The Connected Shower: Studying Intimate Data in Everyday Life

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This paper presents the design and field study of the Connected Shower, a bespoke IoT device that captures water flow, temperature, shower-head movement, and shower product weight. We deployed the device in six UK homes for a week to understand the use of 'intimate data' as captured by IoT systems. Findings from our contextual interviews unpack a) how such intimate data is collaboratively made sense of by accounting for the social order of showering practices as part and parcel of everyday routines; b) how the data makes details of showering accountable to their partners; c) how people reason about sharing intimate data both with third parties and their partners. Our study shows that intimate data is not intimate per se, nor is intimacy a property of the data, but is an interactional outcome arising from the articulation of shower practices to their co-present partners. Thus, judgments as to whether the data is too sensitive, private, or intimate to share are contingent on situated sense-making and therefore subject to change; however, there was a general consensus that sharing intimate data with service providers was acceptable if the data was sufficiently abstract and anonymised. We discuss challenges in the design of trustworthy data-driven IoT systems, and how they need to be warranted to be both acceptable and adopted into our intimate practices.

CCS Concepts: • **Human-centered computing → Empirical studies in ubiquitous and mobile computing**;

Additional Key Words and Phrases: Ubiquitous Computing, Internet of Things, Intimacy, Intimate Data, Privacy, Data Work, Technology Probe

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1 INTRODUCTION

Ubiquitous Computing (UbiComp) is pervading more and more of domestic life in the form of Internet of Things (IoT) devices. These network-connected products, such as 'smart' thermostats, TVs, and smartspeakers, harvest data to enable a variety of services for householders, such as occupancy-sensitive and predictive heating, but often also to provide service providers with revenue through advertising, consumer profiling, direct marketing, product sales, etc. Moreover, IoT devices are entering and collecting data about intimate practices, such as grooming, bathing, and sleeping. Thus, our work is concerned with understanding how people view the use of this kind of 'intimate data' in the context of the intimate, yet everyday activity of showering, to understand the risks and

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benefits of using this data for the provision of potential IoT-based services. Such data may for example enable prediction of water use where water is a scarce resource, or to better understand product use in the shower, which may be used by manufacturers to improve products so that they need less water in production and use e.g., when rinsing off shampoo.

Researchers in HCI and UbiComp have studied and designed for the monitoring of energy and water consumption [10, 17, 30, 41]. However, most of the work has focused on the design of eco-feedback systems, in-home display (IHD) systems [10, 21], or persuasive technology in terms of behaviour change [3, 30, 36]. The persuasive computing angle has been criticized as ignoring the fact that people are not rational actors, but instead consume resources to carry our everyday practices, which are "mediated by social, cultural, technical and institutional dynamics" [48].

In turn, in our work we adopt a 'practice lens' [35]; in order to examine technology embedded "within the sites and the relations of their everyday use" [49, p. 47] we have designed an IoT shower kit to deploy as a technology probe [28] that uses multiple sensors to collect potentially 'intimate data' by virtue of indexing an intimate practice, including, water usage, water temperature, flow rate, shower head movement, and product usage. Through week-long deployments in six homes in the UK, and subsequent interviews we explored how participants practically make sense of this 'intimate data', and what kind of sensitivities arise about potentially sharing this data with service providers, or even with other family members? To do this, we follow the premise adopted in prior studies of 'data work' in examining how people make sense of energy data retrospectively: data is merely 'indexical' to the sites and practices of its production; thus, these circumstances cannot be simply 'read off' the data but require articulation of the context and practices in which it was produced [19, 51].

Thus, an objective for our work is to establish not just whether or not people are concerned about possible data usage, but how do people articulate concerns about 'intimate data' collected from intimate practices; just what about the data makes 'intimate data' intimate, sensitive, private etc. and what does not? Through our study, we answer the following interconnected research questions: **a)** How is 'intimate data' made sense of by accounting for the social practices in which it is embedded? **b)** How does the data make details of the shower practice socially accountable? **c)** How are sensibilities around the potential sharing of the data articulated?

We discuss our findings in the context of designing IoT systems around intimate data, including reflections on the finding that intimate practices do not necessarily generate sensitive data. Intimate data is not intimate per se, nor is intimacy a property of the data, but is an interactional outcome. Thus, judgements whether the data is too sensitive, private, or intimate to share are contingent on situated sense-making; however, there was a general consensus that sharing intimate data with service providers was acceptable if the data was sufficiently abstract and anonymised. We consider challenges in designing trustworthy data-driven IoT systems, and the overall challenge that the design of IoT systems for intimate practices needs to be warranted to be acceptable and adopted into people's intimate practices such as showering.

Our main contribution is an understanding of the use of 'intimate data' in IoT systems, which may benefit researchers wishing to study the intersection of technologies and intimate practices, as well as designers seeking to design for or leverage data from intimate practices.

2 BACKGROUND

This paper builds on socio-technical design research at the intersection of energy monitoring, privacy and intimate data in HCI, CSCW, and ethnographic studies of domestic practices. We provide a brief review of the 'practice of showering', especially in the UK, and then move on to the related work in UbiComp and HCI.

2.1 Changing Habits: from Bathing to Showering

Showering has superseded bathing as the activity of daily life that fulfills the social expectations of comfort, cleanliness, and convenience, at least in the UK [46]. These expectations are deeply ingrained in people's habitus and social norms [7]. In modern society, the shower accounts for a significant proportion of domestic water consumption [31].

The meaning of cleanliness and manner of 'removing dirt' have been transformed throughout the generation, also according to region [43], which is a result of the interplay of cultural values and social structure [9]. In the case of the UK, the majority of houses now have at least one shower per property. The level of penetration has climbed significantly since the late 1990's to reach around 90% in 2016, this is equivalent to 23.9 million UK homes [45]. Herrington claimed that data on domestic water consumption shows the changing practice of traditional British bathing habits to frequent showers, especially with the rise of 'power showers', which have higher water pressure, and therefore a higher water usage rate [25]. Daily showering has rapidly become a standard routine of 'normal' life and this transition has been only possible by the technological innovation in the construction of infrastructure and resources [23]. Showering has a reputation for being invigorating, offering relaxation, and enhancing individual well-being. However, the spread of routine showering has been viewed as being responsible for increased water consumption as well as some environmental concerns [46]. Thus, HCI scholars have already engaged with showering from a sustainability angle [6] and more specifically, a water conservation angle [17].

Furthermore, in light of technological innovation, environment policy practitioners have investigated ways to help people manage resources through smart metering and energy labelling on appliances [52]. The environmental policies generally presume existing routines and 'ways of life' with only little heed of context [44]. Thus, environmental policy laid greater focus on resource management than on changing people's habits [23].

In this paper, we examine UbiComp technology in the context of 'showering' as an example of an intimate and essential daily practice. Moreover, we wish to shed light on product design and manufacturing systems that are faced with new design opportunities to empower design process from data collected in our everyday life.

2.2 Studying Water and Energy Consumption in HCI

With growing concerns in water scarcity and conservation, water usage in the home has been studied with ubiquitous computing technology both by the manufacturing industry [31], as well as the UbiComp and HCI community [17]. Blevis established 'environmental sustainablity' as a mainstream topic in HCI [6]. With respect to sustainable HCI (e.g., [16]), growing concerns about water and energy conservation have boosted HCI research in water or energy monitoring [17], and energy eco-feedback system [34, 41, 48]. Many of these previous works have focused on resource conservation and management. Pierce and Paulos [42] reviewed energy-related HCI research and categorized 51 publications into three themes of energy management. Froehlich et al. conducted a notable review by tracing an eco-feedback study from 40 years of research in environmental psychology, showing that electricity consumption attracted most attention in energy related HCI research [21]. There is a host of work concentrated on the design of artefacts for persuasive interface and feedback techniques (e.g. [3], [36]).

However, our interest in this space is to investigate shower practices as a socially embedded activity to unpack the lived experience of domestic water consumption. There are some notable studies that have investigated water consumption in everyday life [22, 42]. In their Water Portal study, Erickson et al. conducted a long-term evaluation of residential water consumption with fine-grained, near real time feedback [17]. In our study, we take a similar qualitative method, but with a different purpose for collecting the data. We examine how people account for IoT enabled 'intimate data' collected from multiple sensors in the shower in terms of their daily pactices, and how they view its use in IoT services, and its sharing with service providers and family members, which may speak to the social accountability of domestic water usage and has the potential to generate multiple design implications for HCI designers.

2.3 UbiComp in the Home

Our work is positioned within research that has long since studied the interplay of technology and social life in the home. The home has been described as a private and intimate place where artefacts (including technological ones) are appropriated and drawn on in the methodical assembly of householders' routines and domestic practices [14]. The domestic environment has been studied from multiple points of view to draw out implications for the design of novel systems that empower our experience with data [15]. In relation to our paper, our work is methodologically aligned with ethnographic studies that inform the design of future domestic technology [11, 13, 50]; and prototype deployment studies in a real setting that have discussed implications of human-data interaction in designing IoT applications for domestic life [12, 19, 40, 51].

Our approach is informed by prior studies that have unpacked the ways in which meaning of sensor data is produced; Fischer et al. showed how co-participants engage in 'articulation work' to retrospectively account for the situated interaction between householders, IoT products, and sites that have produced the data. [18, 19]. However, these previous studies have not examined the collection or sense making of data from intimate practices.

2.4 Privacy and Intimacy

Privacy is now an important topic in UbiComp and HCI, especially with the rise of mobile phones equipped with multiple sensors capable of tracking and recording [39]. The 'personalisation' of applications and services by the use of user data raises privacy concerns [32]. Van de Garde-Perik et al. (2008) identified that privacy concerns are contingent on the type of information collected, the degree of user control over disclosure, the terms of accessibility, and how it will be used.

As digital applications become more widespread, it may seem inevitable that they will also reach to collect data from intimate activities; thus, increasing privacy concerns. There is a host of literature in this space that spans a variety of domains including women's health and intimate care [1, 4], maintaining intimate relationships with technology [24], designing self body-tracking and wearable devices that implicitly collect information about users as they go about their daily tasks and activities [2, 20, 38]. Self-tracking may create a new intimacy between the computer and the body by collecting data of the innermost parts of the self [26]. In light of these previous studies on intimate data and privacy, we probe this space by recording intimate data from one of the most common intimate activities: showering.

The bathroom presents several design challenges, as a cultural probe study by Lucero et al. has revealed [37]. Showering of course is not just about 'removing dirt', but includes other hygiene-related or intimate behaviours that could be seen as too sensitive for data collection, insofar as they can be 'read off' the data or be called to account for by others that see the data.

Although HCI studies of or relating to intimate practices are scarce, one notable exception is Almeida et al.'s research that set out to support female users to better understand the health of their sexual organs. In their research, the by provided a pair of underwear and a mobile phone app that asks users to take photo of their intimate body part to gain nuanced knowledge of pelvic muscle structure. Their research provides valuable insights into the design of a system for intimate practices, as well as the use of data that may be perceived as unusual and awkward.

In our study, we explored a familiar and seemingly intimate practice that people do on a daily basis, showering. We fundamentally ask whether this space is intimate or uncomfortable to collect, aggregate, show and talk through the data. Thus, we aim to see how the 'intimate data' captured by sensors might also become intelligible through householder's account of what they mean and how they are oriented to in their everyday practices.

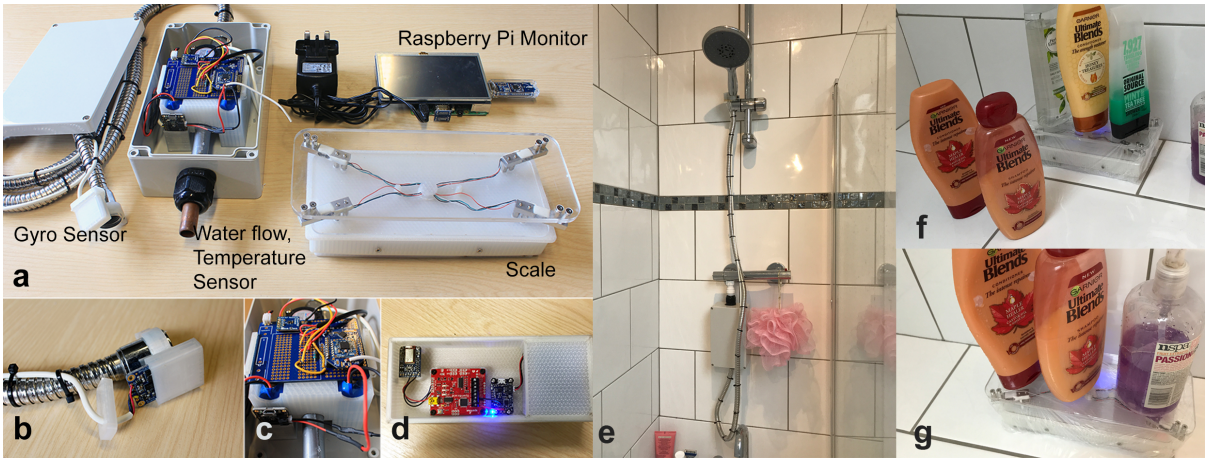

Fig. 1. (a-d): IoT shower kit. (a) Overview of components of the kit, and closed-up view of (b) gyro sensor, (c) water flow and temperature sensor board, (d) Bluetooth enabled weight sensing board connected to 4 load cells on the scale. (e-g):IoT Shower Kit in-situ. (e) IoT shower kit installed in one of the households, (f) and (g) demonstrates each householder's products on the scale; male's and female's, respectively.

3 DEPLOYMENT OF THE CONNECTED SHOWER

We deployed the Connected Shower, an IoT shower kit for in-situ data collection in participants' homes, allowing us to subsequently examine the relationship between the artefact (the shower), the data generated by its usage, and people's everyday lives [49]. Through this study we probe what happens when we manifest the data around the practice of the daily shower, therefore drawing on a data-driven technology probe. Technology probes are a method used in HCI to explore technology-in-use in a real-world setting in order to understand user needs, and design implications [27, 28]. We developed a two-stage technology probe and deployed it in an open-ended field study. The first stage of the study involves an IoT shower kit being installed in households for data collection in situ. The second stage of the study revolves around a contextual interview with participants in their homes, facilitated by the data collected by the IoT shower kit and against a backdrop of potential future scenarios. The study focuses on explicating participants' sense-making of the data in situated interactions in the contextual interviews, their sensitivities about data collection, data being used by third-parties, and other privacy-related concerns around IoT systems. In this section, we describe the probe and the field study.

3.1 IoT Shower Kit

The technology probe is a collection of data logging components that are integrated into a household shower. The probe is comprised of three logging components and a Raspberry Pi that stores sensor data broadcast from the logging components via Bluetooth. The kit (Figure 1) includes an accelerometer and gyro package to capture movement and manipulation of the shower head, an in-line sensor box that captures the rate and temperature of the water flow, and a weight scale in the form of a product shelf that captures the change in volume and usage of the products in the shower. The components are battery powered; to preserve battery power logging only occurs when the water flows. The Raspberry Pi is mains powered, and is therefore located in an adjacent room or hallway. Due to the risk of water leaking into the components, the prototypes were designed to be low-power, water-tight and mountable to standard connectors universally used in most showers. The data is stored locally on the Pi, and the Pi is not connected to the Internet.

3.2 Scenarios

Prior to the field study, we held two envisioning workshops with 20 designers (from a partnered design-focused institution) and HCI researchers (from our own institution) separately on two different occasions, to discuss data-driven systems for everyday life. From the workshop, we derived three potential future scenarios that reflect possible new user experiences of an IoT shower system. We employed the scenarios in the contextual interview to prompt complementary broader reflections against the logged data, and to highlight questions and issues related to collecting and sharing one's intimate, possibly sensitive data. The three scenarios are as follows:

- **Water Conservation**. The local water authority is monitoring not just your water consumption, but how you are using water. Your household is rewarded for using water frugally, and may be charged more if you are using excessive amounts.
- **Personalised Product Offers**. Manufacturers of your favourite shower gel and shampoo use the data on how you use their product to send you offers, and reminders that you are running out. In return your data lets them understand how their products are really used
- **Smart Shower Scheduling**. A service helps your household to schedule showers to avoid family conflict. It learns to predict how much time you will spend in the shower, and how this affects your household's daily usage. It reminds you to have a shower at the optimum time to avoid anyone running late.

3.3 Participant Recruitment

After gaining approval from our institution's Ethics Committee, we hired a recruitment agency to recruit six households in the UK that spanned a range of age groups and occupation (see Table 1). We asked the agency to look for households who would agree to have shower sensing technology put into their shower for a week, explaining that this would measure things like flow rate and temperature, product use (via a scale), and shower head movements. The households must have a non-electric (hot water boiler-fed) shower so that the Connected Shower could be installed by the researchers. We asked that participants take part in an hour-long interview at the beginning and end of this week in their own homes, and that the reimbursement would be 50GBP per household. We instructed the agency to forward the information sheet approved by the Ethics Committee to the participants, which explained the study in more detail. Due to ethical reasons we excluded households with children using the same shower. The agency recruited six households consisting of an adult male-female couple, one household also had a one-year old baby.

Table 1. **(Left four columns)** Participant demographics. In the paper, we signify each household member as 'Household ID.M/F' **(Right four columns)** Overview of water consumption and time spent showering in the week-long deployment.

Household ID	Members	Age group	Notable features	Total water consumption (litres)	Total shower time (mins)	Average water consumption (litres per shower)	Average shower time (mins per shower)
H1	2	20s	Both work in the city. Male participant initially rejected sharing data but agreed later.	2,318	180	145	10
H2	2	60s	Both retired. Concerned water and energy conservation.	726	60	48	5
H3	3	30s	A couple living with a baby (9 months). They are budget-conscious.	490[a]	34	38	3
H4	2	50s	Shower routine was tied with work and gym patterns. Woman retired.	603	60	21	2
H5	2	50s	Both work in the city. Objects sharing data with water company.	1045	60	65	3
H6	2	50s	Woman leaves home in the morning to work.	704	60	50	6

[a]Only one person's showers were recorded.

3.4 Deployment and Data Collection

Each candidate participant household received an initial in-home visit during which the shower kit was installed and tested, and the installation documented after gaining informed consent. During the installation we asked participants to select two or three products to place and keep on the scale (more would not fit). We briefed them on the kinds of data that the system would collect and that the data would only be stored locally on the Raspberry Pi. Participants were told that they could actively disable logging at any time by unplugging the Raspberry Pi. Figure 1e shows a typical installation, with the in-line sensor connected to the shower outlet, and a selection of products placed on the scale. Participants were told that after 7 days, we would visit them again, remove the shower kit and conduct a contextual interview by showing visualisations of the recorded data, and discussing the data with the members of the household. The final interview would typically last between 40-50 minutes.

The semi-structured interview combined a review of the shower data from the previous 7 days, with a researcher prompting a collaborative sense-making activity between the participants in the household around the data. The goal for the interview was to capture the participants' reasoning around underlying patterns, explanations and ideas by way of inviting rich description of the data. A single laptop was connected to the Raspberry Pi to display the collected shower data, as shown in Figure 2, and collectively participants and researcher navigated through it, moving from the aggregated household level to more detailed inspection of data from individual showers. The interview followed three main phases: I) scenario introduction, II) household-level view, III) selected shower-level view. Table 2 shows the key questions covered within each phase of the interview. The table provides an overview of the general questions asked in every household (follow-on questions customary in a semi-structured interview were asked when appropriate). Moreover, Figure 2 depicts the data dashboard presented in phase II (see Figure 2a) and III (see Figure 2b,c) of the interview. Throughout the interview the researcher prompted the participants to explore the data but also to actively attempt to make sense of it and to provide explanations. In this way the researcher and participants collaboratively made sense of the data; and this activity itself is the subject of our analysis to understand how this sense-making was practically achieved in-situ.

Table 2. Key questions covered in each phase of the interview.

Interview Phase	Interview Questions
I) Scenario introduction Participants are introduced to the scenarios (see section 3.2).	"What's your initial reaction to the scenarios?" "Would you agree with them using your data in that way? If not, why not?"
II) Household-level view Participants shown overview screen with showers taken in the week including aggregate total and average shower duration and water usage (see Figure 2a).	"Is there anything that catches your eye here?" "Can you spot your own showers?" "How does your shower time and duration relate to your household's routine?" "Can you read the difference between your weekday and weekend routines?" "Would you be fine with sharing this information with your water company? "
III) Shower-level view Participants select individual shower instances to look at in more detail, navigating to the detail view showing water flow, temperature, scale, and shower head movements (see Figure 2b,c).	"Which one of these showers would you like to look at in more detail, and why?" "Does this data reveal anything about how you actually organise getting into the shower and activities you perform in the shower? If so, where?" "How do you feel about seeing each other's data?" "Would you be happy to share this data with others, third party companies?" "Which graphs do you think are most revealing?" "What about when you combine this with other data?"

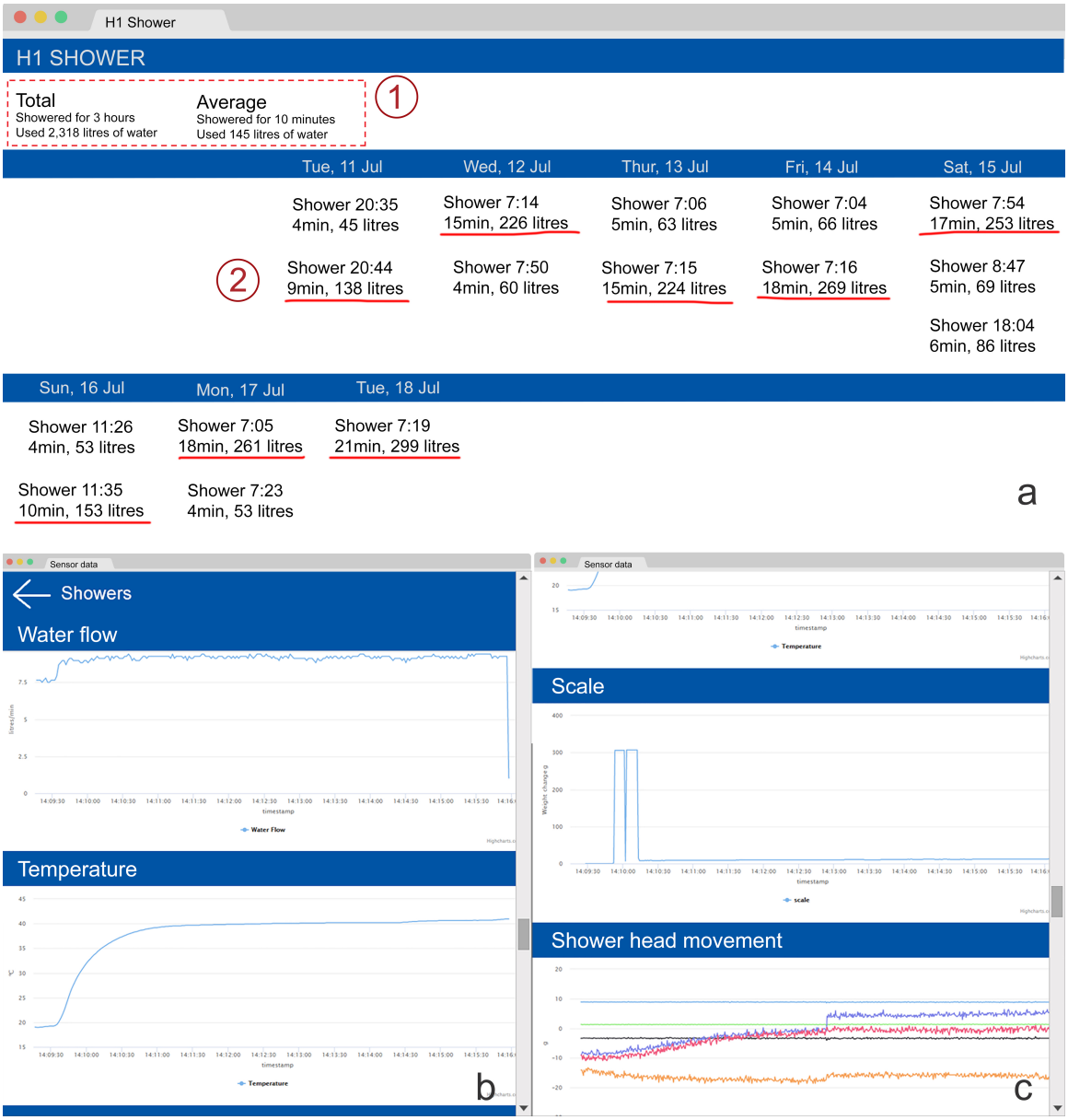

Fig. 2. Screen view of the data used in the interview. **a) Household-level view.** ① total and average water consumption and duration. ② individual showers by day, showing start time and duration, and volume of water used. Annotations show whose shower it was, as identified by participants in the interview (H1.F's showers are underlined). **b,c) Shower-level view.** Revealed when clicking on an individual shower above. (Redrawn to enhance readability.)

3.5 Data Analysis

After conducting the field-study each of the interviews was fully transcribed (approximately 237 minutes in total). We then conducted a data-driven thematic analysis [8] of the transcriptions. A single researcher performed an affinity analysis [5] to identify recurrent themes. These themes were iteratively refined in several collaborative data sessions involving the authors, with the second and third authors acting as critical reviewers of the themes suggested by the first author. The analysis yielded the three key themes as presented in the following section.

4 UNDERSTANDING INTIMATE DATA

Here we thematically unpack the data from the collaborative sense-making activity in which we engaged the participants in a review of their intimate data; interleaved with interview questions (as described in section 3.4).

Participants had a varied range of shower use, ranging from 2 to 10 minutes on average, each consuming between 21 to 145 litres on average. The four right columns in Table 1 show the water usage and duration of the shower for each household over the week-long deployment. In the interview, each household was only able to see their own data. In the following sections, we will unpack the sense-making interview in detail to illustrate how this potentially 'intimate data' is oriented to as a mundane feature of householders' everyday life including work and gym routines and other priorities, but also how certain usage and sharing scenarios can alter the sensibilities associated with the data in unexpected ways. In what follows, we will exhibit how people make sense of intimate data by orientation to daily practices and priorities; how the data makes details of showering practices accountable to their co-habiting partner; and how certain data usage and sharing contexts configure people's views on privacy and sharing their intimate data with third parties outside of the home. To illustrate the themes we draw on quotes, to which we add relevant contextual detail in parentheses, and clarifying comments in brackets.

4.1 Intimate Data and Everyday Practice

When presented with the household-level view (see Figure 2a), most participants oriented to the date and time of the shower as an 'index' of their daily routines with ease; they were quickly able to locate their shower within activities such as waking up, having breakfast, getting ready, and leaving for work. Interestingly, households whose total consumption was above the average (approx. 600 Litres), albeit this was not revealed at the time of the interview, frequently commented upon seeing the number of litres they used. For example, H5.M responds upon seeing their overall consumption in the week (1045 Litres):

H5.M:*That's a lot! (pause) But it doesn't worry me or concern me. If I want to use less I'll put smaller shower.*

After his unprompted judgement ("that's a lot!") followed by a few seconds-long pause (pauses frequently index trouble in interaction), the potential trouble is quickly brushed aside with the statement that if it was a problem he could address it by installing a less powerful, and therefore more water conserving shower.

This lack of concern is in line with prior studies that have found that people pay little attention to the running cost of everyday utilities (e.g. water and electricity) [42], and consumer products such as shampoo and conditioner [31]. We found such tendencies frequently coincided with an orientation to showering as a reward for getting through the day, a sort of leisure activity. For those people, although the data revealed the exact amount of water that they are paying for, neither bill nor water usage outweighed their pleasure in showering. The following fragment shows the researcher asking H1.F, who used the most amount of water in our study about her consumption:

Researcher: *If you thought it was a lot would you make your shower any shorter?*
H1.M: *It's not relevant to me… Emily? (pointing at her maximum usage, 299 litres) 300 litres, you gonna shower for less?* **H1.F:** *No.*

H1.F makes it clear that she refuses to reduce her shower time, despite what seems to be oriented to by the co-participants as high usage. As the interview continued to unpack her water consumption, we asked her opinion about sharing her data by referring to the first scenario. In turn she offered the following account of how she values her daily shower.

Researcher: *Would you be happy with Severn Trent [UK water company] having this [household-level] information?*
H1.F: *I don't care about sharing data but I don't want to be punished for my long showers. That's my happiest moment in the daytime.*

Her follow-up makes it clear that she attaches considerable hedonic value to her showers; she recognised that this data could be used in potentially problematic ways to "punish" her, to the extent that she would not happily share her data if it could be used in that manner.

Interestingly, we found that people tend to downplay the amount of their own water consumption. This was expressed for example by H2's participants when comparing themselves with their acquaintances. Having read the scenarios, the couple in H2 claimed that they were concerned about water and energy conservation and talked to their friends who time their showers on the water meter.

H2.F: *Interesting for me, because talking about my friends shower... four-minutes, mine isn't* ***that*** *[our emphasis] long. Just couple of minutes longer. So that's alright. [Her showers are 6mins, 5mins, 7mins] I'm nearly there. 6 minutes, that's not too bad?*

H2.F here can be seen to attempt to align herself with a potentially socially acceptable level of consumption, which by virtue of their friends' diligence should have been achieved. We noticed that, participants who are concerned to see their water consumption rate at a socially acceptable level tend to estimate that their own consumption is probably average or near-average.

Furthermore, contesting the partner's account of what went on was a frequent feature of the sense-making activity. The following vignette shows that the couple in H4 contesting each other's water use, accompanied by pointing out the contested data points in each other's showers (Figure 3).

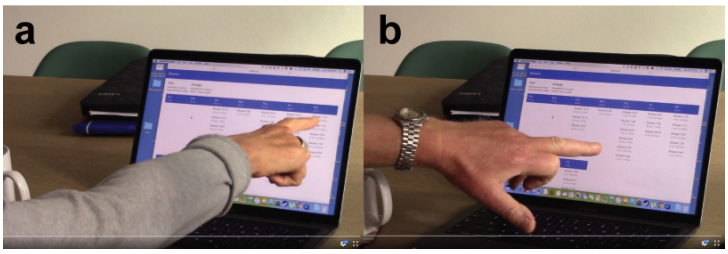

Fig. 3. (a) H4.F pointing at H4.M's shower data, (b) vice versa.

H4.F: *That's interesting, because that's you, the early morning one (pointing at the morning showers, see Figure 3a). 30 liters one day 21 liters the other. But that's both four minutes. You used more water in same amount of time.*
H4.M: *Didn't turn it up as much.*
H4.F: *Ah, it's interesting isn't it? Look, you used 34 litres on Friday morning and yet, you were showering for the same amount of time [four minutes].*
H4.M: *But you showered for two minutes and crack through 25 litres.*
H4.F: *(Shouting) where, where?*
H4.M: *Thursday (pointing, Figure 3b) that's you. I'm at work already.*
H4.F: *Um.. Yeah, but.. (laughs), that was me on Thursday, you are right.*

H4.M accounts for the differing amounts of water usage despite showering for the "same amount of time" by bringing to bear the mechanical operation of the valve ("didn't turn it up as much"), but in turn retorts by pointing out that she "cracked through 25 litres in two minutes" and that it would have to have been her as he was at "work already". The sense-making here then is not just indexing the couple's daily routine, but the apportioning work being done here (i.e., who's shower was the uneconomical one?) is wrapped up in friendly banter between a couple, who share a laugh and a joke.

In the interview, we also prompted participants to reflect on specific routines that might have a bearing on their daily shower practice.

Researcher: *Do you go to the gym on particular days?*
H4.F: *If I'm in the normal routine, I'm going on Monday, Wednesday and Friday. (...) But last week was Mon, Wed, Fri. I know what I do, like this morning. Can you see, 9.50 and 9.55. I showered, put on my moisturizer, came out, pottered around went back in and showered it off. So, that's me going in twice.*
H4.M: *22 litres. What is normal for the shower's use though? Sounds like a lot of water but I don't know...*
H4.F: *That's me on Thursday morning again, because I didn't go to the gym.*

Data became intelligible to participants as they remember the network of practices that accountably embeds the showering activity. Like H4.F did while she was indexically making sense of the data, participants often unpacked their practices in detail, such as the sequential order of activities that comprise overall grooming routines in which showering may be embedded, including other activities they do in between applying products to the body. Although participants make sense of the data in relation to the lived practices embedding the showering, participants did also remark on the numerical nature of the data.

Researcher: *Is it interesting to you just to see how you handle?*
H4.F: *Yeah, it's interesting to see litres because you don't think showers in litres do you? And I would never begin to be able to guess how many litres you get through.*
H4.M: *I was surprised to see this actually.*

What is noteworthy here is that H4.F is making explicit that perhaps counter-intuitively showers are not thought about in terms of litres of water consumption, and that the seeing of this makes for a 'surprise'; but quite to the contrary we would contest that this orientation that highlights numbers as the remarkable feature makes a lot of sense; it echoes prior work that highlights people do not think about household consumption as rational actors, but as part of everyday practices bound up with social, cultural and normative values (cf., [48]). As the interview went on to work through the individual sensor graphs, thus showing finer grained data, households make sense of the data (graphs) in multiple ways. The following fragment shows how H1 draws on their experience and knowledge about the water-consuming appliances in their house when making sense of an unusual blip in a flow rate graph in one of H1's showers (see Figure 4).

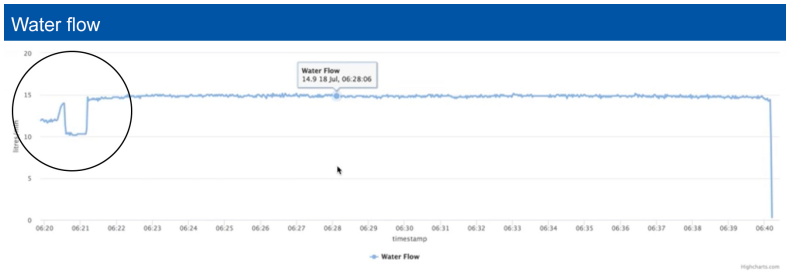

Fig. 4. An unusual blip in the flow rate of H1.F's shower graph.

H1.M: *I'm guessing you've been to the toilet and the water pressure has dropped and the…*
H1.F: *Could be, yeah.*
H1.M: *If you flush the toilet then the water pressure drops.*

As is frequently the case with data work, the couple here are drawing on common sense knowledge and technical knowledge in their interpretation of sensor data (cf. [18]). What the data has shown so far then, is that just as other forms of household consumption, showering is oriented to as an everyday practice, and sensor data recorded in the shower serves to index that practice in unremarkable, mundane ways.

4.2 The Social Accountability of Intimate Data

The attentive reader will already have noticed that the data presented in the previous section frequently speaks to the social accountability of the 'intimate data'. This section takes a closer look at this pervasive feature in our dataset, providing insights into the social embeddedness of sense-making among the co-habiting couples. H1 was the household with the highest volume of water consumption in our study (cf. Table 1). In the following vignette, consider how they account for their domestic water consumption. (They are looking at the household-level overview).

H1.M: *It's quite obvious whose shower is whose. Because mine's about a third of the time of yours… if not a quarter, and it surprised me how many litres.*
H1.F: *Yeah you don't want to see litres do you?*
H1.M: *No, I mean 300 litres.*
H1.F: *Shh, don't say it out loud.*
H1.M:*(Looking at his partner's showers throughout the week.) 21 minutes, I mean, I don't think it's a lot necessarily. I think it's in line, isn't it? 18 minutes is 269 litres, 21 minutes is... It's just a long shower that's all.*

Initially, H1.M voices his surprise to see the volume of water his partner used, which is reciprocated by her comment "don't say it out loud", but then he moves to account for her use as "in line", and "it's just a long shower that's all", effectively normalising the consumption. Later, after the data revealed that H1.F's water usage was much higher than her partner's, she accounts for her consumption by pointing out that she spends all of her bathroom time in the shower, and lists the activities she does in the shower. Often, participants invoke similar details to legitimate consumption. Throughout the interview, we came across the situation when the participants are held to account to make their data legible to others by articulating the details of actions.

As a family, there are a certain degree of the shared responsibility (e.g. on bills) which may shape the determination of what is an appropriate level of consumption. The scale graph afforded reading the position, duration, and amount of product use. This was oriented to as a further resource to account for showering practices. For example, H4.F remarks about her partner's product usage when reading his scale graph. *"I have to say I am quite concerned that you have to use that much shampoo when you haven't got any hair."* Again, there is of course a playful element of 'banter' here rather than a serious charge, but it demonstrates that the graph is read to call to account what is perceived as unusual product usage. Consider the following, in which H4 discuss the observation that H4.F spends more time with the water running before she uses the first product (see Figure 5).

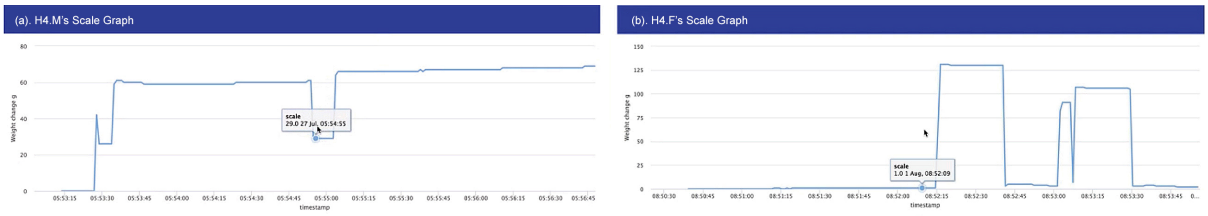

Fig. 5. (a) H4.M already uses product after 45 secs, (b) H4.F takes about one minute longer before product use.

H4.F: *You are in a hurry aren't you?* **H4.M:** *Yeah*
H4.F:*You see, I'm leisurely showering, whereas you're going to work. It will be very different if I was going to work. Because I will be lot more focused, I know that. I haven't got time pressure. You know you've got time pressure. (Pause) It does make the difference. And often, I might turn it on and then "Oh, I forgot to do something" and I leave...* **H4.M:** *Leave it running?*
H4.F: *Yeah, well, I did. I might do something and then I would come back at the right temperature, so you're not waiting but get straight back in.*

The differences in the graphs for the couple are accountable, and they are accounted for by H4.F by reasoning why her shower is longer ("I'm leisurely showering, whereas you're going to work"). She then furthermore accounts for a practice that may have been the cause of the lag before product use; turning the water on and then realising she "forgot to do something", which she then goes away and does, with the water running.

The above vignette shows how H4.F is accounting for her shower practices, which H4.M was apparently unaware of before this interview. In the setting where members view each other's intimate data for the first time, the data makes participants accountable for the actions that produced the data in the first place, and thereby make the data intelligible to their partners. Thus, while the fine grained sensor data helped householders to examine the details of situated actions that caused water waste, they also made the intimate practices that produced them accountable to one another.

Furthermore, the sensor data was not only oriented to in order to requests accounts of product and water use, but also to disclose intimate practices that they have ostensibly not necessarily discussed before. While looking into the individual shower data in H6, a patterns was identified as 'odd' which was recurring in H6.M's data, which prompted the following exchange.

H6.M: *(Explains his two-pronged product usage shown in the scale graph in Figure 2c)*
Researcher: *So you do that right in the beginning of the shower. So, you put it on the sponge, then have about 6 minutes.*
H6.M: *I might possibly done it, because it's when the shower wasn't quite hot enough to stand under.*
H6.F: *You took a long time there... (pointing at the tail of the scale graph in Figure 2c)*
H6.M: *(Overtalking) Alright, alright. I know my lesson now.*

Here we note that, as H6.F starts to read her partner's data, she is unconvinced by his account for the long time he spends in the shower by reference to the shower's heat up time. She remarks that he "took a long time there". In response, he cuts her off, silencing her by saying he has learnt his lesson. The sense of awkwardness is resolved by her laughing it off in response, perhaps realising that a detailed account would be embarrassing her partner. An account for the long duration of water use after the use of the product then, is not provided, but successfully avoided. One gets the sense here that the accountability of shower practice explicating the data was perhaps too intimate and uncomfortable too bring up in the interview setting.

What we aimed to demonstrate in this section is how the sense-making of intimate data is bound up with and accountable to the social order of the couples' relationships. The accountability of the intimate data turns upon details of shower practices, many of which are mundane, some of which are resources for humour, but others may be too intimate to openly account for in a research study interview.

4.3 Sharing Intimate Data

Our study also aimed at examining householders' views on sharing the IoT sensor data collected from everyday intimate activities in the shower. As we have seen in the previous sections, the accountability of the data prompted articulation work between the households in which accounts of intimate shower practices and their routines were provided. Routines articulate large or primary patterns of action [11], which we have seen to be drawn upon to frame the articulation of the intimate data in our study. What the analysis so far has revealed is that sensor

data is not intimate per se, but it gets its intimate connotations by articulation of shower practices in certain ways. In this section, we pay closer attention to how this reasoning on intimate data is shaped by considerations of who the data is shared with.

Consider the following vignette from H3. When looking at the household-level view, H3.M is immediately able to identify his showers. (Until this point, no one had realised that the system only recorded H3.M's data, since H3.F used the overhead rain shower, which was unmonitored.)

> **H3.M:** *I think they are mine, the first ones. More or less, at exactly the same time, most days. I notice my shower times are no more than four minutes according to this.*

By correlating the times of the showers with his work schedule H3.M is able to recognise the showers as his in a straightforward manner. Also note that M3.M discovers the pattern in the data himself, as being "more or less, at exactly the same time, most days", and the shower time being no more than four minutes. There is a strong sense of a routinised pattern here, the showers occurring at nearly the same time each day, and being of near-equal duration. Later on, the interview turned to discussing the future scenarios; to recap, one of the scenarios introduced the idea of personalised products based on detailed data about product use gauged by combining various data sources including the scale and the shower head data. The other scenario that's relevant here is the one that proposed smart scheduling of showers with time-of-use pricing based on the householder's showering schedule. Here's what H3.M has to say:

> **H3.M:** *Not bothered about personalised product scenario. Smart scheduling seems sort of controlling, telling you bit of the routine. (…) Depends if you like routine. I don't like routine. It feels a bit military to me.*

Provided that, as we have seen, H3.M's data by his own admission shows off his routinised shower pattern clearly, the rejection of the scenario that makes use of this information to schedule is perhaps unsurprising. Notable however is that he is 'not bothered' by the personalised product scenario, which is reliant on more detailed and thus, or so one might assume, more intimate data. This initially counter-intuitive finding goes to show that what data is and is not 'too intimate' to share is not predetermined, nor a direct property of the data, but one that receives meaning through situated sense-making. H3 couple's following reasoning on H3.M's routine is insightful in that regard:

> **H3.M:** *You are in bed until I go to work, aren't you? With me, I have my breakfast and everything, then have shower about 6 o'clock.*
>
> **H3.F:** *People could probably read routines if they know about his work.*
>
> **H3.M:** *Nothing happening before work… This makes me uncomfortable actually, I don't know... you don't want to be readable all the time, do you? There's definitely a pattern.*

In articulating his morning routine as consisting of breakfast, showering, and going to work, H3.F suggests that if H3.M's shower data is shared with details about his occupation, a third party "could probably read [his] routines". H3.M in turn expresses his discontent with the idea of sharing the data, that he would be "readable all the time" given their insight that there's a clear regularised pattern to his data.

On the issue of legibility of routines in the data, for H3.M it was the regularity of the time stamps of his shower that was sufficient to mark out the sequences of routines such as, 'at home', 'out for work'. In other cases, the sensor data such as scale graph and the shower head movement were seen to reveal distinctive profiles. As one of our participants noted, *"the data is just another form of a fingerprint"*.

When moving on to review finer-grained data in the interview, we asked participants' opinion about sharing the data, both with third party companies and within their home. Interestingly, and conversely to our expectations, with the exception of H5, participants rarely cared about sharing data with third parties. H5.M had held exceptionally strong objections about data sharing. At the basis of his reluctance, there was skepticism that the companies might attempt to use the data to control their behaviour to make more money, for example through Time-of-Day pricing.

H5.M: *I wouldn't have a smart meter either.*
Researcher: *That's interesting. Why?*
H5.M: *They might control you in a way that you use the products, I want the freedom to use them. If I want to save money then I'll manage it, I don't need them to manage our lifestyle.*

H5.M was concerned that the service provider might attempt to control his lifestyle if the data was shared with them. There was a sense in which, having ownership of the data is to maintain the freedom to manage their own lifestyle. Moreover, ownership implied other concerns such as, permission and appropriateness in the use of data. For example, H1.M stated that, although he is not objecting to data sharing per se, he would require information on what types of data the water company needs and for what purpose. While he was initially not keen to give his data away, he became more relaxed by the end of the interview as he thought the data will not be comprehensible to third party companies and hence, useless.

In our study, there was a sense that the sensibility of the data turns upon the householders' articulation of the data. Subtle changes in the sensor data were seen as meaningless unless articulated by themselves. Thus, the level of abstraction the data provides might in some sense be seen to sufficiently abstract away the details of intimate practices which are too sensitive to share. That sentiment seemed to be frequently alluded to when saying there was no reason 'not to share' the data with third parties - *"what would they do with it?"*. For others, a clear incentive to share the data was important:

H3.M: *If they offer 20 pounds off, I'm happy with that [installing the shower system]. Would accept for a tenner but not for a fiver.*
H3.F: *If it saves you anything it would be worth it...*

H3.M's statement suggests that they would trade-off their data for a discount on their bills, that discount would have to be worth it, H3.F is less strict in adding that any savings would make it worthwhile. Another important factor mediating acceptance of data sharing was transparency of how and when the data is being collected by the sensors in situ.

Researcher: *Does it feel invasive at all, they knowing exactly how much you are using on what?*
H2.F: *I think it depends on the equipment they use to monitor it. Although we've got used to this, to have this is not intrusive, you recognise that it's there.*

H2.F's view on whether the monitoring feels invasive turns upon a judgment of the monitoring equipment. Our shower kit was installed by attaching onto the household's shower facilities, and, for H2.F, the recognition of the kit as 'being there' meant it was not seen as intrusive. However, we are not suggesting that this generalises to any monitoring equipment; the judgment of the use context is multifaceted. However, providing a clear visual cue on its presence and whether or not it is recording (e.g., the sensors were visibly flashing LEDs when collecting data) is probably a good practice. H2.F's view suggests that clear visibility of the IoT system and its sensitive operation could be an important design element for making the user aware of its status when using IoT in their private space.

Sharing the data with their partner was not generally regarded as a concern, and sometimes even seen as something interesting (**H3.F:** *Seeing each other's data is fine, It's interesting to see what he is like.*). However, the view on data sharing was contingent on the mode by which the data was shared. Being able to monitor the data remotely and in real time, even within the family, was a matter of concern in terms of privacy. Consider how H6.F puts it in the following vignette.

Researcher: *How about if this information was available on a mobile phone so you can view it. Do you think it will impact on… For instance, who's gonna surprise one another when you are home, that sort of ...?*
H6.F: *No, that's scary no.*
Researcher: *So you wouldn't want that system because of that?*

H6.F: *It's like stalking a little bit isn't it? Don't you think? "Oh, I know she's at home now, or I know he is at home now." No, that's too much big brother. You can track where each other is. I don't think that's right at all.*

The idea here that data could be accessed remotely in real time, even by her partner, is seen as "scary, stalking, and big brother". This was notable because, even those people who agreed with sharing data with third party companies did not want to share their data with their partners in real time, in a remotely accessible way. Nonetheless, overall the householders found sharing their shower data acceptable. Data sharing was frequently being referred to as something normal, something people are used to from other contexts. Consider H4.F's explanation about changes in her perception of privacy.

H4.F: *I'm less paranoid... every time we use a credit card, every time we go to the supermarket, there's already a terrific amount of data. Probably far more than we realise... It's out there anyway. If there's something I might find useful, yeah! [agreeing with sharing data]*

Data sharing then, is seen as something that is "out there anyway", familiar from using services such as electronic payment systems and supermarket loyalty programs. However, conditions warranting the monitoring do still apply, i.e., in this case it still has to be seen to be "useful".

In general, there was a sense that if an individual's data is being anonymised and processed in bulk, people did not show much concern about privacy, nor did they express concerns that the intimate data was too sensitive to share. However, when scenarios conveyed an impression that they can be monitored remotely and in real-time whilst being unawares (e.g., via a mobile phone app), the system was regarded as unacceptable even if the monitoring was restricted to their partner.

Overall, views on sharing the data were contingent on the kind of information that could be gleaned from the data, rather than with whom the data was shared per se. Sharing 'intimate data' then, is not necessarily sensitive, 'perceived' sensitivity of data is not a stable property, but bound up with judgments of what can be read from the data, by whom, and for what potential purposes.

5 DISCUSSION

Herein we discuss our findings more broadly, drawing on the pertinent literature and reflecting on designing for intimate practices. In the previous section we have seen how our findings are unpacked to answer our original research questions, a) how intimate data is made sense of by accounting for the social order of showering practices within mundane, everyday practices; b) how the data makes details of the shower practices socially accountable to their co-present partners; c) how people reason about sharing intimate data both with third parties as well as with their partners.

These findings have emerged from the data work conducted by the participants with the researcher during the contextual interview. Data work has a retrospective character, in that the meaning of the data turns upon how participants articulate the data, and themselves make it accountable to the routines of domestic life, and daily patterns of showering. Thus, our findings mirror the lessons learned from ethnographic observation of data work around domestic energy consumption conducted by Fischer et al. [18, 19].

However, in comparison with data-related studies conducted in UbiComp and HCI, we focus on what purports to be one of the most intimate activities that we conduct on a daily basis. Here we draw lessons from our findings that expand from views on individual water consumption and expectations as to how people account for data within the household, to concerns around broader sharing of data generated from intimate practices. In this section, we now reflect on the lessons learned and the design challenges highlighted by the technology probe.

5.1 Intimate Data is not Sensitive Per Se

Sensor data from daily activities is contingent upon the social organization of the householder's routine, and might be used as a pattern for designing systems for domestic environments [40]. Fischer et al. argued that such

patterns are unable to simply be read-off, and that data is merely indexical to the practices that produced it, and therefore must be articulated to be made sense of [19].

We presumed that the intimate nature of the data would be particularly challenging, since the shower might be a highly private, and yet unremarkably mundane scenario probably not talked over in detail even between couples. However, our findings reveal that participants had little trouble in retrospectively making sense of the data. The time and duration of the shower was often sufficient to index the larger organisation of everyday life including grooming practices, showering routines, product use, house chores, gym routines etc. The offered explanations were often surprisingly detailed in terms of the procedures and actions involved. Interestingly, the intelligibility of the intimate data made for some enjoyable and humorous exchanges for participants of the same household, in terms of their own intimate data as well as one another's habitual actions. This might serve as a 'motivational mechanism' in the design of a meaningful user experience for the intimate IoT [17].

What did generate sensitivity was not the accounts of the intimate practices that produced the data, but the collaborative talk in the interview that invoked the broader accountability of actions. While articulating their data, participants were able to understand which activities and habits were accountable for the water usage that directly affected their bill. Householders share responsibility for the broader domestic economy, and as such requested their partner to account for the data that seemingly evidenced a habitual wasting of water or products. This seemingly induced a subtle sensitivity in the 'guilty' participant or participants. The data prompted the householders to account specifically for wasteful practices, which led to either justification of actions ("You used more water" "but I didn't turn it up as much"), or hasty glossing over of the data ("Alright, alright, I know my lesson now").

Our contextual interview involved a collaborative sense-making activity to closely examine observational data about participants' actions and displayed situated reasoning through talk. The need to retrospectively account for details of the intimate practices that produced the data might have engendered awkwardness or discomfort in the dialogue. However, such discomfort was not simply a property of the intimate data; rather, the sensitivity emerged from the accountability of the intimate data in situ: sensitivity was bound up with the level of detail in the accounts of the intimate practice offered, or avoided in turn, within the discussion with the researcher and their co-present partner. The fine-grained behaviours in the shower that could be guessed or read from the shower head movement or the scale data were not problematic per se; rather, when the daily routine becomes perceived as being readable by unspecified "others" even without additional accounts of the practices that produced the data, it was felt to be uncomfortable.

5.2 Trust and Data-Driven Systems

Personal data has become a valuable, if not necessary, asset in the design of UbiComp enabled services and products, and this has resulted in users expressing very real concerns around issues such as privacy, security, and trust [33]. In recent years, privacy has been a critical design element for interactive systems in potentially intimate domains such as health and sexual wellbeing [1, 55], or domestic environments [12]. However, expectations of privacy are not fixed [29] and change with the rapid development of systems underpinning end-user services. In our study, we have seen how the degree of user awareness and acceptance of these personalised services changes in regard to privacy issues, to quote one of our participants: "Every time we use a credit card, every time we go to the supermarket, there's already a terrific amount of data. It's out there, anyway".

The privacy, legal, and ethical consequences regarding data collection are (allegedly) widely understood by our participants, who have already adapted to a range of online services that require their personal data. Our study shows that potential users of new IoT systems now have a degree of understanding around the collection of data and its uses. However, transferring privacy policies from one domain to another domain may not be straightforward, i.e. what can really be transferred from the financial domain to the domain of intimate practices?

It will still be necessary to consider ethical values on a case-by-case basis, to design appropriate technology (cf. [56]), and to take into account its (potential) role within the social fabric of the home.

Our participants were concerned about the utility companies that might seek to exploit their data due to a scepticism around incentives that the companies might pay for the data. There was a distinct lack of trust between the utility providers and customers in terms of service plans derived from aggregated data. Households suspected that, akin to energy providers, water companies might use detailed data to steer their patterns of using the shower by changing service plans, or charge customers a higher tariff. As our participants remarked, if the companies provided sufficient information about the reasons behind data collection, how the data had been analysed and how it had been actioned, they might be less dubious around offers and subsequent advertisement. As with any other data driven system, energy and water providers who would wish to convince their customers of the benefits of using IoT utility devices should work to ensure that the system is suitably transparent, and the algorithms suitably accountable.

5.3 Designing a Shower for the Future

In this section, we further consider implications for the design of future IoT shower products and systems. Here we might envisage a water-poor future in which technologies to support demand-side management of water, or indeed attempt to nudge or persuade users towards less wasteful habits are common place. We also consider implications for the broader design space of intimate IoT technologies.

Prominent Awareness of Data Capture. Interaction and product designs are increasingly encountering a new challenge in designing IoT devices and similarly networked products, in which the interfaces increasingly become minimalised if not invisible. Following Mark Weiser's seminal article [54], the UbiComp vision has influenced the design of smart products to such a degree that interfaces become seamless, unremarkable [51], and even disappearing, delivered only through gesture, proximity and voice. Our shower kit shows that for IoT devices that operate automatically at the user's periphery (e.g., starting to record data when turning on the shower), the invisibility of the interface should be reconsidered regarding the location and context in which the product is being installed. Displaying the status of the device, whether it is collecting data, paused or powered off and so forth, would reduce user anxiety when performing activities that would be of concern if captured. For example, a participant in our study noted that the flashing light from the sensor board differs when capturing and not capturing. When she was using the bathroom but not the shower, she could reason and was reassured that the sensing device existed but was not recognising her presence. IoT devices for intimate settings such as the bathroom might require ambient interfaces that provide the user explicit feedback at-a-glance as to whether they are capturing data or not, rather than discretely activating the system on the user's behalf. Moreover, this might prompt the user to reflect that they might be subsequently called to account for the data captured.

Warranting IoT Systems for Intimate Practices. Given the potential sensitivity of intimate data and the broader domain of IoT systems for intimate practices, it appears particularly pertinent that the use of these systems is warranted from the users' point of view. Our study showed that the nature of the sharing scenarios strongly mediated people's views on sharing, including factors such as mode of access (e.g., real-time, remote), granularity of the data, anonymity, and purpose. Thus it is critical that the perceived benefit of an IoT system outweighs the risks associated with sharing the data.

One potential way to increase the benefits for householders is to design smart shower systems that fit in with the householders' values underlying everyday practices, such as cleanliness and comfort [47]; in line with most people's main reasons for having a daily shower. Previous design and studies of eco-feedback systems have emphasised energy and water conservation from a resource management angle[17, 22, 34]. Strengers has pointed out that this framing can be problematic as it views householders as rational decision makers, and ignores the underlying normative, social, and cultural drivers of everyday practices [48]. Similarly, our participants were not

motivated to change their showering practices as a result of seeing the number of litres of water they consumed. However, those who reportedly showered for pleasure used significantly more water than those who showered for primarily pragmatic reasons (cleaning and grooming).

Thus, if a smart shower is to incentivise the conservation of water (and our participants have unsurprisingly responded positively to monetary savings as a potential benefit to sharing the data), its design needs to take seriously the motivations for why people shower, and build this into the design in order to create an IoT system that is warranted. A starting point could be for the shower system to learn the patterns of what type of shower the householders prefer (e.g. quick power shower in the morning, relaxing shower in the evening). This information could then be used in a demand-side management system that seeks to balance load across the water network, to reward when the user showers as expected through learning, or other personal preferences relating to temperature or water flow in order to achieve more sustainable water management.

5.4 Limitations

While our study has generated useful insights and design implications on intimate data collecting systems, it has several limitations. First, the field study only lasted one week for each household. While we believe longer-term use could have provided more insights, we were constrained by the limited battery life of our prototypes and concerned about the durability of the bespoke electronics located in a wet and humid environment for a longer duration. Second, the interviewer's presence probably had an effect on the collaborative sense-making of the intimate data. There were some instances that participants glossed over the accounts explicating their data or skirting around questions during the interview. However, limitations around interviewing are an unavoidable feature of an ethical, non-covert research practice to which we are committed.

6 CONCLUSION

In this paper, we presented the design and a field study of the Connected Shower, which consists of various sensors that capture water use, temperature, flow, shower head movement, and product weight. We presented findings from week-long deployments of the Connected Shower in six households in the UK and subsequent contextual interviews including a collaborative sense-making activity with the co-habiting couples. Our findings unpack how intimate data is made sense of a) by referencing the social order of showering practices embedded in everyday routines; b) by requesting and producing accounts of the details of the shower practices to the interviewer and their co-present partners; and the findings reveal c) how people reason about the sharing of their intimate data contingent on different sharing scenarios presented to them. Working on the premise of prior studies of data work, it is in and through the participants' articulation of their domestic rhythms and routines and potential wider usage scenarios by which intimate data is made sense of.

We discussed our findings to show that intimate data is not intimate per se, nor is intimacy a property of the data, but is an interactional outcome. This outcome is contingent upon with the articulation work to account for the practices that produced the data to their co-present partners. It is also contingent on a multitude of factors governing the potential sharing scenarios presented. Thus, judgments whether the data is too sensitive, private, or intimate to share depend on situated sense-making and is therefore changeable; however, there was a general consensus that sharing intimate data with service providers was acceptable if the data was sufficiently abstract and anonymised. We considered challenges in designing trustworthy data-driven IoT systems, and the overall challenge that the design of IoT systems for intimate practices needs to be warranted to be acceptable and adopted into people's intimate practices.

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