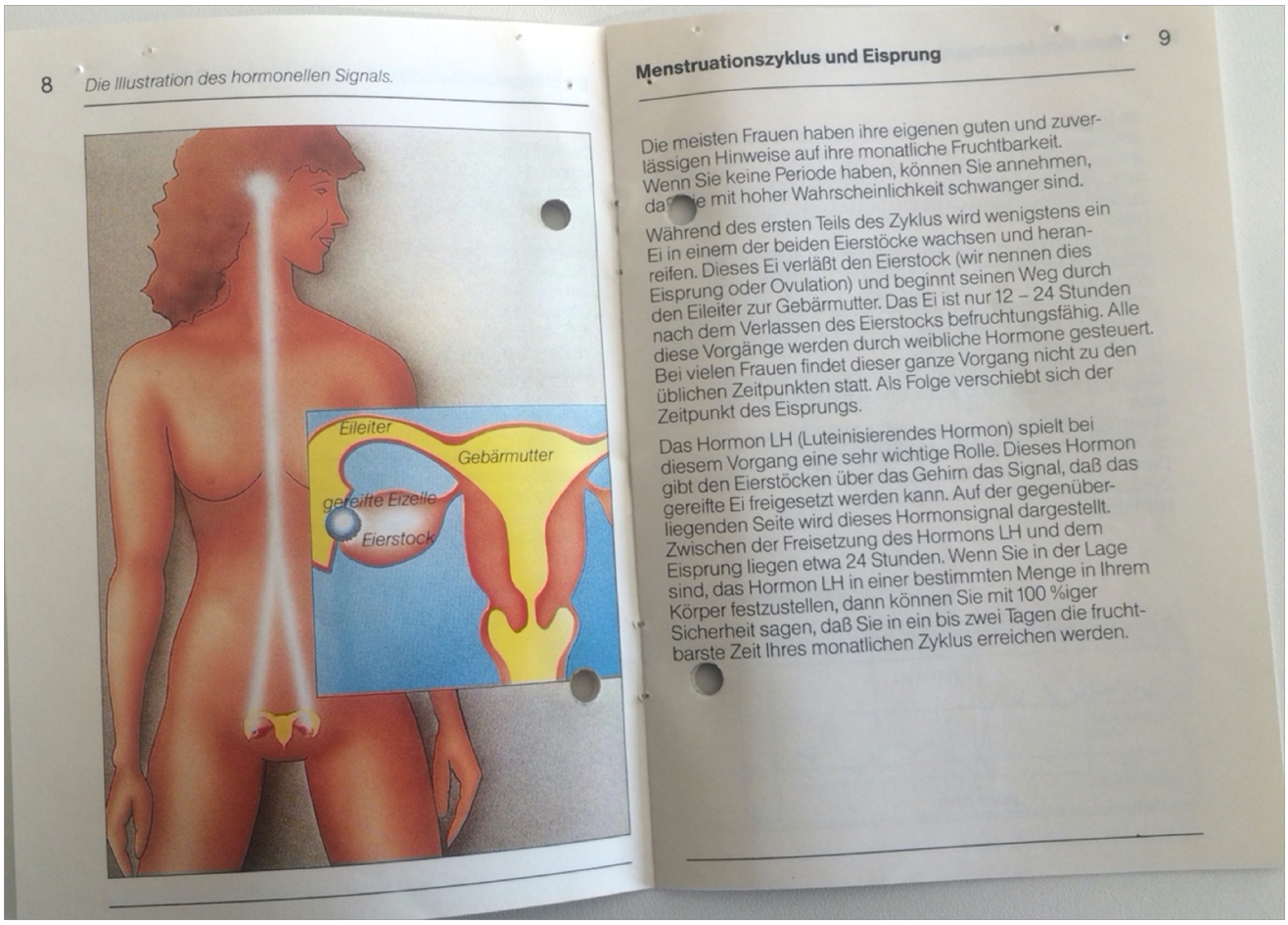
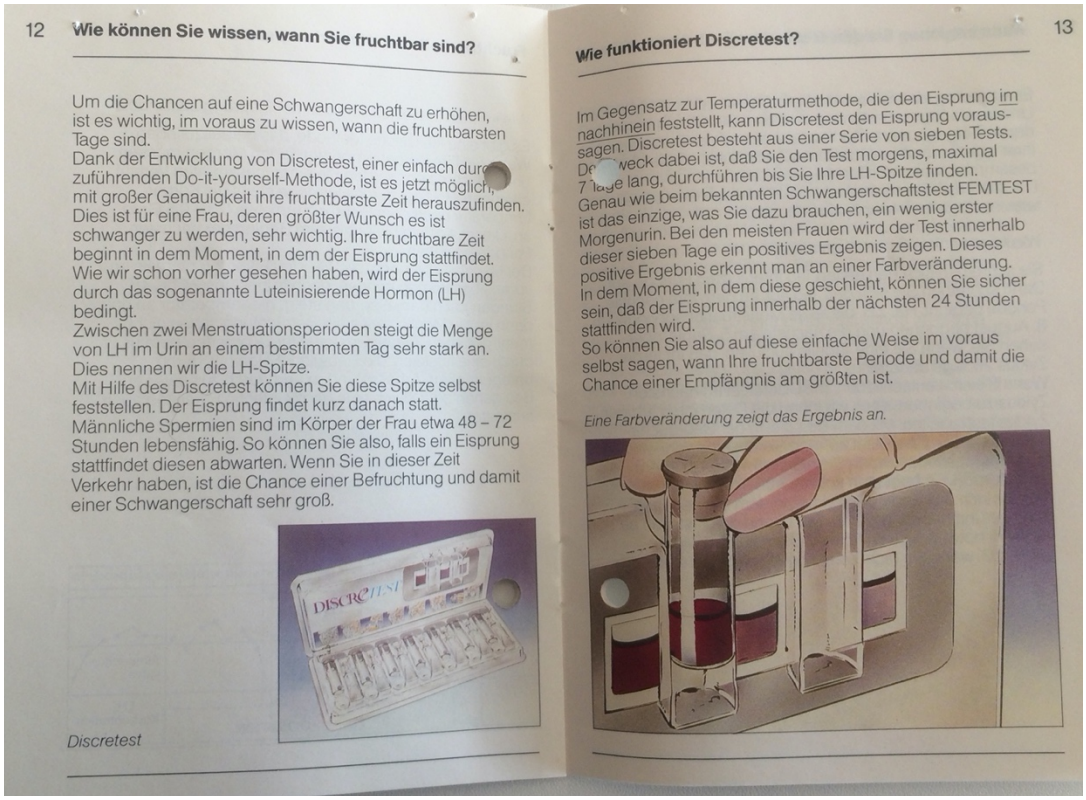


Figure 29: Discretest



12 **Wie können Sie wissen, wann Sie fruchtbar sind?**

Um die Chancen auf eine Schwangerschaft zu erhöhen, ist es wichtig, im voraus zu wissen, wann die fruchtbarsten Tage sind.
Dank der Entwicklung von Discretest, einer einfach durc[illegible] zuführenden Do-it-yourself-Methode, ist es jetzt möglich, mit großer Genauigkeit ihre fruchtbarste Zeit herauszufinden. Dies ist für eine Frau, deren größter Wunsch es ist schwanger zu werden, sehr wichtig. Ihre fruchtbare Zeit beginnt in dem Moment, in dem der Eisprung stattfindet. Wie wir schon vorher gesehen haben, wird der Eisprung durch das sogenannte Luteinisierende Hormon (LH) bedingt.
Zwischen zwei Menstruationsperioden steigt die Menge von LH im Urin an einem bestimmten Tag sehr stark an. Dies nennen wir die LH-Spitze.
Mit Hilfe des Discretest können Sie diese Spitze selbst feststellen. Der Eisprung findet kurz danach statt.
Männliche Spermien sind im Körper der Frau etwa 48 – 72 Stunden lebensfähig. So können Sie also, falls ein Eisprung stattfindet diesen abwarten. Wenn Sie in dieser Zeit Verkehr haben, ist die Chance einer Befruchtung und damit einer Schwangerschaft sehr groß.

Discretest

Wie funktioniert Discretest? 13

Im Gegensatz zur Temperaturmethode, die den Eisprung im nachhinein feststellt, kann Discretest den Eisprung voraussagen. Discretest besteht aus einer Serie von sieben Tests. De[illegible]weck dabei ist, daß Sie den Test morgens, maximal 7 Tage lang, durchführen bis Sie Ihre LH-Spitze finden. Genau wie beim bekannten Schwangerschaftstest FEMTEST ist das einzige, was Sie dazu brauchen, ein wenig erster Morgenurin. Bei den meisten Frauen wird der Test innerhalb dieser sieben Tage ein positives Ergebnis zeigen. Dieses positive Ergebnis erkennt man an einer Farbveränderung. In dem Moment, in dem diese geschieht, können Sie sicher sein, daß der Eisprung innerhalb der nächsten 24 Stunden stattfinden wird.
So können Sie also auf diese einfache Weise im voraus selbst sagen, wann Ihre fruchtbarste Periode und damit die Chance einer Empfängnis am größten ist.

Eine Farbveränderung zeigt das Ergebnis an.

Figure 30: Discretest

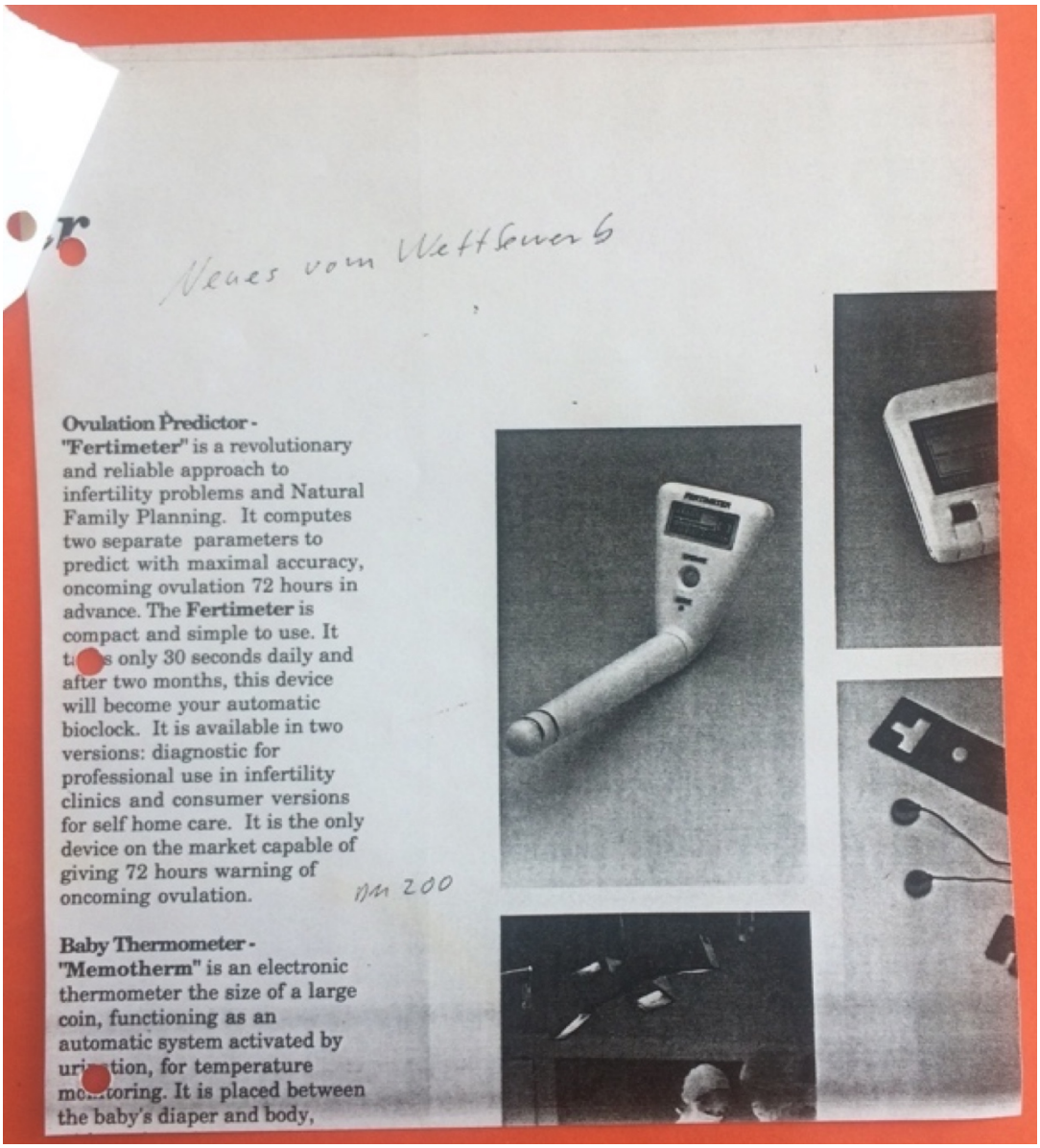


Figure 31: Fertimeter

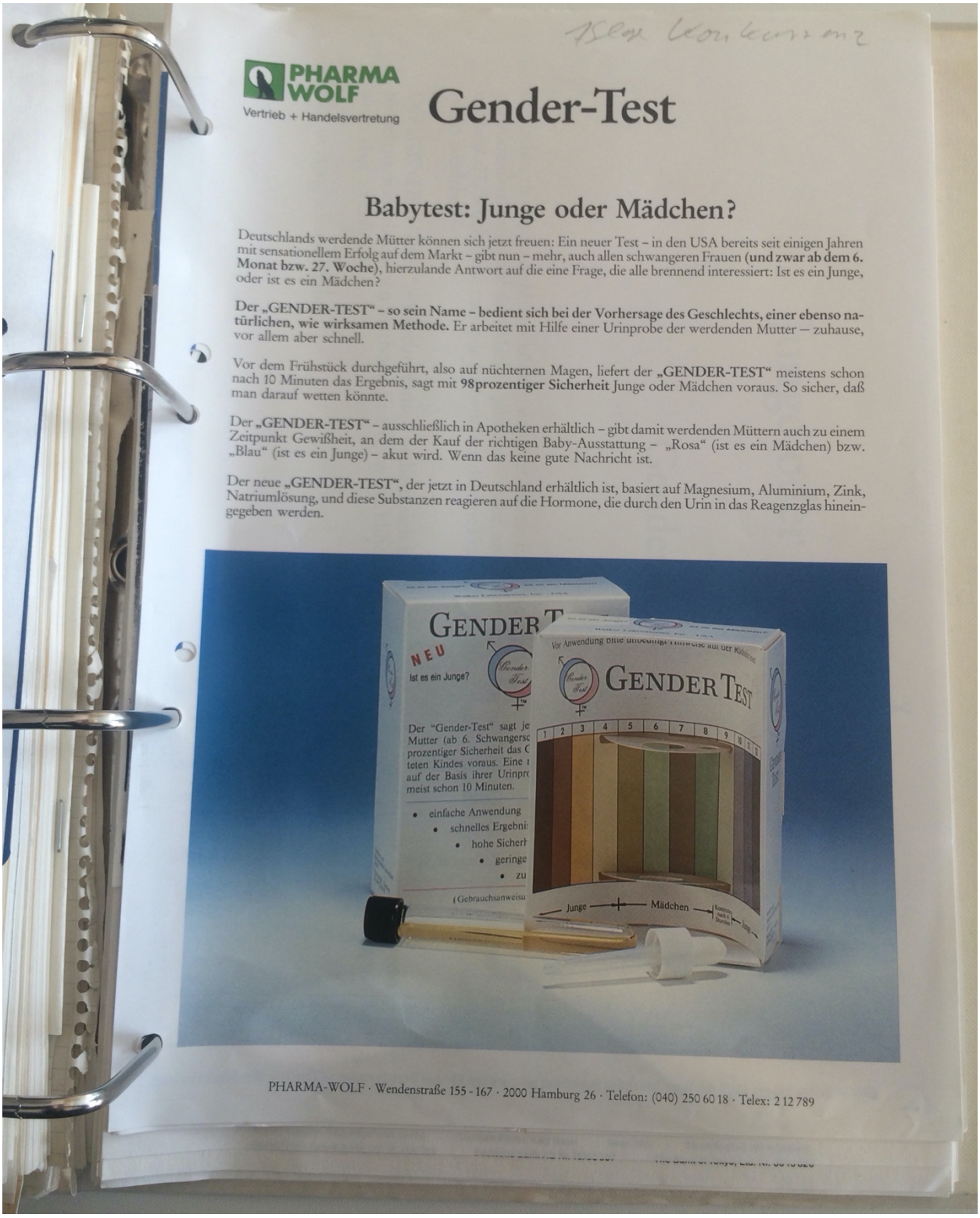


Figure 32: Gender-Test "Ablage konkurrenz"

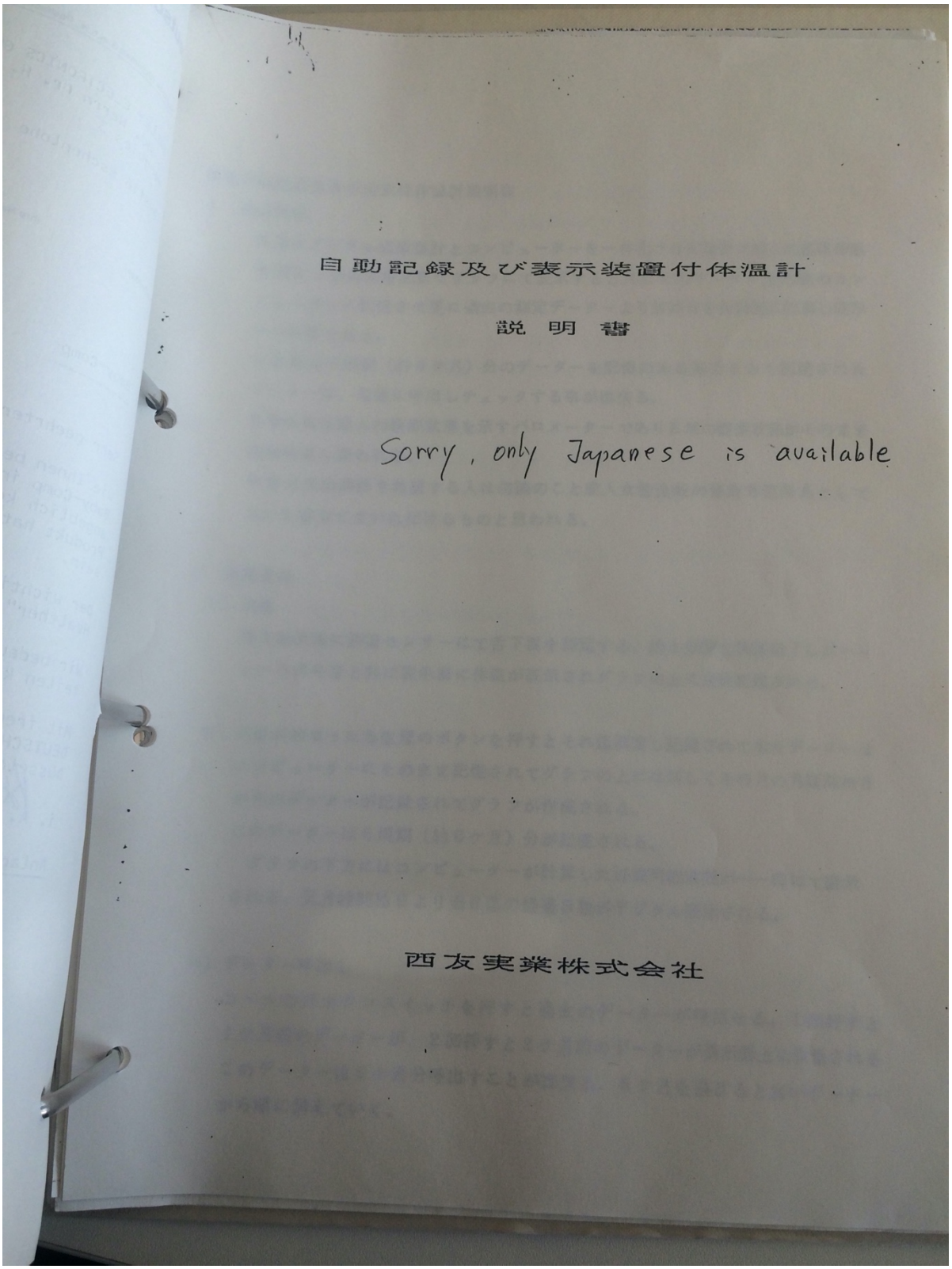


Figure 33: “Lady Healther”, “sorry, only Japanese is available”

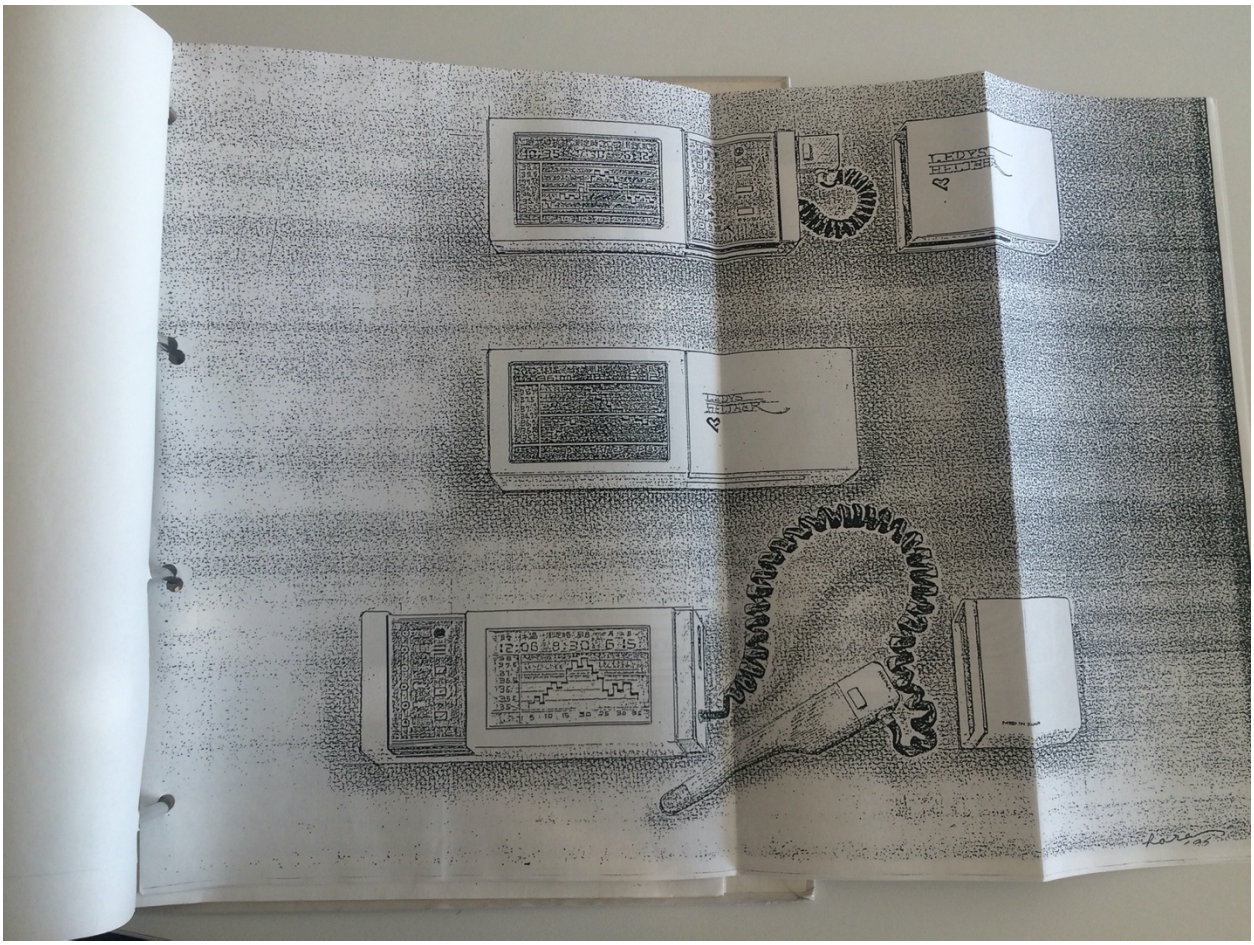


Figure 34: Lady Healther

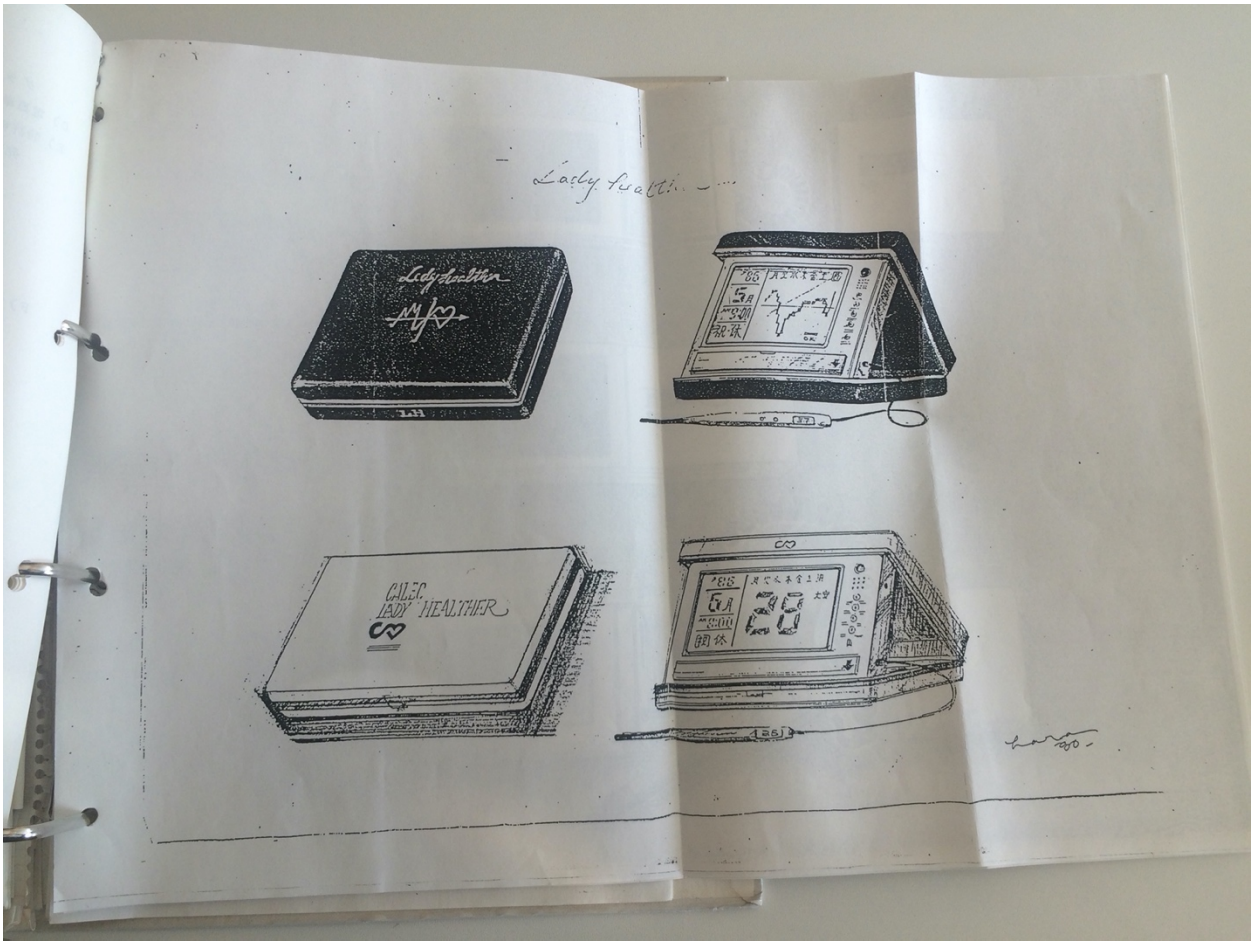


Figure 35: Lady Healther

Figure 36: Ovix, user's manual

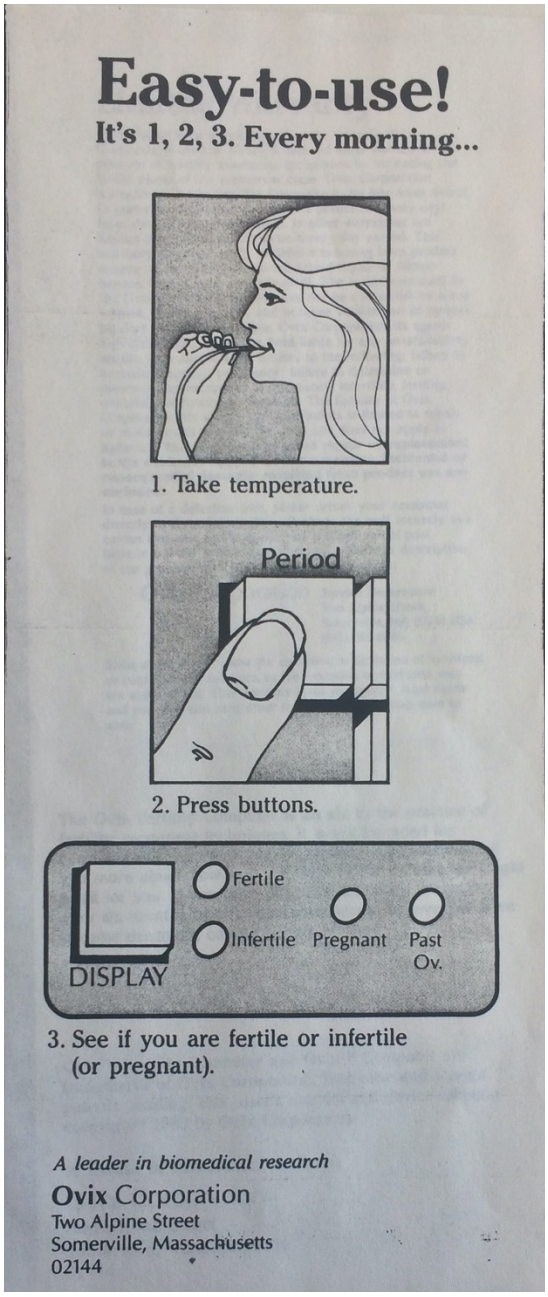


Figure 37: Ovix, user's manual

Ovix Fertility Computer can help.

A Useful First Step Approach to Fertility Problems

Sometimes getting pregnant takes more than luck. A woman is fertile for only a few days of her menstrual cycle. The Ovix™ Fertility Computer will tell you whether or not ovulation is occurring normally and when the best days are to conceive. It will help you and your doctor find out more about your fertility cycle. If you've been trying to have a baby, Ovix can help.

Planning Your Pregnancy

If you'd like to plan your next child, you will want to know the best days of your menstrual cycle to try to become pregnant. The Ovix Fertility Computer eliminates guesswork by tracking fertility signs and pinpointing the five to seven days of maximum fertility. If you're planning a family, or combining family and career, Ovix can help.

Easy-to-use Personal Bedside Computer

The Ovix Fertility Computer helps take the complexity and uncertainty out of fertility awareness techniques. All you do is use the compact battery-operated computer every morning to record your body temperature. Then, press the appropriate buttons to tell the device about conditions which may affect your fertility cycle. The computer analyzes and stores this data and alerts you to the best times to become pregnant.

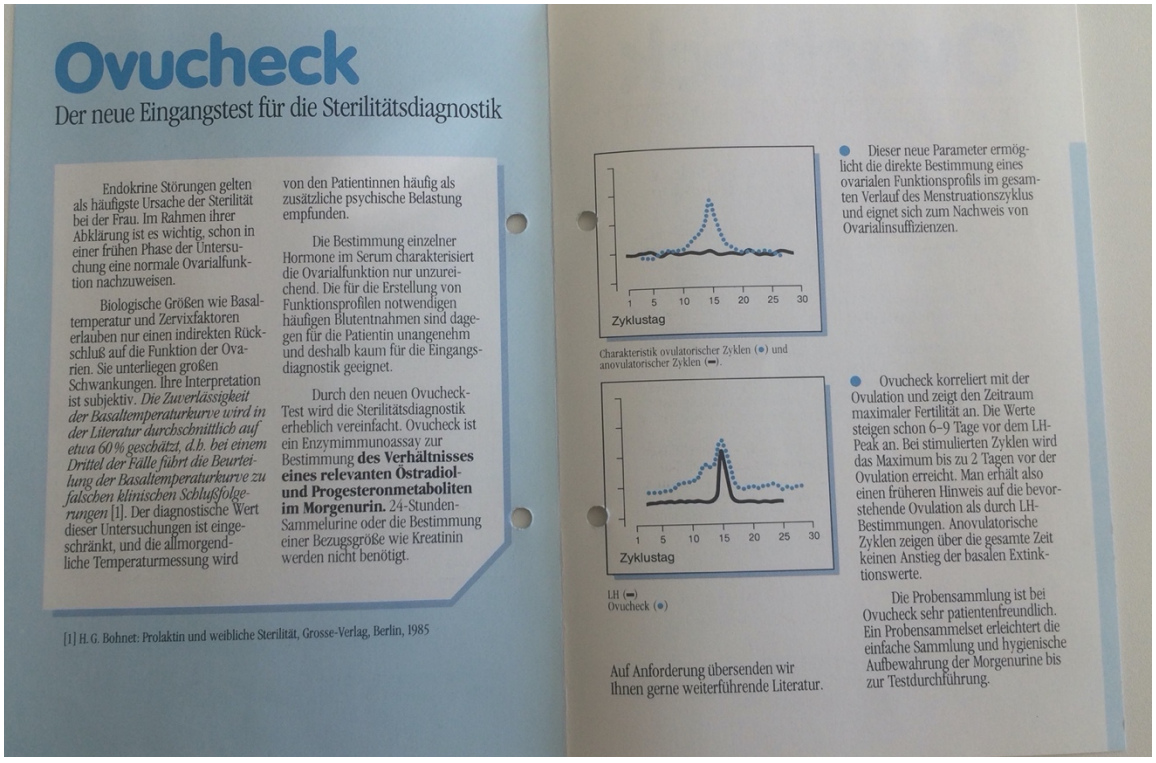
Precision Engineering

We combined the latest advances in fertility monitoring with precision engineering and backed up our research with intensive laboratory and field testing. The result: an accurate, reliable and consistent system for fertility monitoring. We've enclosed the Ovix™ Computer in a trim contemporary case which snaps closed for privacy.

The Ovix Fertility Computer will help you get the best possible information about your own fertility cycle. It's like a daily consultation with your gynecologist.

Figure 38: Ovix

Figure 39: Ovucheck



Ovucheck

Der neue Eingangstest für die Sterilitätsdiagnostik

Endokrine Störungen gelten als häufigste Ursache der Sterilität bei der Frau. Im Rahmen ihrer Abklärung ist es wichtig, schon in einer frühen Phase der Untersuchung eine normale Ovarialfunktion nachzuweisen.

Biologische Größen wie Basaltemperatur und Zervixfaktoren erlauben nur einen indirekten Rückschluß auf die Funktion der Ovarien. Sie unterliegen großen Schwankungen. Ihre Interpretation ist subjektiv. *Die Zuverlässigkeit der Basaltemperaturkurve wird in der Literatur durchschnittlich auf etwa 60 % geschätzt, d.h. bei einem Drittel der Fälle führt die Beurteilung der Basaltemperaturkurve zu falschen klinischen Schlußfolgerungen* [1]. Der diagnostische Wert dieser Untersuchungen ist eingeschränkt, und die allmorgendliche Temperaturmessung wird von den Patientinnen häufig als zusätzliche psychische Belastung empfunden.

Die Bestimmung einzelner Hormone im Serum charakterisiert die Ovarialfunktion nur unzureichend. Die für die Erstellung von Funktionsprofilen notwendigen häufigen Blutentnahmen sind dagegen für die Patientin unangenehm und deshalb kaum für die Eingangsdiagnostik geeignet.

Durch den neuen Ovucheck-Test wird die Sterilitätsdiagnostik erheblich vereinfacht. Ovucheck ist ein Enzymimmunoassay zur Bestimmung **des Verhältnisses eines relevanten Östradiol- und Progesteronmetaboliten im Morgenurin.** 24-Stunden-Sammelurine oder die Bestimmung einer Bezugsgröße wie Kreatinin werden nicht benötigt.

[1] H.G. Bohnet: Prolaktin und weibliche Sterilität, Grosse-Verlag, Berlin, 1985

Charakteristik ovulatorischer Zyklen (●) und anovulatorischer Zyklen (▬).

● Dieser neue Parameter ermöglicht die direkte Bestimmung eines ovarialen Funktionsprofils im gesamten Verlauf des Menstruationszyklus und eignet sich zum Nachweis von Ovarialinsuffizienzen.

LH (▬)
Ovucheck (●)

● Ovucheck korreliert mit der Ovulation und zeigt den Zeitraum maximaler Fertilität an. Die Werte steigen schon 6–9 Tage vor dem LH-Peak an. Bei stimulierten Zyklen wird das Maximum bis zu 2 Tagen vor der Ovulation erreicht. Man erhält also einen früheren Hinweis auf die bevorstehende Ovulation als durch LH-Bestimmungen. Anovulatorische Zyklen zeigen über die gesamte Zeit keinen Anstieg der basalen Extinktionswerte.

Die Probensammlung ist bei Ovucheck sehr patientenfreundlich. Ein Probensammelset erleichtert die einfache Sammlung und hygienische Aufbewahrung der Morgenurine bis zur Testdurchführung.

Auf Anforderung übersenden wir Ihnen gerne weiterführende Literatur.

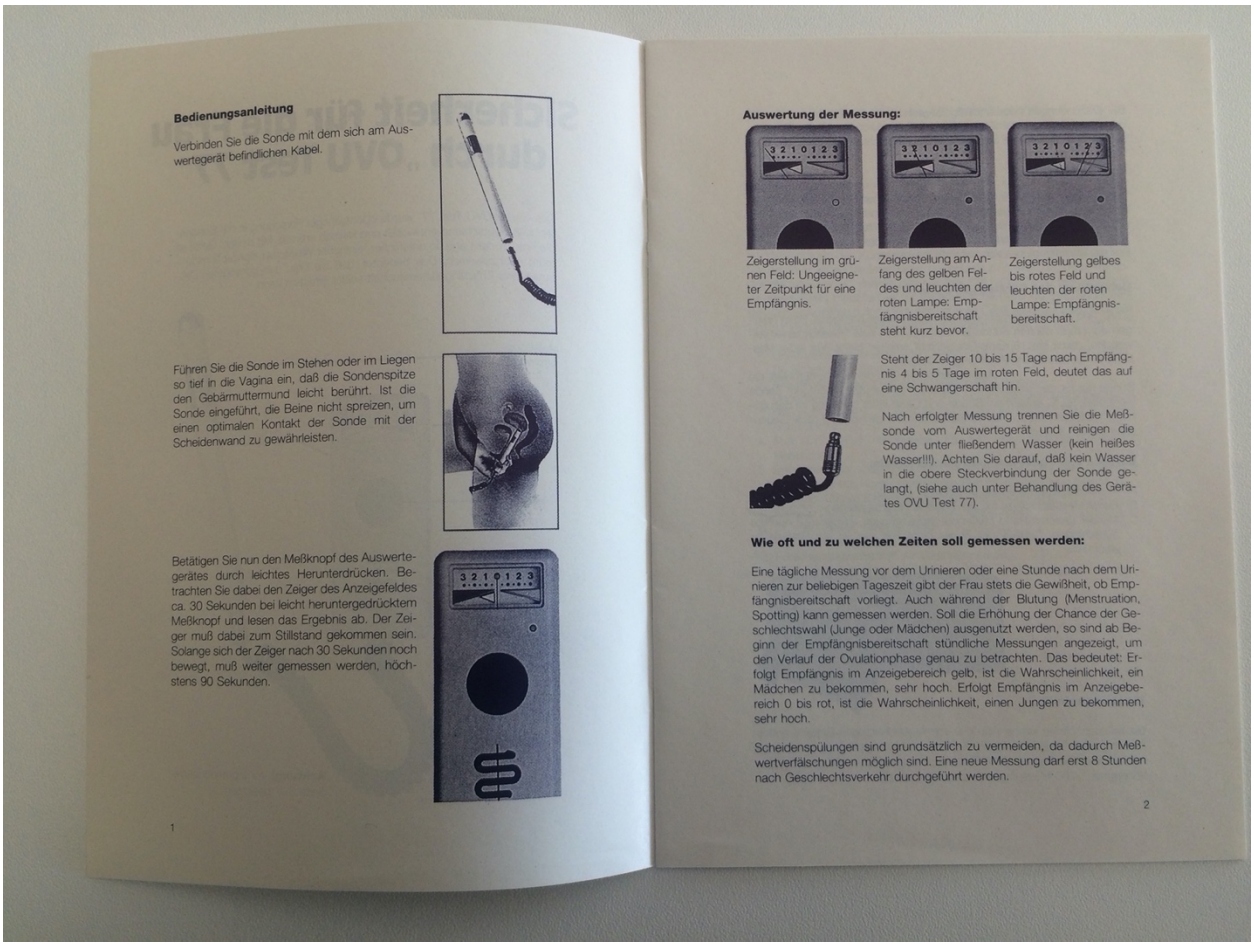
Figure 40: Ovucheck

Figure 41: Ovulator

Figure 42: Ovulator

Figure 43: Ovulator

Figure 44: Ovu test 77



Bedienungsanleitung

Verbinden Sie die Sonde mit dem sich am Auswertegerät befindlichen Kabel.

Führen Sie die Sonde im Stehen oder im Liegen so tief in die Vagina ein, daß die Sondenspitze den Gebärmuttermund leicht berührt. Ist die Sonde eingeführt, die Beine nicht spreizen, um einen optimalen Kontakt der Sonde mit der Scheidenwand zu gewährleisten.

Betätigen Sie nun den Meßknopf des Auswertegerätes durch leichtes Herunterdrücken. Betrachten Sie dabei den Zeiger des Anzeigefeldes ca. 30 Sekunden bei leicht heruntergedrücktem Meßknopf und lesen das Ergebnis ab. Der Zeiger muß dabei zum Stillstand gekommen sein. Solange sich der Zeiger nach 30 Sekunden noch bewegt, muß weiter gemessen werden, höchstens 90 Sekunden.

1

Auswertung der Messung:

Zeigerstellung im grünen Feld: Ungeeigneter Zeitpunkt für eine Empfängnis.

Zeigerstellung am Anfang des gelben Feldes und leuchten der roten Lampe: Empfängnisbereitschaft steht kurz bevor.

Zeigerstellung gelbes bis rotes Feld und leuchten der roten Lampe: Empfängnisbereitschaft.

Steht der Zeiger 10 bis 15 Tage nach Empfängnis 4 bis 5 Tage im roten Feld, deutet das auf eine Schwangerschaft hin.

Nach erfolgter Messung trennen Sie die Meßsonde vom Auswertegerät und reinigen die Sonde unter fließendem Wasser (kein heißes Wasser!!!). Achten Sie darauf, daß kein Wasser in die obere Steckverbindung der Sonde gelangt, (siehe auch unter Behandlung des Gerätes OVU Test 77).

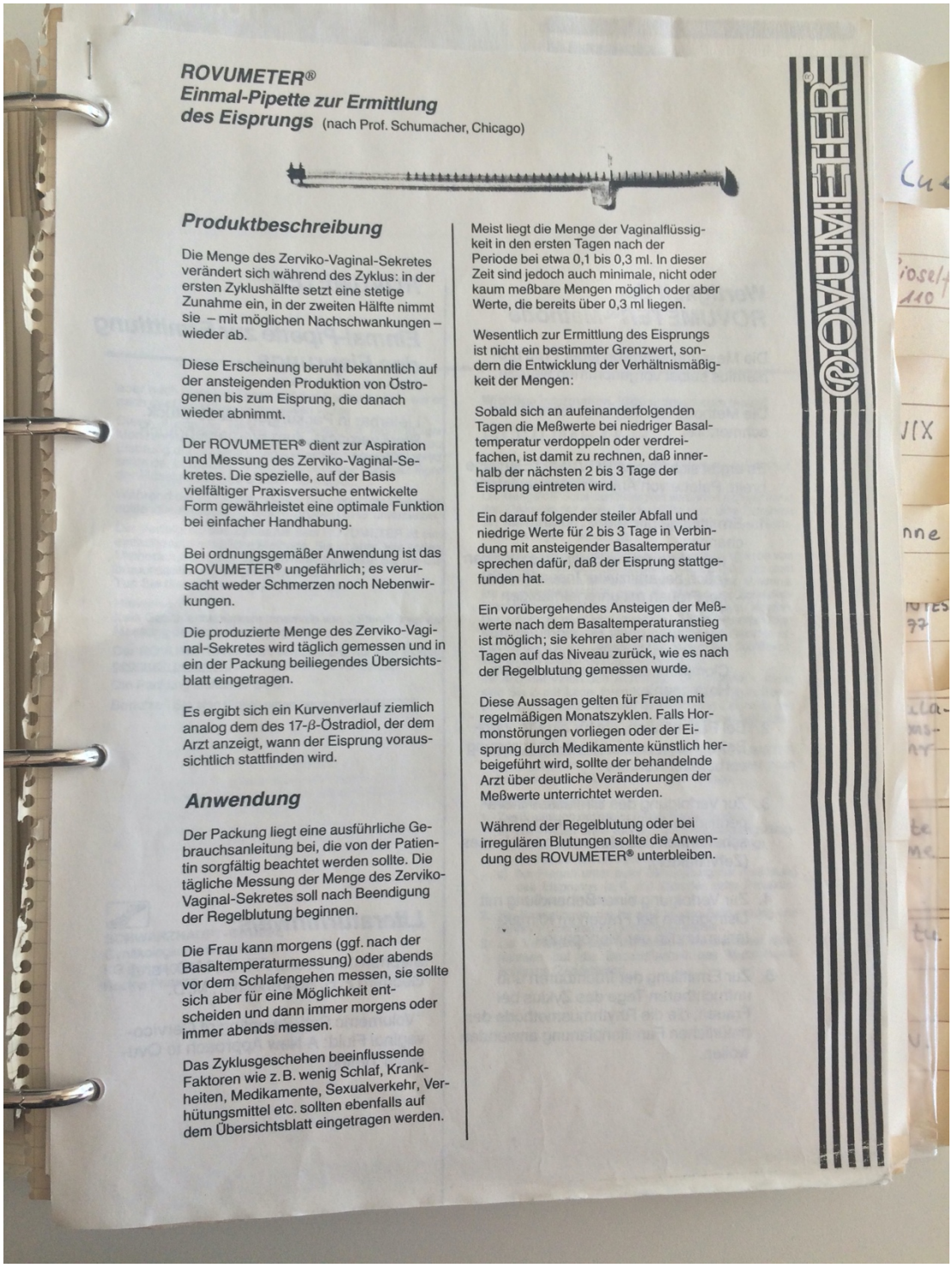
Wie oft und zu welchen Zeiten soll gemessen werden:

Eine tägliche Messung vor dem Urinieren oder eine Stunde nach dem Urinieren zur beliebigen Tageszeit gibt der Frau stets die Gewißheit, ob Empfängnisbereitschaft vorliegt. Auch während der Blutung (Menstruation, Spotting) kann gemessen werden. Soll die Erhöhung der Chance der Geschlechtswahl (Junge oder Mädchen) ausgenutzt werden, so sind ab Beginn der Empfängnisbereitschaft stündliche Messungen angezeigt, um den Verlauf der Ovulationphase genau zu betrachten. Das bedeutet: Erfolgt Empfängnis im Anzeigebereich gelb, ist die Wahrscheinlichkeit, ein Mädchen zu bekommen, sehr hoch. Erfolgt Empfängnis im Anzeigebereich 0 bis rot, ist die Wahrscheinlichkeit, einen Jungen zu bekommen, sehr hoch.

Scheidenspülungen sind grundsätzlich zu vermeiden, da dadurch Meßwertverfälschungen möglich sind. Eine neue Messung darf erst 8 Stunden nach Geschlechtsverkehr durchgeführt werden.

2

Figure 45: Ovutest-77



ROVUMETER®
Einmal-Pipette zur Ermittlung des Eisprungs (nach Prof. Schumacher, Chicago)

Produktbeschreibung

Die Menge des Zerviko-Vaginal-Sekretes verändert sich während des Zyklus: in der ersten Zyklushälfte setzt eine stetige Zunahme ein, in der zweiten Hälfte nimmt sie – mit möglichen Nachschwankungen – wieder ab.

Diese Erscheinung beruht bekanntlich auf der ansteigenden Produktion von Östrogenen bis zum Eisprung, die danach wieder abnimmt.

Der ROVUMETER® dient zur Aspiration und Messung des Zerviko-Vaginal-Sekretes. Die spezielle, auf der Basis vielfältiger Praxisversuche entwickelte Form gewährleistet eine optimale Funktion bei einfacher Handhabung.

Bei ordnungsgemäßer Anwendung ist das ROVUMETER® ungefährlich; es verursacht weder Schmerzen noch Nebenwirkungen.

Die produzierte Menge des Zerviko-Vaginal-Sekretes wird täglich gemessen und in ein der Packung beiliegendes Übersichtsblatt eingetragen.

Es ergibt sich ein Kurvenverlauf ziemlich analog dem des 17-β-Östradiol, der dem Arzt anzeigt, wann der Eisprung voraussichtlich stattfinden wird.

Anwendung

Der Packung liegt eine ausführliche Gebrauchsanleitung bei, die von der Patientin sorgfältig beachtet werden sollte. Die tägliche Messung der Menge des Zerviko-Vaginal-Sekretes soll nach Beendigung der Regelblutung beginnen.

Die Frau kann morgens (ggf. nach der Basaltemperaturmessung) oder abends vor dem Schlafengehen messen, sie sollte sich aber für eine Möglichkeit entscheiden und dann immer morgens oder immer abends messen.

Das Zyklusgeschehen beeinflussende Faktoren wie z.B. wenig Schlaf, Krankheiten, Medikamente, Sexualverkehr, Verhütungsmittel etc. sollten ebenfalls auf dem Übersichtsblatt eingetragen werden.

Meist liegt die Menge der Vaginalflüssigkeit in den ersten Tagen nach der Periode bei etwa 0,1 bis 0,3 ml. In dieser Zeit sind jedoch auch minimale, nicht oder kaum meßbare Mengen möglich oder aber Werte, die bereits über 0,3 ml liegen.

Wesentlich zur Ermittlung des Eisprungs ist nicht ein bestimmter Grenzwert, sondern die Entwicklung der Verhältnismäßigkeit der Mengen:

Sobald sich an aufeinanderfolgenden Tagen die Meßwerte bei niedriger Basaltemperatur verdoppeln oder verdreifachen, ist damit zu rechnen, daß innerhalb der nächsten 2 bis 3 Tage der Eisprung eintreten wird.

Ein darauf folgender steiler Abfall und niedrige Werte für 2 bis 3 Tage in Verbindung mit ansteigender Basaltemperatur sprechen dafür, daß der Eisprung stattgefunden hat.

Ein vorübergehendes Ansteigen der Meßwerte nach dem Basaltemperaturanstieg ist möglich; sie kehren aber nach wenigen Tagen auf das Niveau zurück, wie es nach der Regelblutung gemessen wurde.

Diese Aussagen gelten für Frauen mit regelmäßigen Monatszyklen. Falls Hormonstörungen vorliegen oder der Eisprung durch Medikamente künstlich herbeigeführt wird, sollte der behandelnde Arzt über deutliche Veränderungen der Meßwerte unterrichtet werden.

Während der Regelblutung oder bei irregulären Blutungen sollte die Anwendung des ROVUMETER® unterbleiben.

ROVUMETER®

Figure 46: Rovumeter

Figure 47: Swiss Lady Watch

Anchoring 2

During my time off-site, I actively search online to discover where interesting things related to fertility biosensors might be happening. Former research experiences while completing my master's thesis on fitness tracking biosensors made me realize that self-tracking practices are enacted differently in promoters' narratives, by users in the wild, or within a community of practice, such as the Quantified Self Community. Therefore, I am convinced that multiplying the sites where fertility-tracking biosensors are promoted, used, or disputed can be fruitful for this inquiry.

Additionally, as I am reading publications in science and technology studies on tech fairs (Schüll, 2016), trade shows (Downey, 1998), and public demonstrations (Rosental, 2013), I am inspired to observe how fertility biosensors come into being in such settings. A biography of computerized fertility-tracking biosensors, as I imagine it, would benefit from not restricting itself to the walls of a single company.

November 30, 2017, morning. University of Lausanne, office space. As I am looking for potentially interesting sites on which to follow biosensors as "objects-in-practice" (Mol, 2002, p. 149), I find out, via an Internet search, about an International Congress on Natural Family Planning, which is to be held in Cologne in April 2018. The Congress website announces scientific

lectures, workshops, and field reports from all over the world about natural family planning.[64] I register.

December 12, 2017, evening. Murnau-am-Staffelsee, Thai restaurant. After spending the whole day in Valley Electronics's German office attending an internal meeting, I go out for supper in town with the Chief Medical Advisor (CMA) and The Chief Marketing Officer (CMO) at a Thai restaurant we have already been to. During the supper, the CMA informs me that a big gynecological conference will be held in Budapest in a few months. He encourages me to register, as many medical researchers working on fertility-tracking apps will be there. I appreciate this information. In my turn, I tell him about the NFP Congress in Cologne, about which I recently learned. The medical advisor is thrilled by the news. He tells me not to hesitate to share such information with him, and I confirm that I will do so. We both register for both events and plan to attend them together.

November 19, 2019. Centreville, Valley Electronics US office. It is my first visit to the American Office. I am discussing the company's latest developments with the Director of Human Resources. When I ask her if the team has planned to attend any congresses or tech summits in the following months, she informs me that they will participate in the Consumer Electronics Show (CES) in Las Vegas in January 2020. I mention my interest in attending such an event. She says she will ask the CEO if they have additional passes. A few days later, I receive confirmation of my invitation to attend the summit as a guest of the company.

[64] Quote (translated from German) from https://www.nfp-online.com/?th_events=international-conference-on-natural-family-planning.

November 22, 2019. New York City, Columbia University. I am attending an interdisciplinary workshop entitled "Multifaceted Menstruation," organized by the Menstrual Health and Gender Justice Working Group.[65] The room is filled with activists and scholars working in public health, social sciences, humanities, law, medicine, and nursing sciences. During a break, I meet an employee of the Natural Cycles company, who is responsible for the Science and Communications team. As we engage in a discussion, I mention the upcoming Women's Health Innovation Summit in Boston,[66] which I am looking for a way to attend. She believes that her company, which will be presenting at the summit, can bring a few guests. After the workshop, I receive an invitation by email from the company, and I will be able to attend the event with special guest status.

[65] This research group seeks to promote the emergence of the new research field of "critical menstruation studies," as described here: https://www.socialdifference.columbia.edu/projects-/menstrual-health-and-gender-justice. See also Bobel et al., 2020.

[66] The event, like many tech summits and investors meetings, costs about $1000 to attend, and my email attempts to receive a researcher's discount have proven unsuccessful.

2 Configuring

In this chapter, I turn to contemporary assemblages in which different apps' promoters envision fertility tracking subjects[67]. More precisely, the chapter explores how promoters imagine what are the best sociotechnical arrangements when it comes to mobile apps[68] for pregnancy prevention. Currently available fertility tracking mobile apps are usually promoted for three intended uses – or "scripts" (Akrich, 1992, p. 208)[69]: to assist users willing to become pregnant, avoid pregnancy or track their cycle[70].

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[67] This chapter is an extended version of an article published in *Learning, Media and Technology*, under the title "Configuring the body as pedagogical site: towards a conceptual tool to unpack and situate multiple ontologies of the body in self-tracking apps" 47:1, 65-78, https://doi.org/10.1080/17439884.2021.2018606.

[68] Critical media scholar Svitlana Matyizenko defines apps, as "an abbreviated software application – figuratively and litterally, linguistically and technically: apps are small programs – pieces of software designed to apply the power of a computing system for a particular purpose" (Matviyenko, 2014, pp. xvii–xviii).

[69] As STS analysts, we can say, using Madeleine Akrich famous terminology, that they envision three "scripts." Akrich developed the notion of "script" as an analytical tool to understand the process through which innovators "inscrib[e]" their "vision of (or prediction about) the world in the technical content of the new object. I will call the end product of this work a 'script' or a 'scenario'" (Akrich, 1992, p. 208). Along with this notion, Akrich has developed an extended vocabulary, allowing for the description – or rather in Akrich's terms, "de-scription" (Akrich, 1992) – of different processes relating the design of an artifact to its use (or non-use, in the case of script's failures).

[70] I draw this observation from participating in a collaborative exploratory project on menstrual cycle tracking apps's using preliminary approaches of what our project facilitators would later call "the infrastructural situatedness of apps" perspective (Gerlitz et al., 2019). During this research project, carried out during the 2017 Digital Methods Initiative Summer School, in Amsterdam, we explore how the top 100 menstrual cycle tracking apps were portrayed by their promoters on the Play store. The project contained two parts: one focusing on apps icons' colors and symbols, and the other, focusing on textual apps descriptions.

My focus in this chapter, and throughout this research, on apps explicitly framing their intended use as apps for pregnancy prevention is based on two things: *a)* the *empirical observation* that it is the most debated use among apps promoters, opponents, regulators, and observers, and, *b)* the *methodological assumption*, shared by many scholars in science and technologies studies, that controversial objects provide analysist with "an essential resource to render the social connections traceable" (Latour, 2005, p. 30).

The analysis will show the multiple and – at times – oppositional "versions" of the body that promoters envision and ultimately materialize through their technology (Mol 2002, p. 142). I have centered the findings in relation to one dimension that revealed central along the analysis process, namely, promoters' relation to *learning*. I will show that the promoters of fertility-tracking apps have varied perspectives on whether and how the body should, or could, become a pedagogical site vis-à-vis their technologies. Therefore, the chapter questions: *To what extent do promoters of consumer fertility self-tracking apps for pregnancy prevention configure users' bodies as pedagogical sites?*

I will draw on empirical observations at two international congresses and three technological fairs. These sites were ideal spaces as they provided the settings for apps' vivid discussions, comparisons, and mostly, promoters' justifications. Additionally, some promoters travelled, like me, across different sites. Encountering these actors in different settings provided an fruitful way to multiply their comparative practices. Indeed, promoters' narratives are clearly shaped by the context in which they are performed[71].

[71] On the field, I introduced myself as a social scientist studying digital fertility tracking technologies, and promoters were eager to share their perspectives. Additionally, I had informal conversations and lead in-depth interviews with promoters during my fieldwork (see appendix D for detail).

Analysis of promoters' discourses sheds light on two themes: (1) promoters' efforts to demonstrate comparability between apps and other contraceptive methods; and (2) their attempts to differentiate the fertility tracking app they are advocating for from those of their competitors. These issues are contentious among promoters. As I will argue in the following sections, the core debate is the extent to which they a) configure users' bodies as pedagogical sites, and b) position users as valuable subjects of (useful) knowledge.

Unpacking and Situating Multiple Configurations

In this analysis, I draw specifically on Lucy Suchman's tripartite notions of "figuration," "configuration," and "reconfiguration" (Suchman, 2007a, 2013). These notions offer methodological tool "for studying technologies with particular attention to the imaginaries and materialities that they *join together*," and how these relationships might be reassembled.

Using this approach to interpretive analysis, I recorded and analyzed the comparisons made by promoters. This led to the construction of the *Body Tracking Configurations Matrix*, which would allow me to attune to the multiple ontologies of the body in fertility self-tracking biosensors[72]. By studying how comparisons are made in practice and foregrounding the multiplicity of sociotechnical configurations, it seeks to problematize "the female fertile body" as a category that might otherwise be left unquestioned.

[72] To create the matrix, I read the fieldnotes several times, annotated them, and grouped emerging themes. Focusing especially on promoters' comparative processes, I first created a table with the main emerging themes as vertical entries and each promoter's discourses on horizontal entries. After several iterations, I distilled a table summarizing the main configurations that emerged in my data and their key attributes, mapping them according to FSTS concepts. This process resulted in an analytical matrix or heuristic tool to examine the different ways promoters configure the relations between bodies, learning and agency through the materiality of their technology.

Table 2 presents the configurations that I identified. As it shows, I identified not one, but four ideal-typical configurations of technology and users' bodies imagined and materialized in promoters' discourses of fertility-tracking biosensors: (1) "the tracked," (2) "the trained," (3) "the tweaked," and (4) "the threatened."[73] These configurations do not represent the full range of fertility-tracking biosensors, nor do they exhaustively describe variation in the sample. Promoters' perspectives sometimes overlapped with more than one ideal-type. Thus, the comparability of the matrix presented here aims to make visible the diversity I observed in the development of fertility tracking technology.

[73] Following anthropologist Marilyn Strathern, the names of these categories, inspired by emic terminologies, emerged as a result of "Strathernian comparison," which is a relational process through which the analytical category and phenomenon emerge together rather than separately (Sørensen et al., 2018, p. 153).

Table 2. The 'Body Tracking Configurations Matrix' applied to fertility-tracking apps promotion (and dissuasion*)

Ideal-typical configurations	**The Tracked Body**	**The Trained Body**	**The Tweaked Body**	**The Threatened Body***
A. Expected performativity of the tracking device	Predicting ovulation *for* the user	Interpreting fertility *with* the user	Estimating fertility *for* the user	Misleading the user
B. Authoritative actor(s)	Technology	Technology, users and related human actors (teachers, practioners, partners)	Technology and users	Scientific experts
C. Instruments; parameters tracked;	App & biosensor; reduced parameters	App & biosensor(s) and body; multi-parameters	App; single-parameter	Hormonal contraception; no parameter tracked
D. Learning regimes	Empowerment in the liberation from learning	Empowerment by learning	Empowerment in the liberation from learning	Not mentioned
E. Ontologies of the Body	Body as data provider	Body as instrument	Body as social entity	Body as entity at risk
F. Central value	Productivity	Autonomy	Convenience	Control

Configuration 1: The tracked body – valuing productivity

> Women's health has been undercapitalized, it's time for a change!; Women don't buy healthcare like they buy shoes ... they need trust.
>
> (CEO of a digital health company, Dec 3 2019, Boston)

On a snowy December day in 2019, I find myself on the 15th floor of a hotel in Boston city-center at the Women's Health Innovation Summit (WHI) listening to promoters of self-tracking apps pitch their technologies to an audience of venture capitalists. Discussions thrive around femtech which is presented as a lucrative and promising market opportunity. Women are referenced mainly in biological terms or gendered consumption behaviors.

Figure 48: Women's Health Innovation Summit, Boston, Dec 3, 2019. Image tweeted by investor Sarah Sossong, @sossongsarah.

In the tracked body configuration, users of self-tracking apps are imagined as objects for whom the app (as the main "agential object" [Suchman, 2007, p. 271]) automatically interprets and predicts personal fertility status. In addition, the tracked body is produced in relation to a biosensor that usually takes the form of a connected thermometer. Promoters describe the tracking method as "simple" compared to traditional methods of fertility awareness, presented as "complex." Simplification comes from the automated interpretation by the device of bodily parameters such as menstruation and basal body temperature. An algorithm translates users' calculated fertility states into simplified and behaviorally actionable information items, usually coded in a binary mode: "fertile" versus "not fertile" (and occasionally, "unknown"). When fertile, users are expected to take contraceptive measures if they are at risk of becoming pregnant. The promise of empowerment is located in users' liberation from the learning as will be described in the next configuration, seen as a burdensome activity. Empowerment is understood as a delegation of a tedious task, enabled by the automated interpretative algorithm.

Although the *learning* process is entirely delegated to the algorithm, a software which is supposed to "learn" from users' regular inputs, promoters usually do not reveal its underlying logic, as one explained:

> Total transparency is not always achievable from a business perspective….We invented the algorithm of the app, and it will be constantly upgraded based on increasing big data. Accordingly, our operation mode or business model is different from other NFP [natural family planning] courses.
>
> (App promoter based in China, email exchange, February 20, 2019)

The secrecy associated with the corporate production and use of algorithms in this configuration embeds knowledge in what I call a "soft(a)wareness": an incentive "to know one's body's internal

logic (via objectifying software) while being prevented from access to the inner workings of the software itself (which is black-boxed)"[74]. This contrasts highly with the "trained body" configuration that will be shown in the next section.

In this instance, users in this tracked body configuration are often described as having a double deficit. They are portrayed as lacking either the ability or time to engage in more complex methods of fertility awareness; sometimes both. Based on this imagined perception, the technology is presented as a mean to reduce the burden of learning, allowing the user to allocate time for other (more productive) activities.

Promoters in the tracked body configuration often emphasize the accuracy and relevance of traditional methods of fertility awareness (where users need to draw charts and calculate their fertility statuses) but acknowledge that, based on their observations or personal experiences, these tasks are too burdensome. Therefore, this is precisely where they situate their market opportunity: in the translation of a "complex" educational method into an "easy-to-use" and marketable tracker. The app becomes a *facilitator* of traditional methods of fertility tracking.

Configuration 2: The trained body – valuing autonomy

> How can natural family planning be implemented in an algorithm? How far can it go in the delegation to the software?
>
> (Gynecologist, Cologne, April 27 2018)

[74] See also Tom L. Lynch (2015).

Figure 49: NFP Congress, Cologne, April 27, 2018. Image by LDB.

These questions about the role of algorithmic technology in natural family planning (NFP)[75] are presented by a speaker at a congress held in Cologne in April 2018 entitled "Family planning today and tomorrow – They say it's love" (figure 49). Under this intriguing title, the congress gathers members of the "Arbeitsgruppe NFP," a working group created in 1981 and dedicated to the evaluation and promotion of NFP methods (NFP Online 2021). The speaker concludes:

[75] As seen in Chapter 1, the wording "natural family planning" is debated by different actors, especially since participants at a WHO workshop, in August 1986, questioned its negatively connotating effects on "non-natural" methods (Obelenienė et al., 2021, p. 3).

> Apps are the future in natural family planning, but the method will still require self-observation. […] Apps cannot take 100% of the work from the woman. They will need to be well-fed, and we'll need prospective effectiveness studies.
>
> (Gynecologist, Cologne, April 27 2018)

As this gynecologist does, promoters in the trained body configuration describe self-tracking for pregnancy prevention as "more than just technology." They present the apps as the medium through which learning can be facilitated, but not replaced. In particular, promoters present self-tracking apps as a means for facilitating decisions about when to have protected of unprotected sex, in order to avoid or facilitate conception.

The expected performativity of apps in the trained body configuration is conceived to enable interpretation *with* the user, but not to do "the work" *for* the user (contrary to apps in the tracked body configuration). In fact, promoters in this configuration mobilize physiological facts assessing that no technology can actually *predict* ovulation. As one promoter states, "Such an event can only be identified by the woman retrospectively, when all the parameters align." The multiple parameters include menstruation dates, temperature, cervical mucus self-observation and secondary symptoms such as breast tenderness or cervix position. In this configuration, the substances tracked play a key role, as the apps rely not only on tracked temperature objectified by a thermometer, but also on users' self-observation of their body, that they enter into the app; based on these self-reported datafied substances and specific "rules," the apps define in/fertile phases.

Promoters typically emphasize the importance of learning and the transmission of expertise from human instructors to human learners who, once trained, become experts on their body and potential teachers themselves. Interpretation is encouraged in its collaborative dimension, i.e. with the help of teachers, practitioners, or partners.

As in the tracked body configuration, the apps function here as a translation on a digital format of the "pen and paper" symptothermal method for NFP. But in the trained body configuration, users are "figured" as able to become interpretative agents in the assessment of their fertility status (Suchman, 2007a, p. 281). They learn to recognize different body parameters, systematize their observations and transfer them on their digital charts to assess fertile and infertile days. Thus, this configuration materializes a "science of perceptible knowledge" (Alexander Gottlieb Baumgarten, as quoted in Jimenez, 2016, p. 207) where knowledge is produced through trained intuition and sensory experiences. Users themselves need to become the authoritative and autonomous figure of expertise. In this configuration, users are imagined to become empowered by learning about and *from* their bodies.

Configurations 3 & 4: The tweaked and the threatened body

Whereas most of my observations fit within either the tracked or trained configurations, two additional configurations, though less frequent, emerged from my field observations: the 'tweaked' and the "threatened body." As the analytical matrix is intended as a tool to articulate differences, I discuss them next to illustrate additional variations of ontologies of the self-tracking menstruating body.

The tweaked body[76] *– valuing convenience*

During the Natural Family Planning (NFP) Congress in Cologne, a session is dedicated to the "practical experience" of NFP promoters from different countries, including Gambia, Belgium,

[76] I am referring to the Merriam-Webster's definition of "tweak" as "to make usually small adjustments in or to" something.

China, Sweden, the United States, Sweden, the Czech and Slovak Republics. A promoter from the United States, a trained anthropologist working in the field of Obstetrics and Gynecology, presents a prospective study based on her team's newly developed fertility tracking app.

The promoter raises two problems related to existing menstrual cycle tracking apps for pregnancy prevention. The first one is related to a lack of rigor surrounding such apps, as she states:

> Fertility apps is a very crowded space. It seems that almost anybody can put an app on the App Store and just call it whatever they like. This is a bit of a problem and requires us to think very hard about how we can move this field forward in a positive way. Because almost none of these apps are based on very rigorous research.
>
> (App promoter based in the United States, Cologne, April 27, 2018)

She cites two reports concluding that apps predicting ovulation are generally inaccurate, insufficiently founded on scientific evidence, and, therefore, unreliable (cf. Setton et al., 2016; Duane et al., 2016). These reports show such apps might not be sufficient for pregnancy prevention, if users don't receive additional training or counseling from health practitioners. The second problem comes with the fact that such additional training or counseling are not accessible for many women lacking appropriate resources (financial, material, educational or infrastructural).

To address these problems, the promoter's research team developed an app in which "complex" methods for fertility tracking are simplified thanks to big data analytics, and therefore don't require additional user training. In parallel, the team launched a prospective efficacy study of (and through) their app to assess its accuracy. The simplification takes the form of minimal tracking requirements, using menstruation dates as the single parameter. This contrasts with the tracked body configuration, in which users are supposed to track both their menstruation dates and

their temperature, or with the trained body configuration where users track multiple parameters such as menstruation dates, temperature, cervical mucus, cervix or breast tenderness.

The tweaked body configuration also differs in how promoters situate users and "non-users" culturally (Oudshoorn & Pinch, 2003). Its promoters emphasize differences between women (and changing perspectives in individuals) when it comes to contraception needs and preferences:

> It's not like either somebody wants to get pregnant, or they don't. It's very nuanced, and we need to recognize that, I think in our teaching and in our studies and in the way we assess advocacy.
>
> (Gynecologist, Budapest, May 11, 2018)

In the tweaked body configuration, promoters attempt to address biosociotechnical complexities. They acknowledge the utility and accuracy of the methods from the trained body configuration, but argue that those technologically mediated practices are not accessible for all women. Therefore, they aim for maximum convenience, rather than maximum productivity, autonomy, or accuracy. Instead of providing users with a techno-determined binary fertility status (such as in the tracked body configuration) or requiring them to triangulate and assess multiple body parameters (such as in the trained body configuration), they provide them with a simple and usable *estimation*, and let them act upon it.

The threatened body – valuing control

This configuration contrasts strongly with the previous ones, as actors in this configuration act as *dissuaders* of fertility tracking for pregnancy prevention. At different field sites, promoters frequently expressed skepticism about one or another conception of users, or how a particular configuration could be actualized. They raised criticism towards misleading or poorly backed-up

research, and the general lack of transparency about how the algorithms were built. While they would at times challenge the relevance of specific fertility tracking technologies and/or create controversies, they would nevertheless agree on the possibility and desirability of using self-tracked data to assess fertility. By contrast, promoters in the threatened body configuration reject fertility tracking for pregnancy prevention in all its forms.

One striking example of such opposing perspectives occurred at the 15th Congress of the European Society of Contraception and Reproductive Health, held in Budapest in May 2018. After hearing a presentation from an advocate of "Natural methods for birth control" – who happened to be the same speaker I had heard in Cologne –, I attended a talk on the "Contraceptive Paradox" by a gynecologist from Austria. In his talk, he invalidates self-tracking for pregnancy prevention and states:

> It's either a woman controls her fertility, or her fertility controls her – only the romantic refuse hormones. Even the words "natural" in "natural contraception" is misleading. Chemical hormones are the language of the body. They really are the only way women can have full control over their reproductive bodies.
>
> (Gynecologist, Budapest, May 11, 2018)

The gynecologist presents a conception of fertility different from the ones seen above. To him, hormones are nothing to fight against, as they represent the "language of the body;" whether they are manufactured by an industry or produced in the body does not make a difference in his narrative. Therefore, he rejects the claims from advocates of "natural methods" (as seen in the tracked, trained, and tweaked body configurations), for whom nature is associated with a subject whose body is not altered by synthetical hormones.

While previous configurations require users not to use hormonal medication that would render tracking inaccurate or meaningless, in the threatened body configuration, it is the *reliance on tracking* that is presented as inaccurate and meaningless. While the tracked and trained configurations often associate potential danger with the contraceptive pill, on the contrary, the threatened body configuration associates danger with not being in control of a – chaotic – woman's body: empowerment results from external control over disclaimed "natural fertility," rather than learning about or with the body. The body constructed in these oppositional relations is configured as a body at risk of misleading claims for accuracy. It is configured as vulnerable and in need of protection; a protection that should be offered by so-called objective science and neutral scientific experts.

Contrasting the Configurations

The typology that emerged from field observations and typified in the *Body Tracking Configurations Matrix* foregrounds not one, but multiple body ontologies, embedded within fertility-tracking biosensors for pregnancy prevention. As a tool for comparison, the analytical matrix makes visible several distinct ontologies of the body that were configured by promoters of fertility biosensors.

For instance, promoters disagree on whether and how the body should or could become a pedagogical site through menstrual cycle self-tracking biosensors. Different versions range from emphasizing the biosensor as single authoritative actor in the pedagogical assemblage (cf. the tracked body), to the multiple actors involved and required in the process of learning and teaching (cf. the trained body), to the app's algorithm as the key learning component (cf. the tweaked body).

Dissuaders, on the contrary, opt for the replacement of learning with external control over the body (cf. the threatened body).

Secondly, promoters mobilize different epistemologies (i.e. data-driven, sensory-based, and evidence-based) when framing the purpose of fertility tracking. Toggling between imaginings of more active users with "low tech" (cf. the trained body) and more passive users with "high tech" (cf. the tracked body, the tweaked body), promoters nevertheless agree on the potential validity of menstrual cycle tracking for pregnancy prevention. Their views contrast with imaginings of tracking as unreliable (cf. the threatened body).

Thirdly, promoters rely on and enact multiple "ontologies" of the body (Mol, 2002), configured as data provider (cf. the tracked body), instrument (cf. the trained body), social entity (cf. the tweaked body), or, for dissuaders, entity at risk (cf. the threatened body). In line with feminist science and technology studies approaches, it reminds us that – gendered – bodies are always constituted in practices (McNeil & Roberts, 2011).

Thus, the matrix is not only a typology, it is an analytical framework for revealing how different technology promoters configure the relationships between agency, learning, and bodies. It helps make visible to what degree agency is being delegated to which actors (app, biosensor, user, partners, teachers, medical doctors, etc.); at the same time, it helps make visible the degree to which learning is deemed necessary for the practice to "work."

Contesting (Some) Configurations

Within the social sciences and HCI literature, the ideal-type of the tracked body is the most commonly found configuration. Scholars studying apps related to this configuration have shown how users' bodies, and "metrified fertility," are positioned by many promoters as lucrative

business opportunities (Roberts & Waldby, 2021, p. 17) and have highlighted, amongst other issues, the ways this configuration often fails to acknowledge for the diversity and "messiness of menstruators"[77] experiences (Pichon et al., 2021). Some social scientists accounts align with dimensions of the threatened body configuration, in which users' are "at risk" of the unintended consequences of such tracking technologies; however, in their accounts, the risk is situated in potential threats to subjecthood and intensification of gendered reproductive imperatives rather than in ineffective contraception (Fox & Epstein, 2020; Healy, 2020; Kressbach, 2021; Lupton, 2015, 2016a; Novotny & Hutchinson, 2019), or in risks related to surveillance and data commodification (Hendl et al., 2019; Mishra & Suresh, 2021). Additionally, a growing number of studies of users' experiences ask *why* and *how* some individuals turn to such apps to track their menstrual cycles (for a scoping review of available research until April 2019, see [Earle et al., 2021]).

In contrast to the tracked body, which has been critically theorized only very recently, the trained body configuration is most commonly found in sociological literature from the 1980s and 1990s, which I discussed in the first chapter.

The tweaked body configuration that I observed has not yet, to my knowledge, been discussed in social sciences. To some extent, it is similar to the tracked body configuration in its reliance on data-driven analytics as a promise of accuracy for the detection of ovulation. However, it differs from the tracked body configuration in its inclusion of more-than-biological dimensions: by highlighting the socially situated positions of users, it can be said to foster a more co-constructivist approach of technology and users. It also aligns with design recommendations from the field of

[77] The term "menstruators" is increasingly used to define "people who menstruate" without presuming any gender identity. For a review of some uses of the notion of menstruator in biomedicial literature, see (Pichon et al., 2021).

personal informatics suggesting representing fertility status as probabilities rather than dichotomic indications such as fertile versus not-fertile (D. A. Epstein et al., 2017, p. 7). Occurrences of the threatened body configuration as a rejection of fertility-tracking apps for pregnancy prevention are most commonly found in the field of reproductive sciences, in which researchers tend to oppose the categorization of such apps as contraceptives, and valorize instead methods with higher clinical effectiveness, such as "injectable and oral contraceptives, sterilization, and long-acting reversible contraceptives" (Austad et al., 2016, p. 342).

Imagining Different Configurations

Scholars have shown that promoters' expectations of imagined users often do not match users' ambivalent and complex experiences with data (Lupton, 2020; Wilkinson et al., 2015), resulting in "disjunctures" (Fors & Pink, 2017, p. 2). To address such concerns, activists and interdisciplinary research teams have suggested design interventions for shaping more emancipatory fertility tracking technologies, assuming that a change in the design will change their effects in society. Among these, some initiatives encourage the inclusion of users' feedback in the design of these technologies in order to better configure and represent users' specific needs and values (for example, Fox and Epstein 2020; Hendl, Jansky, and Wild 2019; Novotny and Hutchinson 2019; Pichon et al. 2021). Indeed, they echo the argument by Hayhurst, Giles, and Wright's (2016) to develop participatory research – or, in healthcare, "experience-based co-design" (Fucile et al., 2017) – as an approach that serves to reorient reductionist market-oriented biopedagogies to the needs of the people they address.

A cadre of radical, self-determined menstrual activists have already started to build collective projects for the design of feminist menstrual cycle tracking technologies. For example, mobile

apps such as drip or POW! are being developed in an attempt to give more agency to users when it comes to privacy, transparency, or data ownership[78]. Another project to be mentioned is Hamdamapp,[79] an app that allows users in Iran and Afghanistan to track their cycle on the Djalali calendar and provides non-heteronormative information about sex and health.

Additionally, some perspectives on women's uses of biomedical technologies do not locate the possibilities for intervention solely in the design process of such technologies but also in the interactions between technologies and users; for example, studying fetal ultrasound, feminist scholars Frost and Haas (2017, p. 92) invite "everyday women" to be "decolonial bricoleurs" in their approaches to technologies. By that, the authors mean to develop, with "communities and allies" (103), critical means of looking at and interacting with technologies in ways that go beyond configurations in which subjects' agency over their bodies is undermined (97).

Frost and Haas' recommendations echo what Jasanoff (2007, 33) calls "technologies of humility," i.e. "disciplined methods" that "compel us to reflect on the sources of ambiguity, indeterminacy and complexity" inherent to technoscientific knowledge. Rather than aiming for a resolution of ambivalences in "human-machines interactions" (Suchman, 2007b, p. 259) with a perfectly-designed artifact – a "technological fix" (Rosner, 2004) –, a more pragmatic attempt to deal with these innovations, as these approaches suggest, might be to engage in reflexive practices about the ambiguity and multiplicities of self-tracking biosensors.

[78] See https://bloodyhealth.gitlab.io/ for the drip app, and https://www.usepow.app/ for POW!

[79] See https://hamdamapp.com/ for Hamdamapp.

Conclusion

In this chapter, I have demonstrated that, within biosensors assemblages, the configurations of bodies, subjects, and values are multiple rather than singular. I suggest that Suchman's tripartite configuration offers helpful resources to study apps beyond framings that implicitly contain a dualistic mode of thinking – between designer/user, empowerment/control, and valuable/invaluable knowledge. Investigating the "situatedness" of apps using a constructionist approach contrasts with critical analyses searching within the app's content, traces to "uncover wider discourses, practices, and beliefs that are circulating about the topics they seek to address" (Lupton, 2016a, p. 82). As a result, while critical analysis studies emphasize the commonalities of fertility apps to alert against envisioned disciplining effects on women's lives, a constructionist approach instead acts as a multiplier of biosensors ontologies, without presuming their impact on people's lives. The matrix leaves room for adaptation, exploration, redefinition.

How does this finding relate to the first chapter? While in the first chapter, the objective was to identify, from a collection of paper documents, assemblages through which the fertility-tracking subject was enacted, in this second chapter, the objective has been to zoom in on promoters' narratives from observations within shared spaces or physical co-location (Beaulieu, 2010, p. 454). Occurrences of the articulation processes identified in the first chapter (i.e., *separating*, *hierarchizing*, *opposing*, *anticipating*) can be found in the present analysis, although articulating different elements and with variable intensities.

A process of *separating women based on geographies* does not appear clearly among the contemporary configurations studied. Most narratives that fit the "tracked body configuration" presume the user as a universal "modern woman," by which one can hypothesize a middle-class, working woman. In the trained body configuration, fertility tracking is presented as a method

accessible to women from any countries, providing that they receive proper education on the method. In the tweaked body configuration, women's differential situations (social, economic, geographic) are mobilized as a criterion to justify the use of the artifact, framed as the simplest, although still valid, method. Country-based separation does not appear in the threatened body configuration.

Hierarchizing is an important process in all promoters' contemporary narratives. They prioritize their artifact compared to competitors' artifacts or traditional non-computerized tracking methods. Mostly, each configuration hierarchizes some values over others (i.e., productivity, autonomy, convenience, control).

The *opposition* between so-called natural and artificial methods is a crucial differentiating criterion in the threatened body configuration. In this narrative, not only are methods set in solid opposition (tracking versus pharmacological methods), but the very naming of "natural family planning methods" is also strongly opposed to "proper" naming (although no alternative is suggested).

Anticipating a child's sex is not mentioned on the field. However, another form of anticipation emerges in the tweaked body configuration. The anticipation is placed in the hope of using the app as a tool to conduct a clinical efficacy study directly from user data collected via the app.

In the next chapter, I turn to users' experiences of a fertility tracking biosensor whose marketing mobilize several characteristics from the "tracked body configuration."

Anchoring 3

On July 18, 2017, following my first visit to Valley Electronics's Swiss office, I email the CEO to inquire about my next visit to the Swiss office. She replies that she will be in the US office for a few weeks and suggests contacting the German office. She connects me by email with the CMA. Willing to support my doctoral research, the CMA inquires about my background and research interests to see if we can find any matches. We exchange the following emails:

Box 6

From: [The Researcher]
Object: Re: Hi from Lausanne
Date: July 17, 2017, at 09:13
To: [The Medical Advisor]

Hallo,

Vielen Dank für die Antwort.
My background is in sociology of health & medicine, with a very strong interest in the digitization of the human body (I've done my master thesis on fitness tracking apps).

For my "Daysy Project," I am interested in the knowledge that needs to be put inside a fertility tracker or that is mobilized to produce the tracker - and the knowledge that the tracker produces or the knowledge that the users, healthcare professionals or scientists produce with the tracker.

So far, I've started a literature review of the clinical trials I've found about digital fertility-tracking. I have read scientific studies about Ava, Bodymedia, Dot, Duofertility, Glow, Ladycomp-pearly-Daysy (the Polish study), Natural Cycles, and other studies that don't specifically focus on one single tracker but that review a large number of menstrual cycle tracking apps (for instance Chen and Mangone, 2016; Duane et al., 2016; Mangone et al., 2016; Setton, Tierney and Tsai, 2016).

Do you think we could find some matches?

Beste Grüße, Laetitia

Box 7

From: [The Medical Advisor]
Object: Re: Hi from Lausanne
Date: August 9, 2017, at 12:07
To: [The Researcher]

Dear Laetitia,

Please excuse the late reply. (…)
[One of the company's research] data sets shows, for example, that XX% (sic.) of Daysy users gained a better understanding of themselves and their cycle by using the app (why?). The data set also shows that interest in one's own data decreases over time (is it because the app is boring to a certain extent, or because users become more confident in dealing with themselves and their cycle?). An interesting phenomenon is the sharing of data, as it shows that in countries with a paying healthcare system [bezahlten Gesundheitssystem], data are shared less, whereas in countries like the USA, data are shared daily by several hundred users in FB groups, etc. It would be interesting to find out whether this is due to the fact that US women avoid going to the doctor, for example, to save money. (…)

I look forward to further exchanges! Many greetings,
[The Medical Advisor]

(*translated from German*)

After further email exchanges and a phone call, I visit the German office in September 2017. On February 20, 2018, the company launches a customer satisfaction survey to better know their users (see figure 50). A few months prior, during my ethnographic observations at the company, the MDA, aware of my interest in user experiences, suggested that the company add a question to the survey asking users if they would be willing to be contacted for an interview.

As a consequence, I receive an Excel file from the MDA with the email addresses of 1,193 active users of Daysy willing to participate. The file does not contain any other information, so it is not possible to build a specific sample, based on age, location, or any other potentially useful sociodemographic characteristics. I start contacting users randomly and gradually (sending ten

emails at a time, see the message in appendix E), and organize online interviews with the people who respond positively. I stop sending emails when I reach twenty-six interviews. While I can continue to exploit the database and send more interviews invitations, I decide not to, in order to maintain the research agenda, and have sufficient time to analyze the extremely rich experiences that these users agreed to share with me.

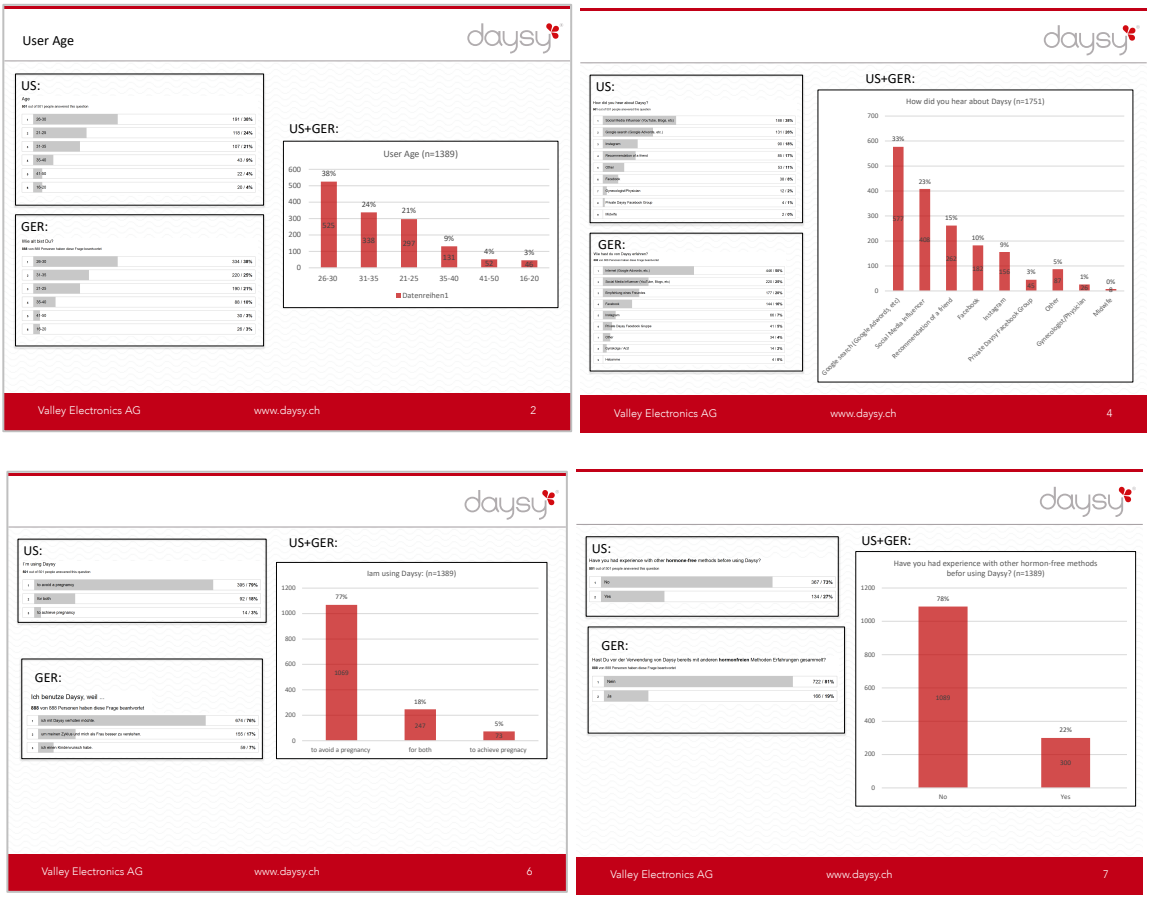

Figure 50: Results from Valley Electronics customer survey, 2018, reproduced with permission of Valley Electronics AG

3 Experiencing

This chapter investigates how a specific fertility biosensor come into being in users' lives[80]. In previous chapters, we have seen how fertility biosensors from the late twentieth century were promoted within multi-purposes *assemblages*, and later, were participating in the *configurations* of differently imagined bodies. Let us turn now to *how users configure themselves* in digitally-mediated fertility-tracking practices.

The chapter conceptualizes users' experiences as a historical "category of knowledge" (Murphy, 2006, p. 64)[81]. We will see how, in users' narratives, trust in data is built rather than given; how self-tracked data can represent reassurance, as well as pain. We will see how, through technologically-mediated practices, very singular experiences of the body emerge. By documenting and situating these experiences, I extend classical anthropological approaches that have investigated women's lived experiences of their body, as always socially and historically situated rather than stable and universal (Duden, 1991; Martin, 1987/2001).

Particularly, the chapter investigates under which conditions some women adopt biomedical constructions of the temporary infertile woman and reflect on their lives accordingly. We will see

[80] This chapter is an extended version of an article published in *Catalyst: Feminism, Theory, Technoscience*, 7 (1): 1–21, entitled "The Cyclic Self: Menstrual Cycle Tracking as Body Politics," https://doi.org/10.28968/cftt.v7i1.34356.

[81] With "category of knowledge," Murphy emphasizes that "[i]t is only through particular methods rooted historically in time and space that 'experience' becomes a kind of evidence imbued with certain truth-telling qualities" (Murphy, 2006, p. 64). As an example of historical practices that have granted "experience" a status of "evidence," she mentions "consciousness raising" practices – a historical practice in which feminists, in self-help groups, collectively produced knowledge in a form that was seen more "authentic" than so-called "expert knowledge" (p. 64).

how users engaging in processes of fertility tracking co-shape a specific relationship with their bodies. I call this process "cyclic self-fashioning" – a process through which the datafied body becomes a catalyst for understanding and intervening on the self. Building upon Joseph Dumit's (1998) concept of "objective self-fashioning," the notion of "cyclic self" provides a heuristic to investigate the normative biosociotemporality of fertility self-tracking practices.

The analysis draws from online interviews with twenty-six users of the Daysy fertility tracker (see appendices E, F, G for details). The twenty-six users I interviewed participated in the customer satisfaction survey launched by Valley Electronics in February 2018 that I mentioned in the previous anchoring section. Except for two—in Switzerland and Denmark— all interviews were conducted online (see appendixes F and G for details).

As the aim of this phase of the study was to further develop an emerging theory of cyclic self-fashioning grounded in ethnographic research, I chose to analyze a small, random sample of 1,193 active users of Daysy without limiting eligibility to a particular nationality or age group. The sample varied demographically. Participants were between twenty-one and forty-two years old, mostly white, middle-class, and highly educated cisgender women. They were married, single, or in monogamous or polyamorous relationships. Some had children, and some didn't. Some were religious (Christian, Jewish), and others were not. All interviews were conducted in English, except for one in French. The interviews spread across different national contexts. Countries of residence included: Switzerland (3), Germany (1), Ireland (1), Denmark (2), Finland (1), the Cayman Islands (1), Italy (1), the United Kingdom (2), the United Arab Emirates (1), and the United States (13). Nine participants were no longer using the tracker at the time of the interview for reasons that will be revealed later.

All interviews were recorded, transcribed, and analyzed abductively to foster theory construction. Stefan Timmermans and Iddo Tavory (2012) argue that abductive analysis "rests on the cultivation of anomalous and surprising empirical findings against a background of multiple existing sociological theories and through systematic methodological analysis" (2012, 169). Thus, building upon my emerging theory of cyclic self-fashioning as a process of challenging normative expectations of the fertile female body, the analysis explores three research questions: (1) What does the digital fertility tracker promise its users, and what drives some people to use it? (2) What does it take for a person and their body to become a subject for whom this technology works? (3) What are the effects and affects produced in a model where anticipated cyclicity is the norm?

Like in previous chapters, my approach is situated in self-tracking scholarship that theorizes the body as a site for interpretation and challenges the singular conception of the neoliberal self-tracking subject (Danesi et al. 2020; Henwood and Marent 2019; Sharon 2015, 2016; Weiner et al. 2020). Consistent with a socio-material practice-based approach that emphasizes the ambivalence and fluidity of people's engagements with technological artifacts, I take investigation of the role of biotemporal mediated entities in everyday life to support and extend previous research demonstrating that experiences of menstrual cycle tracking devices are far from being unified (Andelsman, 2021; Blair et al., 2021; French et al., 2022; Gambier-Ross et al., 2018; Grenfell et al., 2021; Hamper, 2020, 2021; Levy, 2020; Levy & Romo-Avilés, 2019, p.; Lutz & Sivakumar, 2020; Zampino, 2020).

By investigating the life of a biosensor in users' realities, this chapter extends previous research further by focusing on practices that have received little attention in the literature so far, namely computerized fertility-tracking for pregnancy prevention[82]. We will see that the fertility

[82] Existing studies have focused mainly on pregnancy seeking or menstrual management practices.

tracker does more than measure a fertility status at a point in time; it also mediates users' relationship with their body and sometimes their relationships with others such as partners, relatives, or healthcare professionals. Additionally, we will see that the tracker rarely acquires a singular authoritative position in the fertility tracking assemblage. It is mobilized alongside other elements (books, online forums, partners, doctors, healers, medicinal foods, friends and families, ovulation kits, and others). Ultimately, we will be able to contrast findings from the present analysis with what we learned in previous chapters.

Configuring the Biosensor

"As easy as 1, 2, 3...Only about 60 seconds per day!"[83] In 2014 Valley Electronics, launches a new fertility tracker called Daysy (figure 51). Like the company's previously marketed hardware, the tracker is promoted as a stand-alone, computer-based thermometer that measures, records, analyzes, and displays a woman's estimated fertility status based on basal body temperature. Every morning, before getting out of bed, the user takes her temperature. Once measured, a color-coded light on the device reports her fertility status: green indicates that the user is not fertile; red signals that she is; and yellow means that the tracker doesn't know. Additionally – this is a significant novelty compared to Valley Electronics' previous devices – the user can connect the tracker to a smartphone app to visualize her data, which appear either as colored days on a calendar or temperature values on a chart. The user is then expected to take appropriate and responsible contraceptive measures based on these colors[84].

[83] https://daysy.me/, (Valley Electronics, n.d.), accessed February 27, 2022.

[84] Despite its apparent simplicity, the tracker is configured for a specific set of users who embody biological, social, and political adequacy. That is, they should have a nineteen- to forty-day menstrual cycle, educational and socioeconomic resources, and the power to choose when, and if, to have sexual intercourse that might result in

Figure 51: Daysy and the DaysyView app. Image from van de Roemer et al. (2021, p. 2), reproduced with permission of Valley Electronics AG.

Mobilizing the fertility-tracking configurations matrix to analyze Daysy's promotion and marketed performativity, I situate the tracker within the "tracked-body configuration."[85] Operating within a tradition of revealing technologies for an "informational body" (Viseu & Suchman, 2010,

pregnancy. This idealized user is most likely to be found in upper socioeconomic classes and Western industrialized countries, a hypothesis confirmed by the sociodemographics of the randomly selected users who agreed to participate in the interviews on which this chapter is based.

[85] During a first interview with the CEO of Valley Electronics, she explained how Daysy was meant as a *facilitaror* of fertility-awareness based methods: "If you really want to dig deep into FAM, fertility awareness method, great, go for it. But for most people, it is too far away to start. It is like learning a complete new thing. And I wanted to create something where you don't have to learn anything. It is supposed to be so easy that anyone can do it, even if you don't want anything to do with FAM [fertility awareness-based methods]. Just no work (*she rubs her hands in a metaphoric gesture*), just no work what so ever, no thinking (*laughs*)" (May 5, 2017, Valley Electronics CEO, Zürich).

p. 175), the fertility tracker promises to bring users closer to their bodies by making perceptible what would otherwise be unknown. Practically, it offers users to identify and predict ovulation for them, relies on reduced parameters (menstruation and temperature) and promises to "support [them] in empowered and informed decision-making[86]." Empowerment is mediated through built-in constraints designed to alleviate potential errors. For example, users can neither measure their temperature twice in a certain time frame, nor edit it. Ultimately, the measurement, charting, and interpretational processes granted to users by design require limited action from users. A "technosexual script"[87] (Waidzunas & Epstein, 2015, p. 193) spares users the burden of superfluous cognitive and contraceptive labour: users can rely on the "intelligent thermometer" to know when to use contraception instead of putting energy into learning fertility awareness methods.

Facing constraints when opting for a computerized fertility tracker

> Over the course of about ten years, I tried the contraceptive pill, had an IUD, so I had a copper coil, and I've had a hormonal Mirena coil. I've had the implant that goes in the arm. I tried a couple of different pills, so progesterone-only pill and a combined pill...Even I tried the diaphragm. I tried condoms. I tried pretty much everything...It either made me physically react badly...or made me emotionally feel like I was completely

[86] https://daysy.me/, (Valley Electronics, n.d.), accessed February 27, 2022.

[87] Waidzunas and Epstein use the concept of "technosexual scripts" "to provide a more careful examination of the orchestrations of bodies, apparatuses, self-understandings, and cultural beliefs that, together, result in particular materializations of [an object of study]" (Waidzunas & Epstein, 2015, p. 194). The object of their research is a is the phallometric test, a measuring device, not intended to distinguish between fertile and not fertile days in women, but between "the erotically normal man" and the abnormal (Waidzunas & Epstein, 2015, p. 204).

> separate from myself. I felt very anxious and just unable to make decisions, and I felt like I wasn't myself at all.
>
> (Nicole, age 30, United Kingdom)

In recalling her contraceptive experiences before buying the tracker, Nicole's not-yet-tracked body materializes as a painful entity. Equipped with different technological devices (pills, IUD, implant, diaphragm, condoms), she experienced either a disturbing body or a disappearing self. Like Nicole, other users describe a long and difficult history of contraception whereby technology would not allow them to align their body with their "embodied self" (Akrich and Pasveer 2016, 71).

This experience of dissociation is complicated by social expectations about proper contraception. Users of the biosensor often face disapprobation[88], especially from medical experts:

> My doctor [in Canada at the time] said, "I hope you're using condoms as well." And I don't really want to argue with my doctor because I respect their opinion, but I also don't want to be on hormonal birth control and...he's never pressured me to be on it, but...that's the only real option that he's ever presented as something for me. Or use condoms. And I'm like, "I think there is another option for me [in fertility tracking] and I've done a lot of research that I think I'm informed enough to make the decision..." But it wasn't well-received from the doctor.
>
> (Chiara, age 30, the Cayman Islands)

[88] A few users mentioned being amicably teased by friends ("aren't you crazy to use this thing?") or talked to with sarcasm by acquaintances ("you know how we call people using such methods? Parents"). Anticipating bad reactions, some users did not tell anyone about using a fertility biosensor, except for their partner if they had any.

The decision to buy the fertility biosensor does not come lightly. Chiara spent five months gathering information before deciding to buy the tracker. She read articles online and the manual *Taking Charge of Your Fertility*. She joined a users' online forum and asked questions.

Stefanie (age 23) from Switzerland echoed that "the process of being convinced before buying [is] hard." She was inspired by a YouTuber narrating her experience with the tracker as a solution to get off of hormonal birth control. In Stefanie's, and many users' narratives, the tracker's appeal was in its promise of "no side effects." When acquiring the tracker, Stefanie concurrently shifted her trust away from the pharmaceutical industry's discourses on hormonal birth control to the company's rhetoric on hormone-free tracking, through which the desirable fertile body is closer to nature, and free from unnecessary chemicals; paradoxically, this particular "shift to nature" happens through the acquisition of an expensive technology.

The cost of the tracker (about US$ 300) often delayed purchase by several months or years[89]. An additional constraint is that many users do not know beforehand if their body is a suitable candidate for the technology. Contrary to buying a smartphone or regular computer, which will work independently of a consumer's biology, acquiring a fertility computer comes with a certain degree of uncertainty from the buyer's body. Nevertheless, some women used a cost-benefit approach to justify the expense. They explained that, assuming their body would work, purchasing a tracker that could last a decade seemed more economical than buying contraceptives every day, month, or year.

Whether acquiescing to a device or using it in service to their bodies, users perceived their bodies as "a site for an anticipatory, future-oriented calculation of value" (Murphy 2017, 115), a

[89] Some users benefitted from an occasional sale discount. For consumers in the United States, depending on their insurance, part of the cost for Daysy can be covered. No users interviewed mention profiting from such coverage.

site for investment. The tracker constitutes self-fashioning users as responsible consumers and resourceful choice makers, a configuration paradigmatic of the "new moral economy of health care" that gave rise to multiple forms of biopolitics in the 1970s (Murphy, 2012, p. 101). The accounts discussed thus far present the tracker as a values-loaded object, with "built-in normativities" (Moser 2008). Yet Nicole, Chiara, and Stefanie should not be seen narrowly as either vulnerable victims of overarching forces or as rational fertility-optimizing consumers. Their entanglement in the fertility-tracking assemblage occurs in a gendered healthcare model of responsibility, where female subjects are expected to take reliable actions to manage their hormonal bodies, even if being denied real, practical choices (Roberts 2006).

Building trustful arrangements

This section asks, what does it take for a body and a person to become a subject for whom the technology is to work?[90] By configuring the body as a site for interpretation, fertility-tracking subjects gain autonomy in specific situations, and challenge the representation of biosensors as "disciplinary [devices], working to tame the sexual and reproductive body by rendering it amenable to monitoring" (Lupton, 2015, p. 449)

Izabella learned about digital fertility tracking from a colleague and, after some research, decided to buy a Daysy. Reflecting on her user history (more than two years and continuing), she described a shift in her willingness to rely on an external entity *only* to make sense of her fertility status:

[90] I am grateful to Bernike Pasveer for suggesting me this question framing during the WTMC workshop "Smart," on December 17, 2018, at Soeterbeeck (NDL).

> At the beginning, I used it before reading anything about the method. I knew people were charting and taking their temperatures, but I didn't want to risk making the wrong assumptions. And I didn't want to manually enter numbers and make a decision. I wanted something easy that just tells me green, red, or yellow.
>
> But then later, maybe one year after using it automatically, like a robot and reading and doing what it says, one friend recommended that book, *Taking Charge of Your Fertility*. I read it and then I started to go backward into my cycle and analyze the data.
>
> (Izabella, age 34, Switzerland)

While, like other users, Izabella had done some prior research on existing devices, she didn't deem it necessary to study the fertility-tracking method itself. Submitting her signaling-albeit-opaque body to the tracker was good enough, as Izabella expected to see a distinct color representing her fertility status. In those days, she described her body as a robot engaging in unprotected sex on green days, with reassurance of no side effects. But following the intervention of a friend and an authoritative fertility book, she transformed from willing object into an active interpreter of her cycle and fertility status. No longer afraid of making erroneous decisions related to her fertile body, she now "recodes" colors on occasion based on her body sensations, and on her readings. Like Izabella, other users shifted from automatically submitting their "bodies-to-be-known" to the tracker to becoming agents of interpretation. In such instances, the tracker loses its expert status as the user claims it for herself.

Some fertility-tracking users had the opposite transformation. It is beyond the scope of the current analysis to fully explain the conditions under which users will shift toward or away from agency through the tracker. However, several users became more trusting subjects of the technology after looking for information to make sense of their tracker, body, and/or data. When

sources (such as books, friends, teachers, websites, customer services, and peers) gave confirmatory information, these users slowly adapted from a skeptical, interpretative position and trustingly delegated the interpretative work to the machine. For Jenny (age 28, Finland), the shift occurred as she took an online class on fertility-tracking methods, after having used the tracker for a few months. Chiara spent considerable time asking questions and reading users' online discussion posts before buying the tracker, and later, trusting it. Cathy used an ovulation predictor kit to confirm the tracker's data: "I wanted to make sure the Daysy was actually accurate. I trusted that it was, I needed a controller, I needed another source to confirm it" (Cathy, age 33, US). The red light on the tracker matched the positive line from the ovulation kit, bolstering Cathy's trust in the tracker as she's engaging in sensory work to make sense of her body in a context of differently mediated data.

After being put to the test, the tracker sometimes becomes a kind of "digital companion species" (Lupton, 2016b), as the boundary between "device as tracker" and "human as tracker" is blurred. Cathy describes her relation to the tracker's yellow light:

> I think Daysy does a good job of using the yellow light. If there's anything that makes it doubt where my body might be going hormonally, it makes it a yellow day, which I find mostly frustrating [laughs]! But it's doing that to protect me.
>
> (Cathy, age 33, US)

Whereas a green or red light is perceived as useful information that buoys action, the bittersweet resignation Cathy describes when her protective tracker is uncertain about her status reveals a

complex relationship. Regardless of fertility status, however, human and nonhuman entities combine through "data rituals"[91] (Forlano, 2017, p. 4) to produce the fertile female body.

As the narratives show, the tracker rarely acquires a singular authoritative position. Its conditional power to shape behavior is related to multiple elements, through which users themselves produce "serviceable truths" (Jasanoff, 2015). The data operate as an active mediator between the body and the embodied self. The tracker takes part in an intricate assemblage, which calls for the problematization of taken-for-granted considerations on the distribution of agency.

Rather than being merely empowered or alienated by technology, users subjectify themselves to a specific regime of attention, seen in chapter 2, that I call soft(a)wareness. As a result, designers create a positive frame of "intentional non-knowing" (Owens, 2017) that functions as a moral imperative for digitally mediated self-management. This cultural promotion of ignorance (Schiebinger, 2005) works alongside the push for technologically mediated "self-knowledge." Users can rely on the tracker to know when to use contraception rather than their own embodied intuition, but they don't know the inner logics of the interpretative software, hidden from their realm of awareness.

Practically speaking, users enact varied versions of soft(a)wareness. These different versions occur *within* and *between* users. For example, early on in the cyclic self-tracking process, Izabella devoted minimal attention to her tracked body by submitting it like a robot to the tracker. Later on, she went beyond the tracker's scripted requirements to devote ample time and energy to understanding, observing, and analyzing her body and her embodied self. Some users kept tracking their cycle, but stopped using the tracker, once they become "confident enough" to do so. Nicole

[91] Forlano conceptualizes "data rituals" as "a feminist data practice—a way of doing science out of feminist theory" which "operate[s] at the intersection of qualitative, quantitative, and technocentric ways of knowing" (Forlano, 2017, p. 4).

purchased a "smarter" tracker that allowed her to continuously track her temperature at night despite having to stand up regularly to feed her newborn. Margaret (age 26, US), on the contrary, turned to a basic thermometer to be less reliant on a costly technology.

When theorizing further the underlying conditions that shape users' reliance on external authority to make sense of their cycle, Emily (Martin, 1987/2001) classic work on women's experiences of menstruation is partially instructive. She found that class was a major factor in women's understandings. While middle-class women were more likely to give authority to scientific discourses—even if these conveyed negative stereotypes such as menstruation as failed pregnancy—working-class women were more able to resist these discourses and tended to account for the process in phenomenological terms (Martin, 1987/2001, p. 111). As the sample analyzed in this chapter mostly includes highly educated subjects that would fall onto Martin's middle-class subjects categorization, such a factor doesn't help much to theorize about differences between women in this analysis. Certainly, differences in national contexts and access to particular types of healthcare systems will play a role[92]. Other factors likely to impact such decisions would involve family and community contexts, risks associated with sex and fertility, marital or partnering status, and individual factors.

[92] Although the use of fertility awareness-based methods (FABM) is increasing (for a study in the US, see Brewer & Stevens, 2021a, p. 183), we still know very little about the demographics of people using FABM (Starling et al., 2018a). One explanation for this lack of knowledge is to be found in the underestimation of the use of these methods in many survey (Polis et al., 2021, p. 319). Another explanation comes from the fact that these methods don't require users to use prescriptions, and therefore can more easily fly under the radar. Finally, the fact that so different methods are categorized under the FABM label doesn't allow for appropriate statistics.

Mediating affects through datafied objectification

Next, I investigate the critical work done by users in multiple configurations. In these configurations, users orientate themselves temporally to maintain or reach a certain level of comfort toward/with their body. They undertake orientations that align their "actual body" and their "potential body." Using Subramaniam and Willey's (2017) terminology, we can say that the potential body is characterized by users' understandings of "capital-B, Biology" (as the hegemonic field of Science), whereas their actual body refers to "lowercase-b, biology" (as the "stuff itself," enacted in bodies). Therefore, I define the actual body as the relation users enact with their present body, whereas the potential body is an imagined relation with their body that will, or could be, enacted in the future. The potential body is characterized by normative expectations of what the menstruating body should do. In the mediation of the relationship between their data and embodied self, users come to an understanding of their body, and the relations their body is in, in a way that allows them to moderate their affective relations with themselves and others.

The tracker is a key element (amongst others) in the project for harmonious attunement between the body and embodied self. For example, Lisbet describes synchronizing her life with her predicted menstrual status:

> I am definitely less stressed out now because I take my time every month when I have my period. I actually plan on having down time...when my body is also having a down time...I understand why my body is doing this, and then it makes complete sense. And I can act like, what does my body need? It needs to relax now. And that's fine. And I actually plan for it, and that's perfect.
>
> (Lisbet, age 31, Denmark)

Lisbet's datafied cycle is a measure that goes beyond the binary code of fertility status. It is a measure of a future physical state ("down time") that it expected, anticipated, and, in her situation, accepted as positive. Her previous self, which was nondatafied, contributed to a lack of understanding about why her body behaved in a certain way. Robin uses her datafied cycle to make sense of her body and emotional states, when possible using the information to plan her day and her interactions. She said,

> The very first thing you do in the morning sets a tone for the day...[The measure] helped me to get to a better question faster. So, if I feel irritated...it helped me to get to "OK, why am I feeling this?" faster, so I can avoid being a big jerk. And accusing others of being a big jerk...I'm going to adjust the day today. Or I'm just not going to talk to these people today because I'm not going to be nice [laughs].
>
> (Robin, age 42, US)

In situating her body on the fertility chart and using that data to understand her emotions, Robin's account demonstrates how the datafied body can become a mediator of relations to others which, in this case, are performed through avoidance.

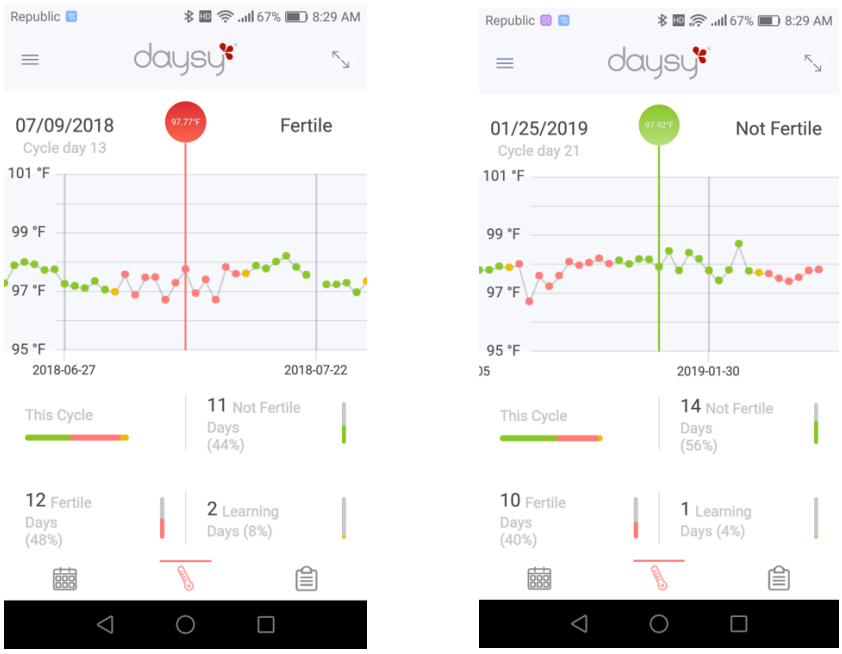

Figure 52: Joyce's "stressful month" on the left *versus* "normal month" on the right. App Screenshot received my email, February 11, 2019.

Joyce regularly synchronizes her app with her Daysy. As she explains:

> I am trying to sync it every single day so that the data stay updated on the app. And then, I look at it, and I see how my trend is going to make sure my hormones are healthy. Because sometimes, if I notice some trends that are unusual, I see "oh, I am feeling stressed out this month," so, instead of having a regular curve, I am going like this [moves her hand to form a zigzag in the air]. And other times, I see, "I am having a healthy month, I am not experiencing a lot of stress, and I have a normal data curve for a period."
>
> (Joyce, age 27, US)

In Joyce's case, the chart is meant to visualize her hormonal trends, taken as proxy for how much stressed she felt during a month. Consequently, a chart indicating a "normal" trend – or a smooth line – produces a reassuring effect (figure 52).

Overall, fertility-tracking users viewed the prospective aspects of the technology as highly practical, especially for aiding their mental and physical preparedness to manage reproductive realities at different points in the life course. The diversity of age in this sample illuminates various ways users in different phases wished to be prepared. For example, unlike most users, Robin's motivation to use the device was never for "contraceptive use" but to monitor menopause. She was expecting her body to start changing and was willing to "do that [menopause] well." For Robin, "doing menopause well" meant "enjoying [her] menopausal problems" by understanding what her body will be doing; her data-driven approach takes part in "local biologies" that challenge negative views of the aging body perpetuated by disease-oriented approaches to menopause (Lock, 1993).

With a focus on the potential body, users like Robin engaged in varied anticipatory practices (Adams et al., 2009) in response to cyclic data (such as taking medications, eating hormone-modifying plants or seeds, and using essential oils, to name a few). In some narratives, the datafied cycle was *retrospectively* viewed as a gauge of well-being. In these situations, users related how living in harmful social environments was reflected in their cycle chart. To "redress" the aberrant data, these users tried to modify their entanglements with these environments whenever possible. This was the case for Margaret (age 26, US) who got an impulse to move out of an unstable living situation and relationship based on her data (recurrent anovulatory cycles). When she observed

that her chart switched back to seemingly ovulatory following the spatial and relational change, the data confirmed to her that she had made the right choice[93].

Cyclic self-fashioning is a process that involves not only what users feel but also who they are, as biosociotemporal entities. In this process, users and data are co- shaped in a "looping effect" (Hacking, 2002) in which individuals, when classified, tend to spontaneously align with the prescriptive characteristics of the classifications; once in the loop, classifications get modified in return. For fertility- tracking users, the charts (or dots, or lights) become "agents" that constitute bodies and selves (Dumit and de Laet 2014). These outputs not only characterize bodies as temporary cyclical entities; they produce an ontological reality, the cyclic self.

Fashioning various selves

In *Picturing Personhood: Brain Scans and Biomedical Identiy,* Joe Dumit describes a process he calls "objective self-fashioning":

> We might call the acts that concern our brains and our bodies that we derive from received-facts of science and medicine the *objective-self.* The objective-self consists of our taken-for-granted notions, theories, and tendencies regarding human bodies, brains, and kinds considered as objective, referential, extrinsic, and objects of science and medicine…We can immediately see that each of our objective-selves is, in general, dependent on how we came to know them. Furthermore, objective-selves are not finished

[93] This observation echoes Robinson's finding in a study on the pregnancy test. Robinson shows that "more than just a test for a pregnancy, the use of the home pregnancy test is a test of roles, relationships, and responsibilities in social life" (Robinson, 2020, p. 1)

> but incomplete and in process. With received-facts, we fashion and refashion our objective-selves
>
> (Dumit, 2004, p. 7).

I find the notion particularly useful and build on it to analyze fertility-tracking practices. However, I also take some distance from framing users' practices in terms of "objective self-fashioning," as I believe that something different happens in users' specific shaping of themselves with a fertility biosensor. First, I replace "objective" with "cyclic" to think analytically about the role of temporality in these processes. Second, by removing the term objective, I want to detach from Dumit's objective to focus on the "object of science" rather than "methods." As Dumit explains in a footnote:

> We keep a dash in objective-self because we need to highlight that it refers to how we are to ourselves and to society an object of science and medicine, not how we "objectively" are to science and medicine. Our concern thus centers around the *object* of science and medicine, not their *methods.* Not what justifies mental illness, but how it is specified by a set of practices, documents, institutions that enable it to be objective.
>
> (Dumit, 2004, p. 189).

Precisely, I aim to focus on the methods. In many users' narratives, the construction of their bodily, embodied self is characterized by a will to escape, to some extent, certain manifestations of biomedicalization (Clarke et al., 2021).

Fashioned by knowing of various sorts, different selves emerge in cyclic self-fashioning processes; we have seen in previous sections some versions that could be referred to as the "active knowledge-seeker" or the "affects mediator". In this section, I analyze four other emerging

configurations that challenge or reproduce gendered expectations for the female body: the "maximizing self," "the erotic self," "the biological self," and the "invalidated self."

One configuration is the maximizing self. If we return to Izabella—who uses her embodied intuition along with the tracker outputs to produce her fertility status— one motivation was to increase the number of green days: "I am trying to maximize the number of green days which I know exist. And I know that Daysy is being more conservative than it should be." As she explains, Daysy gives her "a little bit of buffer in order to make it safer for everybody." This standardization is deemed "too conservative;" therefore, she interprets some yellow and red dots as green. The maximizing self can also be enacted through behavioral actions. For example, Linda takes medicinal plants to increase the length of her cycle and get more green days (age 26, US). Contrary to Izabella, Linda doesn't recast the tracker's outputs, but tries to act earlier in the process by altering her body's hormone balance. Yet in the narratives, maximizing the number of green days is not only a goal in itself. It is also a way to be reassured that one's body is working "as it should." Green days can be associated with the "conceptive imperative" (Wilkinson et al., 2015) in which menstruating subjects understand themselves as primarily fecund entities. But the notion of cyclic self also challenges the reduction of the female body to procreative capacities, as seen with Robin's menopause tracking.

The exploration of another configuration, the erotic self, leads beyond widely discussed themes in the datafication of health (Ruckenstein & Schüll, 2017). For example, Jane (age 21, US) associates green days with the bliss of "de-equipment[94]." In her description, green light signifies "fun" defined as sexual intercourse without contraception. When communicating her colored data

[94] The configuration can be seen as what sociologists of innovation Goulet and Vinck have called "innovation through withdrawal" (no pun intended) (Goulet & Vinck, 2012)

to her partner, she imbues the data point with a coupled identity, toggling between "I'm green" and "We're green" in her reporting. As when couples share news that "We're pregnant," Jane implies that her partner is fully invested in the outcome. Similarly, Christine (age 24, US) was sending screenshots of her colored prognostic to her closer partner in order to plan safe dates for unprotected sex. The mobilization of data in service of anticipated, pleasurable sexual activities serves as a means to eroticize users' embodied self. The erotic self is, in that sense, powerful and relational (Willey, 2016).

The configuration of the "biological self" materializes a gendered entity, built in opposition to the male body, as illustrated in Nicole words:

> I am not just a small man. I'm a woman. And that's different [light laugh]. And biologically, I'm going to feel very different things. I'm going to feel about four distinct different things. Because there's going to be four different phases to my cycle. And just being aware of that makes me feel so much more in control and calm, rather than just kind of brushing it under the carpet and ignoring it; which I think is what most of the world kind of wants you to do.
>
> (Nicole, age 30, United Kingdom)

The constitution of Nicole's self as a woman, as opposed to a smaller version of a man, is defined by the four phases of the menstrual cycle, understood as menstruation, the follicular phase, ovulation, and the luteal phase. Tracking her cycles is a way to enact her womanhood.

Cyclic self-fashioning also creates "embodied differences" (M'charek 2010) that materialize in a failed relationship with the "digital companion species" when the user's body does not meet technological specifications. In such cases, users become invalidated. This was the case for Adeline (age 34, US). She had been using the tracker to avoid pregnancy for several years. When

she and her husband decided to conceive a child, they used the tracker to help pinpoint optimal cyclic timing. After several months, she was still not pregnant. Despite assessments at infertility clinics, there was no clear reason why. The tracker had made Adeline fertile, but never pregnant. The disconnect resulted in pain and frustration toward the tracker. She explained, "It gave me a false sense of control or knowledge about what was happening with my body;" her potential body never materialized. Tess's (age 31, US) invalidation resulted from being unable to use the tracker properly, as she almost always received that inconclusive yellow light. Instead of agency, she received daily confirmation of an "uncertain" rather than "cyclic" body that was stressful enough for her to want to stop using the device.

Discussion

Analyzing users' practices through a "cyclic self-fashioning" lens contributes to opening "a space for ambivalence" in digital health studies (K. Weiner et al., 2020, p. 134). On the one hand, users' anticipatory practices occur within a gendered model of healthcare characterized by moral imperatives, where female subjects are prompted to act towards the preservation and optimization of "their best possible futures" (Adams, Murphy, and Clarke 2009); an imperative of the "idealized reproductive citizen" strengthened by digital technologies (Lupton, 2016a). On the other hand, by engaging in "data rituals," users perform a particular form of care (Forlano, 2017, p. 4). Acting *with*, rather than *against* their body, users challenge negative representations of the female body as chaotic, and menstruation as a failure (Martin, 1987/2001).

In cyclic self-fashioning practices, users sometimes experience the ambivalence associated with the fact of existing as a "biosocial entity" shaped through "physiological tracking" (Pantzar et al., 2017, p. 23). Through these processes, users align multiple elements, including their

embodied self, datafied cycle, relations with others, biomedical knowledge, experiential knowledge, bodily sensations, and others. In these distributions, the roles of Biology (as "the disciplinary field of Science") and biologies (as "the processes of bodily and natural explications") are ambivalent, potentially acting as both validating as well as invalidating entities (Subramaniam & Willey, 2017, p. 11). If we are to problematize the role of B/biology in users' lives, it is important to acknowledge the dual tension in which they are intricated.

Furthermore, users with different bodies and lives do not make the same experience of cyclic self-fashioning ambivalence. Users who find, in data, socially acceptable reasons for their emotions and behaviors represent a form of embodiment of the self, in which lowercase-b biology is used as a validating entity, even while edging towards what could be seen as biologism. Yet while certain biologies are normalized and therefore validated in cyclic self-fashioning, others are not. In this sense, processes of cyclic self-fashioning also (re)produce embodied differences that result in the labeling of non-conforming bodies—a process of technologically based scrutiny that can be a source of pain and anxiety rather than empowerment.

Returning to the analytical matrix developed in chapter two proves helpful to unpack the situated construction of empowerment. In some circumstances, users' narratives tend to echo some aspects of the "tracked body configuration." In this ideal-typical configuration, users' bodies are configured as data providers, submitting themselves to a technology that would detect and predict fertility phases for them; for example, we recall Izabella's robotic practice of blindly offering her body to the technology, a process perceived as highly practical.

However, users' practices are not necessarily stable over time. Indeed, while most users define their body in terms that would fit the "body as a data provider" narrative, they also regularly mention how their body is a complementary instrument used to compare their sensations with the

tracker's fertility statuses. Additionally, while recalling their contraceptive or medical history, the majority of users announce having searched for the least damaging contraceptive method, therefore also fitting characteristics attached to the "tweaked body configuration," in which convenience is the major value.

Interestingly, elements from the "threatened body configuration" emerge in total inversion. While in the previous chapter, opponents would accuse fertility-tracking methods to put the body at risk and recommend pharmacological contraception, in most users' narratives, the pharmacological industry is charged with presenting a risk compared to fertility-tracking. Many users share painful experiences with the birth control pill or other pharmaceutical products that are seen as threatening users' bodies and their sense of self and authenticity[95].

When it comes to learning, some users combine aspects of the "tracked body configuration" with the "trained body configuration." By turning to additional educational resources to better understand how their bodies work, users center their "will-to-know" not on the tracker's internal logic but instead on the body's internal logic. Sometimes, a user abandons the combination of educational training and automated biosensor after a while, as seen with Margaret. Instead, Margaret switches to a basic thermometer to become more autonomous and not reliant on an expensive biosensor.

Users' practices bridge different characteristics from the matrix's ideal types without clearly fitting a single category. Therefore, they can be seen as incorporating what Laura Mamo calls "hybrid technology." Mamo uses this concept to define:

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[95] For a discussion of the birth control pill crisis, in the early 2010s, in France, see Bajos et al., (2014); Thomé & Rouzaud-Cornabas (2017). Cécile Thomé and Mylène Rouzand-Cornabas show how, despite the normalization of the birth control pill being challenged during the crisis, the gendered nature of contraceptive work being assigned to women remained unquestioned.

> practices that reconstruct or recombine practices that generally have been seen as mutually exclusive…The prefix *hybrid* highlights the combination and complexity obscured by more binary terms (high-tech/low-tech, routine/advanced, expert/lay, medical/ de-medical).
>
> (Mamo, 2007a, p. 373)

While, in promoters' discourses, the trained-, tracked-, tweaked-, and threatened body configurations were "mutually exclusive," in users' practices, they are thoroughly entangled with one another.

As seen in previous chapters, ovulation monitoring technologies have regularly attracted feminist criticism. Part of this critique challenged the predominant figure, in conventional Western epistemologies, of the ideal subject of knowledge as a neutral male observer who is separated from the object of study. Likewise, activists from the Fertility Consciousness Group in Cambridge, Massachusetts, argued that mechanical devices for cervical mucus tracking both keep women ignorant of their bodies and replace traditional indigenous forms of knowledge production (Bell et al. 1980, 32). Tia DeNora (1996) theorized that ovulation kits risk reinforcement of traditional gender binaries, as the kit delivers fertility status via "external and more authoritative confirmation to male observers" such as male partners or clinicians, whereas women are framed as passive, inexperienced objects upon which "modern Western" medicine is exerted (DeNora 1996, 375). More recently, Deborah Lupton (2015) warned that smartphone apps intensify self-surveillance regimes further within a digital knowledge economy and often without user's knowledge, particularly for women who want to take charge of their female reproductive bodies. However, feminist literature also suggests that the alienation-through-objectification critique is more complicated once we observe women's engagement with technologies in practice, as Charis

Thompson (previously Cussins) (1996) demonstrated in her ethnographical fieldwork of infertility clinics in which women increased their agency through the objectification process[96], when desired. Taking part in these debates from a feminist phenomenological perspective, the goal of this chapter was to question what it takes for a person and their body to become a willing and empowered subject for fertility-tracking technology. We have seen that, fashioned by knowing of various sorts, different selves emerge in cyclic self-fashioning processes.

Conclusion

This chapter had two aims: (1) to provide empirical insights on self-tracking practices heretofore neglected in self-tracking scholarship, and (2) to provide a conceptual framework for the analysis of self-tracking practices based on feminist theories of the body and technology. Investigating "cyclic-selves fashioning" as resultant of the sociohistorically situated alignment among digital data, technology, and the biology provides insight into new understandings of the conditions under which self-tracking technologies of the menstrual cycle reproduce and challenge power relations, as well as (re)configure women's experiences of health, fertility, and sexuality. By situating the multiple and complex negotiations that necessarily occur between users, technology, and the body as a particular site of power, the presentation herein offers an analytical toolkit that allows for the description of self-tracking practices, without ultimately portraying users as victims of technology or technology as deterministic.

By emphasizing varied enactments of menstrual cycle tracking, the chapter showed how tracking practices shape physiological "facts" about the fertile female body while also promoting

[96] Similarly, Lara Marks showed how women, rather than being passive objects of scientific experimentation, had an active role in clinical trials for the development of the birth control pill (Marks, 2000).

a particular relation to the body and self. Throughout the twentieth century, different proxies have been used to construct the technoscientific figure of the female body as a predominantly cyclical entity. I have developed the concept of cyclic self-fashioning to explore how the premise of cyclicity embedded in the technology works to reduce the complexity of bodies to a simple set of color-coded indicators whilst opening them up to question, discussion, and intervention. Building on feminist studies of objectification (Cussins, 1996), anticipation (Adams et al., 2009), and materialization (Willey, 2016), I have described how users mobilize varied sources of authority when confronted with the material agency of a fertility objectifying biosensor.

This chapter opens a dialogue with feminist inquiries to illustrate that self-tracking practices are multiple rather than singular. Fertility-tracking can be seen both as a way to resist the increasing biomedicalization of women's bodies as well as a means to perpetuate neoliberal imperatives such as the responsible, reproductive citizen in charge of her health. Investigating such practices with a "cyclic self-fashioning" lens makes room for ambivalence within our analyses. Feminist scholars have similarly argued that processes of "self-care" are conflicting: self-care as privilege bears potential for reproducing neoliberal imperatives that lead to self-empowerment rather than social change (Bobel 2010, 84); yet, self-care enacted as political action (as seen in the context of political struggle against anti-Black racism [Ahmed, 2014]) may also bring about change. Practices analyzed in this chapter fall in between, and may be more aptly framed in terms of "self-determined care"[97] (Brown, 2012).

[97] Feminist activist Adrienne Maree Brown (2012) offers the term "self-determined care" to suggest a reframing of self-care that builds social justice through love and against the devaluation of certain lives.

Anchoring 4

January 23, 2018, 14h45, Zürich, 16th day of observation in Valley Electronics offices. After greeting the four employees present at the customer service department that day, I tell two of them that I want to show them something. I invite them to take a look at a picture on the screen of my computer. It is a film poster I discovered by chance on a streaming platform a few weeks ago (figure 53). On the film poster for a 1972 horror movie called *Baron Blood*, there is an eyeball dripping among the characters screaming. In the middle of the picture, a screaming woman is locked in a cage. The eyeball, which leaves a drop as a trace on the poster, contains a large blue iris with a smaller red pupil in the center. They cannot believe it. The resemblance with Daysy is striking (cf. figure 51).[98]

Figure 53: Baron Blood, film poster.

Same day, January 23, 2018, 15 minutes later. The CEO, the CMO, and I are seated in the meeting room. I ask what convinced them to eventually include a mucus-tracking function.

[98] At that time, the monitor (first version) had a blue activation button at the center, and its cap and cover were entirely white. In a second version, launched in 2019, the blue button was replaced by a white one, and a blue line was added at the cap junction (cf. figure 55, in the next chapter).

THE CEO: Customers. Really, customers. We have different types of customers. We have customers like me. I don't want the mucus function. I don't need that. But we also have women trying to find anything that works, who are ready to look for anything down there. And we have NFP specialists. So, we wanted to implement mucus to make it more available for everyone.

THE RESEARCHER: But how do you know that some customers want a mucus-tracking function?

THE CEO: Because they tell us. Per email: "Could you make a function to track the mucus?" We made polls on social media… Honestly, I just don't get it, why they want it so bad. For me, the mucus parameter causes more confusion. But it will not affect the algorithm. So, it's not such a big deal to have it. I mean, for planning, it's useful. Because you can see how your mucus is, and maybe you don't have much of it, and you can try to do something to change that. But if you are trying not to get pregnant, it is very confusing. For example, it's really difficult to distinguish between sperm and mucus. How can you know? A lot of women input the mucus completely wrong.

THE RESEARCHER: What resources will users have or need to use this mucus button?

THE CEO: There will be a few options: light, heavy, creamy, egg white (*she laughs a bit while enumerating these terms, as if saying, "What a mishmash!"*). And then they choose, and they input what they want on the app. It's not difficult to implement. But you need a little pamphlet that shows you how.

The CEO stands up, exits the meeting room, and comes back a few seconds later with two heavy books that she lays on the table (figure 54).

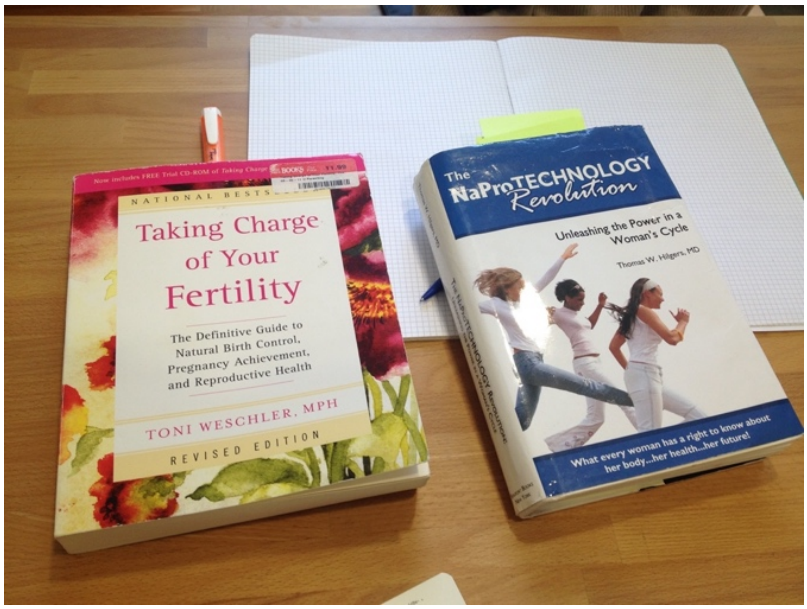

Figure 54: The CEO's "bibles": Toni Weschler (2001), Taking Charge of Your Fertility: The Definitive Guide to Natural Birth Control. Pregnancy Achievement, and Reproductive Health, and Thomas W. Hilgers (2010) The NaProTechnology Revolution: Unleashing the Power in a Woman's Cycle. Photo: LDB.

THE CEO: I read them in detail before having a child. Now, I don't have so much time anymore. It's crazy that they expect us to read this to really understand fertility awareness-based methods. Daysy is easy compared to NFP methods.

A child starts crying in another room.

THE CEO: Oh, it's my baby. *(CEO exits the room.)*

THE RESEARCHER (to the CMO): Have you read these books?

THE CMO: I haven't, actually.

The CEO comes back with a child, who must be about two years old. He is excited; he smiles and climbs on her knees.

THE CEO: These books are sort of like bibles!

THE RESEARCHER: So, will the mucus function come with the next app update?

THE CEO: Yes. But first, we will launch the new app. Then, the function will be implemented afterwards. And we will probably do a test phase to check the function and see how it works. It will for sure create a lot of confusion. There will probably be a lot of questions: "Daysy tells me this, but my fluid is like that…" We will see how we can handle it.

THE RESEARCHER: Mhm, alright. Well, thank you for this discussion. (The child goes around the table and comes toward me. He holds out his arms to me. I deduce that he wants to get on the bench. I pick him up and sit him on my knees. He takes my pen and starts scribbling on my notebook.

THE CEO (to the child): No!

THE RESEARCHER (laughing): Don't worry, it's fine! (Turns the page to a blank page and tells the child he can draw a picture on it, which he does without delay.)

The CEO laughs, takes a picture with her smartphone, and continues talking about different companies and methods...

THE CEO: Have you read about the scandal that just came out surrounding a contraceptive app? So far, the company did not communicate about it. They have not yet informed their customers. I heard some rumors saying it was not true, and that it was a kind of big pharma conspiracy trying to harm the company. I don't know. It might start a completely new discussion. It might be a risk for us. The last scandal I heard similar to that one happened some years ago when it was found out that a company was selling faulty breast prostheses. It was also TÜV that had certified the products, the same regulatory body that granted the contraceptive app a medical device status in Europe.

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By revealing such details about my 16th visit to Valley Electronics, I want to convey two things. The first is a reminder that comparisons can take many forms and have very different (emotional) effects. At the customer service department, the visual comparison provoked surprise and laughter. On the contrary, some comparisons I will analyze in the next chapter will inspire pride as well as skepticism, happiness, and also concern. The second relates to my researcher position. By engaging in a comprehensive ethnography, I have gradually accepted that I needed to let myself be affected by Valley Electronics's developments and the unfolding consequences. I did not try to maintain an artificial, distanced, or neutral scientific position. On the contrary, I have embraced the situated position, and partiality associated with it.

4 Assessing

> [A]n app that miscalculates users' fertility window has more serious consequences than one that miscalculates the number of steps they took in a day.
> –Nathaniel DeNicola, gynecologist, The Verge, Dec. 19 2018.

> I think we need regulations, because otherwise everyone could produce something, whether it works or not, nobody cares. So I think it is a security for the end user…But what is not discussed [in regulations] is the Pearl index. You have to have a Pearl Index study, yes…But it doesn't matter how good the Pearl Index is. The Pearl Index is an old standard that can easily be misinterpreted. And that makes it ridiculous to me.
> – CEO of Valley Electronics, interview, May 17, 2017.

The Politics of Digital Contraception

This chapter leads us further into exploring the life of fertility biosensors. It unpacks issues related to their assessment as suitable candidates for pregnancy prevention. More precisely, it investigates the processes through which fertility biosensors are put to the test in an attempt to gain more validity. Pursuing ethnographic inquiry, I expand the phenomenon's complexity and bring to the

foreground several frictions that emerge when fertility biosensors undergo regulatory processes. As we will see, actors have different positions toward fertility app assessment.

Commentators inquiring about fertility apps' safety frequently raise concerns and call for regulatory action. For example, when studying fertility apps' data circulation, consumer protection organizations regularly denounce how data recorded on certain fertility apps are sold to third parties and circulate in vulnerable digital infrastructures (Beilinson, 2016; Felizi & Varon, n.d.; Quintin, 2017; Schechner & Secada, 2019; William et al., 2021). These organizations call on users to be vigilant and companies to make technical changes. In parallel when studying fertility apps' content, a growing number of biomedical and law studies call for stricter medical and regulatory control over their distribution (Ali et al., 2021; Rosas, 2019; Taylor, 2020; Zwingerman et al., 2020).

However, it is unclear whether intensifying control from regulatory agencies will enable the distribution of safer apps. At a pragmatic level, digital health scholars have raised questions concerning the challenges policymakers would face in meeting the requirements of an "endorsement approach" to mHealth apps (van Velthoven & Powell, 2017, p. 2). Indeed, Swiss-based bioethicist Agata Ferretti and colleagues have shown that the existing compartmentalization of authorities responsible for the development of mHealth regulation and guidance might contravene their utility for app developers (Ferretti et al., 2019); as Ferretti et al. (2019) put it, "data protection authorities and health authorities tend to each have sight blinders that compartimentalize what they aim to regulate, leading the first to focus exclusively on 'privacy and data protection issues, and the latter to focus on 'safety and efficacy'" (p. e55). This compartmentalization is also reflected in the social sciences literature on fertility-tracking apps, in

which many commentators seem to be "blind-sided by privacy," to use philosopher Tamar Sharon's formulation[99] (Sharon, 2020).

In this chapter, I suggest shifting the perspective on regulatory issues from what should be done to how different actors assess what constitutes a good fertility-tracking app. To unpack the actors' positions on the issue, I suggest the notion of "regimes of acceptability." Regimes of acceptability refer to particular sets of rules, standards, discourses, and values produced and mobilized by actors to assess whether something is deemed *acceptable enough* for a specific purpose in specific contexts, which are defined simultaneously. This notion builds on Murphy's (2006) "regime of perceptibility" (p. 10), which builds on Foucault's "regime of truth"[100]. This notion allows for analyzing how actors in diverse assemblages mobilize different elements to make certain claims more or less valid and credible. While in the digital health literature, acceptability tends to be weighted from the intended users' "side,"[101] I suggest shifting the perspective and

[99] Sharon (2020) uses the notion to question the growing *legitimacy* granted to tech giants like Google and Apple in the spheres of health, medicine, and politics. According to Sharon, these companies recently acquired further legitimacy in social life when privacy experts lauded their technical developments in COVID-19 contact-tracing apps. Sharon demonstrates how focusing only on privacy runs the risk of obscuring important aspects in the shaping of expertise in our technoscientific societies. In the fertility app landscape, the "privacy lens" is primarily mobilized to construct companies' *illegitimacy* in the spheres of health and medicine.

[100] With the notion of "regime of perceptibility" Murphy (2006) analyzes "the way a discipline or epistemological tradition perceives and does not perceive the world" (p. 10). Steven Epstein offers a good summary of the distinction between Murphy's notion and Foucault's: "Where Foucaultian 'regimes of truth' establish the boundaries between what is sayable and unsayable, or thinkable and unthinkable, Murphy's 'regimes of perceptibility' instead determine whether and when matter becomes something that matters" (S. Epstein, 2009, p. 954). I adopt Murphy's notion to investigate, instead of the perceptibility of something, its acceptability; in other words, how some *things* (individuals, technology, intended users, standards, etc.) are configured and articulated in order to become *acceptable* within a specific situation, which is simultaneously configured during the process.

[101] In such framings, app promoters usually design health interventions and evaluate how acceptable they are for intended users. Questions are frequently asked in a pragmatically orientated way, summarized as "to which extend

questioning how acceptability is produced by different actors and how they justify their construction of acceptability.

I deploy the notion in analyzing controversies in which two companies marketing digital fertility trackers have been accused of misleading their customers. These selected situations revolve around disputed certification processes through which claims about fertility-tracking biosensors are granted or denied space in public and scientific spheres. The first situation is related to claims about Daysy, and the second to Natural Cycles. These two cases were temporarily settled, with two diverging resolutions. While claims about Natural Cycles gained FDA approval, statements accompanying Daysy suffered scientific retraction. Through the analysis of various sources concerning these certification processes, we will see how multiple actors, such as regulatory agencies, advertising authorities, innovators, scientists, and users, mobilize specific regimes of acceptability and produce different definitions of what a good fertility biosensor is or should be.

Case 1: Daysy—From 99.3% Effective to 99.4%... and Back to 99.3%

Between 2016 and 2018, Valley Electronics conducted a survey-based study on Daysy to assess whether the addition of a mobile app would increase the method's effectiveness (compared to the company's other biosensors that do not function with an app). The team published their findings on March 8, 2018 in *Reproductive Health*. The article announced that following the addition of the app, the method was deemed more effective than it had been previously. They presented the following conclusion:

---

will the intervention be accepted by users; how can the acceptability be increased?" For some examples, see the numerous research articles published in the past five years in the journal *Digital Health*.

> It seems that combining a specific biosensor-embedded device (Daysy), which gives the method a very high repeatable accuracy, and a mobile application (DaysyView) which leads to higher user engagement, results in higher overall usability of the method.
>
> (Koch et al., 2018, p. 1)

When focusing on "the typical-use related Pearl-Index," the authors found the method to have "significantly improved from 3,8 to 1,3"(Koch et al., 2018, p. 2). The company happily shared a Facebook post indicating that the device was now 99.4% effective, compared to the previous 99.3%.[102] The company based this efficacy statement on Koch et al.'s (2018) study, which produced the comparison by mobilizing a study done on Daysy's ancestor, a version of Babycomp/Ladycomp (figure 55). Koch et al. compared a retrospective study of a 1992 version of Babycomp/Ladycomp[103] with their retrospective study of a 2017 version of Daysy.

[102] Post, on the company's US Facebook page, March 15, 2018, reprinted in Polis, 2018, p. 2.

[103] The study used for comparison is the following: Freundl, G., Frank-Herrmann, P., Godehardt, E., Klemm, R., & Bachhofer, M. (1998). Retrospective Clinical Trial of Contraceptive Effectiveness of the Electronic Fertility Indicator Ladycomp/Babycomp. *Advances in Contraception*, *14*(2), 97–108. https://doi.org/10.1023/A:1006534632583

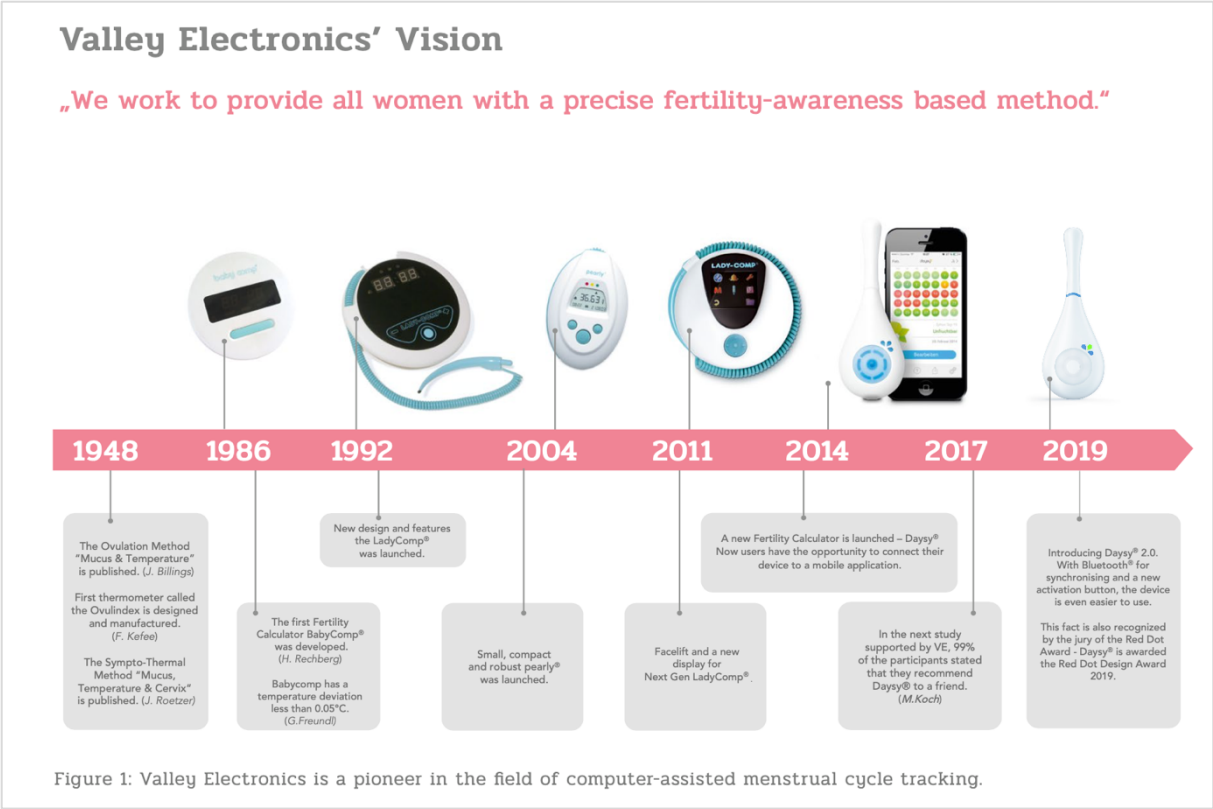

Figure 55: Extract from the factsheet "Valley Electronics: A reliable partner for health-conscious women" (Valley Electronics, 2019, p. 2)

In Freundl et al.'s retrospective study, the authors calculated the effectiveness as a "contraceptive aid" of a Babycomp/Ladycomp ("BC/LC") (cf. Freundl et al., 1998, p. 97). Babycomp and Ladycomp were evaluated as the same device, although the authors noted a technical difference between the two models[104]:

[104]As explained by Kern in the 2003 medical Ph.D. thesis "Safety and acceptance of cycle computers and the symptothermal method" (title translated from German): "These functions can be retrofitted to the Ladycomp. The purchase price for the Babycomp is about 700 euros, and about 500 for the Ladycomp" (p. 6, translated from German). Therefore, a customer could buy Ladycomp and purchase the additional "baby-planning" functions and add them on the same device. Today, the planning and prevention functions are sold within one device: the new Lady-Comp (https://lady-comp.com/us/en/).

> Babycomp (BC) differs from Ladycomp (LC) in that it includes the option of entering the date of intercourse, as well as incorporating an additional program level which shows the optimal conception time and the probable sex of the offspring following intercourse on a particular day of the cycle relative to ovulation[105].
>
> (Freundl et al., 1998, p. 98)

On June 14, 2018, Chelsea Polis, an epidemiologist working on contraception and fertility awareness-based methods for pregnancy prevention, requested, in a commentary published in the same journal (*Reproductive Health*), the study's immediate retraction. Polis accused Valley Electronics of "falsely increas[ing] consumer confidence" with misleading marketing (Polis, 2018, pp. 4–5) and detailed the reasons she found the article unacceptable; among them were the retrospective format of the study and how the authors calculated pregnancy rates. Additionally, she complained about terminology (for example, the use of "unwanted" instead of "unintended" pregnancy [Polis, 2018, p. 3]). Polis urged the editors to retract the article, as it "could lead to inappropriately inflated consumer confidence in the contraceptive effectiveness of Daysy and DaysyView, and could leave consumers more vulnerable to the risk of unintended pregnancy" (Polis, 2018, p. 1).[106]

In parallel (June 2018), users actively took part in the debate on the company's English-speaking Facebook group:

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[105] Here, we find a combination of the life-enhancing and sex prediction assemblages discussed in the first chapter.

[106] This position echoes the "threatened body configuration" presented in chapter 2. However, it is significantly different, as it does not reject fertility tracking for pregnancy prevention in all its forms, but specific versions deemed insufficiently backed up by adequate research.

Box 8

USER 1: There is apparently controversy in the scientific community over the low quality of Daysy and Ladycomp studies. This means that the advertised efficacy is unreliable and could actually be much lower in reality. I always thought Daysy was a great alternative for those who are not willing or able to chart and I've recommended it, but now my confidence is shaken. 😕 I would love to hear your thoughts!

(…)

USER 2: Over 3 years & no babies. That says it all for me 🤦‍♀️

USER 3: 1.5 years and no babes here. 🤦‍♀️

USER 4: 2 years no babies

USER 2 to USER 1: I get it. It could be less effective for some. For me it's 100%. There's a lot of variables in people's sex lives & what they do on red days, so I don't know how any one study could take all variables and apply them equally across the board anyway IMO [in my opinion].

In these extracts, users responded to the efficacy question by mobilizing personal experience with the tracker. We could summarize such positions as: "Whatever the controversies, Daysy works for me." In the following comments, users justify, still referring to personal experiences, that "Daysy may or may not be that much effective, it remains *better* than other contraceptive options on the market":

Box 9

> USER 4: Eh. Consumers should be looking into products before they purchase anyway. I didn't buy daysy thinking…that I wouldn't have to know anything about my body or cycle and it would do everything for me. I wanted to know what the temperatures meant so I bought TCOYF [*Taking Charge of Your Fertility*] alongside daysy and the combined knowledge from the two is enough for me. I still would have bought a daysy even if they advertised 87% effectiveness. I just didn't want to be on the pill anymore and was in search of a natural alternative that still had science behind it.
>
> USER 2 to USER 4: I would have still bought it too. I was done with the pill & IUD's [intra-uterine devices].

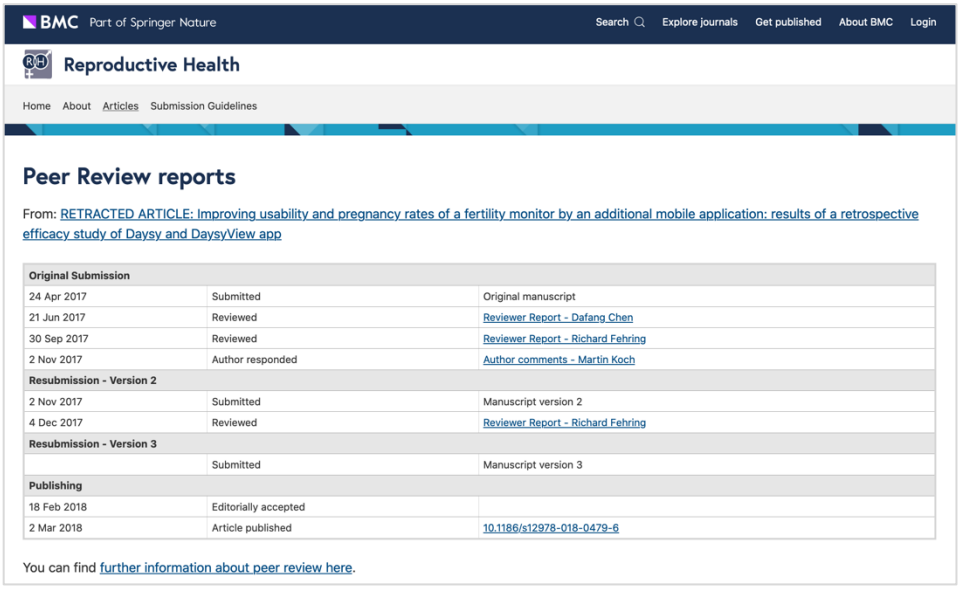
Additionally, some users mobilized the political importance of taking a position in the debate in order to change the dysfunctional distribution of information and consent within reproductive healthcare systems:

Box 10

> USER 5 joins the discussion: As long as you have informed consent about the lack of quality studies and accept that. The problem is when customers don't know or are mislead.
>
> USER 2 to USER 5: Yes let us talk about informed consent! Do doctors warn patients of all potential side effects from the pill & IUD's? Mine didn't. At the end of the day, you do your own research and make your own decisions.
>
> USER 5: Informed consent being a problem with HBC [hormonal birth control] doesn't make informed consent with FAM [fertility awareness-based methods]

> irrelevant. Both battles are important in establishing legitimacy of natural birth control. We cannot let issues with Daysy slide because we'll never be taken seriously by scientific community and our doctors. This fight for scientific integrity and transparency in advertising will only benefit us.
> (The discussion continues…)

In the discussion, beyond the "experiential dimension," some users also mobilized the political aspect related to taking part in what is presented as "battles" and "fight" for information transparency.



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Reproductive Health

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Peer Review reports

From: RETRACTED ARTICLE: Improving usability and pregnancy rates of a fertility monitor by an additional mobile application: results of a retrospective efficacy study of Daysy and DaysyView app

Original Submission		
24 Apr 2017	Submitted	Original manuscript
21 Jun 2017	Reviewed	Reviewer Report - Dafang Chen
30 Sep 2017	Reviewed	Reviewer Report - Richard Fehring
2 Nov 2017	Author responded	Author comments - Martin Koch
Resubmission - Version 2		
2 Nov 2017	Submitted	Manuscript version 2
4 Dec 2017	Reviewed	Reviewer Report - Richard Fehring
Resubmission - Version 3		
	Submitted	Manuscript version 3
Publishing		
18 Feb 2018	Editorially accepted	
2 Mar 2018	Article published	10.1186/s12978-018-0479-6

You can find further information about peer review here.

Figure 56: Timeline of Koch et al.'s publication, available on the *Reproductive Health* website[107]

[107] https://reproductive-health-journal.biomedcentral.com/articles/10.1186/s12978-018-0479-6/peer-review

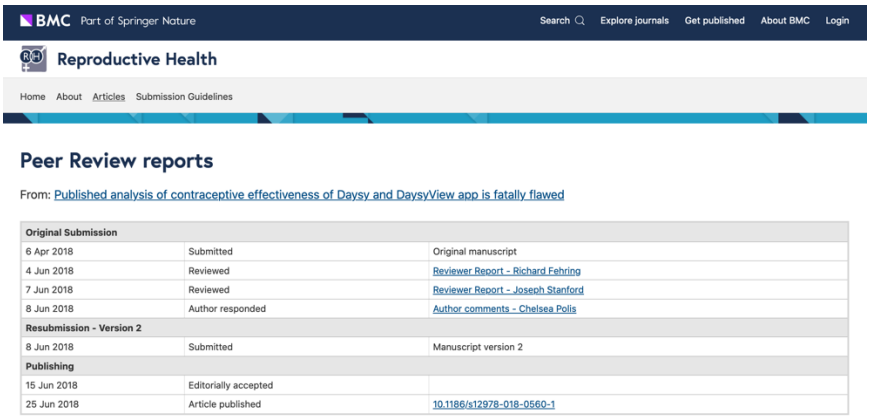

Figure 57: Timeline of Polis's comment publication, available on the *Reproductive Health* website[108]

On May 14, 2019, the editor retracted Koch et al.'s article. The authors published a clarification in a letter to the editor in which they reiterated the limits of their study, although acknowledging that it nonetheless remains useful and valid:

> We request the author to accept that the annotated publication is a retrospective study with all of the known advantages and disadvantages of such. We agree that the reproductive study, like all studies, has the known and named weaknesses and that further, ideally prospective, research is necessary. We believe, as Polis noted in her commentary, that "while some issues in data collection and analysis are not unique to this study," that the outcome of the study is strong and can be compared with other studies, especially in the field of fertility awareness methods.
>
> (Koch et al., 2019, p. 2)

[108] https://reproductive-health-journal.biomedcentral.com/articles/10.1186/s12978-018-0560-1/peer-review

In this controversy's closing, different values of sciences are opposed: on the one side, Koch et al.'s pragmatic approach (which I summarize as "It may not be ideal, it produces nonetheless useful knowledge"), and on the other, Polis's "higher" standards of scientific evidence. Following the article retraction, some of the article's authors participated in two additional studies on Daysy: one assessing its "performance" (rather than previous "effectiveness") (van de Roemer et al., 2021) and another exploring the effect of stress during the COVID pandemic on menstrual cycles (Haile et al., 2022).

Case 2: Natural Cycles—From "Highly Accurate" to *Relatively* Effective

In January 2018, two regulating agencies received complaints alerting against Natural Cycles' claims of efficacy, which were deemed misleading and therefore put users at risk. One complaint was filed by midwives working at a Swedish hospital to the Swedish Medical Products Agency against Natural Cycles. It aimed to "aler[t] authorities that thirty-seven women who had sought abortions in a four-month period had all become pregnant while using Natural Cycles as their primary form of contraception" (Altman, 2018). The same month, two sex ed activists and master's students from the London School of Hygiene and Tropical Medicine, Amy Hough and Maggie Bryce,[109] filed another complaint against Natural Cycles to the UK Advertising Standards Authority (ASA).[110] These complaints led the two authorities to investigate the Natural Cycles app and marketing. The authorities came to diverging conclusions that they pronounced at about the same time (August–September 2018) (ASA, 2018; Swedish Medical Products Agency, 2018).

[109] For background information on Maddie Bryce and Amy Hough, hear them present themselves on episode 12 of the Brain Buzz podcast, available at https://brainbuzzpod.com/episodes/2018/8/10/sex-ed-with-maggie-bryce-and-amy-hough.

[110] The ASA is the UK's independent regulator of advertising across all media (https://www.asa.org.uk).

After investigating Natural Cycles' disputed claims, the UK agency concluded that it was *not acceptable* for Natural Cycles to advertise its app as "highly accurate." On August 29, 2018, the agency explained the following:

> Given the very low level of perfect-use by users of the app [9.6%] and the significant difference between the effectiveness of the app when in perfect- and in typical use, we considered that it would be misleading to base an accuracy claim on the perfect-use results (…)
>
> Because the evidence did not demonstrate that in typical-use it was "highly accurate" and because it was significantly less effective than the most reliable birth control methods [such as long acting reversible contraceptive methods], we considered that in the context of the ad the claim was likely to mislead.
>
> We concluded that the claims "Highly accurate contraceptive app" and "Clinically tested alternative to birth control methods" were misleading.
>
> (ASA, 2018)

The agency required the following action:

> The ad must not appear again in the form complained about. We told Natural Cycles Nordic AB Sweden not to state or imply that the app was a highly accurate method of contraception and to take care not to exaggerate the efficacy of the app in preventing pregnancies
>
> (ASA, 2018)

Although the ASA banned Natural Cycles' advertising claims, Hough and Bryce expressed partial satisfaction with the agency ruling. Following the ASA's comment, Hough and Bryce published a

"personal view" in *BMJ Sexual and Reproductive Health*, in which they pointed out the limits of the ASA's investigation for protecting users, especially users outside of the UK (Hough & Bryce, 2019, p. 72). They declared a need for "tighter regulations and more efficient investigations by the ASA" (Hough & Bryce, 2019, p. 72). Additionally, the authors regretted the time delay between the issuing of the complaint and the agency's action and that social media influencers' promotion of Natural Cycles escaped the agency's regulating scope (pp. 71–72).

Contrary to the UK regulating agency, the Swedish Medical Products Agency decided, after investigation, that the failure rate reported by midwives from the Swedish hospital fell within the *acceptable* range of failure announced by Natural Cycles.

Expected number of pregnancies

The investigation shows that the number of unwanted pregnancies and the Pearl Index is consistent with data shown in the clinical evaluation included in the certification documentation. The failure rate in typical use was 6.9% both in the clinical evaluation and in the 6 months post market follow up review.

Post market follow up in Sweden, January – June 2018:

	January	February	March	April	May	June
Unwanted pregnancies	110	101	112	121	120	112
Pearl Index	6.7%	6.7%	6.6%	6.6%	6.8%	6.9%

The clinical evaluation included in the technical file for Natural Cycles, that has been reviewed by the Swedish Medical Products Agency in the investigation, show that during one year 7 women out of 100 will be unwanted pregnant in typical use of the app as contraception method.

Figure 58: "Expected number of pregnancies" (Swedish Medical Products Agency, 2018)

The Swedish agency justified its position with the publication of a comparative table upon which it based its decision (Figure 58). In the table, a total of 676 unwanted pregnancies were observed over an investigation period of six months. The agency announced this number to have been compared with Natural Cycles "registered" and "active users," which were not disclosed.

In the September 13, 2018, *New Yorker* article "The Unlikely Politics of a Digital Contraceptive," reporter Ana Altman commented with skepticism on the Swedish Agency's calculative rationalization; questioning the validity of a number "that only includes the unwanted pregnancies disclosed directly [from users] to Natural Cycles," Altman pushed the calculative approach to acceptability further:

> There's no available data on how many people actively use Natural Cycles, but if all of the people who have registered with Natural Cycles were to use it as their contraceptive method "typical use" would result in more than sixty-two thousand unintended pregnancies.
>
> (Altman, 2018)

At about the same time, another regulatory agency, the American FDA, ran its own evaluation of Natural Cycles.[111] On August 10, 2018, the FDA published a press release that would substantially impact further developments in the fertility-tracking app landscape. In this document, the FDA announced granting Natural Cycles the new label "software application for contraception." [112] Under this new category, the FDA allowed Natural Cycles to market its app as the "first direct-to-consumer app for contraceptive use to prevent pregnancy" (FDA, 2018). The press release stated:

---

[111] On August 28, 2017, the FDA issued an order finding Natural Cycles "not substantially equivalent to a device not requiring premarket approval" (US Government, 2019, p. 7994); this means that Natural Cycles had to undergo a more critical investigation than needed if it could prove equivalence to another device to be authorized to market its app in the United States. Following this order, on September 20, 2017, Natural Cycles submitted a request to be considered for De Novo classification (US Government, 2019, p. 7994). When approved, De Novo classification opens the path for future devices deemed "substantially equivalent," which precludes the need to follow a lengthy evaluation process. The investigation presented in this section results from Natural Cycles' De Novo request.

[112] The certification occurred following a De Novo certification pathway (see note 111).

> The FDA reviewed the Natural Cycles app through the de novo premarket review pathway, a regulatory pathway for novel, low-to-moderate-risk devices of a new type. Along with this authorization, the FDA is establishing criteria, called special controls, which clarify the agency's expectations in assuring the accuracy, reliability and effectiveness in preventing pregnancy using apps indicated for contraception. These special controls, when met along with general controls, provide a reasonable assurance of safety and effectiveness for apps used for contraception. This action also creates a new regulatory classification, which means that subsequent devices with the same intended use may go through the FDA's 510(k) process, whereby devices can obtain marketing authorization by demonstrating substantial equivalence to a predicate device.
>
> (FDA, 2018)

TABLE 1—SOFTWARE APPLICATION FOR CONTRACEPTION RISKS AND MITIGATION MEASURES

Identified risks	Mitigation measures
Unintended pregnancy.	Software verification, validation, and hazard analysis; clinical performance testing; human factors and usability testing; and labeling.

Figure 59: FDA's rules on "mitigation measures" (US Government, 2019, p. 7994)

Therefore, to be accepted in the new category, the FDA required Natural Cycles to comply with a series of risk-mitigating measures (or "special controls") (figure 59). These measures encompassed providing 1) "clinical performance testing" (i.e., "demonstrat[ing] the contraceptive effectiveness of the software"); 2) "human factor and usability testing" (i.e., "demonstrat[ing] that intended users can self-identify" and correctly use the app); 3) "software verification" (related to cybersecurity

vulnerability, and algorithm's fertility detection functions); and 4) "labeling" (including some mentions about the fact that "no contraceptive method is 100% effective," that users need to use "another form of contraception [or abstinence]" on certain days, that some factors may affect the fertility statuses, and that the app does not protect against STD) (Krueger, 2018, pp. 2–3).

To establish the app's acceptability, the FDA opted for a strategy aimed at ensuring that non-intended users don't engage with it. Therefore, users for whom a pregnancy would be devastating should be discouraged from using Natural Cycles; similarly, users whose cycles are not comprised within a specific range of days should understand that the app will work less effectively. In the "De Novo Classification Request for Natural Cycles," it is stated that "85% of users have at least a university degree" (Natural Cycles, n.d.-a, p. 7). Therefore, it appears that within the FDA's regimes of acceptability, users' level of education operates as what Karkazis and Jordan-Young call "ghost variables"[113] (Karkazis & Jordan-Young, 2020, p. 763).

A note on "real-world data"

By leading my own inquiry in the course of this biography of artifacts and practices, I noted different observations related to the Natural Cycles app and efficacy studies that raised some questions that remained unanswered. I will briefly expose one of them here.

[113] Introducing a special issue in *Science, Technology, & Human Values* on "race as ghost variable," Karkazis and Jordan-Young use the notion to define "variables in program languages that do not correspond to physical entities' (Karkazis & Jordan-Young, 2020, p. 763). As an example in the special issue, Carlin and Kramer show how race is a "ghost variable" in polycystic ovary syndrome "because its impact on the diagnosis is generally disregarded and unremarked" (Carlin & Kramer, 2020, pp. 6–7).

Figure 60: Illustration of a user' temperature chart, with heart symbols above the highest temperature line (Facebook post, Natural Cycles Users private Facebook group).

According to the Natural Cycles' manual, users must register protected sex on the app, using the locked heart symbol, and unprotected sex with a plain heart symbol.[114] On the company's private English-speaking Facebook group, a user posted her chart (figure 60) and asked other group's members for some help interpreting it:

Box 11

USER A (*posts a chart on the group wall and inquires*): Did I ovulate? (…) I'm inclined to think I did ovulate. It's just so weird it's not been confirmed [by the app].

USER B: Are you preventing? Because if you are that heart at CD16 is risky.

USER A: Yeah, it's all protected. I just like the way the hearts look on the graph. Much nicer aesthetic

USER B: Hahaha yeah I agree, Not keen on the little lock hearts!

USER A: I've got a very sophisticated code of emojis I use to look back on the little hearts so If there's a fail point I'd be able to identify it 🔎🔎

(The conversation continues…)

[114] We find here the love euphemism identified in the marketing of apps ancestors in chapter 1.

Following the above conversation, we learned that User A used the symbols differently than expected. Instead of using the locked heart symbol to indicate unprotected sexual activities (as envisioned in the Natural Cycle's manual), User A opted instead for the unlocked heart for aesthetic reasons. From an external perspective (User B), the heart on day 16 appeared "risky" and could lead to pregnancy; such a sign would qualify User A's behavior as dangerous if she was preventing pregnancy. By reading User A rationalization, we understand that assuming her behavior based on symbols would have been reductive.

Discussion: Mobilizing Different Regimes of Acceptability

In the presented situations, various actors mobilize different regimes of acceptability. The regimes are more or less permissive and involve differently situated elements. In discussions surrounding Daysy's case, we have seen how some scientists justified the acceptability of Daysy's efficacy through the mobilization of a regime of acceptability based on empirical comparisons. In these scientists' discourse, Daysy was deemed comparable to the previously developed tracker Babycomp/Ladycomp. Therefore, the results from a retrospective study on Daysy were assumed to be comparable to those of a retrospective study on Babycomp/Ladycomp. For another scientist, Polis, on the other hand, the methodology used in retrospective studies is deemed insufficient (among other things) to assess a tracker's efficacy; therefore, the company's claims are presented as unacceptable. Polis centered her discourse on methodological acceptability. In users' discourses, the un/acceptability of the tracker was based on personal experience, lack of other convincing options, or the political importance of "being taken seriously" by doctors and scientists.

In discussions surrounding the acceptability of Natural Cycles, we have seen how the UK consumer agency deployed a pragmatic regime of acceptability based on insufficient evidence of

so-called perfect use. The UK agency concluded that the company was misleading users in claiming the app to be "highly accurate" and requested it not to exaggerate its efficacy. The Swedish consumer agency, on the contrary, mobilized a calculative rationalized regime of acceptability based on the expected failure rate of the app and concluded that unexpected pregnancies were, in fact, coherent with the predicted failure rate. Finally, the FDA encouraged instead an exclusionary regime of acceptability in which it attempted to secure that users for whom the app may not work do not engage with it.

The introduction by the FDA of a "new regulatory classification" (FDA, 2018) can usefully be conceptualized as an interesting case in which *novelty* is mobilized as a sociotechnical "achievement" (Pickersgill, 2021). Sociologist of science and medicine Martyn Pickersgill conceptualizes novelty in the following way:

> Novelty is a discursive achievement; as such, it can be undone as well as assembled – it is negotiable, not quintessence. Novelty is not just a pivot for analysis, but an important problematic in itself. Attention to the material and semiotic work that goes into positioning discourses, practices, and entities as novel can cast new ("new") light on how action is enjoined or inertia maintained – generating insights into wider questions of order, power and meaning.
>
> (Pickersgill, 2021)

"What does the characterization of [Natural Cycles app] as novel help achieve?" (Pickersgill, 2021).[115] Via the De Novo approval pathway, the FDA introduced not only a "new" software category (i.e., "software application for contraception") but also a new distinction between FDA-labeled and non-labeled biosensors. This new category is expected to have significant implications for future developments in the fertility-tracking app landscape, as any company able to prove its substantial equivalence to Natural Cycles becomes eligible to claim the new label for itself. For now, the first observation is that, consequently, Natural Cycles was able to make "strategic use of labeling" (Mulinari & Davis, 2019). Benefitting from being the first FDA-certified software application for contraception, the company–in what we could frame a "fallacy of misplaced concreteness"[116]–quickly adapted the label to call itself the "first contraceptive app."

Conclusion

In this chapter, I have shown how diverse actors promote different regimes of acceptability of a fertility tracker. While some actors make a company's efficacy claims unacceptable, others legitimize such claims by mobilizing, for example, personal experience or reducing the scope of their validity. While a tracker's failure rate is unacceptable for some, it is perfectly acceptable *within specific contexts* for others. What is especially interesting are the strategies that come with each regime's justification. We have seen, for example, that some strategies require the exclusion of divergent or misfitting biologies. In contrast, other strategies promote more inclusive

[115] I adapted this question framing from Pickersgill's original question: "What does characterising a specific viral variant as 'novel' help to achieve?" (Pickersgill, 2021)

[116] Gregory Bowker explains A. N. Withehead's notion of "fallacy of misplaced concreteness," as "when one mistakes an abstract belief, opinion, or concept about the way things are for a physical or 'concrete' reality: 'There is an error; but it is merely the accidental error of mistaking the abstract for the concrete'" (Gregory & Bowker, 2016, p. 221).

configurations in which "local biologies" (Lock, 1993, p. xxi) are acknowledged and valued. The regimes, therefore, can be more or less exclusive, strict, tolerant, ambiguous, precautionary, undecided, fluid, contextual, judiciary, technocrat, personal, experiential, or standardized.

We have seen how some actors—be it promoters, users, scientists, healthcare professionals, activists, consumer protection agencies, reporters, or regulatory bodies—define the conditions under which a tracker becomes "the right tools for the job" (Clarke & Fujimura, 1992); with that expression, Clarke and Fujimura theorize a relational approach*,* in which artifacts, practices, and what they call "rightness" "are each and all situationally constructed. That is, they are *co-constructed,* mutually articulated through interactions among all the elements in the situation" (Clarke & Fujimura, 1992, p. 5).

Similar to Annemarie Mol's multiple versions of the body within a university hospital (Mol, 2002), here too, multiple versions of an artifact are articulated over different sites and among different actors. Notably, specific regimes are not attached to particular categories of actors; for example, scientists can mobilize different regimes. Similarly, users do not uniformly rally to personal regimes of acceptability. An actor can mobilize a particular regime at a certain time and then switch to another one, closer to their values, at a different time. While some versions align (after some adjustments with various regulatory bodies, in the case of Natural Cycles), others contrast and are even conflicting. What this chapter aims to unravel is the situated construction of the "rightness" of a tracker.

From there, we can start reflecting on the possibilities offered when uncovering the assumptions behind different versions of what a "good" tracker is or should be. As seen, differently situated actors mobilize different regimes of acceptability at some point in time, and, so doing, shape different intended users and contexts of use. What conclusions can one draw from comparing

the similarities, intertwinements, and divergences of different versions? These reflections bring me to the concluding chapter of this thesis, in which I synthesize the main findings of this research.

Conclusion

Digital fertility awareness-based methods of birth control are an attractive alternative to hormonal or invasive birth control for modern women.

–Jack T. Pearson et al. (2020, p. 1)

Keeping a pulse on the market, I noticed some key opportunities for further innovation to meet the needs of the modern woman. I found that pill sales were stagnating and women were looking for healthy, hormone-free alternatives that were simple, fast, and accurate. Knowing the busy lifestyle we all have, it was evident that we needed to create a tool that seamlessly connected to a smartphone so women on the go could have access to their fertility information at their fingertips.

–CEO of Valley Electronics, June 28, 2018 (in Weiner, 2018)

Synthesizing Findings – Innovating to Meet the Needs of the Modern Woman[117]

On two occasions when I presented my research project, feminist colleagues shared with me their concerns about the power of fertility tracking biosensors, and the companies that produce or monitor them, on women's bodies. On one such occasion, I was advised to focus on biosensors aimed at period management instead of biosensors aimed at pregnancy prevention, as the former were less likely to be viewed as the product of a neoliberal agenda promoting an idealized version of responsible womanhood, in which women actively work toward increasing both their productivity and their reproductibility. As I had not explicitely criticized (i.e. rejected) these technologies, I was asked if I was promoting them.

These colleagues' positions led me to question my own positioning towards my research. It ultimately helped me to frame the question raised in the fourth chapter: What makes fertility tracking biosensors acceptable, in which situations, and for whom? Throughout the research process, I documented and analyzed the position(s) of different actors on various locations regarding how these technologies were meant to become useful in women's lives. By using a pragmatic approach, I sought to avoid using a dichotomic moral conception of technology.

Therefore, I have studied fertility-tracking biosensors as examples of sociotechnical innovations in which an artifact (i.e., computerized fertility) travels across various places and times and, along the way, acquires or loses different meanings and values attached to specific performativities. In this investigation, I have attempted to make room for the blurring of some analytical categories usually found in self-tracking studies; indeed, a focus on relational practices

[117] I selected this quote verbatim from the chapter's second epigraph.

made the analytical distinctions between users/designers, nature/culture, knowledge/non-knowledge[118], digital/material and feminism/nonfeminism[119] no longer fundamentally relevant. Taken as such, these self-imposed categories blind rather than help understand complex sociotechnical practices.

I employed a praxiographic-BOAP approach to uncover different aspects associated with the shaping of the "modern woman" through fertility-tracking practices (Mol, 2002, p. 158). Focusing on relational practices, I followed an artifact (computerized fertility) through different times and locations, in places where its "coming into being and passing away" are disputed (Daston, 2000, p. ix).

The empirical observations led me to a twofold argument: first, the enactments of the fertility-tracking subject via computerized biosensors are intrinsically multiple (Mol, 2002, p. vii); second, taking part in different assemblages (Murphy, 2006, p. 12) and materialized within specific configurations (Suchman, 2013) of bodies, technical artifacts, knowledges, and values, fertility-tracking practices not only shape (modern) tracking subjects but the particular conditions of their

[118] On the problematic distinction in social scientists' accounts "between knowledge and non-knowledge," see Kellie Owens (2017, p. 855); Owens suggests, instead of a binary way of thinking, "to think of knowledge and non-knowledge along a continuum rather than as mutually exclusive categories" (Owens, 2017, p. 856).

[119] While some scholars use the category "feminist" as an analytical tool to distinguish the impact of technologies (e.g., "minimally," "moderately," or "radically feminist technology" [Layne, 2010, p. 14]), or its context of use (such as "feminist" or "nonfeminist reproductive politics" [Takeshita, 2012, p. 3]), in this dissertation, I have taken some distance from such framings, as it did not prove helpful to analyze the observed practices. Indeed, I realized during the study that categorizing technology or practices as feminist or not was strongly polysemic among actors in the field. For example, some women interviewed expressed strong resistance to the term "feminist," which they associated with representations of angry women advocating for abortions and refusing marriage. In contrast, in other discourses, the term "feminist" was equated with women gaining autonomy. Promoters also self-identified differently as "feminists" or "non-feminists." As with every analytical category, "feminist" results from complex histories that resonate differently with our own histories and requires unpacking. Such an investigation was beyond the scope of my inquiry.

acceptability, which are deeply embedded in the historical and political contexts in which they operate.

In this final chapter, I summarize the dissertation findings enabled by the praxiographic-BOAP approach and synthesize the different versions of what "good" cycle-tracking practices are or should be, according to different actors' positions. I then relate the dissertation findings to previous scholarly literature and debates. I conclude with a discussion of the implications of the research findings.

Tracking the Natural Body

The dissertation presents a new case for understanding a sociohistorically specific construction of the menstruating female body. In *Beyond the natural body: An archeology of sex hormones*, Nelly Oudshoorn (1994) investigated how, during the twentieth century, scientific conceptions of women's fertility had been progressively located in the uterus, the ovaries, and later, in hormones, based on scientific technologies and understandings available at the time. With computerized fertility-tracking practices, this dissertation demonstrates that women's fertility continues to travel, currently finding itself situated (and sought after) in digital data.

In fertility-tracking practices, the construction and normalization of the so-called "natural" female body take specific forms. By categorizing "female fertility" into color-coded fertility statuses, fertility biosensors represent women's bodies as organisms that emit signals from which fertility can be detected. Self-tracked temperature is viewed as a proxy for hormonal change that in turn serves as a proxy for ovulation, which is equated with fertility and conflated with fecundity. In the typical "tracked body configuration," a *good* tracker is a tracker in which data seemingly represent "nature accurately."

The construction of the modern woman has long been a topic of investigation in social studies of health and medicine. Medical historian Barbara Duden studied "the construction of the modern body" based on a doctor's records of women's complaints in his office in eighteenth-century Germany (Duden, 1991, p. 3).

> The category "woman," therefore, is a product of nineteenth-century natural science, comparable to other categories with a naturalistic appearance, such as "family," "reproduction," "kinship," and "sexuality." One of the great achievements of women's studies is that it uncovered and critiqued the ideological implication of this intellectual construct.
>
> (Duden, 1991 [1987], p. 21)

While acknowledging "woman" and the "natural female body" as sociomaterial constructs, the phenomenon presented in this dissertation contrasts with studies of feminist scholars that documented particular configurations of the biomedical female body through the birth control pill (Marks, 2001), menstrual suppression methods (Mamo & Fosket, 2009; Sanabria, 2016), and intra-uterine devices (Takeshita, 2012). In fertility-tracking practices, the construction and normalization of the so-called "natural" female body take specific forms. We have seen how the notion of nature has been associated by actors with different ideals and values: a lifestyle free from pharmaceutical side-effects, a more authentic self[120], a community (as in Natural Family Planning),

[120] Discussing the promoting discourse of Alisa Vitti, "a self-proclaimed wellness guru", Fox and Spektor develop the concept of "hormonal advantage" as "a genre of self-care…promoted under a neoliberal feminist agenda of optimization and demonstrating an impulse to extend market rationality to all aspects of life" (Fox & Spektor, 2021, p. 3).

a (natural) contraceptive as opposed to artifical means of contraception, a marketing label (as in the app Natural Cycles). Whereas in the marketing of the menstrual supression pill Seasonale, nature is promoted as a way to skip the "artificial" period *caused by the pause* (Mamo & Fosket, 2009; Sanabria, 2016), nature in the context of the fertility tracker is equated with an "unequipment" of the body, detached from synthetic hormones. The present research extends this body of literature, showing that rather than being a given, "the modern female body" is a complex construction, historically shaped by technoscientific, cultural, political, and psychological elements[121].

FERTILITY TRACKING SOFTWARE PREEXISTED FEMTECH

In the first chapter on "Assembling," I discussed fertility tracking software promoted at the turn of the twenty-first century. I showed that fertility trackers were meant for different purposes, not only contraception. This chapter then investigated different assemblages in which computerized fertility biosensors took part at the turn of the twenty-first century. Drawing on an archives file collected by Valley Electronics' founder, Dr. Hubertus Rechberg, I identified four assemblages. I distinguished the assemblages based on what the different written sources indicated the biosensors were expected to achieve. In the assemblages, biosensors are imagined to solve the population crisis, assist doctors in infertility diagnoses, enhance a couple's sex life, and predict the gender of a child. In each assemblage, specific relations between different actors, materialities, knowledges, and values are articulated.

[121] For edited volumes on women's health, medicine and technology, see, for example, Jacobus et al. (1990), Saetnan et al. (2000), and the more recently published *Routledge international handbook on women's sexual and reproductive health* by Ussher et al. (2019).

I argued that particular "technico-moral compatibilities" shape the articulations. As a result, the fertile female body is constructed in a series of comparison, opposition, hierarchization, and anticipation processes, in which morals and techniques play an important role. Importantly, these assemblages are characterized by overlaps and versatility.

The chapter allows for the inscription of fertility biosensors in a particular historical moment. Illustrative of many innovation narratives, computerized fertility tracking was envisioned to solve women's problems with modernized technical artifacts. However, whereas technological fixes were prescribed in some radical feminist movements as a way to empower women in liberating them from the oppressions caused by "the tyranny of reproduction" (e.g. by Shulamith Firestone and the idea of artificial wombs [Wajcman, 1991, p. 56]), with fertility biosensors, it has been promoted as a way to empower women by "getting closer" to their biology. Additionally, this historical inscription allows for the problematization of novelty claims mobilized in promotional discourses of fertility-tracking biosensors in the femtech market[122].

PROMOTERS DON'T AGREE ON WHAT MAKES A GOOD FERTILITY-TRACKING APP

Focusing on the promotion of fertility biosensors, I unpacked, in Chapter Two on "Configuring," contrasting configurations of the life-enhancing/pregnancy prevention assemblage. By following biosensors in technological fairs and scientific congresses, I observed that promoters disagree on whether and how fertility biosensors can and should enhance users' (i.e., women's) lives. To make sense of my observations, I produced an analytical tool (the fertility-tracking configuration matrix), which enabled me to identify four ideal-typical configurations of biosensors and users' empowerment. I have distinguished the "trained," "tracked," "tweaked," and "threatened" body

[122] The biosensors in the assemblages are not immutable but require work to stabilize in one form or another; without such work, as with any innovation, they are more likely to disappear.

configurations based on how their promoters justified the added value of fertility biosensors compared to other technical artifacts for pregnancy prevention. I argued that promoters differ in their expectations related to the performativity of the biosensor, as well as in their views on which (human or non-human) actors should be granted the most interpretative agency within the configuration and which elements should primarily be measured. Therefore, the configurations enact different forms of empowerment, body ontologies, and values.

Among the contrasting configurations, the *tracked body* is the one verging closest to a pursuit of "objective knowledge" constructed through the minimization of users' involvement. I developed the concept of "soft(a)wareness" to characterize the particular incentives observed in this configuration, in which a user is prompted to know the internal logic of one's own body while being prevented from accessing the inner workings of the software itself. The *trained body* configuration, by contrast, mobilizes the promotion of a more comprehensive form of awareness, in which it is assumed that the more a user understands the method and physiology, the better. The *tweaked body* configuration lies somewhere in between, recognizing that users come with limited resources and inherently biosocial properties; this configuration turns to big data to produce approximate but good enough fertility statuses. The *threatened body* configuration can be found in discourses that emphasize the risks related to the undesirable consequences of fertility-tracking practices, such as unintended pregnancy and intimate or menstrual surveillance[123].

[123] Scholars and reporters have developed the notions of "intimate" and "menstrual surveillance" to draw attention to some dangers associated with menstrual cycle tracking apps. In 2015, legal scholar Karen Levy coined the term "intimate surveillance" to alert against the risks to privacy related to the normalization of increased data-gathering of information on intimate behaviors (including fertility-tracking) by individuals themselves (Levy, 2015). A few years later, Vox reporter Kaitlyn Tiffany (2018), commenting on the work of Levy, used the notion of "menstrual surveillance" in an article entitled "Period-tracking apps are not for women: The golden age of menstrual surveillance is great for men, marketers, and medical companies." The notion of menstrual surveillance has been used in several

Women's bodies have been, and continue to be, the site of extensive body politics. The recent (June 24, 2022) overturning in the United States of the supreme court decision *Roe v. Wade*[124] that guaranteed the constitutional right to abortion for nearly a half century led to concerns that menstrual tracking apps could be used against women in criminal investigations.[125] Many activists and commentators alike have urged women to review the privacy policies of their tracking apps or just delete them altogether to avoid risking misuse of their personal data[126].

As feminist science and technology scholar, I argue that the perpetuation of fear about companies (and governments) mishandling personal tracking data should not result in simply advising women *not to use* technology. Such argument is technodeterminist and can be seen as patronizing, as it tends to conceal rather than explain fundamental issues surrounding women's rights to self-determination and use of technology as they deem appropriate. Instead, discourses such as those undertaken by consumer protection organizations and collectives could focus on informing users on the differences between mutliple biosensors, their privacy settings, and what can be done to increase privacy (Beilinson, 2016; Felizi & Varon, n.d.; Quintin, 2017; Roberts, 2022; Schechner & Secada, 2019; William et al., 2021).

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publications since (Ayers 2019, Mahdawi 2019, Gilman 2021). Human-computer interaction scholars Sarah Fox and Franchesca Spektor (2021) offer a complementary account of practices of menstrual surveillance by historicizing them and linking them with corporate surveillance in the workplace in the twentieth century.

[124] Following this decision by the U.S. Supreme court, 10 out of 50 U.S states have banned abortion (as of July 8, 2022) (see The New York Times [https://www.nytimes.com/interactive/2022/us/abortion-laws-roe-v-wade.html]).

[125] For some reflections on the legal and regulatory questions about self-tracked data, see Neff & Nafus (2016, pp. 178–182).

[126] For example, Elizabeth H.C. McLaughlin: "If you are using an online period tracker or tracking your cycles through your phone, get off it and delete your data" (3 May 2022, 5:27 p.m.) Tweet. Retrieved from https://twitter.com/ECMcLaughlin/status/1521511730584514561.

THE DATAFIED BODY BECOMES A CATALYST FOR UNDERSTANDING AND INTERVENING WITH THE SELF

In Chapter Three on "Experiencing," I closely examined women's experiences of a specific biosensor called Daysy. I analyzed how Daysy, a biosensor produced by Valley Electronics, is experienced by different users and participates in the shaping of various biosocial identities. Mainly, I showed how, in specific "data–human mediations" (Ruckenstein & Schüll, 2017, p. 268), users and trackers *become complicit* in the shaping of knowledge. I situated how users came to the tracker in a series of consumer choices shaped by different constraints (such as dissatisfaction with previous methods of contraception) or opportunities (such as a presentation by a friend or a social media influencer). I analyzed how users describe their life-enhancement with Daysy, as well as deception in some cases, for example when their body never materialized as "fecund."

I developed the concept of "cyclic self-fashioning" as an analytical tool to account for how users receive and shape biomedical "facts" about the "fertile female body" and mobilize these facts in practice. I identified different entities that emerge during fertility-tracking practices: among them, active knowledge-seeker (when a user actively interprets their data and bodily signs); affects mediator (when a user mobilize their data to understand their emotional states and orientate their social interactions); maximizing self (when the production of green days becomes a goal); erotic self (when a user communicate the anticipation of green days to their partner); biological self (when temperature data are understood as what makes a woman different from a man); and invalidated self (when the body does not materialize in a biphasic temperature curve). This chapter has also shown that users' practices encompass ambivalent dimensions; they vary over time and are broader than merely pregnancy prevention such as menopause, and (mental) health monitoring.

FERTILITY TRACKING BIOSENSORS ARE ONLY MADE ACCEPTABLE WITHIN SPECIFIC CONTEXTS

Finally, in Chapter Four on "Assessing," I turned to fertility-tracking biosensors assessment and showed how different actors (such as scientists, users, journal editors, midwives, medical products agencies, sed ed activists and reporters) participate in biosensors in/validation. Specifically, actors do not necessarily agree on whether and how fertility biosensors should be promoted, nor under which conditions. Focusing on the assessment of two biosensors, Daysy and Natural Cycles, I showed, using the notion of "regimes of acceptability," that the "rightness" of a biosensor –or the moral assessment of its use– is not inherently found in the device but is instead enacted in practice. While some actors mobilize regimes that echo the "threatened body configuration," presenting users as vulnerable, others emphasize the trust built through personal experience with the biosensor. Again, in these assessment practices, the envisioned subjects of fertility-tracking biosensors are profoundly multiple.

Additionally, in Chapter Four, I documented the FDA's introduction of the new regulatory category, "software application for contraception." The FDA's definition of a "safe" fertility biosensor aims to standardize devices and their use by ensuring the exclusion of non normative biologies or lifestyles. Therefore, the FDA definition differs drastically from more constructionist definitions that acknowledge the flexibility of technological artifacts. The effects of the new regulatory category on the fertility apps landscape remain to be observed. As shown in the chapter, temporality is key in the analysis of fertility biosensors, as throughout various assessment rounds, some trackers are validated, while others are not.

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To address the compartmentalization of research in fertility tracking studies, I developed an analytical toolkit (see figure 61) to allow for a transversal approach to fertilty tracking biosensors

and practices that would cut across aspects of fertility tracking practices that were outside the literature scope: namely, their developments before the use of smartphones, their promotion in tech fairs, their use for pregnancy prevention, and their regulation in practice. This transversal approach was made possible by holding a dialogic stance with apps providers, as well as users. Furthermore, while previous research primarily focused on menstrual cycle experiences within a single country, the scope of the present research offers contrasting elements from different geographical locations.

In addition to analyzing the transversal dimensions of fertility tracking practices, this research followed a praxiographic-BOAP approach that enabled me to produce a series of analytical concepts, meant as heuristic devices to better understand technologically mediated fertility-tracking practices. Building upon studies in the fields of sociology of health and medicine, and feminist science and technology studies, and drawing more heavily on the work of Joe Dumit, Michelle Murphy, and Lucy Suchman, I referred to these as "the body tracking configuration matrix," "soft(a)wareness," "cyclic self-fashioning," and "regimes of acceptability." Following John Law, I see this analytical toolkit as "a combination of reality detector and reality amplifier" (Law, 2004, p. 14).

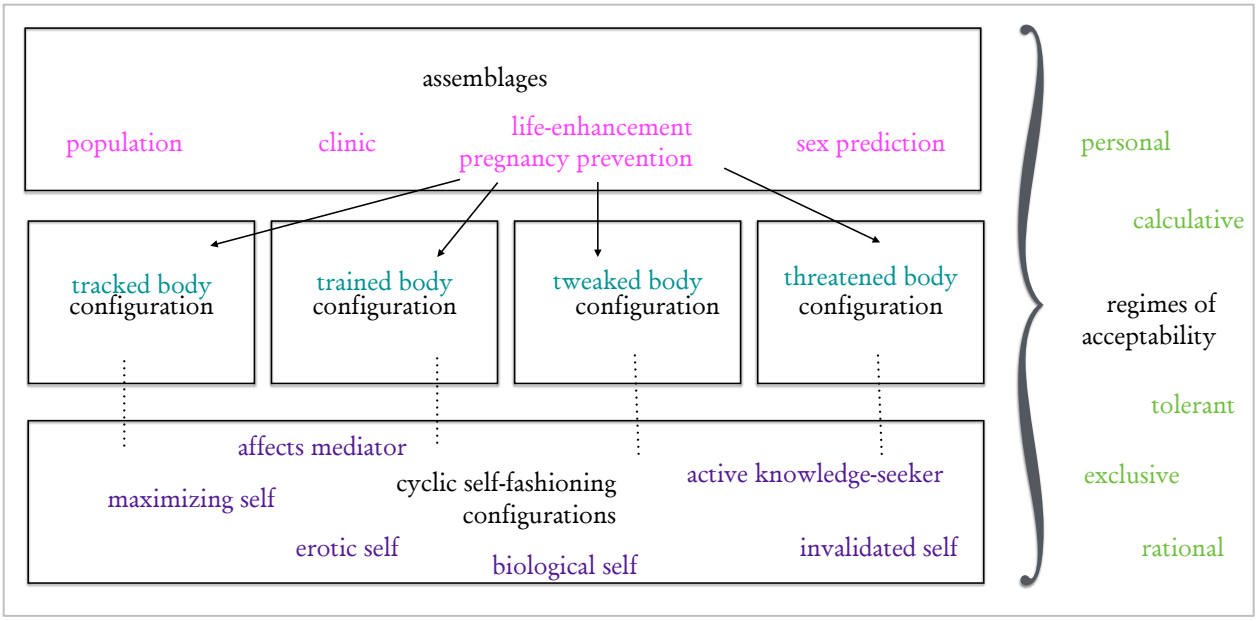

Figure 61: A new analytical toolkit for the study of self-tracking biosensors

Research Contribution and Implications

With this dissertation, I hope to have contributed to constructionist perspectives, which rather than promoting simple "de-technologization" (Stanković, 2017, p. 7), incite us to consider technologically mediated practices in the multiple contexts of their enactments. Unpacking and expanding our understandings of the ways menstrual cycle tracking practices *are* and *can be* part of multiple biosocial assemblages open up new and creative ways to live in our increasingly technoscientific environments amid rapidly changing geopolitical terrain.

From there, useful avenues for intervention—such as participatory research, critical reflexivity (Frost & Haas, 2017), and humble engagement with technoscientific artifacts (Jasanoff, 2007, p. 33)—offer promising opportunities to carve out the third space needed to widen the scope

of the empowerment vs. discipline debate and expand our understanding of technologically mediated bodily practices.

The analytical toolkit I developed as part of this dissertation is meant to help open that third space. It is a first step towards the development of creative interventions that could benefit scholars, researchers, policy makers and app users. First, the toolkit enables one to vary the boundaries drawn around biosensors as research objects. By zooming in and out of specific technosocial configurations, it can help researchers in particular to engage in what Fors and colleagues call "creative interpretations of what data might mean in historic as well as present and future contexts" (Fors et al., 2020, p. 25). Second, the toolkit can help researchers and activists to map changes that occur over time within self-tracking apps ecologies. In action-oriented work, it would be helpful to identify what could be different in various configurations and assemblages and who could benefit from a specific change. In this sense, the toolkit could help to reframe existing interventionist approaches that primarily focus on the app interface to enable appropriate user experiences and instead include other elements (such as partners, healthcare professionals, regulators, political actors, and others). The resulting cartographies could help users and healthcare professionals navigate complex apps ecologies.

Box 12: Areas for Further Research

The research highlights two key areas that warrant further investigation from feminist science and technology studies. The first concerns the concept of the "fertile window" that was introduced in biomedical research during the late 1990s and early 2000s (Dunson et al., 1999; Wilcox et al., 1995, 2000). The historical demarcation of disciplinary fields (leaving biological matter to biomedical scientists and social matter to social scientists [Birke, 1986, 1999]) and the

marginalization of the reproductive sciences by other sciences during the twentieth century (Clarke, 1998, p. 21) might explain why the fertile window remained understudied in medical humanities. This coupling might have prevented feminist scholars and social scientists from further delving into the sociocultural history of the fertile window and related epistemologies. Such investigations would answer the call by historian Monica Green "for a fuller, richer history of women's healthcare that shows medical epistemologies as various kinds of situated knowledge" (Green, 2008, p. 489). By deconstructing medical science and knowledge in this way, scholars may learn: How predicted ovulation came into existence? How do we know what we know about the so-called fertile window? Which bodies have been included in these experiments, which have not? How have cyclicity and womanhood become associated? And what are the effects of such association?

The second area relates to recent developments in biomedical research, endocrinology, and immunology. Using menstrual cycle tracking biosensors to collect data from a multitude of users, research teams have started to produce new knowledge on the menstrual cycle and its relation to health, outside of strictly reproductive frameworks. Selected examples include: Citizen Endo, a research project led by the Department of Biomedical Informatics, at Columbia University, in partnership with patients diagnosed with endometriosis[127] and research on the vaginal microbiome at the Digital Epidemiology Lab of the Swiss Federal Institute of Technology Lausanne, and Stanford University (Symul et al., 2019, 2021; Symul & Holmes, 2022). Central questions stemming from this emerging research could include: How are subjects configured within the research itself? What kinds of partnerships are mobilized? Which actors are positioned as data providers and knowledge producers? What values are associated with the menstrual cycle? Who might benefit from these (new) knowledges, and in what circumstances? What may be the unintended consequences of the various configurations and knowledges that emerge?

[127] http://citizenendo.org/

There are certain limitations to use of the praxiographic-BOAP approach. First, by following certain practices, the approach necessarily enables the study of some research situations (as discussed throughout the chapters) while occulting others—namely the role of partners and fertility awareness-based teachers in fertility-tracking practices, and the motivations, backgrounds, and infrastructures situated beyond promoters' more immediate work with fertility tracking biosensors. Second, by focusing on "data–human mediations" (Ruckenstein & Schüll, 2017, p. 268), the dissertation is less invested in users' inscriptions in country-specific healthcare systems. Third, the praxiographic-BOAP approach could have benefited from integrating an intersectional feminist lens to assess differences and power hierarchies pertaining to race, (dis)ability, (non-normative) sexuality, and gender spectrums that are enacted through fertility-tracking practices. Though these may be considered to be empirical blind spots, it is my hope that the findings and analytical toolkit developed from this dissertation will offer productive outcomes for ongoing research into the intersections of science, technology, and feminism.

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Appendix A

	A	B	C	D	E
1	**Nom entreprise**	**Lieu**	**Device**	**Sorte (wearable, thermomptre, app, etc.)**	**Commentaire**
2	Ava	CH (Zürich), USA	x	wearable thermo, move, etc.	reprod (+K)
3	ayda		x	wearable, infra	Worn only during sleep, Ayda enables women to effortlessly identify when they are most fertile so they can maximize their chances of conceiving naturally. The Ayda fertility tracker is a seamless, non-invasive experience, automatically logging biometric data during sleep to a connected app on an easy to use platform. Ayda removes the burden associated with fertility tracking, providing women and couples with actionable data and peace of mind.
4	Bellabeat Leaf	USA	x	wearable thermo, move, etc.	
5	bioself (valtronic) n'existe plus	CH	x	computer (mais pas app)	
6	Clearblue (SPD - Swiss Precision Diagnostic GmbH)	UK (Bedford), CH (Ge)	x	device test	
7	comper	China?	x	temperature	designed with innovations and amazing oral experience (sur kickstarter)
8	Cyclotest Lady	DE (production winterthur)	x	computer (mais pas app), (produit par UEBE, Thermomether factory in Germany)	contra, reprod.
9	Daysy (+daysyview app) (Valley Electronics AG - The Lady-Comp, Baby-Comp and Pearly)	DE, CH (Zürich), USA	x	device thermo	contra, reprod, predict
10	DuoFertility (Cambridge Temperature Concepts Limited - CTC)	UK (Cambridge)	x	wearable (bracelet sensor)	reprod / alternative to IVF
11	Earlysense		x		
12	EMAY	Chine (Hong Kong)	x	device thermo (ressemble bcp à iFertracker -> design, vendu aussi sur amazon…)	
13	Femometer (Bongmi)	Chine	x	device thermo	pub anniversaire (!!), chine /contra + reprod
14	FertiGO (Swan Diagnostics)	Netherland	x	sperme?	
15	Home kit test lab (Anjavo)	DE (Dresden)	x	sperme	
16	iFertracker. iThermonitor	Chine (Beijing), USA (Boston)	x	wearable thermo "souris" (raiing)	Rem: iThermonitor FDA approved, iFertracker non. / rem: se colle sous le bras, open API… check, analyse quality of sleep,
17	Knowhen	USA	x	saliva tracker	contra, reprod.
18	Mira fertility monitor	USA	x	urine	apparamment voudrait toucher aussi allergies et autres…
19	myLotus (Concepta)	UK (London, Bedfordshire)	x	device test urine + app	reprod
20	Natural cycles	SU (stockholm), 1er bureau CH (Zu)	x	thermo (un thermomètre produit par UEBE, Thermomether factory in Germany; l'autre thermo produit par Veridian Healthcare, USA)	contra
21	Ova Ova		x		Rem: twitter dead depuis 2012.
22	ovacue	USA	x	device thermo	(FairHaven Health)

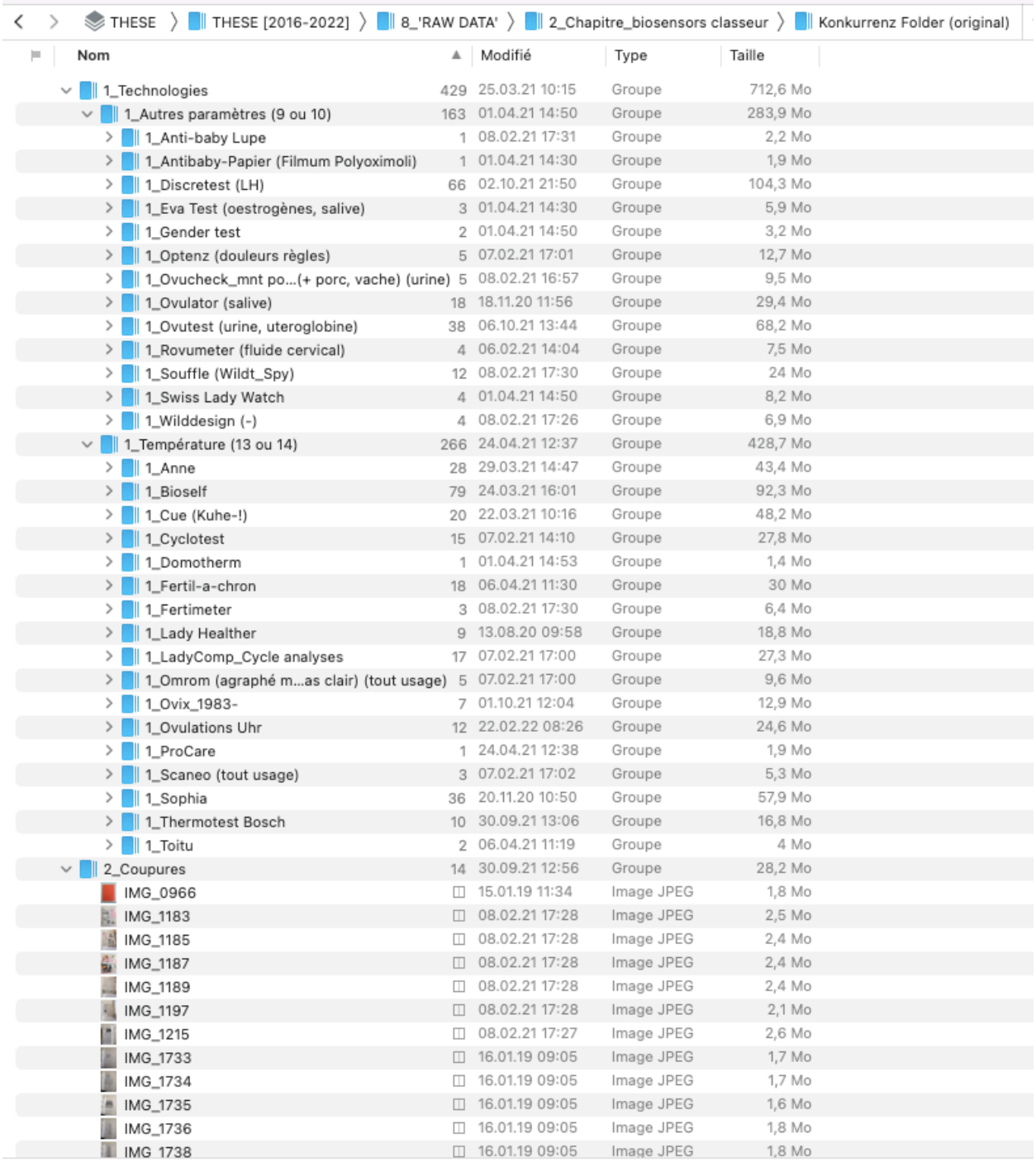
	A	B	C	D	E
1	**Nom entreprise**	**Lieu**	**Device**	**Sorte (wearable, thermomptre, app, etc.)**	**Commentaire**
23	Ovatemp	USA	x	device thermo	contra, reprod. Rem: Ondo Out of stock. Rem: co-fondateur, Daniel Graf, Suisse.
24	ovularing	DE	x	temperature	
25	Ovusense	UK (warwick)	x	device (vaginal sensor-thermometer)	en continu, nuit, vaginal / code couleur différentd'autres trackers, moins dichotomique que yes,no,dontknow}
26	Ovy	D?	x	thermo	nach nfp
27	Persona (SPD - Swiss Precision Diagnostics GmbH)	Bedford, Ge (pas email)	x	device test urinaire	
28	Priya ring	USA	x	vagina ring	
29	Tempdrop	Israel	x	wearable (bracelet ou autocollant thermo sensor "goutte")	
30	trackle	DE	x	thermo-tampon (nuit)	
31	Trak (Sandstone Diagnostics)	USA	x	sperme	
32	Well twigs	USA	x	device hormones tracker - pipi stick	reprod. predict.
33	Wink (Kindara)	USA	x	device thermo	"Our Mission: Our mission is to empower women by providing the tools and knowledge they need to live their best lives and optimize their health."
34	Yono	USA	x	wearable in-ear thermo	reprod, contra. machine learning algorithms
35	Shecare	Chine?	x	thermo blutooth	
36	kindara (Wink)	USA	x	device thermo	
37	Ziranfa	Chine	x	thermo	
38	premom	US?	x	BBT thermo + app / hormone visualisation	reprod / You track. We predict. / The AI-powered algorithm analyzes all your ovulation signs and boosts your accuracy for ovulation and period prediction.
39	Smartal Electronic Co. Ltd		x	bluetooth thermo patch (jusqu'à 120 jours?)	https://www.globalsources.com/product/bm01-home-smart-fertility-tracker_1151193979f.htm
40	iXensor Co., Ltd.	taipei	x	eveline ovu stick reader	
41	computer-assisted semen analysis (CASA) / M.K. Kanakasabapathy et al., Science Translational Medicine (2017)	USA (Boston)	x	sperme	contrairement aux autotests déjà sur le marché comme SpermCheck, FertilMARQ ou The Trak, ce nouveau dispositif permet non seulement de connaître le nombre de spermatozoïdes présents dans la semence, mais aussi ceux qui sont en mesure de bouger. http://mashable.france24.com/tech-business/20170324-sperme-appli-fertilite-test
42	Yo (Medical electronic system)	USA (los angeles)	x	sperme	

	A	B	C	D	E
1	**Nom entreprise**	**Lieu**	**Device**	**Sorte (wearable, thermomptre, app, etc.)**	**Commentaire**
43	CycleBeads (Cycle Technologies)	USA?	x	device non digital (collier de perles)	contra, reprod. / global south?
44	2Day Method (Cycle Technologies)	USA?			
45	baby planner				
46	Bloomlife				
47	Brown fertility				
48	Celmatix	USA			
49	Charting App				
50	clue	Berlin			Ida Tin coined the term FemTech
51	conceivable				
52	Concepta diagnostics				
53	Cyclendar				
54	CycleProGo				
55	Cycles				
56	Dot (Cycle Technologies)	USA			contra, reprod.
57	Eve				
58	FemCal				
59	FEMM				
60	Fertility & Ovulation				
61	fertility +				
62	Fertility Calendar				
63	Fertility Clock				
64	Fertility focus				
65	fertility friend				
66	Fertility Pinpoint				
67	Flower Kid				
68	Genosis (male + female home fertility test)				
69	get baby				

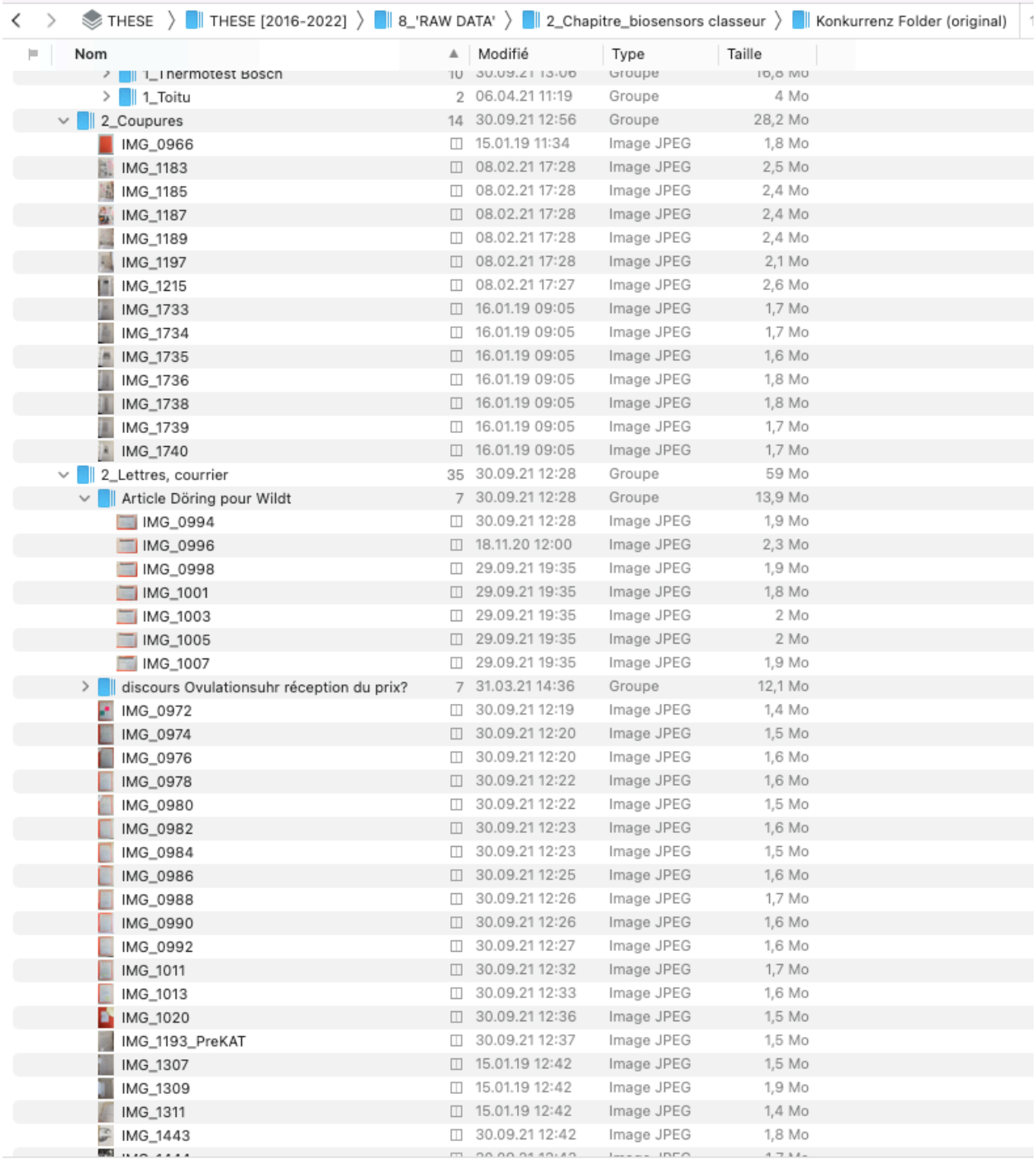
	A	B	C	D	E
1	**Nom entreprise**	**Lieu**	**Device**	**Sorte (wearable, thermomptre, app, etc.)**	**Commentaire**
70	glow				Reprod. / An App for fertility and beyond / Also, Glow is the only app that also tracks male fertility! / Glow is an ambitious enterprise that uniquely applies the power of data science to health. Our personal health tracking products illuminate health through data, and empower people with new information about their bodies.
71	Go28days	PO			
72	Groove				
73	Groove fertility pro				
74	iCycleBeads				
75	iCyclus				
76	Lady Cycle				
77	Lady Timer				
78	Life				
79	Lily				
80	LilyPro				
81	Maybe baby				
82	Menstrual Cycle Woman Log				
83	Menstruation & Ovulation				
84	mfNFP.net				
85	my days				
86	My Fertility MD				
87	my pill				
88	MyFertilityCharts.com				
89	NaProTechnology				
90	NFP Charting				
91	NFP Project Caruso				
92	OvaGraph				(FairHaven Health)
93	ovia (Ovuline) (fertility, pregnancy, parenting)				
94	Ovulation calendar				web seulement?

	A	B	C	D	E
1	**Nom entreprise**	**Lieu**	**Device**	**Sorte (wearable, thermomptre, app, etc.)**	**Commentaire**
95	ovulation mentor	USA			
96	OvuView (sleekbit)				??
97	OWhealth (Flo Period Tracker app)				reprod, K, predict.
98	P. Tracker				
99	Period & Ovulation Calendar				
100	Period Calendar				
101	Period Diary				
102	Period Log				
103	Period Pace				
104	period planner				
105	period tracker				
106	Period tracker lite				
107	pink pad				
108	Pink Pad Pro				
109	Progny				
110	Progygny				
111	sympto.org				
112	Symptopro				
113	The Flow App	USA?			neural network, artificial intelligence // male partner, learn to read the female cycle
114	Woman Calendar				

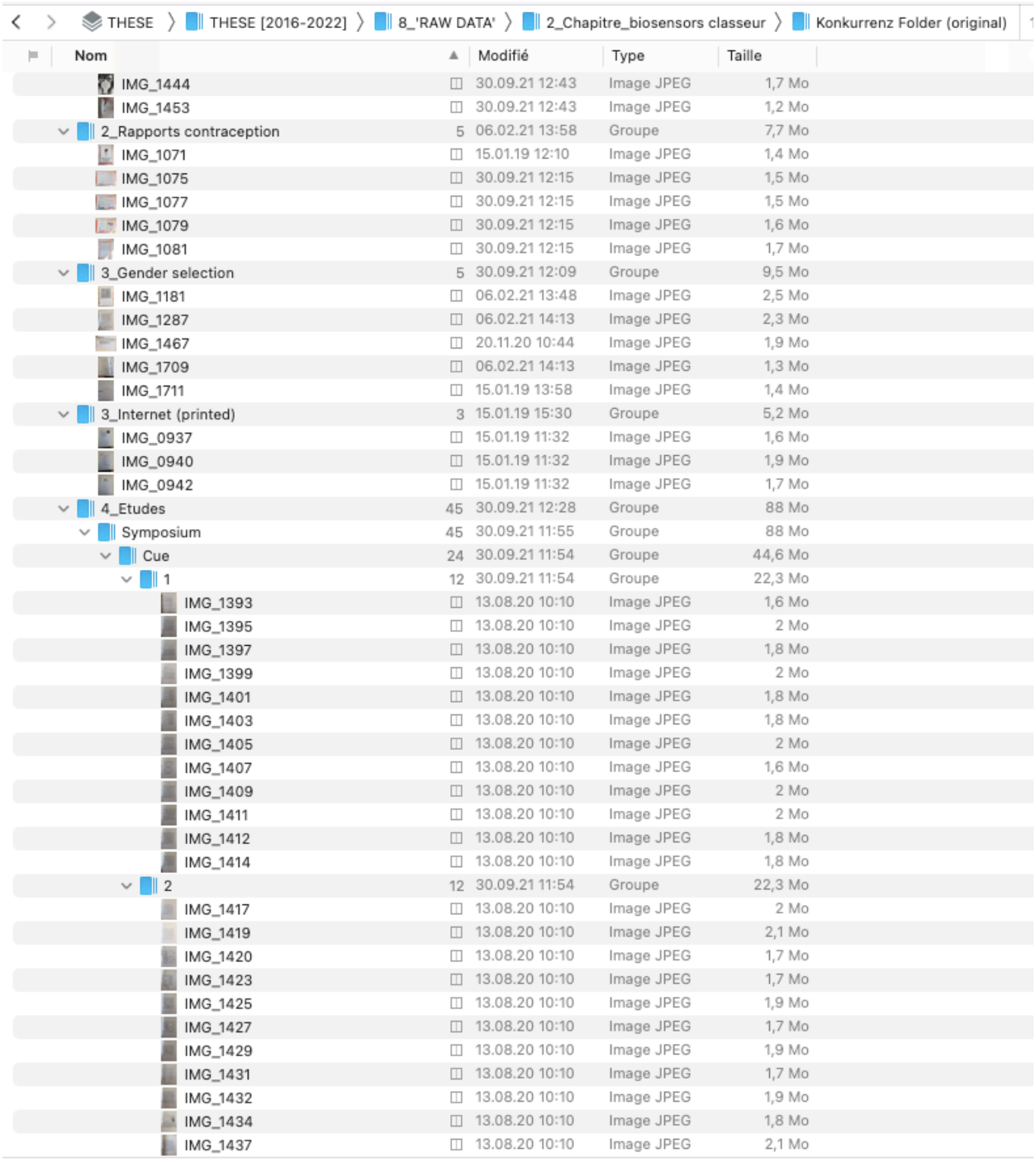
Appendix B



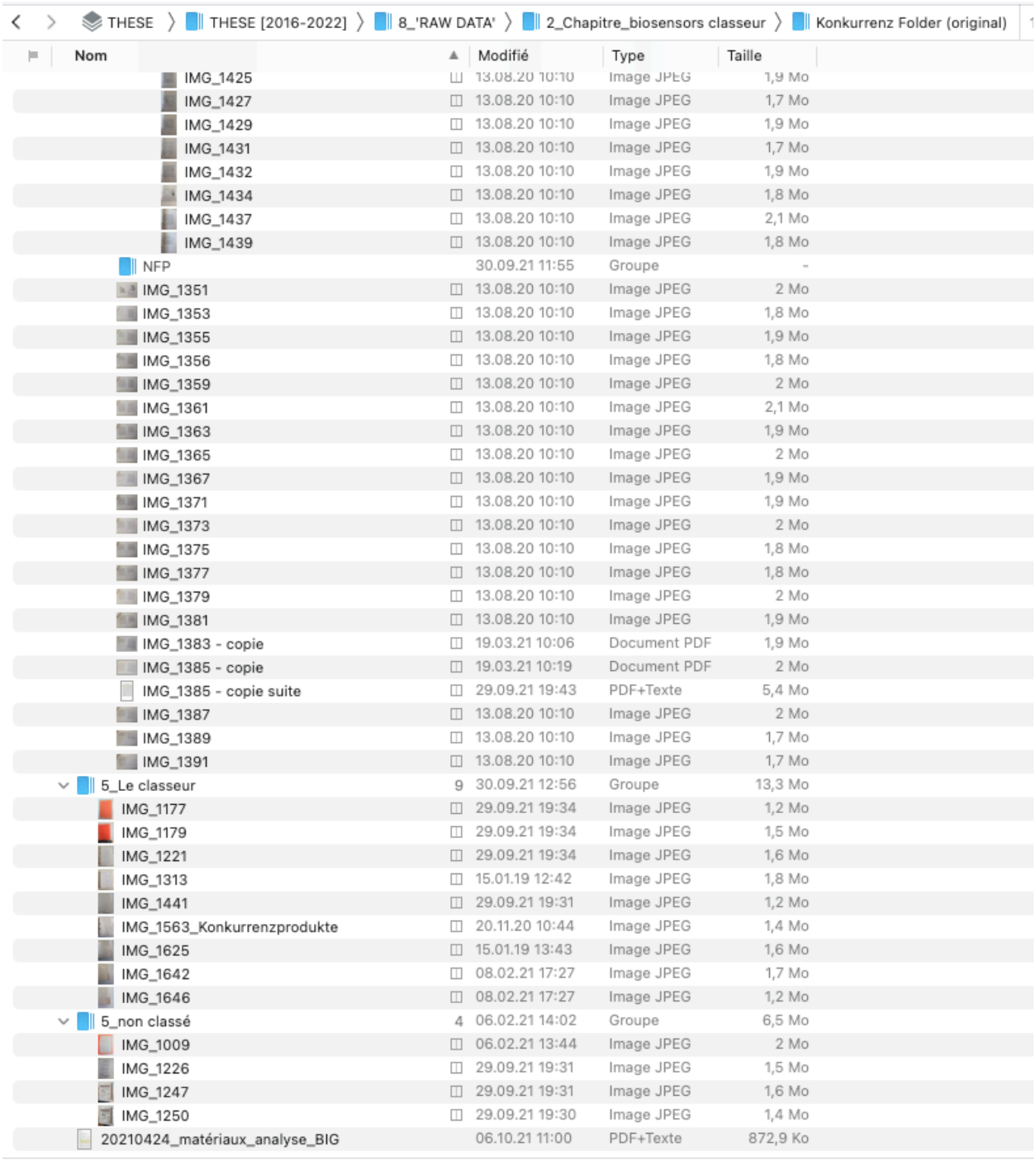
Nom		Modifié	Type	Taille
1_Technologies	429	25.03.21 10:15	Groupe	712,6 Mo
1_Autres paramètres (9 ou 10)	163	01.04.21 14:50	Groupe	283,9 Mo
1_Anti-baby Lupe	1	08.02.21 17:31	Groupe	2,2 Mo
1_Antibaby-Papier (Filmum Polyoximoli)	1	01.04.21 14:30	Groupe	1,9 Mo
1_Discretest (LH)	66	02.10.21 21:50	Groupe	104,3 Mo
1_Eva Test (oestrogènes, salive)	3	01.04.21 14:30	Groupe	5,9 Mo
1_Gender test	2	01.04.21 14:50	Groupe	3,2 Mo
1_Optenz (douleurs règles)	5	07.02.21 17:01	Groupe	12,7 Mo
1_Ovucheck_mnt po...(+ porc, vache) (urine)	5	08.02.21 16:57	Groupe	9,5 Mo
1_Ovulator (salive)	18	18.11.20 11:56	Groupe	29,4 Mo
1_Ovutest (urine, uteroglobine)	38	06.10.21 13:44	Groupe	68,2 Mo
1_Rovumeter (fluide cervical)	4	06.02.21 14:04	Groupe	7,5 Mo
1_Souffle (Wildt_Spy)	12	08.02.21 17:30	Groupe	24 Mo
1_Swiss Lady Watch	4	01.04.21 14:50	Groupe	8,2 Mo
1_Wilddesign (-)	4	08.02.21 17:26	Groupe	6,9 Mo
1_Température (13 ou 14)	266	24.04.21 12:37	Groupe	428,7 Mo
1_Anne	28	29.03.21 14:47	Groupe	43,4 Mo
1_Bioself	79	24.03.21 16:01	Groupe	92,3 Mo
1_Cue (Kuhe-!)	20	22.03.21 10:16	Groupe	48,2 Mo
1_Cyclotest	15	07.02.21 14:10	Groupe	27,8 Mo
1_Domotherm	1	01.04.21 14:53	Groupe	1,4 Mo
1_Fertil-a-chron	18	06.04.21 11:30	Groupe	30 Mo
1_Fertimeter	3	08.02.21 17:30	Groupe	6,4 Mo
1_Lady Healther	9	13.08.20 09:58	Groupe	18,8 Mo
1_LadyComp_Cycle analyses	17	07.02.21 17:00	Groupe	27,3 Mo
1_Omrom (agraphé m...as clair) (tout usage)	5	07.02.21 17:00	Groupe	9,6 Mo
1_Ovix_1983-	7	01.10.21 12:04	Groupe	12,9 Mo
1_Ovulations Uhr	12	22.02.22 08:26	Groupe	24,6 Mo
1_ProCare	1	24.04.21 12:38	Groupe	1,9 Mo
1_Scaneo (tout usage)	3	07.02.21 17:02	Groupe	5,3 Mo
1_Sophia	36	20.11.20 10:50	Groupe	57,9 Mo
1_Thermotest Bosch	10	30.09.21 13:06	Groupe	16,8 Mo
1_Toitu	2	06.04.21 11:19	Groupe	4 Mo
2_Coupures	14	30.09.21 12:56	Groupe	28,2 Mo
IMG_0966		15.01.19 11:34	Image JPEG	1,8 Mo
IMG_1183		08.02.21 17:28	Image JPEG	2,5 Mo
IMG_1185		08.02.21 17:28	Image JPEG	2,4 Mo
IMG_1187		08.02.21 17:28	Image JPEG	2,4 Mo
IMG_1189		08.02.21 17:28	Image JPEG	2,4 Mo
IMG_1197		08.02.21 17:28	Image JPEG	2,1 Mo
IMG_1215		08.02.21 17:27	Image JPEG	2,6 Mo
IMG_1733		16.01.19 09:05	Image JPEG	1,7 Mo
IMG_1734		16.01.19 09:05	Image JPEG	1,7 Mo
IMG_1735		16.01.19 09:05	Image JPEG	1,6 Mo
IMG_1736		16.01.19 09:05	Image JPEG	1,8 Mo
IMG_1738		16.01.19 09:05	Image JPEG	1,8 Mo



Nom		Modifié	Type	Taille
1_Thermotest Bosch	10	30.09.21 13:06	Groupe	16,8 Mo
1_Toitu	2	06.04.21 11:19	Groupe	4 Mo
2_Coupures	14	30.09.21 12:56	Groupe	28,2 Mo
IMG_0966		15.01.19 11:34	Image JPEG	1,8 Mo
IMG_1183		08.02.21 17:28	Image JPEG	2,5 Mo
IMG_1185		08.02.21 17:28	Image JPEG	2,4 Mo
IMG_1187		08.02.21 17:28	Image JPEG	2,4 Mo
IMG_1189		08.02.21 17:28	Image JPEG	2,4 Mo
IMG_1197		08.02.21 17:28	Image JPEG	2,1 Mo
IMG_1215		08.02.21 17:27	Image JPEG	2,6 Mo
IMG_1733		16.01.19 09:05	Image JPEG	1,7 Mo
IMG_1734		16.01.19 09:05	Image JPEG	1,7 Mo
IMG_1735		16.01.19 09:05	Image JPEG	1,6 Mo
IMG_1736		16.01.19 09:05	Image JPEG	1,8 Mo
IMG_1738		16.01.19 09:05	Image JPEG	1,8 Mo
IMG_1739		16.01.19 09:05	Image JPEG	1,7 Mo
IMG_1740		16.01.19 09:05	Image JPEG	1,7 Mo
2_Lettres, courrier	35	30.09.21 12:28	Groupe	59 Mo
Article Döring pour Wildt	7	30.09.21 12:28	Groupe	13,9 Mo
IMG_0994		30.09.21 12:28	Image JPEG	1,9 Mo
IMG_0996		18.11.20 12:00	Image JPEG	2,3 Mo
IMG_0998		29.09.21 19:35	Image JPEG	1,9 Mo
IMG_1001		29.09.21 19:35	Image JPEG	1,8 Mo
IMG_1003		29.09.21 19:35	Image JPEG	2 Mo
IMG_1005		29.09.21 19:35	Image JPEG	2 Mo
IMG_1007		29.09.21 19:35	Image JPEG	1,9 Mo
discours Ovulationsuhr réception du prix?	7	31.03.21 14:36	Groupe	12,1 Mo
IMG_0972		30.09.21 12:19	Image JPEG	1,4 Mo
IMG_0974		30.09.21 12:20	Image JPEG	1,5 Mo
IMG_0976		30.09.21 12:20	Image JPEG	1,6 Mo
IMG_0978		30.09.21 12:22	Image JPEG	1,6 Mo
IMG_0980		30.09.21 12:22	Image JPEG	1,5 Mo
IMG_0982		30.09.21 12:23	Image JPEG	1,6 Mo
IMG_0984		30.09.21 12:23	Image JPEG	1,5 Mo
IMG_0986		30.09.21 12:25	Image JPEG	1,6 Mo
IMG_0988		30.09.21 12:26	Image JPEG	1,7 Mo
IMG_0990		30.09.21 12:26	Image JPEG	1,6 Mo
IMG_0992		30.09.21 12:27	Image JPEG	1,6 Mo
IMG_1011		30.09.21 12:32	Image JPEG	1,7 Mo
IMG_1013		30.09.21 12:33	Image JPEG	1,6 Mo
IMG_1020		30.09.21 12:36	Image JPEG	1,5 Mo
IMG_1193_PreKAT		30.09.21 12:37	Image JPEG	1,5 Mo
IMG_1307		15.01.19 12:42	Image JPEG	1,5 Mo
IMG_1309		15.01.19 12:42	Image JPEG	1,9 Mo
IMG_1311		15.01.19 12:42	Image JPEG	1,4 Mo
IMG_1443		30.09.21 12:42	Image JPEG	1,8 Mo

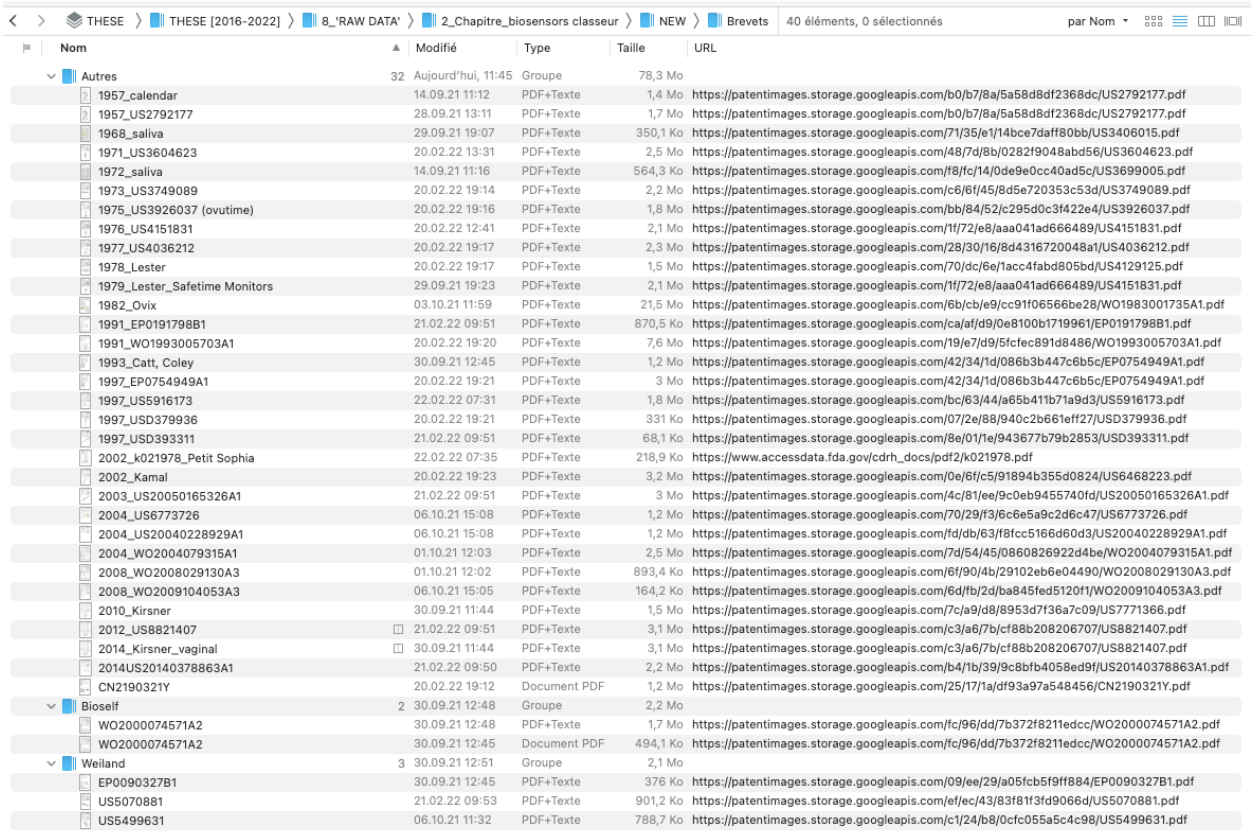


Nom		Modifié	Type	Taille
IMG_1444		30.09.21 12:43	Image JPEG	1,7 Mo
IMG_1453		30.09.21 12:43	Image JPEG	1,2 Mo
2_Rapports contraception	5	06.02.21 13:58	Groupe	7,7 Mo
IMG_1071		15.01.19 12:10	Image JPEG	1,4 Mo
IMG_1075		30.09.21 12:15	Image JPEG	1,5 Mo
IMG_1077		30.09.21 12:15	Image JPEG	1,5 Mo
IMG_1079		30.09.21 12:15	Image JPEG	1,6 Mo
IMG_1081		30.09.21 12:15	Image JPEG	1,7 Mo
3_Gender selection	5	30.09.21 12:09	Groupe	9,5 Mo
IMG_1181		06.02.21 13:48	Image JPEG	2,5 Mo
IMG_1287		06.02.21 14:13	Image JPEG	2,3 Mo
IMG_1467		20.11.20 10:44	Image JPEG	1,9 Mo
IMG_1709		06.02.21 14:13	Image JPEG	1,3 Mo
IMG_1711		15.01.19 13:58	Image JPEG	1,4 Mo
3_Internet (printed)	3	15.01.19 15:30	Groupe	5,2 Mo
IMG_0937		15.01.19 11:32	Image JPEG	1,6 Mo
IMG_0940		15.01.19 11:32	Image JPEG	1,9 Mo
IMG_0942		15.01.19 11:32	Image JPEG	1,7 Mo
4_Etudes	45	30.09.21 12:28	Groupe	88 Mo
Symposium	45	30.09.21 11:55	Groupe	88 Mo
Cue	24	30.09.21 11:54	Groupe	44,6 Mo
1	12	30.09.21 11:54	Groupe	22,3 Mo
IMG_1393		13.08.20 10:10	Image JPEG	1,6 Mo
IMG_1395		13.08.20 10:10	Image JPEG	2 Mo
IMG_1397		13.08.20 10:10	Image JPEG	1,8 Mo
IMG_1399		13.08.20 10:10	Image JPEG	2 Mo
IMG_1401		13.08.20 10:10	Image JPEG	1,8 Mo
IMG_1403		13.08.20 10:10	Image JPEG	1,8 Mo
IMG_1405		13.08.20 10:10	Image JPEG	2 Mo
IMG_1407		13.08.20 10:10	Image JPEG	1,6 Mo
IMG_1409		13.08.20 10:10	Image JPEG	2 Mo
IMG_1411		13.08.20 10:10	Image JPEG	2 Mo
IMG_1412		13.08.20 10:10	Image JPEG	1,8 Mo
IMG_1414		13.08.20 10:10	Image JPEG	1,8 Mo
2	12	30.09.21 11:54	Groupe	22,3 Mo
IMG_1417		13.08.20 10:10	Image JPEG	2 Mo
IMG_1419		13.08.20 10:10	Image JPEG	2,1 Mo
IMG_1420		13.08.20 10:10	Image JPEG	1,7 Mo
IMG_1423		13.08.20 10:10	Image JPEG	1,7 Mo
IMG_1425		13.08.20 10:10	Image JPEG	1,9 Mo
IMG_1427		13.08.20 10:10	Image JPEG	1,7 Mo
IMG_1429		13.08.20 10:10	Image JPEG	1,9 Mo
IMG_1431		13.08.20 10:10	Image JPEG	1,7 Mo
IMG_1432		13.08.20 10:10	Image JPEG	1,9 Mo
IMG_1434		13.08.20 10:10	Image JPEG	1,8 Mo
IMG_1437		13.08.20 10:10	Image JPEG	2,1 Mo



THESE 〉 THESE [2016-2022] 〉 8_'RAW DATA' 〉 2_Chapitre_biosensors classeur 〉 Konkurrenz Folder (original)

Nom	Modifié	Type	Taille
IMG_1425	13.08.20 10:10	Image JPEG	1,9 Mo
IMG_1427	13.08.20 10:10	Image JPEG	1,7 Mo
IMG_1429	13.08.20 10:10	Image JPEG	1,9 Mo
IMG_1431	13.08.20 10:10	Image JPEG	1,7 Mo
IMG_1432	13.08.20 10:10	Image JPEG	1,9 Mo
IMG_1434	13.08.20 10:10	Image JPEG	1,8 Mo
IMG_1437	13.08.20 10:10	Image JPEG	2,1 Mo
IMG_1439	13.08.20 10:10	Image JPEG	1,8 Mo
NFP	30.09.21 11:55	Groupe	-
IMG_1351	13.08.20 10:10	Image JPEG	2 Mo
IMG_1353	13.08.20 10:10	Image JPEG	1,8 Mo
IMG_1355	13.08.20 10:10	Image JPEG	1,9 Mo
IMG_1356	13.08.20 10:10	Image JPEG	1,8 Mo
IMG_1359	13.08.20 10:10	Image JPEG	2 Mo
IMG_1361	13.08.20 10:10	Image JPEG	2,1 Mo
IMG_1363	13.08.20 10:10	Image JPEG	1,9 Mo
IMG_1365	13.08.20 10:10	Image JPEG	2 Mo
IMG_1367	13.08.20 10:10	Image JPEG	1,9 Mo
IMG_1371	13.08.20 10:10	Image JPEG	1,9 Mo
IMG_1373	13.08.20 10:10	Image JPEG	2 Mo
IMG_1375	13.08.20 10:10	Image JPEG	1,8 Mo
IMG_1377	13.08.20 10:10	Image JPEG	1,8 Mo
IMG_1379	13.08.20 10:10	Image JPEG	2 Mo
IMG_1381	13.08.20 10:10	Image JPEG	1,9 Mo
IMG_1383 - copie	19.03.21 10:06	Document PDF	1,9 Mo
IMG_1385 - copie	19.03.21 10:19	Document PDF	2 Mo
IMG_1385 - copie suite	29.09.21 19:43	PDF+Texte	5,4 Mo
IMG_1387	13.08.20 10:10	Image JPEG	2 Mo
IMG_1389	13.08.20 10:10	Image JPEG	1,7 Mo
IMG_1391	13.08.20 10:10	Image JPEG	1,7 Mo
5_Le classeur	9	30.09.21 12:56	Groupe	13,3 Mo
IMG_1177	29.09.21 19:34	Image JPEG	1,2 Mo
IMG_1179	29.09.21 19:34	Image JPEG	1,5 Mo
IMG_1221	29.09.21 19:34	Image JPEG	1,6 Mo
IMG_1313	15.01.19 12:42	Image JPEG	1,8 Mo
IMG_1441	29.09.21 19:31	Image JPEG	1,2 Mo
IMG_1563_Konkurrenzprodukte	20.11.20 10:44	Image JPEG	1,4 Mo
IMG_1625	15.01.19 13:43	Image JPEG	1,6 Mo
IMG_1642	08.02.21 17:27	Image JPEG	1,7 Mo
IMG_1646	08.02.21 17:27	Image JPEG	1,2 Mo
5_non classé	4	06.02.21 14:02	Groupe	6,5 Mo
IMG_1009	06.02.21 13:44	Image JPEG	2 Mo
IMG_1226	29.09.21 19:31	Image JPEG	1,5 Mo
IMG_1247	29.09.21 19:31	Image JPEG	1,6 Mo
IMG_1250	29.09.21 19:30	Image JPEG	1,4 Mo
20210424_matériaux_analyse_BIG	06.10.21 11:00	PDF+Texte	872,9 Ko



THESE 〉 THESE [2016-2022] 〉 8_'RAW DATA' 〉 2_Chapitre_biosensors classeur 〉 NEW 〉 Brevets — 40 éléments, 0 sélectionnés — par Nom

Nom		Modifié	Type	Taille	URL
Autres	32	Aujourd'hui, 11:45	Groupe	78,3 Mo	
1957_calendar		14.09.21 11:12	PDF+Texte	1,4 Mo	https://patentimages.storage.googleapis.com/b0/b7/8a/5a58d8df2368dc/US2792177.pdf
1957_US2792177		28.09.21 13:11	PDF+Texte	1,7 Mo	https://patentimages.storage.googleapis.com/b0/b7/8a/5a58d8df2368dc/US2792177.pdf
1968_saliva		29.09.21 19:07	PDF+Texte	350,1 Ko	https://patentimages.storage.googleapis.com/71/35/e1/14bce7daff80bb/US3406015.pdf
1971_US3604623		20.02.22 13:31	PDF+Texte	2,5 Mo	https://patentimages.storage.googleapis.com/48/7d/8b/0282f9048abd56/US3604623.pdf
1972_saliva		14.09.21 11:16	PDF+Texte	564,3 Ko	https://patentimages.storage.googleapis.com/f8/fc/14/0de9e0cc40ad5c/US3699005.pdf
1973_US3749089		20.02.22 19:14	PDF+Texte	2,2 Mo	https://patentimages.storage.googleapis.com/c6/6f/45/8d5e720353c53d/US3749089.pdf
1975_US3926037 (ovutime)		20.02.22 19:16	PDF+Texte	1,8 Mo	https://patentimages.storage.googleapis.com/bb/84/52/c295d0c3f422e4/US3926037.pdf
1976_US4151831		20.02.22 12:41	PDF+Texte	2,1 Mo	https://patentimages.storage.googleapis.com/1f/72/e8/aaa041ad666489/US4151831.pdf
1977_US4036212		20.02.22 19:17	PDF+Texte	2,3 Mo	https://patentimages.storage.googleapis.com/28/30/16/8d4316720048a1/US4036212.pdf
1978_Lester		20.02.22 19:17	PDF+Texte	1,5 Mo	https://patentimages.storage.googleapis.com/70/dc/6e/1acc4fabd805bd/US4129125.pdf
1979_Lester_Safetime Monitors		29.09.21 19:23	PDF+Texte	2,1 Mo	https://patentimages.storage.googleapis.com/1f/72/e8/aaa041ad666489/US4151831.pdf
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1997_USD393311		21.02.22 09:51	PDF+Texte	68,1 Ko	https://patentimages.storage.googleapis.com/8e/01/1e/943677b79b2853/USD393311.pdf
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WO2000074571A2		30.09.21 12:45	Document PDF	494,1 Ko	https://patentimages.storage.googleapis.com/fc/96/dd/7b372f8211edcc/WO2000074571A2.pdf
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US5499631		06.10.21 11:32	PDF+Texte	788,7 Ko	https://patentimages.storage.googleapis.com/c1/24/b8/0cfc055a5c4c98/US5499631.pdf

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1971_US3604623	20.02.22 13:31	PDF+Texte	2,5 Mo	https://patentimages.storage.googleapis.com/48/7d/8b/0282f9048abd56/US3604623.pdf
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1975_US3926037 (ovutime)	20.02.22 19:16	PDF+Texte	1,8 Mo	https://patentimages.storage.googleapis.com/bb/84/52/c295d0c3f422e4/US3926037.pdf
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1982_Ovix	03.10.21 11:59	PDF+Texte	21,5 Mo	https://patentimages.storage.googleapis.com/6b/cb/e9/cc91f06566be28/WO1983001735A1.pdf
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1/6 https://patentimages.storage.googleapis.com/b0/b7/8a/5a58d8df2368dc/US2792177.pdf 4555 m

May 14, 1957 J. B. KER 2,792,177

CALCULATOR FOR PREDICTING MENSTRUAL CYCLES

Filed Aug. 28, 1955 2 Sheets-Sheet 1

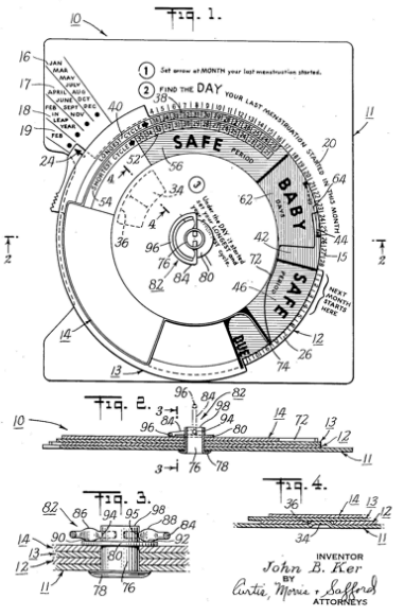


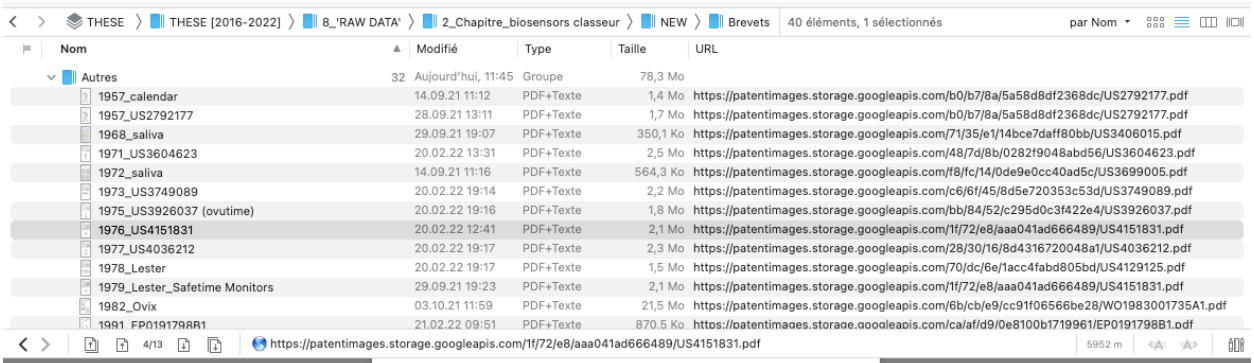
Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

INVENTOR
John B. Ker
BY
Curtis, Morris & Safford
ATTORNEYS


THESE
THESE [2016-2022]
8_'RAW DATA'
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NEW
Brevets
40 éléments, 1 sélectionnés
par Nom
Nom
Modifié
Type
Taille
URL
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1979_Lester_Safetime Monitors 29.09.21 19:23 PDF+Texte 2,1 Mo https://patentimages.storage.googleapis.com/1f/72/e8/aaa041ad666489/US4151831.pdf
1982_Ovix 03.10.21 11:59 PDF+Texte 21,5 Mo https://patentimages.storage.googleapis.com/6b/cb/e9/cc91f06566be28/WO1983001735A1.pdf
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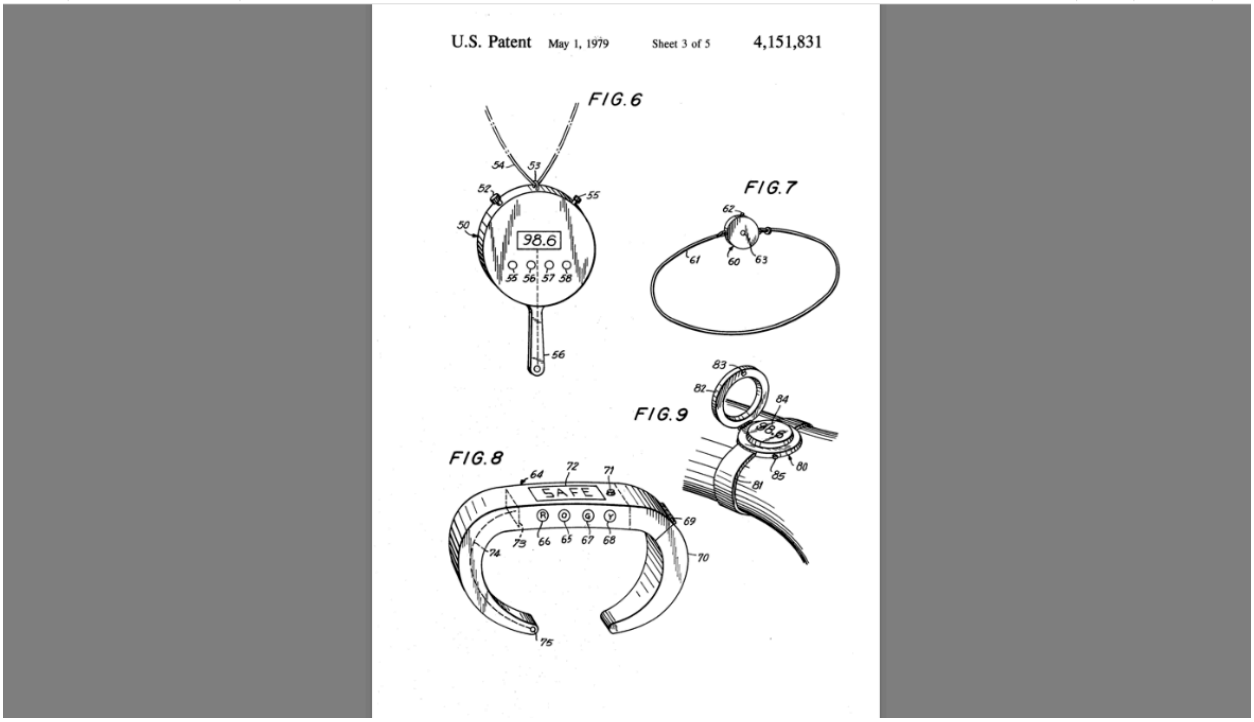
U.S. Patent May 1, 1979 Sheet 3 of 5 4,151,831
FIG. 6
98.6
FIG. 7
FIG. 8
SAFE
FIG. 9

Appendix C

Nom du fichier numérisé	Biosensor	Langue	Remarque
IMG_1463	Fertil-a-chron		
IMG_1467	ProCare		
IMG_1465	Fertil-a-chron		
IMG_1195	Swiss Lady Watch		
IMG_1213	Swiss Lady Watch		
IMG_1217			
2021-03-17	Swiss Lady Watch		
IMG_1217	Cyclotest-D		
IMG_1285	Fertil-a-chron		
IMG_1455	Fertil-a-chron		
IMG_1459	Fertil-a-chron		
IMG_1461	Fertil-a-chron		
IMG_1363	Cue		
Ranjit et al._2	Cue		
IMG_1383	NFP		
IMG_1385	NFP		
IMG_1385 – copie suite	NFP		
IMG_1446_COMPARAISON	Bioself		
Bioself_1	Bioself		
Bioself_2	Bioself		
Ranjit et al._1	Cue		
IMG_1469_bioself	Bioself	D	mode d'emploi
IMG_1471._bioself.JPG	Bioself	D	suite de IMG_1469_bioself, mode d'emploi
IMG_1473_Fertil-a-chron	Fertil-a-chron	E	
IMG_1474_COMPARAISON	Bioself	D	comparison HR
IMG_1476	Bioself	G	suite de 1474, comparison HR
IMG_1478	Bioself	G	suite de 1474, comparison HR
IMG_1481_Bioself	Bioself	G	lettre à VE
IMG_1483.interview innovateur bioself	Bioself	F	suite de IMG_1481_Bioself
IMG_1549	Bioself	D	suite de IMG_1485, chart
IMG_1550	Bioself	D	suite de IMG_1485, chart
IMG_1551	Bioself	D	suite de IMG_1485, chart
IMG_1552	Bioself	D	suite de IMG_1485, chart
IMG_1553	Bioself	D	suite de IMG_1485, chart
IMG_1554	Bioself	D	suite de IMG_1485, chart
IMG_1555	Bioself	D	suite de IMG_1485, chart
IMG_1556	Bioself	D	suite de IMG_1485, chart
IMG_1557	Bioself	D	suite de IMG_1485, chart
IMG_1558	Bioself	D	suite de IMG_1485, chart
IMG_1559	Bioself	D	suite de IMG_1485, chart
IMG_1560	Bioself	D	suite de IMG_1485, chart
IMG_1561	Bioself	D	suite de IMG_1485, chart
IMG_1562	Bioself	D	suite de IMG_1485, chart
IMG_1485	Bioself	D	page de titre
IMG_1487	Bioself	D	table matière
IMG_1489	Bioself	D	suite de IMG_1485, Intro
IMG_1490?	Bioself	D	suite de IMG_1485, Beschreibung
IMG_1492	Bioself	D	suite de IMG_1485, description (schéma)
IMG_1495	Bioself	D	suite de IMG_1485
IMG_1496	Bioself	D	suite de IMG_1485
IMG_1499	Bioself	D	suite de IMG_1485
IMG_1501	Bioself	D	suite de IMG_1485
IMG_1503	Bioself	D	suite de IMG_1485
IMG_1505	Bioself	D	suite de IMG_1485
IMG_1507	Bioself	D	suite de IMG_1485
IMG_1509	Bioself	D	suite de IMG_1485
IMG_1511	Bioself	D	suite de IMG_1485
IMG_1514	Bioself	D	suite de IMG_1485
IMG_1515	Bioself	D	suite de IMG_1485
IMG_1517	Bioself	D	suite de IMG_1485
IMG_1518	Bioself	D	suite de IMG_1485
IMG_1519	Bioself	D	suite de IMG_1485

Nom du fichier numérisé	Biosensor	Langue	Remarque
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IMG_1521	Bioself	D	suite de IMG_1485
IMG_1522	Bioself	D	suite de IMG_1485
IMG_1523	Bioself	D	suite de IMG_1485
IMG_1524	Bioself	D	suite de IMG_1485
IMG_1525	Bioself	D	suite de IMG_1485
IMG_1526	Bioself	D	suite de IMG_1485
IMG_1527	Bioself	D	suite de IMG_1485
IMG_1528	Bioself	D	suite de IMG_1485
IMG_1529	Bioself	D	suite de IMG_1485
IMG_1530	Bioself	D	suite de IMG_1485
IMG_1531	Bioself	D	suite de IMG_1485
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IMG_1545	Bioself	D	suite de IMG_1485
IMG_1546	Bioself	D	suite de IMG_1485
IMG_1547	Bioself	D	suite de IMG_1485
IMG_1548	Bioself	D	suite de IMG_1485
IMG_1565	Anne	D	brochure
IMG_1566	Anne	D	suite de IMG_1565
IMG_1567	Anne	D	suite de IMG_1565
IMG_1568	Anne	D	suite de IMG_1565
IMG_1569	Anne	D	suite de IMG_1565
IMG_1570	Anne	D	suite de IMG_1565
IMG_1571	Anne	D	suite de IMG_1565
IMG_1572	Anne	D	journal
IMG_1573	Anne	D	suite de IMG_1572
IMG_1574	Anne	E	brochure
IMG_1575	Anne	E	suite de IMG_1574
IMG_1576	Anne	D	revue pharma?
IMG_1585	Anne	D	journal
IMG_1586	Anne	D	journal
IMG_1587	Anne	D	journal
IMG_1588	Anne	D	journal
IMG_1578	Anne	D	courrier
IMG_1579	Anne	D	suite de IMG_1578
IMG_1580	Anne	D	suite de IMG_1578
IMG_1581	Anne	D	suite de IMG_1578
IMG_1582	Anne	D	suite de IMG_1578
IMG_1583	Anne	D	suite de IMG_1578
IMG_1584	Anne	D	suite de IMG_1578
IMG_1577	Anne	D	Courrier
IMG_1593	OVU Test	D	
IMG_1594	OVU Test	D	verso de IMG_1593
IMG_1595	OVU Test	D	photo
IMG_1596	OVU Test	D	photo (// vache)
IMG_1597	OVU Test	D	
IMG_1598	OVU Test	D	
IMG_1599	OVU Test	D	
IMG_1600	OVU Test	D	
IMG_1601	OVU Test	D	

Nom du fichier numérisé	Biosensor	Langue	Remarque
IMG_1602	OVU Test	D	
IMG_1603	OVU Test	D	
IMG_1605	OVU Test	D	courrier (accusation de OVU test d'être basé sur fausse expertise médic)
IMG_1606	OVU Test	D	suite de IMG_1605
IMG_1607-1	OVU Test	D	
IMG_1608	OVU Test	D	Même flyer que IMG_1593
IMG_1609	OVU Test	D	
IMG_1610	OVU Test	D (+E)	suite de IMG_1609?
IMG_1611	OVU Test	D	hinweise für arzt und apotheker
IMG_1612	OVU Test	D	suite de IMG_1611
IMG_1613	OVU Test	D	
IMG_1614	OVU Test	D	
IMG_1615	OVU Test	D	
IMG_1616	OVU Test	D	
IMG_1617	OVU Test	D	
IMG_1618	OVU Test	D	
IMG_1619	Umwelt/mais suite Ovu	D	reveu gyn, umweltschutz
IMG_1620	OVU Test	D	suite de IMG_1619
IMG_1621	OVU Test	D	suite de IMG_1619 / critique de publi bunte
IMG_1622	OVU Test	D	journal Bunte
IMG_1623	OVU Test	D	
IMG_1624	OVU Test	D	Suite de IMG_1623 (Medical tribune, critique scandal bunte publi sur ovu-test)
IMG_1627	Ovulationsuhr	D	
IMG_1628	Ovulationsuhr	D	
IMG_1629	Ovulationsuhr	D	
IMG_1630	Ovulationsuhr	D	Suite de IMG_1629
IMG_1631	discours??	D	
IMG_1632	discours??	D	Suite de IMG_1631
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IMG_1634	discours??	D	Suite de IMG_1631
IMG_1635	discours??	D	Suite de IMG_1631
IMG_1636	discours??	D	Suite de IMG_1631
IMG_1637	discours??	D	Suite de IMG_1631
IMG_1627 (autre moitié)	Ovulationsuhr	D	
IMG_1638	Ovulationsuhr	D	
IMG_1626	Ovulationsuhr	D	
IMG_1640	Ovulationsuhr	D	
IMG_1639	Anti-baby papier; Ovulationsuhr	D	
IMG_1641	Ovulationsuhr	D	
Toitu Pregno (not gendered-)	toitu	E	
Toitu	toitu	E	
IMG_1647.JPG_fertil-a-chron	Fertil-a-chron	E	
IMG_1650	discretest		
IMG_1651	discretest		Suite de IMG_1650
IMG_1652	discretest		Suite de IMG_1650
IMG_1653	discretest		Suite de IMG_1650
IMG_1654	discretest		Suite de IMG_1650
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IMG_1656	discretest		Suite de IMG_1650
IMG_1657	discretest		Suite de IMG_1650
IMG_1658	discretest		Suite de IMG_1650
IMG_1659	discretest		Suite de IMG_1650
IMG_1686	discretest		
IMG_1687	discretest		Suite de IMG_1686
IMG_1688	discretest		Suite de IMG_1686
IMG_1689	discretest		Suite de IMG_1686
IMG_1690	discretest		Suite de IMG_1686
IMG_1691	discretest		Suite de IMG_1686
IMG_1692	discretest		Suite de IMG_1686
IMG_1693	discretest		

Nom du fichier numérisé	Biosensor	Langue	Remarque
IMG_1695	discretest		Suite de IMG_1693
IMG_1696	discretest		Suite de IMG_1693
IMG_1697	discretest		Suite de IMG_1693
IMG_1698	discretest		Suite de IMG_1693
IMG_1699	discretest		Suite de IMG_1693
IMG_1700	discretest		Suite de IMG_1693
IMG_1701	discretest		Suite de IMG_1693
IMG_1702	discretest		Suite de IMG_1693
IMG_1703	discretest		Suite de IMG_1693
IMG_1704	discretest		Suite de IMG_1693
IMG_1705	discretest		Suite de IMG_1693
IMG_1706	discretest		Suite de IMG_1693
IMG_1707	discretest		
IMG_1710	gender test	D	
IMG_1708	gender test	D	
IMG_1712	Bosch thermotest	D	
IMG_1713	Bosch thermotest	D	Suite de IMG_1712
IMG_1714	Bosch thermotest	D	Suite de IMG_1712
IMG_1715	Bosch thermotest	D	Suite de IMG_1712
IMG_1716	Bosch thermotest	D	Suite de IMG_1712
IMG_1717	Bosch thermotest	D	Suite de IMG_1712
IMG_1718	Bosch thermotest	D	Suite de IMG_1712
IMG_1719	Bosch thermotest	D	Suite de IMG_1712
IMG_1720	Bosch thermotest	D	Suite de IMG_1712
IMG_1721	Bosch thermotest	D	Suite de IMG_1712
IMG_1722	Bosch thermotest	D	Suite de IMG_1712
IMG_1723	Domotherm	D	
IMG_1728	Lady Healther	D	
IMG_1729	Lady Healther	J	
IMG_1730	Lady Healther	J	Suite de IMG_1729
IMG_1724	Lady Healther	J	Suite de IMG_1729
IMG_1725	Lady Healther	J	Suite de IMG_1729
IMG_1731	Lady Healther	J	Suite de IMG_1729
IMG_1727	Lady Healther	J	Suite de IMG_1729
IMG_1732	Lady Healther	J	Suite de IMG_1729
IMG_1726	Lady Healther	J	Suite de IMG_1729
IMG_1733	Bioself	D	
IMG_1734	Bioself	D	
IMG_1735			
IMG_1736			
IMG_1738			
IMG_1739			
IMG_1740			

Appendix D

Table 4. Research sites

Method	Date	Location	Description
Field observations			
Within Valley Electronics			
	15 May 2017	Swiss office	First meeting with the CEO
	4 Sept. 2017	Co-presence	Phone call with Medical Advisor
	11-13 Sept. 2017	German office	Ethnographic observations
	9 Oct. 2017	Swiss office	Customer services observations, discussions with CH team
	20-21 Nov. 2017	Swiss office	Customer services observations
	27-28 Nov. 2017	Swiss office	Customer services observations
	11-14 Dec. 2017	German Office	Ethnographic observations
	23 Jan. 2018	Swiss office	Meeting with CEO + CMO
	5 Apr. 2018	Swiss office	Ethnographic observations, Interviews with 4 employees
	12 Apr. 2018	Co-presence	Phone call with Medical Advisor
	23-24 Apr. 2018	German office	Observations, meetings, discussions
	16 Oct. 2018	Co-presence	Phone call with Medical Advisor
	2 Nov. 2018	Co-presence	Phone call with Medical Advisor
	11 Oct. 2019	Co-presence	Phone call with US team
	19-20 Nov. 2019	American office	Ethnographic observations

	27 May 2021	Co-presence	Skype/Discussing (Sharing research with the Daysy Community)
International Congresses			
NFP Congress	27–28 Apr. 2018	Germany	International Congress on Natural Family Planning, on site with Chief Medical Advisor (CMA), field notes
Medical Congress	8–12 May 2018	Hungary	15th Congress of the European Society for Contraception and Reproductive Health, on site with CMA, field notes, and transcripts from audio files
Technological fairs and summits			
Alternative Medicine Fair	31 Jan. 2019	France	Salon Bien Être et Médecine Douce, field notes, and transcripts from audio file
Innovators and Venture Capitalists Summit	3–4 Dec. 2019	United States	Women's Health Innovation Summit, field notes, and transcripts from audio files
Consumer Show	7–10 Jan. 2020	United States	Consumer Electronics Show 2020, on site with CMA, field notes, and transcripts from audio files
Femtech Summit	13 Mar. 2018	Asynchronous/ Recorded Online	Femtech: Women & Health in the Trump Era
Explorative and follow-up interviews with other promoters			
Open interviews	16 Oct. 2017, 15 Dec. 2017, 6 Nov. 2019	Switzerland, Germany, United States	Transcripts from three face-to-face interviews with technology promoters
Open e-interviews	Nov. 2018 – Mar. 2020	Co-presence	Emails exchanged between the author and three technology promoters, based in Switzerland, and in China

Online observations		
Users Facebook Groups (Daysy, Ladycomp, Ava, Natural cycles)	Asynchronous, Online	
Interviews with apps users		
Explorative semi-structured interviews with menstrual cycle tracking apps users (n=12)	Face-to-face	Della Bianca (2021a)
Daysy users (n =26)	Co-presence	

Appendix E

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Do you use or have been using Daysy to track your cycle?

Hi there,

my name is Laetitia Della Bianca. I am conducting research on digital menstrual cycle tracking.

Some time ago you indicated through a survey launched by the Daysy team that you would be interested in being contacted about a study needing participants. I am very grateful for that!

Participation in this research includes taking part in a short interview about the way you use or have been using Daysy, and will take approximately 40 minutes. The results are anonymized. This research is independent of Daysy's company.

If you are willing to participate, please contact me by replying to this email. If you do so, you will have the chance to find out more about the study before coming to any decision. You would be under no obligation to take part and could change your mind at any time.

If you are interested in taking part or would like more information, please contact me at laetitia.dellabianca@unil.ch or text me at +1 202 751 9591.

Thank you!
Sincerely,
Laetitia Della Bianca

———-

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Appendix F

Table 3. Study participants (Daysy Users)

No.	Country of residence	Age	Relationship status
1	United States of America	26	In a relationship (married)
2	Denmark	31	In a relationship
3	Switzerland	34	In a relationship (married)
4	United States of America	26	In a relationship (married)
5	Ireland	39	Single
6	Denmark	25	In a relationship
7	Switzerland	34	In a relationship (married)
8	Switzerland	23	Single
9	United States of America	33	In a relationship (married)
10	Finland	28	In a relationship
11	United Arab Emirates	32	In a relationship (married)
12	United States of America	42	Single
13	United States of America	24	In (a polyamorous) relationship
14	United States of America	34	In a relationship (married)
15	United States of America	30	In a relationship (married)
16	Belgium	35	In a relationship (married)
17	United States of America	31	In a relationship (married)
18	United States of America	36	In a relationship (married)
19	United Kingdom (Cayman Islands)	30	Single
20	United States of America	26	Single
21	United States of America	21	In a relationship (engaged)
22	United Kingdom	30	In a relationship (married)
23	United States of America	34	In a relationship (married)
24	Italy	33	In a relationship
25	Germany	40	In a relationship (married)
26	United States of America	36	In a relationship (married)

Appendix G

Grille d'entretien utilisatrices (2017–) [working document]

Thématiques	Catégories	Sous-catégories	Questions
1. Qu'est-ce qu'elles font ?	1.1 Pratiques	1.1.1 **Découverte** de l'app	1.1.1.1 Pouvez-vous me raconter comment vous en êtes arrivé à utiliser cette app ? 1.1.1.2 Pouvez-vous me raconter qu'est-ce qui vous a amenée à chercher/utiliser cette app ?
		1.1.2 Usage, histoire d'utilisation	1.1.2.1 Pouvez-vous me parler de votre **histoire** d'utilisation ? évolution ? papier, changement d'app ? 1.1.2.2 Comment vous servez-vous de cette app ? 1.1.2.3 A quelle **fréquence** environ (tous les jours, de temps en temps, etc.) ? 1.1.2.4 Comment percevez-vous votre usage (contraignant / pratique) ?
		1.1.3 Utilité	1.1.3 Pouvez-vous m'expliquer en quoi elle vous est **utile** ?
2. Comment elles le font ?	2.1 Interprétation des données	2.1.1 Choix des mesures	2.1.1.1 Quelles **données** mesurez-vous et pourquoi ? 2.1.1.2 Apprentissage de l'usage, pairs ?
		2.1.2 *The material life of graphs*	2.1.2.1 Que regardez-vous sur l'app ? (Graphes, **calendrier**, autre ?) 2.1.2.2 Comment comprenez-vous les **graphes** représentant vos données ?
		2.1.3 Informations sur l'app	2.1.3.1 Lisez-vous les **conseils**, infos disponibles sur l'app ? 2.1.3.2 D'après-vous s'agit-il d'informations valides, fiables ?
		2.1.4 *Commodification of data*	2.1.4.1 D'après-vous, qui analyse les

			données récoltées ? Comment est produite l'information ? 2.1.4.2 Imaginez-vous que des **1/3** ont accès à vos données ? 2.1.4.3 Comment réagiriez-vous si vos données étaient rendues **publiques** ?
	2.2 Validité / validation des données	2.2.1 *Objective self-fashioning*	2.2.1.1 Comment évaluez-vous la **fiabilité** des données, des prévisions ? Améliorations algo ? 2.2.1.2 Avez-vous déjà utilisé des codes, vos propres catégories, etc. ? 2.2.1.3 Que pensez-vous des **prédictions** que donne l'app ? Quel rapport à votre ressenti ?
3. Orientation des comportements	3.1 Agency de l'app	3.1.1 *Self-knowledge through numbers, measures*	3.1.1.1 Avez-vous constaté des **changements** depuis que vous utilisez l'app ? 3.1.1.2 Avez-vous l'impression de vous **connaître** différemment avec cette app ? 3.1.1.3 Pouvez-vous en dire plus sur cette connaissance de vous ? / Que faudrait-il pour gagner en connaissance ?
		3.1.2 Conceptions motivationnelles	3.2 Quel est d'après vous **l'effet** de cette app sur votre **quotidien** ?
4. Socialités	4.1 Communauté	4.1.1 Usage	4.1.1 L'app dispose d'une fonction « partage », l'utilisez-vous ? 4.1.2 Si oui, pouvez-vous expliquer comment et pourquoi ? 4.1.3 Vous arrive-t-il de **discuter** de l'app ou de votre cycle avec d'autres ?
		4.1.2 Effet envisagé	4.1.2 Quel est d'après vous l'effet de la fonction « partage » ?

	4.2 Les échanges	4.2.1 Définitions de l'autrui	4.2.1 Pouvez-vous expliquer qui sont les gens avec qui il vous arrive d'**échanger** ? (Partenaire(s), communautés, ami-e-s, parents, médecins, etc.)
		4.2.2 Communication, transferts	4.2.2. Quel type d'information échangez-vous ?
		4.2.3 Echanges avec le milieu médical	4.2.3.1 Vous arrive-t-il d'échanger des informations issues de l'app à votre médecin, **gynéco** ? à d'autres professionnels de la santé ? 4.2.3.2 De votre point de vue, est-ce que les données que vous saisissez ont une pertinence médicale ou sanitaire ?
5. Conclusion	5.1 *User-design*	5.1.1 Eventuelles limites de l'app	5.1.1 Voyez-vous des limites à cette app ? Des aspects/fonctions qu'il serait intéressant d'améliorer, ajouter ou éventuellement de laisser tomber ?
	5.2 Suppositions	5.2.1 Imaginaires	5.2.1 Est-ce que vous seriez prête à utiliser les prédictions de l'app comme moyen **contraceptif** ? 5.2.2 Envisagez-vous de maintenir votre utilisation de l'app ?
	5.3 Représentations	5. Soi-hormonal	5.3.1 On entend parfois parler de l'influence qu'auraient leurs **hormones** sur les femmes. Comment vous voyez les choses par rapport à ça ?