Toward Feminist Ways of Sensing the Menstruating Body

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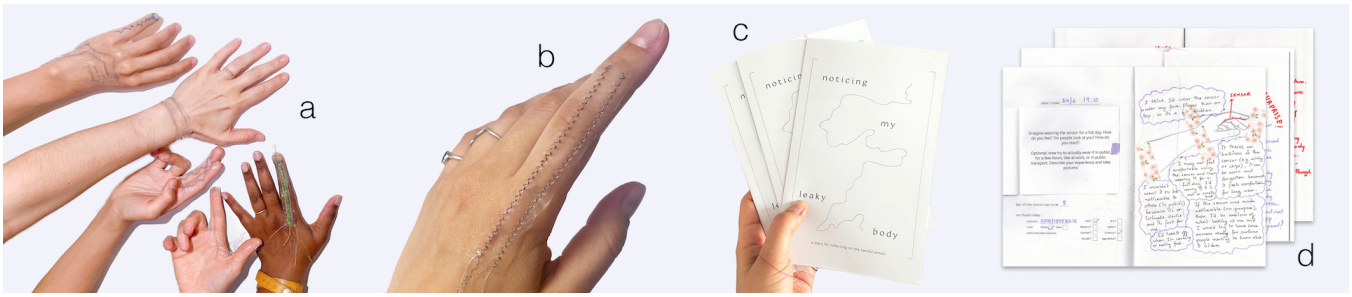

Figure 1: a) Sensors made by participants during workshop FW3, b) The sewn sensor designed by the authors, c) A booklet given to participants of the home study, d) Scanned responses to the booklet (by participant Ana).

Abstract

Bodily fluids associated with the menstruating body are often disregarded in the design of menstrual-tracking technologies despite their potential to provide valuable knowledge about the menstrual cycle. We prototyped a finger-worn sensor that measures vaginal fluid conductivity, which fluctuates throughout the cycle, and brought it into conversation with people through two speculative workshops (18 people), four fabrication workshops (17 people), and a deployment study where participants brought the sensor into their daily lives (7 people). We unpack that taking a material and sensory approach to intimate tracking nurtures a feminist way of sensing while creating tensions around how we want to know our bodies—tensions around how, where, and when to touch the body, hygiene, data storage, interpretation practices, and labor. With epistemological commitments to feminist materialist and posthuman theory, we invite designers to embrace these tensions.

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CCS Concepts

• **Human-centered computing** → **Interaction design**; *Empirical studies in interaction design*; *Interaction design process and methods.*

Keywords

sensing, leaky bodies, feminist hci, menstrual cycles, vaginal fluids, research through design, wearables, touch

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1 Introduction

Menstrual technologies are increasingly shaping how we perceive our intimate bodies by predicting period onset, identifying fertile windows to aid with contraception or pregnancy planning, and visualizing patterns across cycles (e.g., [25, 28, 83]). The design of menstrual and fertility technologies has historically focused on self-tracking smartphone apps where users input data—such as period dates, flow, mood changes, or pain—and track patterns through graphs, calendars, or charts. With the introduction of biosensing, the latest generation of digital trackers now offers wearable sensors (e.g., a ring, bracelet, vaginal thermometer, etc.), providing a layer of automatic sensing of relevant biomarkers (including temperature, heart rate, vaginal conductivity, glucose) in an attempt to offer a holistic understanding of the menstrual body (e.g. [54]).

Despite getting closer to the body, the prevalent approach to biosensing for menstrual cycles does not engage with the body's felt senses and with the body's materiality: the sensors perform the act of sensing on behalf of the user, bypassing the body's sensory faculties such as vision, touch, hearing, and smell. As a result, knowledge production often happens at a distance from the body, mediated through smartphone screens [4, 19, 41]. There has been a recent yet growing push within the HCI community advocating for more feminist approaches that nurture a deeper engagement with the body's materiality and existing felt senses when designing such intimate tracking technologies [19, 83]. Engaging with the body's 'materials' —the messy and leaky parts of the body— not only provides new knowledge about the body but also works towards destigmatizing menstruation [19]. In this work, we respond to this call, grounded in our commitment to feminist materialist epistemologies, "taking bodies seriously as both the subject and object of thinking" [2, p. 3].

Taking a Research through Design approach, we built a sewn finger-worn sensor, iterating on the *Tactful sensor* [17], which measures the conductivity of vaginal fluids and supports a feminist reclaiming of the sense of touch [9, 19, 70]. Next, we conducted a series of workshops with experts and potential users to unpack plausible interaction scenarios and data practices for this kind of active and sensory menstrual tracking. Aligning with Tuli et al.'s recommendation for 'designing for the self' [83], we invited people to fabricate their own versions/prototypes of the sensor[1], followed by a 'home study' where participants were given a set of prompts to simulate interacting with the sensor and reflect on how it fit (or not) into their daily lives. Our study reveals that taking a fleshy, material, and sensory approach to intimate tracking creates tensions around how we want to know our bodies. Here, the enduring sentiment is the need for control and choice—control on how, where, and when to touch, how to interpret data, and whether data is stored.

[1]The sensors were non-functional, i.e., they did not include any circuitry and/or computational elements

2 Related Work

To contextualize our contributions within HCI literature, we draw upon research of intimate technologies, with a particular focus on menstrual and vaginal technologies, touch, and tactile sensing.

2.1 Intimate Technologies, Menstrual Technologies, and Vaginal Technologies

A growing number of researchers have been contributing to and shaping a flourishing body of work on technologies for intimate, reproductive, and sexual health and wellbeing, including for pelvic fitness [3, 75], menstrual health (e.g., [19, 21, 45, 46, 60, 77, 78, 83]), menopause (e.g. [10, 22]), sexual pleasure (e.g., [42, 43]), reproductive health and fertility (e.g., [23, 25, 39, 48, 63, 73]), and how data privacy with these kinds of technologies are handled (e.g. [20, 57]). Much of this work has been explored through a feminist lens [11], shedding light on the potential for technology to create knowledge about the body but also pointing out where and when these technologies fail or even cause harm, for example, by excluding non-normative bodies. Notably, Søndergaard proposed a critical perspective on designing for intimate technologies by "staying with the trouble," i.e., rather than trying to design technologies that 'solve' things like menstruation, designers might question the status quo and critically explore the plurality of experiences of menstrual health [76]. In this paper, we engage with these feminist framings of intimate health technologies to explore opportunities for designing a novel technology-mediated intimate interaction with vaginal fluids throughout menstrual cycles.

The FemTech industry (a gendered term that has been said to originate from 'female/feminized technologies' [8]) has traditionally relied on active sensing to monitor menstrual and fertility cycles. This typically requires consistent participation from users to input data into mobile apps throughout their cycle. Some FemTech solutions provide a digital layer of interpretation of urine-based chemical tests such as pregnancy tests and LH (luteinizing hormone) tests for detecting ovulation (e.g., [58]), requiring the user to collect their urine or pee on a test strip. More recently, companies have started to offer a complimentary passive sensing component, claiming enhancements in data accuracy and prediction and reductions in the amount of labor involved in performing the sensing. The menstrual/fertility sensors available on the market (or under development) mainly track basal body temperature via wearable thermometers (e.g., smart rings like the Oura ring [62], bracelets, and vaginal thermometers [80], and even fertility tracking ear-pods [87] or, potentially, earrings [86]). Some sensors offer advanced sensing including breath [47], heart rate [7], glucose (see [55] using a Dexcom sensor), and cervical mucus conductivity [49]. All of these sensors help track changes in the menstrual cycle toward determining its phases, predicting ovulation, and upcoming cycle dates. Most of these technologies aim to aid with contraception and/or timing conception, yet, as we have seen in the literature, there are many more reasons one would track their cycle—finding patterns between different parameters (e.g., pain, mood, and diet), preparing for and planning around upcoming cycles, or understanding one's body [25, 28, 83]. Recently, there has also been a rise in home-to-lab self-test kits that let users send samples, such as finger-prick blood

or vaginal swabs, to a lab and receive microbial or hormonal health results via an app [15, 66].

The overall prevalent approach in FemTech has been critiqued for neglecting our embodied and sensory experiences, often creating interactions that happen around the body rather than directly with it [4, 19]. This is partly due to how, in the mainstream tech landscape, quantitative data often gets prioritized, overshadowing qualitative data [26]. In turn, FemTech technologies mainly avoid direct contact and touch with the 'messy' or 'fleshy' materials of the body, such as the skin, engaging with pain, or with bodily fluids like menstrual blood, discharge, or breast milk [18, 19, 37, 65]. The sensory and material aspects of intimate experiences are often lost, and *"the messy and multiple complexities, sensual experiences, perversities and quirky contradictions of sexual and reproductive desires and capacities are rendered flat, one-dimensional and dull, subjected as they are to rigid normalised categories"* [56, p. 99]. In this work, we explore how menstruating individuals perceive a technology that intentionally engages with these messy and 'leaky' parts of the body.

Our work contributes to a nascent body of research within HCI that involves technologies that touch or are inserted into the vagina. The vagina, a part of the body that has been historically and is presently subject to societal taboos and patriarchal oppression, has been underexplored not only in HCI but also in medical research, making it hard for designers to navigate a web of uncertainties and myths [16, 31]. Dominant narratives of sex and reproduction also position the vagina and the ovaries as passive, as well as linking sexual pleasure to penetration [31]. Challenging these associations has long been a feminist struggle, and these tensions often emerge throughout HCI as well. Almeida et al.'s Labella project fostered looking at the vagina through the phone as a way to understand pelvic anatomy [5] and similarly, Ståhl et. al. designed a shape-changing chair that prompts users to notice their anatomy through touch [75]. Hua et al. have discussed the patriarchal history of vaginally-inserted sex toys [43], and, most relevant to this project, we build on our previous work where we present a vaginally insertable sensor [17]. These projects advocate for autonomy and a feminist shift away from viewing the vagina as passive or submissive, instead inviting people to explore their anatomy, pleasure, and taking control of their vaginal health and well-being. Adjacent to these projects, the concept of 'insertables' has been brought into HCI to describe technologies that are typically inserted under the skin or ingested orally [34, 35, 50, 53]. We build on these explorations to unpack how potential users might engage (or not) with a vaginally-insertable technology.

2.2 Leaky Bodies, Touch, and Tactile Sensing

The 'leaky' body has been conceptualized by feminist materialists and posthuman scholars as a way to both literally and figuratively describe the porosity and blurry boundary of the human body. Shildrick entangles this with aspects of gender, exposing how, although all bodies are leaky, some bodies are leakier than others, especially those conceptualized as 'female,' emphasized by experiences such as menstruation or childbirth[2] [74]. In most Western societies, female-gendered fluids such as discharge, menstrual blood, or breast milk might even be stigmatized at greater lengths than urine, tears, sweat, saliva, or other bodily fluids that can often be 'controlled' or 'contained' or that do not hold associations with female reproduction and sexuality [13, 67, 74]. Thus, these leaky experiences have been at the core of significant gendered oppression, driven by societal attempts to conceal and hide the leakiness: *"The very sign of fertility, the menses, has been regarded as evidence of women's inherent lack of control of the body and, by extension, of the self"* [74]. Thus, engaging with leakiness in design can be a way to reframe this 'lack of self-control,' reclaiming our 'lack of closure' [74] and unapologetically broadcasting how, indeed, we do leak.

Furthermore, leaky bodies threaten defined categories that uphold much of modern dualist thinking: *"Those differences - mind/body, self/other, inner/outer - which should remain clear and distinct are threatened by loss of definition, or by dissolution"* [74]. When these boundaries between the self and the 'other' are dissolved or transgressed, they cause discomfort, disgust, 'abjection,' or even horror [27, 52]. Persdotter, drawing from Mary Douglas' influential book, "Purity and Danger" [27], reasons how bodily fluids become stigmatized and taboo precisely because they are a transgression of these boundaries: *"For example, most of us are perfectly fine with swallowing saliva when it is in our mouth, in fact we do it all the time. But we have to spit it out into a cup, most of us react with strong revulsion to the idea of taking a sip of it"* [67, p. 49]. These associations may not be universal, but they largely contribute to why bodily fluids such as menstrual blood or vaginal discharge are stigmatized and deemed disgusting and dirty. Through internalizing associations of disgust towards our bodily fluids, these feelings *"become given features of menstruation and embodiment throughout menstruants' lives, and effectively produce a distancing between the menstruating self and their menstruation."* [67, p. 54]. As described in the previous section, the prevalent menstrual and intimate technologies are a product of and contribute to this 'distancing.' We argue that engaging with the leaky body helps narrow this distance.

In HCI, 'leaky' has been used to describe the blurry boundaries between people, technology, and environments [6, 36, 37, 68], how pain 'leaks' beyond an individual body [65], or how materials produced by the body "spill over", *"from one state to another; from one material to another; or between soft materials and soft flesh"* [81]. Drawing from Helms' work on designing with leaky breastfeeding bodies [37], we focus on vaginal fluids and use the concept of "leakiness" as something to seek and draw out, rather than ignore or conceal, when designing for menstruating bodies. Specifically, we use the embodied sense of *touch* to make evident this leakiness, drawing from calls to resist the dominance of vision and screens in the design of technologies [9, 70]. We were inspired by feminist scholars Barad and Bellacasa and previous studies exemplifying literal and metaphorical meanings of touch to facilitate technology-mediated knowledge about the intimate body [17, 19]. This "tactful" way of sensing can be both a way to account for and care, with 'tact', for a multiplicity of bodies, but also elevate the sense of touch, which can be supported by digital sensors [17]. Thus, in this paper, by celebrating the body's leakiness and elevating the felt senses, in particular, the sense of touch, we build on feminist scholarship and work towards a feminist way of sensing.

[2]In our paper, we use 'leaky bodies' also as a way to include all genders that menstruate and experience leakage of vaginal fluids. Many women, transgender men, non-binary and genderfluid people menstruate, and not all women menstruate

3 The Sewn Tactful Sensor

We build on our prior work, published in a pictorial [17], where we introduce the design of a wearable sensor for measuring cervical mucus conductivity. In the pictorial, we proposed different interactive technologies to track and sense vaginal electrical resistance (VER), one of which we prototyped: the *Tactful Sensor*. The Tactful Sensor is an on-skin sensor that leverages the existing practice of observing and touching vaginal fluids with one's own fingers, often used in Fertility Awareness Methods to pinpoint ovulation [29]. The sensor combines this embodied sensing with the quantitative measurements of the conductivity. Worn on a finger, a person can insert the sensor into the vagina in order to obtain the VER. This conductivity varies across the menstrual cycle, increasing mid-cycle, around ovulation, and correlates with changes in physical texture and quantity of the mucus [51]. The mucus becomes more watery and transparent during mid-cycle, and clumpy and white pre- and post-menstruation [61]. Tracking these changes has been used as a common way to determine the date of ovulation, thus approximating a fertile window, which can help people time conception, help with contraception, predict when their period might come, or gain a deeper understanding of their menstrual cycle. While the initial tactful sensor offered a conceptual alternative to VER sensing, the work primarily focused on fabrication and did not include user studies to explore the potential uses, perceived benefits, risks, and implications of the technology. We extend this work by inviting people to discuss, craft, and reflect with us on how the sensor would fit (or not) in their everyday lives.

3.1 Designing the Sewn Tactful Sensor

For our study, we built the Tactful Sensor following the original fabrication procedure involving printing two electrode shapes with a liquid metal alloy on a thin, semipermeable film subsequently sealed with soft silicone to prevent contact, and built a version of the circuit to obtain sensor readings [17]. Wearing the sensor on a finger allows for direct contact with the fluid (to test it, we used salt water), which permeates the film and records electrical resistance between the electrodes. However, during our fabrication process, we discovered a risk of the sensor breaking and the liquid metal leaking, making it essential to find safer and more robust alternatives. Additionally, the fabrication process required a ventilation hood for spraying the liquid metal and protective lab equipment, which increased the cost and complexity, making it difficult to scale up fabrication for the large number of sensors we would need for a user study. Thus, three authors (Nadia, Laia, and Jan) brainstormed alternatives to the metal alloy sensor and decided to explore conductive thread, as it could also measure electrical resistance and could be easily fabricated using the in-house available makerspace materials and equipment. Further, it supported participatory and DIY approaches, aligning with our commitments to feminism and participation.

To build our Sewn Sensor (see figure 3), we were inspired by Yu et al.'s Skinergy project, which uses conductive thread, dissolvable thread (made out of PVA, polyvinyl alcohol), and tear-away backing to sew directly into silicone, then dissolve the PVA threads and obtain silicone with conductive threads sewn into it [88]. Rather than using PVA thread, we opted for PVA sheets (commonly used in sewing to stabilize thin and slippery fabrics) to stabilize the silicone, allowing us to sew into it with a sewing machine and wash it away under warm water. The use of sewing was particularly appealing to us as it allowed us to reclaim a traditionally feminized craft and labor while also leveraging our familiarity with it—many of the authors are already acquainted with or proficient in the craft.

Figure 2: During the design process of the sewn tactful sensor we experimented with different stitching options and silicone types. The final prototypes were made with 1.5mm thick Smooth-On EcoFlex 00-20 platinum cure silicone. Some versions had SLIDE™ STD Liquid Surface Tension Diffuser added to provide a softer, less tacky sensation.

4 Methodology and Ethics

This research follows a Research through Design methodology [71], where we prototyped an artifact, the sewn sensor, and brought it into conversation with other designers and users. Our goal was to find out how people would design and use a sensor that required touching intimate bodily fluids, how this might narrow the distance between a user and their body, and what implications this would bring to a data-driven FemTech landscape. Our study, approved by the Swedish Ethical Review Board, took place in Stockholm, Sweden, between December 2023 and August 2024. Taking a participatory design approach, we conducted: 1) workshops for speculating on data practices, 2) sensor fabrication workshops, and 3) home deployment studies. The data practices workshops aimed to unpack plausible practices of data interpretation, storage, and long-term use that would emerge when using the sensor, and the fabrication workshops, which had a first-person design element, focused on prototyping a sensor and exploring aesthetic possibilities. For this study, we did not work with functioning sensors, i.e., they were not connected to any circuitry, because this involved further ethical clearance. The home study, where participants were asked to take the sensor prototype home, aimed to reveal the practicalities of the sensor in everyday life, as well as the data practices, this time from a first-person perspective. To recruit participants, we followed opportunistic and snowball sampling by sharing flyers on social media and within our accessible networks, both personal and professional. Since our recruitment involved using personal

Figure 3: Fabrication process of the sewn sensor, from left to right: cutting out silicone shapes for the base of the sensor, sewing into a silicone shape 'sandwiched' between two PVA sheets, washing off the PVA sheets, final sensors adhered to the hand.

connections to the authors, we made sure the design of the workshops and the home study included space for critique, for instance, by specifically asking participants for drawbacks or flaws they saw in our prototype. Our flyer sought participants aged 18+ years who could join in person, emphasizing and encouraging participation from LGBTQIA+ individuals. We stated in our recruitment materials that participants would be asked to engage with or touch their intimate bodily fluids during the study, which we acknowledge could lead to a limited sample, mainly attracting people who were familiar with the use of intimate products such as the menstrual cup or menstrual trackers. Recognizing that interacting with vaginal fluids might be unfamiliar or even uncomfortable for many, we prioritized inviting those who were willing and curious to participate as an initial step. Furthermore, we anticipated that insights from these participants would inform future studies, helping us and our research communities to engage broader audiences with varying levels of comfort.

In line with feminist principles of participation [12], we actively worked with our participants to nurture a safe space. Before obtaining consent, we invited them to review the terms of participation and core values—inclusivity, transparency, privacy, the right to withdraw voluntarily, and resisting a universalizing Western view on taboos and reproductive health in general. During the workshops, we, along with our participants, contributed toward building an environment of active listening and turn-taking, ensuring these principles were upheld. The data was mainly gathered in English, though participants could choose to use Spanish or Catalan —the first author's spoken languages— if they preferred. We used pseudonyms, external encrypted hard drives, password-protected files to store digital data, and secured cabinets to store the hard drives and the non-digital data (e.g., booklets, crafts, sensors, etc). Since this project took place in Europe, the digital data remained on university servers and was processed according to GDPR.

We asked participants to report and self-describe demographic details, including their age, gender, sexuality, cultural background or ethnicity, and occupation, as these factors shape an individual's experiences of intimate health. In particular, acknowledging shifting cultural identities and belonging to more than one culture, we invited our participants to describe their "cultural background and/or ethnicity." This data helped us to contextualize our participants' experiences. Participants were referred to by their stated pronouns. Once the paper draft was ready, we invited participants to read, ask questions, or request the withdrawal of any data.

Given that our recruitment included a few academic researchers, we clarified that their participation in the study was *not* a requisite to be a co-author on any future publications. The goal was to foster deeper engagement and gain richer insights from their lived menstrual experiences intertwined with expert opinions during the sessions. After the data collection phase, we invited the participants from the home study who were researchers to join as co-authors, in line with feminist citational and research justice practices [1]. This decision reflects our recognition of the *situatedness* of knowledge production and the inseparability of a researcher from their context, identity, and positionality [32]. Likewise, the first author (Nadia), who led the design process, data collection, and analysis, was inspired to pursue this work by turning inward onto her lived, intimate, and personal experiences of irregular cycles and tracking her cycle for more than ten years, including five years using temperature sensing, as a way to understand and make sense of her fluctuating experiences.

This research took place in Europe, in Sweden, where Western understandings of menstruation and taboo are predominant, yet several of the authors grew up and have lived in non-Western countries. All authors, except one, have personal experiences with menstruation, and several of us identify as queer. Several of us have been working at the intersection of HCI and intimate health for 5+ years. The arguments in this paper are shaped by our shared commitment to bring attention to and collectively emphasize the leaky and messy parts of the menstruating body through the design of digital interventions that engage directly with them.

Table 1: Demographics of workshop participants. All names are pseudonyms. "Gender and/or sexuality" and "cultural background and/or ethnicity" were self-described.

Workshop code	Participant pseudonym	Age	Gender, and/or Sexuality	Cultural background and/or ethnicity (geographic subregion)
W1	Rain	28	woman, straight	Eastern Asia
	Esra	25	nonbinary, queer	Northern Europe
	Mia	25	woman, straight	Southern Asia
	Orla	27	woman, straight	Eastern Europe
	Holly	33	woman, straight	Northern America
	Ada	36	woman, hetero	Western and Northern Europe
	Sylvie	34	woman, straight	Southern Asia
	Fia	29	woman, straight	Southern Asia
	Ingrid	34	woman, straight	Southern Europe
W2	Nina	26	woman, bisexual	Southern Europe and Northern America
	Tamara	30	woman, straight	Eastern Europe
	Calliope	31	woman, bisexual	Northern Europe
	June	33	woman, straight	Southern Europe
	Sofia	31	woman, bisexual	Northern Europe
	Olive	23	woman, straight	Southeastern Asia
	Bora	25	woman, heterosexual	Eastern Asia
	Ella	35	woman, heterosexual	Southern Asia
	Iris	36	woman, heterosexual	Southern Europe
FW1	Daniela	25	woman, straight	Eastern Europe
	Vera	31	woman, heterosexual	Eastern Europe
	Vrinda	33	woman, heterosexual	Southern Asia
	Elise	22	woman, lesbian	Central Europe and Eastern Asia
	Mahgol	37	woman, straight	South-Western Asia
FW2	Hillary	29	woman, straight	Northern Europe
	Elsa	27	woman, straight	Northern Europe
	Nina	26	woman, bisexual	Southern Europe and Northern America
	Astrid	23	woman, straight	Northern Europe
FW3	Sorang	31	woman, heterosexual	Eastern Asia
	Orla	27	woman, straight	Eastern Europe
	June	33	woman, straight	Southern Europe
	Ana	38	Gender non-confirming, identify as woman	Southern Asia
FW4	Mar	26	woman, bisexual	Southern Europe
	Simone	63	woman, heterosexual	Southern Europe
	Iro	33	cishet woman	Southern Europe
	Arlet	29	woman, heterosexual	Southern Europe

4.1 Data Practices Workshops

We hosted two workshops (W1 and W2) to understand how potential users perceive and speculate on interacting with the Tactful Sensor. The goal was to encourage speculations about sensor-generated data—whether qualitative, quantitative, or both—and how it might be managed, represented, and interpreted for the various interaction scenarios.

4.1.1 Recruitment and Participants. We invited experts who had relevant experience (or a great interest in) in menstrual, sexual, or reproductive health, as well as electronic engineering, biotechnology, medicine, or tech in general. We recruited 18 participants (9 per workshop), of whom 17 identified as women and one as nonbinary. Four participants identified with queer sexual orientations, while the rest identified as heterosexual. Participants' backgrounds were diverse, including growing up or having lived in countries in Asia, Europe, and North America. Most participants were professionals or students working in HCI, computer science, electronic engineering, or interaction design, with a few others working in fields such as psychology, marketing, the video game industry, and biomedicine (See Table 1). Some participants joined the workshops together as friends or colleagues, but most were unfamiliar with each other.

4.1.2 Workshop Procedure. The workshop included four main activities, with group work in the second and third where teams shared their discussions. It began with introducing the sensor and inviting participants to redesign it by drawing on their hands with

washable pens, reflecting on electrode positioning and shape. As we lacked prototypes for everyone, this simulated the experience of wearing the sensor. In the second activity, participants were paired or grouped and given cards with "what if" scenarios (e.g., "you use the sensor at the office" or "your 3-year-old walks in on you while using the sensor"), sparking discussions on the sensor's everyday use and data practices. Next, participants were given a printed graph of one full menstrual cycle's *synthetic* sensor data of a fictional user, accompanied by a brief of the user's lifestyle and motivation for using the sensor. We referred to these printouts as "data stories." They discussed what they could infer from the data and what additional information the character from the data story would need. Finally, participants created their own "data stories" and imagined how the sensor data would look for them. Our choice to use a graph visualization was driven by its prominent use in digital health trackers, thus offering a familiar vocabulary to our participants for critiquing and reflecting on their preference for data visualization for this particular use case.

4.2 Fabrication Workshops

We hosted four fabrication workshops (FW1–FW4), inviting designers and non-designers to make Sewn Tactful Sensor(s) in our lab. The goal was to assess potential users' reactions to the sensor by having them fabricate it themselves and observe if and how they would adapt it to their bodies, lifestyles, aesthetic preferences, and context of use.

4.2.1 Recruitment and Participants. We recruited from the list of participants who attended our previous workshops and additionally made a new call for participation, seeking participants who have/had experiences of menstruating. Since our study centers on designing an intimate interaction with the vagina, we aimed to create a comfortable environment by encouraging participation from groups of friends or family members. 17 people joined us, of which three had participated in our previous workshops. The first workshop (FW1) was conducted with a group of 5, and the rest (FW2–FW4) with a group of 4 participants, all identifying as women. FW4 was run in Catalan and the rest in English. We grouped participants according to availability, whether colleagues/friends were participating, and preferred spoken language. Each workshop composition differed slightly: FW1 included professionals and students within HCI/Interaction Design and familiar with our lab and/or with making practices; FW2 was a group of friends working in different industries and were close to the first author (Nadia); FW3 included HCI researchers and designers, and FW4 was a group consisting of a mother, her two daughters, and an HCI researcher. Participant demographics are presented in Table 1.

4.2.2 Workshop Procedure. Each workshop, led by the first author (Nadia) and facilitated by the fifth author (Dee), began with an introduction, followed by two hours of sensor-making, and a 30-minute discussion over a shared meal. Participants worked with precured silicone sheets as the sensor base, following the fabrication procedure outlined in section 3. Before cutting the sensor base, participants were invited to speculate on how a sensor for their specific need and personal use might look by drawing directly on their skin, sketching it out, and gesturing with their hands how they might use the sensor. After cutting the silicone shapes, they were introduced to basic sewing techniques with our machine, practicing with spare fabric before sewing electrodes onto their designs. Once completed, participants rinsed the PVA off their sensors, tested them on their fingers, and shared reflections.

Figure 4: Left: the booklets we gave to participants. Right: The materials included in the home study

4.3 Home Study

We invited participants from the fabrication workshops to continue exploring and reflecting on plausible sensor interactions at home. The goal was to examine how they might imagine engaging with the sewn sensor to observe changes in their cervical mucus throughout their menstrual cycle. Thus, we recruited participants who ovulate, i.e., people taking medication or using devices that inhibit ovulation (such as the birth control pill) could not participate. We made this decision because the changes in texture, elasticity and (although not collected in this study) conductivity all happen due to the hormonal fluctuations that occur during ovulation [51, 59, 69] and we were interested in gathering experiences of simulating the use of the sensor and tracking the changes in mucus over time. All participants were shown the take-home study kit before opting in and signing additional consent forms. The kit included a pre-made Sewn Tactful Sensor, a handheld mirror, markers, washi tape, and an activity booklet with prompts and space to note down the color, texture, and quantity of their vaginal fluids (see figure 4). The prompts asked for reflection on wearing the sensor, imagined sensor data, and interaction in everyday scenarios, such as: *"Imagine wearing the sensor for a full day. Do people notice? How do you feel?"* Or *"What are the negatives of using the sensor? Can you imagine any problems that would arise if you used it regularly?"*

We encouraged participants to also include their self-fabricated sensor(s) in the kit. The sensor(s) were not functional, i.e., not connected to any circuitry. Despite using body-safe materials in all prototypes, we clearly instructed participants *not* to insert the sensor into their vagina and only simulate using the sensor. The aim was to encourage participants to be "in the moment" with the sensors to nudge them to reflect on using it in their everyday lives. The kit also included clear instructions on how to wear the

Table 2: Demographics of home study (HS) participants, including self-reported health conditions and preferred products. All names are pseudonyms. Ana identifies as a gender non-conforming heterosexual woman, while the others are cisgender heterosexual women.

Name	Age (yrs.)	Background	Area of work/study	Menstrual tracker	Cycle regularity	Menstrual product	Health conditions
Mahgol	37	South-Western Asia	HCI research	Apple Health	Regular	Menstrual Cup	Not disclosed
June	33	Southern Europe	HCI research	Clue	Regular	Menstrual Cup	Type 1 diabetes
Vrinda	33	Southern Asia	HCI research	Clue	Regular	Menstrual Pad	Borderline PCOS
Ana	33	Southern Asia	UX, Interaction Deisgn	Drip	Regular	Menstrual Cup	Not disclosed
Hillary	29	Northern Europe	Sustainabile development	Flo	Regular	Menstrual Cup	Not disclosed
Vera	31	Eastern Europe	Tech/FemTech	Apple Health	Regular	Menstrual Cup	Not disclosed
Astrid	23	Northern Europe	Game development	Apple Health	Irregular	Tampon	PMDD

sensor, information on changes in vaginal fluid throughout the menstrual cycle, and a safety card reminding them to avoid anything discomforting. Eight participants enrolled, and seven completed the study (Table 2), which spanned one menstrual cycle (approximately one month). Following the study, participants were invited for unstructured interviews and to share their completed booklets.

4.4 Data Analysis

Data was gathered as audio recordings, field notes, and visual materials, including scanned booklets, photos from the workshops, and photos shared by participants. The first author (Nadia) transcribed all audio recordings and translated them into English when necessary before performing the analysis. Our analysis was inspired by qualitative, open coding approaches [14], where we focused on articulating key insights and lessons learned for each of the data collection sessions, i.e., data practice workshops, fabrication workshops, and home studies. The first author (Nadia) began by performing initial open coding, reading transcripts line by line, and annotating visual materials (images from workshops and home studies). In this initial stage of the analysis, we were curious to follow up on and unpack the tensions that were introduced in our previous work: *"visibility (how visible the design is to others), proximity to the body (if it is a wearable or standalone object), and temporality (when the data is collected)"* [17]. This initial level of coding was conducted chronologically, following the sequence in which data was collected. Sample codes included: 'cleaning', 'hygiene', 'reusability', 'body posture', 'comfort of wearing in public', 'material safety', or 'commitment to using the sensor'. After generating initial codes for all the data collection sessions, the first author (Nadia) organized them into categories corroborating data across the sessions. Throughout this process, Nadia discussed and refined these categories during brainstorming sessions with the rest of the authors. Sample categories included: 'cleaning, hygiene and safety', 'sensor mobility', 'sociality and taboo', 'visibility', or 'labor'. Finally, to develop themes, Nadia conducted another analysis round by revisiting the quotes corpus for each category. Sample themes included: 'comfort in use is related to cleanliness and privacy', 'hacking the sensor design' or 'need for choosing between accumulated and non-accumulated data'. The themes were reviewed, discussed, and mapped during multiple brainstorming sessions with the team to finalize the structure of the findings.

5 Findings

We have organized the findings chronologically, following the imagined life of the sensor: we first unpack participants' experience of (re)designing and making the sensor, followed by perceived use cases and interaction with the sensor, and finally, envisioned data practices that might emerge over time.

5.1 (Re)Designing the Sensor

We first present our analysis of participants' approaches to designing their version(s) of the sensor, an activity incorporated in varied capacities across our methods (FW#, W#, and HS).

5.1.1 Diverse leaky bodies call for diverse ways of touching the vagina. The fabrication workshops welcomed a plurality of bodies and first-person designs; many participants 'hacked' or redesigned the initial sensor design (consisting of two straight electrodes on the top of the finger) to adapt to their own body, their own lifestyles, and imagined uses: *"You create a connection to it. It's your personal sensor"* (Simone, FW4). Participants tried different sewing stitches, making complex swirls and curves, or experimenting with contrasting color threads because *"it stands out a little bit more on my skin color"* (Ana, FW3; see figure 5, g).

Most participants agreed they would be comfortable inserting their finger and the sensor into the vagina. Yet some wondered about material safety and imagined if it was possible to not insert any electronics into the vagina (Sorang, FW3), and others discussed if it was possible to avoid any penetration at all since, for them, it was entangled with other complex experiences of sexual and reproductive health (Vrinda, HS). Vrinda reflected on how she would have no problem touching her fluids, but she was doubtful about the idea of penetration. During the home study, she reflected on how she would use the mirror from the kit to look at her vagina, and this would help her know how comfortable she would be with touch. She wrote in her diary:

> *"I know it will cause me a bit of discomfort when I am required to insert my finger into my vagina. I am not super comfortable with penetration in general... [...] But I have no discomfort with touching fluids. I can check and touch the discharge when it is dripping out."*
> —Vrinda, HS

Vrinda shared she "was working with the assumption" that the sensor would work with fluids *outside* of the vagina, too: *"So I'll find*

my hack [...] I know where I can find that blob of vaginal discharge [...] so I can pick it up from there" (Vrinda, HS). Similarly, Sorang and June (FW3) both designed sensors that would sit on top of the hand or on the wrist, like a bracelet (see Fig. 5, a and d). Sorang described that it would be *"like when you do makeup"*, you would take the mucus with the other hand and dab it onto the sensor hand, a sort of *"indirect touch"*. This way, she explored the possibility of not inserting the actual technology into the vagina yet maintaining a very tactile interaction with the fluids. June also made a two-finger sensor with one electrode on the index finger and the other on the thumb, envisioning sensing between the two fingers by pinching and stretching the mucus (see Fig. 5, e). June and the other participants pointed out that the pinching gesture is commonly used to check the elasticity of the fluids. Thus, it would encourage the user to perform that kind of tactile sensing. Iro (FW4) also pointed out how the location of the sensor on the finger also determined how deep the finger had to be inserted, and *"as a provocation"* she put the electrodes very close to the base of the finger, so you would have to insert a finger all the way. Other redesigns (Mar, Astrid, Hillary) consisted of making a sort of "thimble" or "condom"-shaped glove covering the whole finger, which Mar (FW4) mentioned she would *"find it easier"* to clean and take on and off, yet *"maybe then you don't have the same sensitivity to your fluids with your finger"* (see Fig. 5, f).

5.1.2 Redesigning the sensor often entailed moving beyond a skin-worn sensor. Some participants mentioned that wearing the sensor on the inner side of the hand would offer the best comfort, sensitivity, and control during sensing: *"there's something about the top of your hand that's not really feely"* (Nina, FW2), yet there were doubts about what to do with the sensor when doing other things with your fingers, like eating, cooking, using the computer or playing the piano (Ada, W1; Ana, HS; Nina, FW2; Iris W2).

Furthermore, participants discussed complete redesigns of the sensor, many of which didn't involve a finger-worn sensor at all, similar to the initial concepts in our previous work [17]. Some discussed how a more durable insertable object, rather than a wearable, would be easy to "wash and reuse," take "on the go," be more "economical" or would provide "hands-off" sensing, yet "would always have less direct contact" with the fluids (Hillary, Astrid, Nina, all during FW2). Similarly, a more permanent or semi-permanent sensor was suggested, which could be "placed inside a menstrual cup" (June, HS) or "you have it for years" like an intrauterine device (IUD) (Astrid, FW2). More imaginative, futuristic, playful designs were suggested, too, such as actually embedding the sensor under the skin, as a permanent tattoo (Vera, HS), or having it integrated into the nail: *"You go to your nail tech, and they're going to be like, which chip do you want today?"* (Nina, FW2).

5.2 Wearing and Speculating on Sensor Interaction

We now outline participants' perceived everyday sensor interaction scenarios, even though they neither inserted the sensor into their vagina nor obtained any measurements. These interaction styles are shaped by concerns about how the sensor might be perceived socially and the context of its use, including location, timing, and boundaries of comfort.

5.2.1 Sensor visibility was important, but only if the use was revealed. Most participants seemed comfortable with the idea of wearing the sensor in public or in places others might notice it on their finger — the sensor might look like something familiar, like jewelry or *"like a fancy silver henna thing"* (Vrinda, HS), so it would not call too much attention. When we asked home study participants to wear it for a bit, some reported forgetting that they were wearing it after a while (June, Ana; HS) and didn't perceive any "bulkiness" (Ana, HS). During the home study, Hillary even ventured outside the home with the sensor on and went for groceries: *"I had it on the inside. Nobody noticed it. It's like my small neighborhood. I don't think anybody saw it."*. But as she pointed out, *"then again, if people knew what it was, I feel like then I would not be as comfortable wearing it."* Hillary also said the problem with wearing the sensor out and about was mainly that the sensor started to roll off when she was handling groceries and carrying bags.

Concerns about sensor visibility were less linked to the appearance of the sensor, but more to its meaning. Participants discussed how the novelty of the sensor might result in a sort of "empowering" secret (Vrinda, HS), "solidarity" among wearers (Fia, W1), becoming an "identifying symbol" of a community (Ada, W1). Not being alone when wearing the sensor would help ease the discomfort of wearing an intimate technology: *"I think if you have a friend with you, it's really easier"* (Mahgol, HS) and would even be a way to start a conversation on taboo subjects with people that *"want to have a conversation, but they don't know how to have a conversation"* (Vrinda, HS). *"People are intrigued, and they want to know"* (Vera, HS), and the sensor might give them an opportunity to talk about things they are normally not allowed to. However, some said they would not disclose specific aspects of the sensor, depending on the scenario, and *"try to have some answers ready in my back pocket for curious people who want to know what it does"* (Ana, HS), or *"maybe lying and just say like, oh, that's, I don't know, body paint."* (Ada, W1). This also highlighted the increased labor involved in explaining what the sensor is for, similar to talking about menstruation in general: *"It's so hard to keep spreading awareness. And I don't want to take up that job every day"* (Ingrid, W1).

5.2.2 Perceptions of hygiene affect how participants envision using the sensor. For many, the social taboos of wearing the sensor were not as important as making sure the sensor was clean and safe to use, which was exacerbated when imagining wearing the sensor out of the house:

> *"[…] the thing I'm most critical about is hygiene, both during insertion and while just wearing the sensor. I can't imagine the sensor being clean after many uses. I'm imagining what if you had to wear your menstrual cup on your finger when you're not on your period? How would that feel?"* —Ana, HS

Here, participants experienced several kinds of hygiene concerns, including the risk of being perceived by others as 'dirty' and the risk of 'dirt' (dust, stains, and also pathogens) entering the vagina. In terms of the first concern, some said this would stop them from wearing the sensor in public: *"I may not feel comfortable using the sensor and then wearing it for a full day. I'd worry if it is wet or smells bad"* (Ana, HS). Yet some didn't feel this was a concern at all: *"I never had a problem. [...] When you have sex, you have lots*

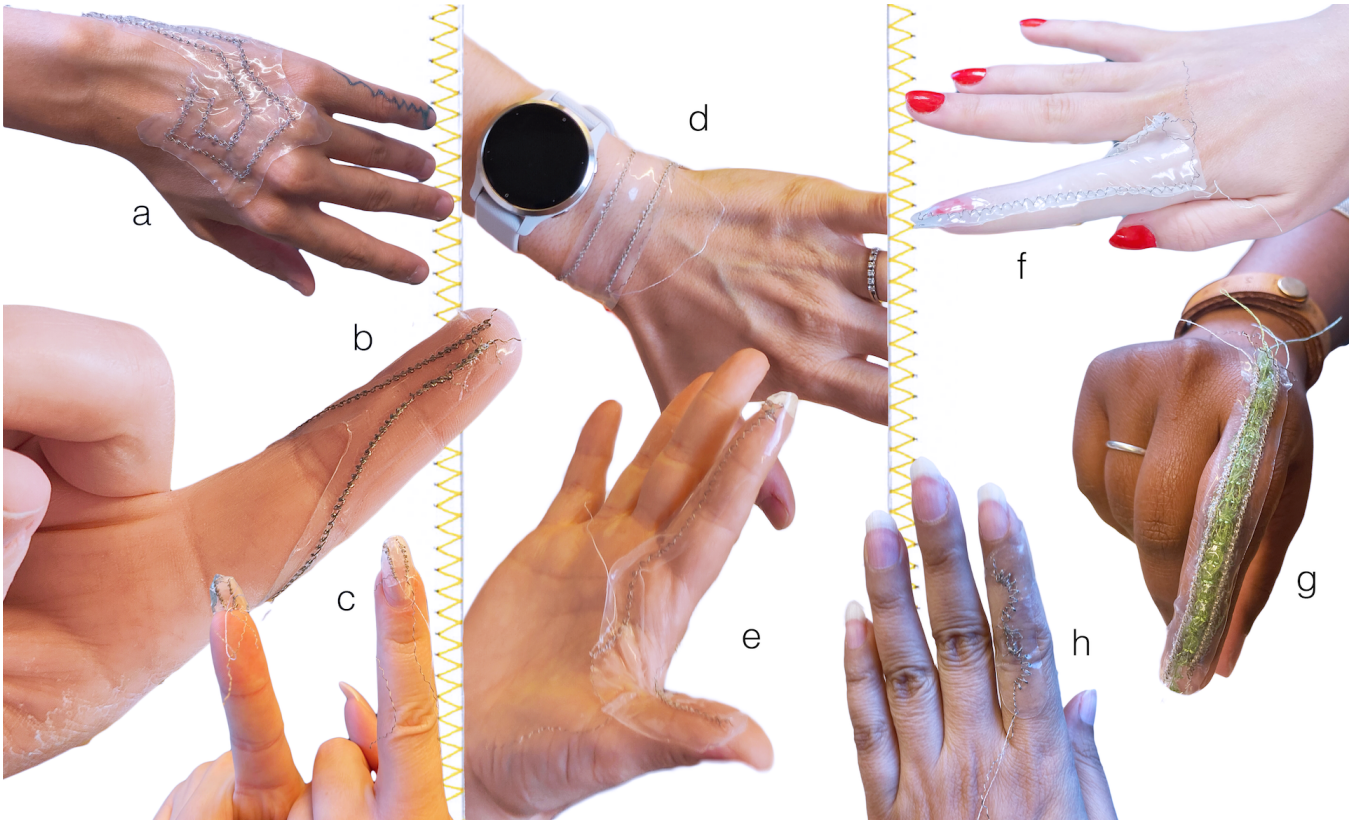

Figure 5: Designs created during the fabrication workshops. a) A sensor on the top of the hand by Sorang, FW3. b) a sensor on the tip of the finger, where the cables would wrap around to the top of the hand, designed by Vera, FW1. c) A nail sensor by Nina, FW2. d) A bracelet sensor by June, FW3. e) a two-finger sensor by June, FW3. f) a finger-glove sensor by Astrid, FW2. g) A fuzzy green sensor by Ana, FW3. h) A sensor with one electrode on each side of the finger, by Vrinda, FW3.

of fluids there. [...] I didn't connect the fluids to be dirty themselves" (Vera, HS). For some, it depended on the situation: *"If it's by my bed, I would do it there, and I would not care to wash off"* (Nina, W2). These understandings of dirt and cleanliness were never simple and clear-cut but complexly layering social and material concerns. For instance, Nina was expressing the second concern (concern about inserting dirty things), but felt like she had to justify herself because she didn't want to come across as stigmatizing her own fluids (first concern):

> *"I have this conflicting thing that, it's my own body, but… I know it's clean and the vagina cleans itself and whatnot. But at the same time, it's this feeling of like, I need things to be clean if they're going to go in there and stuff, if that makes sense?"* —Nina, W2

The concern about getting dirty things in the vagina was the most prominent, prompting discussions about how to sanitize the sensor between uses. Participants offered various solutions: Mahgol (HS) suggested using the same soap for cleaning her menstrual cup, while Vera (HS) suggested a "deep clean" once a day or per cycle. All home study participants found the sensor easy to clean while attached to the hand. Others proposed options like using sanitizer, sterilizing with UV light (Hillary, Nina; FW2), incorporating antimicrobial materials in a storage box (Hillary, Nina; FW2), or designing a portable case to keep the sensor dust-free (Vrinda, HS) or a ventilated dry place (Ana, HS). However, the need for extreme cleanliness was also problematized: *"And I also almost feel like it's too sterilized. I don't know. It also feels like it's maybe sterilizing me. Or like, it's like, too clean. Like you're not supposed to put soap up there."* (Hillary, HS). This highlights another existing uncertainty when it comes to the vagina: *"But... Do I need to kill all the germs?"* (Nina, W2), which participants realized was not so simple, but instead, the definition of clean vs dirty was quite blurry. Referring to sex, Vera reflected: *"we don't have a problem with someone else introducing fingers into you, and you don't know where they were or if they washed them. But the sensor that you wear, and you kind of know how clean it is, you have a problem?"* (Vera, HS). Participants were well aware of these internal conflicts and often embraced these double standards with a bit of humor: *"It's not sanitized... Well, the cups aren't either, and a lot of things we put in. [...] you put some things up there you don't know where they've been before [...], Like men, don't we? We don't know where they were before [laughs]"* (Simone, FW4). However, the fear of pathogens was a common and serious concern, which highlights the need for more knowledge on vaginal health in general, and for

technologies to not introduce more pathogenic risk: *"I would be a bit afraid of an infection because it's something that I usually get frequently"* (June, HS).

5.2.3 If using the sensor is not time-sensitive, participants prefer sensing at home, yet mobility is an advantage for some. Finally, participants reflected on different temporalities of use, imagining various possibilities: as something you put on just when you are going to measure, or something you wear all day, even weeks, if it were robust enough. Wearing the sensor for long periods of time would then change the way they would perform other activities: *"would you shake hands with another person? Like while you are wearing it?"* (Orla, FW3), *"This also is the hand you eat with"* (Ada, W1), *"I would take it off when I'm eating food or if I'm cooking"* (Ana, HS). There were many discussions on how the sensor might fit into somebody's daily routine: as part of a bedtime routine (Hillary, HS), in the shower (Bora, W2), at the same time as measuring temperature (Nina, FW2), sitting on the toilet or squatting (Ana, HS; Astrid, HS; Vrinda, HS; June, HS; Hillary, HS), maybe even using it in bed (Mahgol, HS; Vrinda, HS), similar to inserting vaginal medication (Vrinda, HS). Likewise, the location of performing the sensing didn't matter so much as long as the facilities were clean and there was access to water to clean the fluids off the sensor, so, undoubtedly, the most comfortable place for many was at home. Participants even questioned the need to ever bring it out into public, especially if the use is not time-sensitive: since we did not have the medical knowledge about how and if vaginal fluid conductivity varied throughout the day, we left this question open. However, some actually highlighted the on-demand interaction with the sensor as a positive for them: *"You can always track wherever you are, if you're at the bar, if you're ready to go home with someone at the bar [...] being able to have this whenever and wherever is a really good choice to have."* (Astrid, HS).

5.3 Speculating on Data Practices

We now unpack participants' anticipated motivations for using this sensor, how these may influence their sensor engagement, and, in turn, how this might lead to novel 'data practices' over time.

5.3.1 For some, benefits already emerge in short-term and analog tracking. While some participants had a very clear idea of what they would use the sensor for, others would want to experiment and explore with it before finding out how it would be useful for them. All HS participants, to different extents, performed an analog tracking of the texture, color, and quantity of their fluids in the provided space on each page of the booklet. For some, this was one of the most enjoyable parts of the study because they learned something new about themselves. In her interview, Vera (HS) was especially grateful and exclaimed how it was almost like having an "epiphany" and how it became a new way to nurture "self-acceptance" because she normally "ignored the fluids". She explains how she made meaning from tracking the changes in her fluids, and how *"just having to do this for a couple of days"* made her much more aware and curious to see patterns across many cycles. For Hillary, *"it was nice to get reacquainted with the fluids"*, since she was already familiar with how her fluids changed throughout the cycle, but she had stopped noticing it because she wasn't actively using a menstrual tracker at the time of the study. And for Astrid, doing the tracking was also a highlight of the study, but also because it made her *"understand the sensor so much more, and it was so interesting to actually have that sensation of what it's doing."* Our findings revealed that tracking the leaky body is a new and "overwhelming" (Astrid, HS) practice for some, so it might need to be introduced in smaller steps, over longer periods of time, or together with complementary materials like the diary, because *"when you sit with it for a while, it actually makes a lot of sense. [...] you can always find a way to come around that [the overwhelming feeling]"* (Astrid, HS).

5.3.2 Practice fluctuates, and long-term data practices don't work for everyone. Participants suggested that some might want to use the sensor only temporarily (Ada, W1), such as during bodily transitions like menopause (Ingrid, W1), or track consistently for a while and then stop once the data becomes predictable (Esra, W1). Others noted the importance of being able to stop without negative consequences: *"I'm not sure I would be able to be consistent. But if it is something that, OK, I know that if I use it for a few months and I could be able to have a better sense of my body, maybe I will use it for a few months and then I will stop"* (June, HS). These insights are in line with previous literature on menstrual tracking: tracking uses fluctuate, and data practices evolve over time.

For Vera (HS), discovering patterns over the course of a longer tracking practice would be most relevant for her: *"for me, it would be very interesting to find, like, what is a full cycle for me? where does it start? how do different cycles vary from each other? Are they the same? Where does it vary?"* Similarly, June (W2) mentioned how she *"would like to understand if there is a correlation with the total unit of insulin that I take per day"* in order to find correlations with her ongoing diabetes tracking. Furthermore, a long-term tracking approach might be preferred in cases where people have more irregularities: *"I'm just curious how it helps people with PCOS because I have so many friends struggling with that and they have tried everything"* (Mia, W1). Astrid (HS) talked about how she would find advantages in using the sensor as a long-term tracking system because it would help her make sense of her irregular cycles and premenstrual dysphoric disorder (PMDD):

> *"[...] I've struggled a lot with irregular cycles. And so that's why I have my app Flo and am trying to track it. But then that's just based on when I have my period. So being able to track all the kinds of fluids, when you're going to have your ovulation, and so on, on the phone, would be very nice. [...] for me, it is very important to be able to go back to the history of your previous cycle."*
> —Astrid, HS

However, several participants discussed the option of not 'tracking' data but instead taking a sensor reading for immediate insights about their fluids without needing to store or review the history. For instance, Esra desired this kind of interaction with their data, as a way to get away from being constantly (self)surveilled by quantified tracking technologies: *"I'm always very conscious of the sort of risk, the sort of emotional slash psychological risk of heavily tracking anything in your life unless it's medically necessary"* (Esra, W1).

Participants questioned the notion of tracking as the default solution for menstrual issues: *"I think it's very easy in our data-driven society to be, like, oh, if we just, self-track a bit, everything*

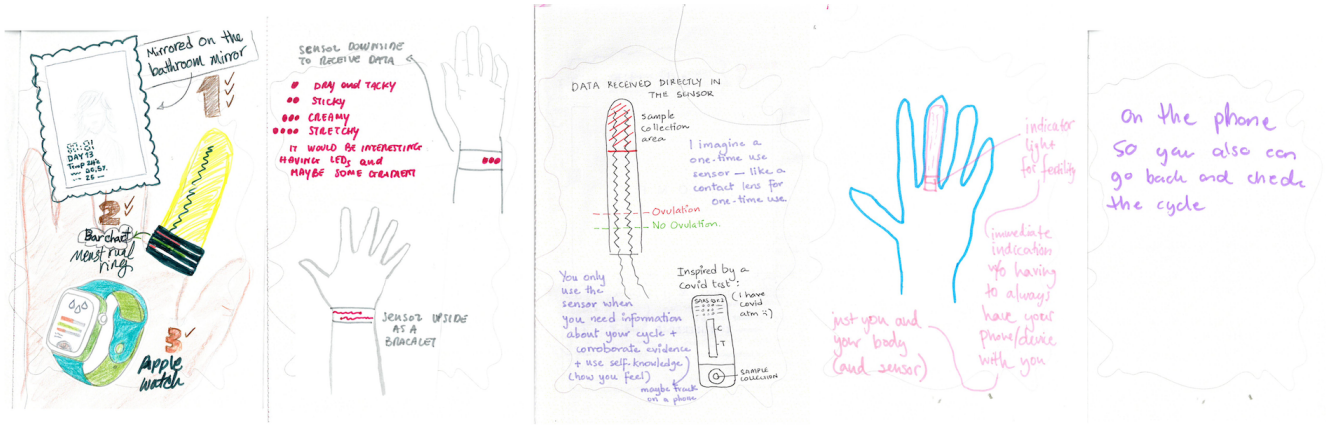

Figure 6: Responses in the home-study booklet to the question "How would you imagine receiving the data from the sensor? Write and/or sketch it out". From left to right: Mahgol, June, Ana, Hillary, and Astrid.

will be fine, and then it's actually another problem, so..." (Sofia, W2). Some acknowledged the benefits of long-term tracking but not for themselves. Ana, who used an open-source menstrual tracker, noted: *"I think personally, accumulated data, I feel, is overrated. It's definitely helpful. I mean, here I'm speaking as a privileged person who never really has to go see a doctor that much. Obviously, if you have issues, and if you need to see every single day where you are [in the menstrual cycle] and show that to a doctor..."* (Ana, HS). To mitigate long-term tracking concerns, June (HS) suggested tracking only a limited history, while Astrid (HS) proposed quickly checking data in the moment without viewing the full history each time: *"maybe I'm just going to do it quickly before I'm going to run to work and I can do it and then I see quickly on the sensor. But then when I'm on the train, I can go in and have an extra check to go through it"* (Astrid, HS).

5.3.3 Participants were wary of the labor involved in interpreting the sensor data. Some participants preferred the sensor to interpret data automatically, minimizing the effort of logging and analyzing: *"I'm like, give me instant information without me having to go somewhere and log in and check in and insert and then add and then write. It's just like a lot of steps... [...] I want the instant gratification of getting the results instantaneously"* (Hillary, FW2). Some envisioned feedback directly from the sensor, like an LED indicating fertility (Hillary, HS) or binary outputs similar to a COVID test or ovulation/pregnancy test (see Fig. 6):*"[...] I imagined this to be like a COVID test, like it's a one time use. And you only use the sensor when you need information about your cycle"* (Ana, HS).

Participants desired varying levels of interpretation depending on the use case, with Bora (W2) emphasizing simple, goal-oriented feedback: *"[...] to them, conductivity or resistance, that doesn't matter. The thing that matters is if they're ovulating or not. Or even being direct, if they're going to get pregnant or not"* (Bora, W2). Some favored more ambiguous visualizations, such as gradients (Vrinda, HS; Hillary, HS), where it's *"not maybe red or green, but a gradient [...] light green, dark green..."* (Hillary, HS). This also came as a reaction to wanting more "visual" data interpretation: *"If somebody gives me just the numbers or just lame graphs, I'll just not use it because that makes no sense to me [...]"* (Vrinda, HS). A more blurry or ambiguous data representation could help balance the control the sensor would have over the interpretation, leaving more up to the user. Here, Vera (HS) cautioned against giving the sensor system too much control over interpretation, especially when it came to the *"responsibility of actually making the choice of what is normal or not normal."* Overall, there was constant discussion on balancing how much the technology would interpret your data for you, on the one hand risking normalization and errors if the system was too much in control, and on the other hand increasing the user's labor if the system made minimal interpretation, or gave the user blurry data.

6 Discussion: Towards Feminist Ways of Sensing

Our study explored what people thought of the Sewn Tactful sensor, a sensor that would require touching their intimate and leaky bodies. We found that this kind of sensing is active, intentional, felt, and emotional, yet sometimes messy, tricky, and demanding. In other words, it invokes the felt senses and the materiality of the body, and it brings into existence a new choice on how to sense the menstruating body. We conceptualize this kind of sensing as a *feminist* way of sensing, elevating core feminist values of advocacy, embodiment, and pluralism [11]. Furthermore, when aligning with these feminist values, and especially when resisting a universal view of menstrual experiences, several tensions arise, which we unpack below. Rather than resolving these tensions, we embrace these complexities and design within them, "staying with the trouble" [33, 78] of leaky bodies, without imposing a technological solution. We believe that, aside from the actual sensing, the sensor allows users to sit with these tensions and confront them head-on, turning inwards to the self, which is already a valuable way to know the body [3, 19, 82].

6.1 Boundaries of Hygiene and the Body

The first tension participants faced when envisioning the use of the sensor had to do with their perceptions of hygiene. For participants,

hygiene entailed a complex layering of biological, social, societal, and cultural understandings and was entangled with participants' experiences of illness/infections, and with existing practices around menstruation, such as the use of pads, tampons, or a menstrual cup. As we note in our findings, hygiene concerns related to the sensor go in many directions: 'things leaving the body and making things dirty,' 'dirty things from outside the body coming into the body and harming it', or even 'things from inside the body that have left the body for a while, become dirt when re-entering the body.' Overall, hygiene concerns had to do with what left the body, or what entered the body, or, in other words, the leakiness of the body—the transgression of the body's boundaries. Moreover, hygiene concerns are deeply entangled with *other* bodies. For instance, if the fluids 'left the vagina' and were on the finger/sensor, and another person perceived this, participants expressed how they would feel uneasy. This reinforces how menstrual stigma is a predominantly socially constructed experience: nobody was uncomfortable with their own fluids until these were perceived by others, echoing similar feelings to fear of staining or leaking when menstruating [67, 85].

Feminist posthuman theories teach us that the boundaries of the body fluctuate and blur to include or exclude bodily materials, technologies, objects, or clothes [30, 40]. The sensor made this blurriness evident, bringing conflicting and confusing tensions to the surface: Inserting fingers does not cause this same hygienic unease, so why does the sensor cause it? Perhaps because the sensor fluctuated between being perceived as part of the body, and as 'other'. The question of "when technologies become part of the body" is recurring across HCI, and it has been gaining even more attention as posthuman and more-than-human studies expand. We have seen how the sensor exemplifies this tension, and hygiene practices make it visible: for some, the sensor was easily imagined as a part of their 'cyborg' body, maybe wearing it all day, and forming a cleaning ritual around that, yet others preferred to view it as a separate tool, choosing to wear the sensor only for a few minutes at home and immediately taking it off after use. We advocate for people to be able to choose where (or if) they draw a line of their body's boundary, as this has pragmatic implications for how to design hygiene practices in intimate technologies. We think that asking participants how they envisioned cleaning and maintaining the sensor helped them reflect on and articulate their boundaries, or even question their preconceived notions of their bodies being sealed and contained entities [77]. As a pragmatic takeaway for designers, we urge deeper consideration for understanding people's hygiene perceptions and to what extent they might be positively challenged when introducing them to a novel, intimate technology. Overall, taking a feminist approach to sensing—one that emphasizes the leaky body—brings people to self-reflect on the subjectivity and situatedness of their menstrual experiences. This brings into question their boundaries and emboldens them to even renegotiate them, taking action to challenge them, or maybe, through long-term engagement, outgrow unjust socially-constructed values.

6.2 Dis/Comfort with Touching the Vagina

As we have seen throughout our studies, using the sensor would involve direct tactile interaction with not only vaginal fluids but also with the vagina itself. However, we found that touching the vagina and its perceived "leakiness" elicited diverse responses, varying widely from an everyday action to a more complex confrontation with uncomfortable associations. For some, this interaction was mundane, akin to using menstrual cups or tampons, or analogous to practices associated with masturbation or sex, resulting in a sense of familiarity. Yet, for others, interacting in a very close and systematic way with the vagina is far from routine. This act is deeply intertwined with cultural and personal histories, shaped by sexual education, past experiences, and one's position within their menstrual, sexual, and/or reproductive journey. Some might be uncomfortable with vaginal penetration because of the negative connotations it carries. Many may want to challenge misogynistic ideals of dominance over women, which feminist movements have tirelessly fought to counter, advocating that 'we are more than a vagina or a uterus' and a move beyond reductive biological understandings, particularly in relation to gender identity [31]. In many ways, touching the "leaky" parts of the body challenges deeply ingrained societal and cultural norms, and for some, breaking these norms is a gradual, complex process that cannot be undertaken alone.

We propose, in line with feminist values of plurality and participation [11, 12, 44], to design to adapt to a plurality of ways of touching the intimate body. We envision that this can be done by developing 'hackable' and low-tech craftable and reconfigurable designs like the Sewn Sensor, or kits with many elements that can be explored (or ignored) (e.g., [19, 78, 79]), crafting joyful and fun and unusual experiences that spike people's curiosity. This can be done through slow and long-term participatory approaches, inviting people to fabrication workshops where they can design their own versions of the technology and then take it with them to explore it further. These approaches not only invite accessible and low-cost technologies but also nurture making for the self, reclaiming control of how we want to discover and know our bodies. We take inspiration from Tuli et al.'s approach to "designing for the self" when designing menstrual trackers, tailoring to users *"throughout their menstrual journey according to where they are in their journey, experience with menstruation, and life choices"* [83].

During the fabrication workshops, we also gained substantial insights into the collaborative aspects of making, the joys of crafting soft, textile-based technologies, and the broader implications of adopting a DIY (do-it-yourself) approach to intimate care technologies. Participants shared stories, learned about each other's menstrual and vaginal health experiences, and nurtured a space where diversity flourished. While this paper primarily focuses on how the sensor involves active sensory interaction with the leaky parts of the body, we also believe that the creation of low-cost, accessible, DIY, collaboratively-made technologies aligns closely with our feminist values. We see this as a possible area of future work, and open up for designers to consider how we might collectively make feminist DIY intimate technologies.

Further reflecting on our methodology, our studies also revealed that many participants found value simply in engaging with their bodily fluids during the research process. We suggest that technologies like the Sewn Sensor may benefit from being accompanied by materials such as booklets or interactive guides, which can help users ease into the practice of self-touch and aid reflection before deciding to adopt the technology. And while the sensor may not

be suitable for all bodies—and that's perfectly acceptable [38]—it may still have a positive impact on those who choose not to use it. As we see from our study, the mere existence of the sensor opens up new possibilities and perspectives on how bodies and intimate experiences can be understood and engaged with. We believe that feminist sensing entails designing for the right to choice, a right to choose between using a technology or not, and we believe that the sensor adds to the existing variety of available technologies to choose from.

Touching vaginal fluids, with digital support from the Sewn Sensor, is just one example of feminist sensing, but there might be many more possibilities. What might a feminist way of sensing the intimate body look like through other senses, such as smell, taste, or hearing? Or a combination of various senses? By focusing on and enhancing felt senses, rather than replacing them with digital sensing, we might find knowledge in the neglected parts of our body. And if accuracy in sensing is the goal, this layered approach, combining both *qualitative* and *quantitative* sensing, could potentially offer more accurate insights than digital sensing alone.

6.3 The Labor of Sensing Practices

Throughout their lives, as bodies fluctuate and needs and goals change, people who menstruate are constantly negotiating between the value they may get from using a menstrual product (or a menstrual technology) and the labor it will take them to use it [64, 83]. In an attempt to not overburden and increase the implicit labor involved in being a leaky, menstruating body, in our work, we explored how this negotiation would occur if our participants were to adopt the Sewn Sensor.

Our data shows that intentionally touching and sensing the leaky body involves new forms of labor, labor that not all are willing to introduce into their lives. For some, the benefit of touching and learning about their fluids was not enough to justify active sensing. Here, as little labor as possible was always preferred. Yet some participants considered the labor of active sensing was worth it, because the sensing would bring them closer to their bodies. Yet other participants didn't think it seemed laborious at all; it fitted into their existing routines. Despite this not being how the sensor was designed, several preferred the idea of automatic sensing. For those who envisioned the sensor as a contraceptive device, the question of labor became even more complex. For them, reducing the labor might be the highest priority, as a feminist reaction to the overwhelmingly unbalanced split of contraceptive labor between a menstruating and non-menstruating partner [64, 83]. However, since, for our participants, the powerful use of the sensor was not solely envisioned as a contraceptive device, but to gain bodily knowledge, the labor introduced by the sensor might be worth it for many.

Feminist ways of sensing pragmatically acknowledge that not everyone has time to slow down and attune to their bodies, yet also intend to probe, at a societal level, what kind of labor we consider valuable. We argue that although feminist sensing may introduce new forms of labor, it could also be a way to prompt us to reconsider how much time and labor we allocate for ourselves, for the self-discovery of our bodies, which could even be seen as a form of self-care. We believe there *is* value in doing this labor and that it is worth trying out and experimenting, even if it is just a first step to understanding what the value might be.

A central part influencing these reflections on labor and value was the way the data practices were envisioned. Since this part of the sensor was left open and undesigned, participants discussed a wide variety of ways the data might be stored and interpreted, which influenced the amount of labor it would require. Participants envisioned what we conceptualize poetically as both *sticky* and *slippery* data practices.

6.3.1 Sticky and Slippery Data Practices. With sticky data practices, participants imagined the sensor being used persistently, once per day, and these daily values are accumulated or stored onto a device with memory — the data "sticks" to you and your device, which can then be seen via a history graph or other common data visualization representations. The current norm in the FemTech landscape is a *sticky* data practice, and it was one that participants were most familiar with. Our findings indicate that many individuals desire and benefit from such practices, particularly in contexts of heightened uncertainty, such as with PCOS or irregular cycles [21], or for those already engaged in long-term health tracking, such as individuals managing chronic illnesses. Feminist approaches to sensing could indeed support those who prefer a quantified, data-driven practice, while still allowing for active, embodied engagement, including tactile interactions with the leaky aspects of the body.

However, several participants also discussed the possibility of not actually 'tracking' the sensor readings at all but instead using them to obtain a sort of snapshot of their menstrual health. Here, the data points would not accumulate or be stored on the device (at least not in a way that is visible to the user); they would "slip" away. This *slippery* practice wouldn't require diligent daily tracking, and instead aligns with irregular and undefined temporalities often observed in the use of menstrual and fertility tracking technologies [24, 64, 72, 84]. This preference was often intertwined with concerns over (self-)surveillance, normativity imposed by self-tracking [56], and mistrust of FemTech companies, particularly given the inadequate data privacy policies of many platforms [57]. We argue that feminist ways of sensing have to take into account these risks, yet we do believe that a sticky data practice might still be achieved in a feminist way, handling data securely, encrypted, and locally stored on the sensor circuit itself.

Given the stated concerns, many participants envisioned a storageless sensor that wouldn't accumulate data at all, resembling a single-use chemical test like LH (luteinizing hormone) urine tests. Yet, from a technical perspective, the current design of the sensor relies on measuring conductivity. To translate this into something meaningful to our participants, such as determining fertility, multiple data points are necessary for comparison —one measurement alone would likely not suffice. However, the speculative nature of our studies encouraged participants to imagine possibilities beyond the current technical limitations of a conductivity-based sensor, sparking ideas for future advancements that we, as designers, may not yet have the expertise to realize. With further medical research and advancements in sensing technologies, such speculative ideas could become feasible. In such cases, we advocate for a feminist approach

to sensing, as outlined in this paper, ensuring that future developments prioritize bodily autonomy, choice, and the complexities of embodied experiences.

7 Moving Forward and Concluding Remarks

With this paper, we have responded to feminist calls for designing with the embodied, material, leaky, and sensory aspects of the body and show how doing this kind of sensing surfaces tensions, tensions that we need to take into account when making design decisions going forward.

Feminism encompasses many values, but we strongly align with the principle of *choice*. A multiplicity of bodies calls for a multiplicity of choices on how to sense the menstruating body, and we believe the Sewn Sensor provides a new choice for bodily self-discovery. As reproductive policies worldwide continue to fluctuate, and leaky bodies have been and are still being stripped of their right to choice, it is more important than ever to critically assess FemTech innovations and work towards creating feminist alternatives to choose from. Moreover, we believe the sensor is not only feminist in its way of sensing, but also in its capacity to nurture discussion, question boundaries, reclaim control, and collectively challenge oppressive stigmas.

We hope this work encourages further HCI research with feminist sensing technologies, collectively crafting a future that cares for curiosity, self-discovery, and, ultimately, bodily autonomy.

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