iasdr 2021 [WITH DESIGN]

PolyU Design
School of Design
The Hong Kong Polytechnic University
5–9 December 2021

User Perspectives on the Acceptability of Realtime Data Capture for Design Research by Connected Products

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Connected products present new opportunities for conducting in-the-wild design research, where live data is transmitted by devices about their use and function. However, industry data gathering practices have raised public concerns around privacy and security. Thus, we need to account for users' perspectives on how data is gathered and used. A technology provocation was used to spark discussion on the acceptability of physical devices collecting information for design research. Attitudes ranged from extreme unease to lack of concern, with varying beliefs about the trustworthiness and capability of researchers and companies. A range of real and speculative contexts prompted participants to examine value trade-offs between themselves and corporations, privacy and ethical issues, agency, and informed consent. Based on this we set out implications for carrying out data-driven design in order to unlock potential value while respecting user privacy and time.

Keywords: Acceptability; Theoretical Framework for Acceptability; Data-driven design; Design research; IoT; Smart devices; In the wild; Human-centred design; Ethics

1 Introduction

Data generated by users is rapidly becoming indispensable across industry, where it is used to drive business strategies, inform decision making and support the design of user-centred products. For digital products and services, there is a history of utilising data analytics, crash reports, and A/B testing as research tools that support design and optimisation (Drachen et al., 2013, Hunt et al., 2009, Linares-Vasquez et al., 2017). The Human Computer Interaction (HCI) community employs a number of in-the-wild research methods, which collect big and thick data, in order to develop implications for design and gain a contextually grounded view of participant behaviour (Bogers et al., 2016, Bourgeois et al., 2014). A combination of quantitative data from sensors and product functions, combined with qualitative data can inform designers how products are used. This insight is used within *data-driven product design*, which covers practices of gathering information from

connected devices used by people in the wild for generating design insight through a range of research methods in order to inform, inspire and ground the development of products (Zimmerman et al., 2007). Such insight can aid optimisation of existing products, as well as the creation of new designs to cater to observed differences between user groups.

Previous research has highlighted the value of data gathering from the wild for design research (Bogers et al., 2016, Bourgeois et al., 2014), however the public has concerns around data sharing (Klasnja et al., 2009, Prasad et al., 2012, Raij et al., 2011), collection (Apthorpe et al., 2018), and surveillance (Mattingly et al., 2019, Saha et al., 2019). This is happening against a backdrop of increased data regulation in parts of the world (Pasquier et al., 2019). In order to support the development of ethical and healthy data-driven design practices we need to account for a user perspective on the acceptability of design-led data collection, where users are the subject of investigation. User perceptions can help identify key public concerns, which can be used to enable the development of human-centred research practices.

Research has highlighted unease with data collection for purposes beyond the function of the technology (Klasnjaet al., 2009), which led us to conduct a series of interviews aiming to scope perceptions around the acceptability of using data from connected products within design research.

In this paper we present a study that analyses responses to a design provocation using the Theoretical Framework for Acceptability (TFA, Sekhon et al., 2017) to investigate how participants data gathering through connected products in terms of consent, agency, and trust. We present a thematic analysis of interviews with 20 participants. They expressed general concerns around data collection, and reflected how they differ in the context of design. The key contribution of the paper concerns the use of the data – while many studies have investigated attitudes to the use of personal data for purposes such as advertising, research on the use of data to improve product function through design is far sparser (Apthorpeet al., 2018). As such, this paper contributes current attitudes towards data driven design research, considerations for informed consent, and implications for data-driven research.

2 Background

The impact of data collection on users has been explored in a variety of contexts outside of data-driven product design. We focus on data-driven practices around connected products and pervasive surveillance, including in the context of health and well-being, where data is often gathered through physical devices. We also draw on concerns around privacy, security and ethics raised within the context of data gathering, and how they translate into emerging data regulation.

2.1 In-the-Wild Product Data Collection & Design Research

Industry data collection for design research is common within digital services. It includes A/B testing, analytics, and crash reports (Drachen et al., 2013, Hunt et al., 2009, Linares-Vasquez et al., 2017). Insights are fed into subsequent software updates and algorithms that create personalised online experiences (Drachen et al., 2013, Hunt et al., 2009,Smith and Linden, 2017). This use of data for design research is less widely discussed in the context of physical products, although there are examples such as the Hövding bicycle helmet that uses data gathering from staged accidents and by monitoring cyclists, in order to increase its safety and accuracy (Abrahams).

In contrast academic HCI research methods that collect data from products in the wild are common, they include thing ethnography (Chang et al., 2017, Giaccardi et al., 2016a,b), entangled ethnography (Murray-Rust et al., 2019),research products (Odom et al., 2016), technology probes (Hutchinson et al., 2003), and experience sampling (van Berkelet al., 2017). These methods are used to unravel the complexities of human behaviour around products, outside of the lab environment to generate insights around baby bottles (Bogers et al., 2016), energy systems (Bourgeois et al., 2014) or Bluetooth speakers (Burnett et al., 2019, Gorkovenko et al., 2019).

2.2 User Perspectives on Data Collection, Sharing, and Surveillance

Public concern around data collection through connected devices is rising, whether the surprisingly detailed data used for targeted advertising observed by the Princeton IoT Inspector (Feather and Flatow, 2019) or the transmission of conversations to human trascribers working on Alexa (Day et al., 2019). Research into sharing of personal sensing data has identified that users weigh the benefits of sensing technology vs its perceived costs. A study on fitness data collection found is acceptable when it is necessary for the product function, but not as a continuous practice (Klasnjaet al., 2009). While there are a range of preferences people have around health data (Prasad et al., 2012), there is growing concern about inferences around "conversation, commuting, and stress"(Raij et al., 2011).

Home owners with Internet of Things (IoT) devices report that they prioritise convenience over privacy concerns and often do not understand the inferences that can be made about them from non-audio/visual data (Zheng et al., 2018). However, a lack of understanding and a willingness to accept data sharing due to convenience does not mean people find data gathering acceptable – using contextual integrity to highlight uses of IoT data, (Apthorpe et al., 2018) found that the indefinite storage of data or its use for advertising was less acceptable than for emergencies.

Temporal factors can have a large effect. The Helsinki Privacy Experiment demonstrated people initially opposed to surveillance but gradually became accustomed to it (Oulasvirta et al., 2012). The Tesserae project looked at what incentives were needed to assure the compliance and engagement of participants (Mattingly et al., 2019) as data from smartwatches, phones, beacons, and social media was ground-truthed through a daily questionnaire (Saha et al., 2019). As well as time, engagement can be a key factor, as Fischer et al. (2017) observed: by combining data logs with collaborative sense-making, energy advisors and homeowners supported each other in understanding the data gathered from sensors to create actionable knowledge.

Finally, experiential and provocative practices can help potential uses to make sense of the implications of technologies. By making data-streams physically visible, the ’Living Room of the Future’(LRoTF) project explores adaptive physically immersive media experiences, where connected products within the home react to the content users are consuming (Sailaja et al., 2019). Connecting this to the idea of personal data storage (Crabtree et al., 2018, Sailajaet al., 2019) discovered that despite the care taken around data gathering, issues around the adoption of this technology remain in terms of data legibility, privacy, agency, customisation, value trade-offs, and trust.

2.3 Data Collection: Ethics and Legislation

Data-driven product design, where products continuously collect data from users in order to gain design insight, is subject to an array of ethical issues including the potential for exploitation and infringing user privacy. It can be seen as a form of *prosumption*, where consumers are actively

engaged in the creation of the products that they consume (Ritzer and Jurgenson, 2010). While this can be seen as mutually beneficial, there is scope for ambiguity about the way that value is created and distributed. It can also be seen through the lens of surveillance capitalism where data from internet activity is used to generate profit through ads by companies, such as Facebook and Google (Zuboff, 2015, 2018). Issues remain around the blackboxing of data-collection and analysis systems (West, 2019), which can diminish user's ability to provide informed consent (Pasquier et al., 2019, Ritzer and Jurgenson, 2010).

Regulation of data collection through digital services has struggled to keep up with the advancement of technology. In Europe the General Data Protection Regulation (GDPR) act, has placed responsibility on data controllers to seek informed consent, protect personal data, and inform users of data breaches (Pasquier et al., 2019). The implementation of GDPR across Europe has been seen to influence digital services worldwide, however tracking without seeking consent is still ubiquitous (Sanchez-Rola et al., 2019). Data regulation results in the development of terms and conditions (T&C) by companies, which users often blindly accept (Böhme and Köpsell, 2010, Obar and Oeldorf-Hirsch, 2020). Nissen et al. (2019) argue that providing informed consent is becoming increasingly paradoxical due to the high complexity of information users are required to understand. Instead, they see potential for consent delegation to various trusted third parties, such as experts and friends (Nissen et al., 2019).

3 RESEARCH OVERVIEW

Twenty participants took part in an interview aimed to explore their views around the acceptability of data gathering from physical products for design research. The interview questions were developed from the Theoretical Framework for Acceptability and discussions explored a variety of connected devices and contexts of use.

3.1 Recruitment

Participants were recruited primarily in a public space hosting a free exhibition called *Data Play* that showcased a range of interactive data projects, with some additions by word-of-mouth. This allowed us to recruit members of the public (all over 18) with varying knowledge of IoT devices and data gathering. To set the context, participants interacted with a prototype IoT device and dashboard *from the Chatty Speaker project* (Figure 1, A) that demonstrated live data collection and analysis for use in data-driven product design. After interacting with the prototype, the participants were taken into a quiet room in the nearby university, where they completed an ethics procedure. They were given a £ 5 Amazon gift-card as a reward for agreeing to take part in the study.

3.2 Interview Procedure and Framing

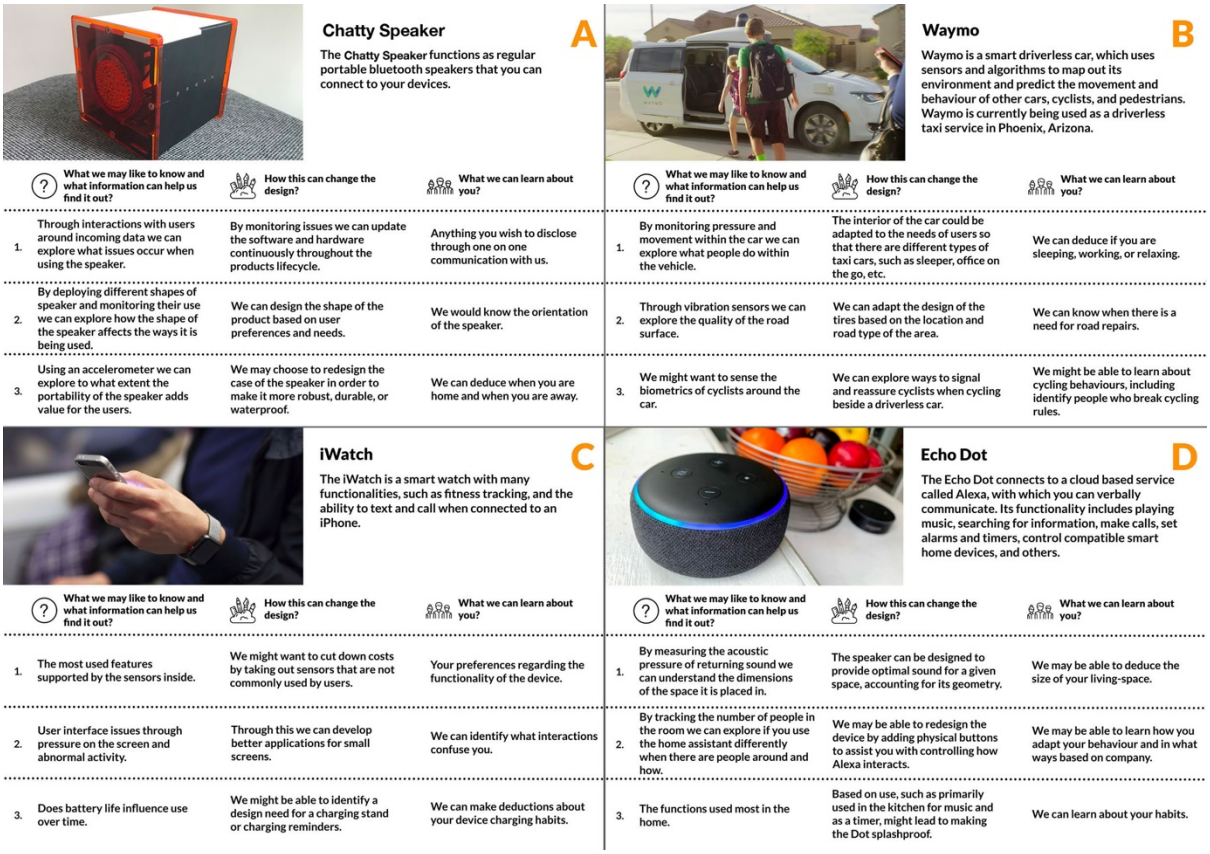

Figure 1 Four cards used to introduce the study participants to data gathering for design research from connected products.

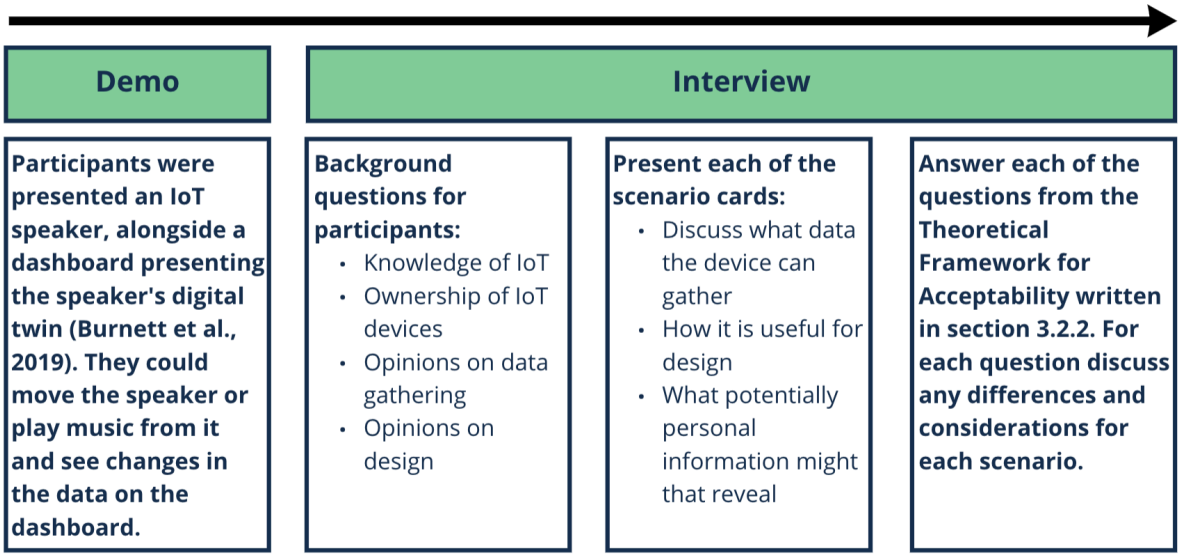

Figure 2: Interview structure

Participants were asked to reflect on the acceptability of collecting data through semi-structured interviews ranging from 20 minutes to 1 hour and 7 minutes conducted by the lead researcher. The majority of interviews were one on one, with the exception of P6-P7 and P10-P11 who took part as

couples. The interviews generated 13 hours and 36 minutes of audio, which was transcribed, removing personally identifiable data. The interview structure was (see Figure 2):

- Background discussion of knowledge of IoT and smart products, whether they own them, how they feel about design research related data gathering, and how would they feel if data generated from smart products was used for design research.
- Discussion of 4 scenario cards and associated design questions (Figure 1)
- Additional synthesis discussion on the acceptability of IoT data collection, framed by the Theoretical Framework for Acceptability (Sekhon et al., 2017)

3.2.1 Scenarios

To capture the ways acceptability varies across device types and settings, the participants were provided with 4 very different examples (Figure 1): a smart Bluetooth speaker, a home assistant, a driverless taxi service, and a smart watch. These were chosen to cover a range of home and public contexts, as well as personally and commercially owned objects. Each card contained range of design questions, constructed *a priori*, covering implications about interactions between the product, the user, the context and ideas of privacy. These also covered the possibility of inferences made on the data and the information users might unintentionally reveal about themselves–a subject highlighted by IoT privacy research (Zheng et al., 2018). Participants were asked to discuss the design questions in the context of the given device.

Data collected from connected devices can happen in a range of contexts and with varying levels of sensitivity. Providing the participants with very different examples gave them the opportunity to consider this variety and identify how their sense of acceptability varies across device types, setting, and possibility for data collection. The findings of the paper aim to capture the breadth and nuance that participants identified when considering each card.

3.2.2 Acceptability

After discussion of each scenario and the associated questions, in order to generalise their views, participants were asked to answer questions developed from the Theoretical Framework for Acceptability (TFA). The framework was developed by Sekhon et al. (Sekhon et al., 2017) in order to assess the acceptability of medical intervention, but has started to be applied within HCI and design (Rooksby et al., 2019). We have slightly adapted the framework–switching self-efficacy for agency–to elicit user perspectives on a set of concerns:

- **Agency:** What would you need to feel in control when being the subject of data gathering from this smart device?
- **Burden:** How much effort would be required to own this smart device and take part in data driven design research?
- **Ethicality:** What are the key ethical considerations for data collection for design research using this smart device?
- **Coherence:** Do you feel you understand why data collection is important and how it might benefit you and others?
- **Opportunity costs:** What do you feel you would have to give up in the process?
- **Perceived effectiveness:** Do you feel this is an effective way to make the products better?

- **Affective attitude:** How do you feel you would be affected if this device collects data for design research?

3.3 Participants

We recruited a cohort of participants interested in IoT, who reported either owning an IoT device or being interested in technology and data more generally (n=20), as such they are people that would likely be affected by this type of data collection. They had varying knowledge of data collection and usage practices. All of them own a smartphone and laptop, and 8 of them currently own an IoT device, including iWatch (P2, P3, P14, P16), Amazon Echo (P3, P5, P13, P14, P17), Apple TV (P8), Google Home (P3), Nest Thermostat (P17), Garmin Edge (P13). Due to word of mouth, several participants were product designers who had a deeper understanding of the uses of data for design research (n=5: P2, P3, P12, P17) – this is noted as a possible biasing factor, but was not considered a large enough sample for separate analysis. They ranged in age from 24 to 54, with mean age of 32. They were resident in the UK, with the exception of P1: British (n=13), North American (n=1), Chinese (n=1), Colombian (n=1), French (n=2), German (n=1), Irish (n=1).

3.4 Data and Analysis

The interviews were audio recorded and anonymously transcribed. The transcripts, including the general data gathering questions and the answers to the TFA, were thematically analysed (Braun and Clarke, 2006). Initial coding by the lead researcher generated 207 initial codes, which were gathered into seven clusters. The clusters, codes and quotes were discussed and refined by two researchers until the final five themes were agreed upon. The thematic analysis provided an overview of the attitudes and perceptions of participants around data gathering.

This was supported by a second deductive (i.e. pre-specified) analysis, through the lens of each individual TFA question in turn (c.f. Rooksby et al., 2019). The results are presented in Table 1, aiming to capture the scope and variety of answers, alongside a few key quotes, highlighting points of similarity and differences.

4 Deductive TFA Results

Table 1 Theoretical Framework for Acceptability Summary of Answers

Question	Summary	Quotes
Agency	The participants felt that they would feel in control if they understood the data collection process; if the process is opt in rather than opt out; the data was delete dafter a certain period of time; the data is anonymously collected; the process is regulated by legislation; and they trusted the company doing the data collection.	*"With the Echo Dot, being able to tell it to stop listening. I don't know if that's a thing already, but it would be cool if I could say, "Alexa, stop listening""*-P12 *"If you can give people agency and if you've got transparency from an ethical point of view, if they have agency, then a lot of people will be quite relaxed about helping."*-P8 *"You're certainly making a decision for yourself, but are you making a decision for someone else?"*-P9
Burden	There is a burden in understanding what data is collected, what inferences can be made based on it, how it is being stored, used and analysed, what rights the user has, and in providing feedback when requested. Burden can	*"There should be that level of control. The problem is, it's too much information for one consumer to go through."*-P1 *"If the product is working seamlessly, there's just no burden in me providing the data"*-P13

	be experienced at different parts of the process, at the point of purchase, when agreeing to the terms of use, and when providing feedback.	*"the people who've bought it and they know about it and they might have a bit more of an idea about it. But then, people on a low-income scale won't have access to that. It's also the education around it as well. It's the burden isn't always on the owner. Sometimes it's on the people who are peripheral to the owner as well"*-P12
Ethicality	Considerations included: data misuse; be-haviour manipulation; selling data to third parties; providing users with informed choice and control; informed consent; for everyone to be aware when data is gathered from them; and limiting hacks and leaks.	*"Is it analysed? What are the boundaries of this data? How far is it going to go? What's it going to be used for? Is it bounded purely for improving your design? Can I trust you that that's all you're going to do with this data?"*-P8 *"I think, there are ways to collect data that don't exploit information."*-P17 *"If it's done without their knowledge, then it becomes unethical."*-P8
Coherence	Views ranged from a lack of understanding of how the data gathering process can be personally beneficial to a level of acceptance and appreciation for the need for data-gathering.	*"I don't understand the ramifications. I don't understand what is going to happen next. My baseline is if I don't understand it then I distrust it."*-P20 *"I think I can understand why it's important and it would help develop products, so it's kind of integral. Especially, say, for driver-less cars, without a system that learns from its mistakes, you're going to keep making mistakes with it."*-P12 *"it's just a natural progression of market research"*P7
Opportunity Costs	The data gathering process can take away user's privacy, cost them time, effort in understanding the process, and make them feel monitored.	*"I feel like a lot of these conveniences just aren't worth what I'd give up in terms of privacy, really."*-P12 *"I guess you'd have to give up a feeling that you were anonymous."*-P19 *"So, redacted, this time to answer questions or to engage with some sort of chat. With Echo Dot, it's privacy, voice recognition, potential data, leaks and hacks."*-P3
Perceived Effectiveness	Gathering data in order to understand how products are used was generally seen as an effective way to gain design insight.	*"I think what is probably a bit more effective is using that in con-junction with asking people about the products"*P12 *"I guess. It's a lot more efficient than going asking every single one of your consumers in person."*-P18
Affective Attitude	The participants felt that they might be positively affected by being able to buy and use products that are well-designed and easy to use. Meanwhile they felt they might also be negatively affected by taking on burden and giving over agency. Perceptions ranged from acceptance, to being unsure, to displeasure.	*"Obviously, it is affecting me, but I think it's something that I can't just cut out with, so it's just something I'm going to have to live with and just have to accept the fact that there's data on the internet about me that could get hacked at one point."*-P12 "I wouldn't be affected."-P2 *"So, effects, it would take up some of my time, but I'm quite happy if it helps improve things. If it's improving a product that's good, if it's improving health services for other people, that's great."*-P8

5 Thematic Results

This section presents the results of the thematic analysis, organised by the five clusters identified. Where relevant, we make links to sections of the deductive analysis in Table 1.

5.1 Theme 1: Data collection for design research

The participants, with the exception of P11, felt that in principle "*if you can give people agency and if you've got transparency from an ethical point of view, [...] then a lot of people will be quite relaxed about helping"* (P8) (Table 1: Agency and Ethicality), and that remote data capture is an effective way to inform design research (Table 1: Perceived effectiveness).

Participants were able to speculate and envision that data gathering can help in the development of better product designs that cater to their needs (Table 1: Coherence), as *"it would help develop products, so it's kind of integral. Especially, say, for driver-less cars, without a system that learns from its mistakes, you're going to keep making mistakes with it."* (P12)

However, data collection through physical devices – particularly audio and video – was seen as potentially more personal than through digital products as *"A Google website, is probably just my online surfing behaviours, it's not necessarily about my personal life. I think this one [Echo Dot] is more invasive"* (P2). A key factor was uncertainty about use – *"you are living with this background knowledge that there is a strange data collection happening on you that you are not really in control of, or aware of the extent to which it is being used, and where it is being stored, and who has access to it"*(P20). Participants balanced a feeling that making data collection visible and explicit allows*"[the consumer to] make a decision based on whether they're comfortable with it or not"* (P19) against a sense that detailed T&C were *"too much information for one consumer to go through"* (P1). Important questions participants had were: what is being collected, what inferences can be made, how would it be used and analysed, how is it protected, would it exist forever and where would it be held.

Participants were critical of the current design of T&Cs and cookie collection requests and speculated that similar practices would emerge within design research. P4, P5, P10, and P14 identified dark design patterns, "*where instead of saying, 'Accept cookies or not?' they say, 'Accept,' or, 'Review.' Then, if you want to turn them off, you have to go through a list of 630 different companies"* (P4), to comply with GDPR but still extract relevant data. This was extrapolated to the design of products that *"start shaping and changing people's behaviour by having easier functionality or harder functionality. So if something's hard to do, people stop doing it"* (P10). Anonymous or aggregate data collection, and the ability to be in control of the data gathering process, were seen to have potential to enable ethical data-driven product design research, although questions were raised about the realism of anonymising data from connected personal devices. P4 and P8 were skeptical that data gathering for design research is done ethically and safely, as *"Google might tell you a story of, 'We collect this data and do X Y and Z.' Again, they have a commercial imperative. Someone like a government organisation might audit them, to know what they're doing"* (P8).

5.2 Theme 2: Consent and Agency

A sense of control could be supported by being able to revoke consent, halt data collection easily, automatically deleting data after a certain period of time and informing users when that happens. With the exception of P19 who felt that purchasing a device was an implicit agreement to data

collection, participants felt that data collection should be opt in, although this could also be positive: *“if someone is gathering my data to improve a product, then... I’d like to opt in. I’d like to know how it’s being used. It would be cool to get an update”* (P14).

From personal experience, participants including P1, P7 and P9, felt that terms of use are too difficult to understand. In order to support informed consent they require redesign with "layman’s words" (P20), which include information about the ways data is captured, used, and stored. While P1 felt that *"you can’t complain"* if you don’t read the terms of use, P9 was doubtful as *“No-one really has time, do they, to look behind the scenes at these kinds of things? I guess it would be good to know that the information is there if I want it, but I wouldn’t necessarily actually go on and access it, because I’d probably not understand it”* (P9).

The contexts presented within the cards, including wearables, driverless taxis, home assistants, and IoT speakers developed by university, drew out some of the perceived differences in agency, consent, and trust. The Bluetooth speaker was described as part of a controlled, academic study, where participants took the research product home, and as such, they had less reservations about data gathering from the speaker due to the context. A few participants, however, recognised that there is a greater burden involved with structured data collection: *“Oh, maybe I can’t be bothered doing it today, but I promised I would”* (P6). Meanwhile P2 and P11 felt confused by the speaker collecting additional sensor data which is not integral to the function of the device, as *“I don’t know why you need an inertial measurement. I’d be like, "Why do you need to know that?”* (P11).

The participants felt that the data collection of the iWatch was the selling point of the device, identifying its health and fitness benefits. As reflected by P3, the convenience of owning a device that distinguishes between different swimming styles is more important than concerns around the personal nature of the data gathered. Those that owned iWatches reported that they made little distinction between the watch and their smartphone, and that they trusted Apple over other companies. Participants also ascribed a high level of agency to the user due to choice about when to wear the device limiting the potential for continuous harvesting of personal data.

At the time of the study Amazon was in the news due to the use of human audio transcribers. The Echo Dot was subject to wide-ranging criticism due to mistrust. The recording of audio was seen as too personal, and the inferences that could be made about users, such as their political inclination (P8), are problematic. Conversely, P5 and P13 reflected they felt that Alexa is *“still quite stupid. (Laughter) I actually once told her, like," Alexa, you are not that smart and I hope people in Amazon are listening to this”* (P13).

Finally, the Waymo car generated discussions around private vs personal space. While requesting the service and entering the vehicle can be seen as giving consent to some level of data-gathering, there is less choice for others, including other drivers, cyclists, and pedestrians, who are captured by the imaging systems of the driver-less car without being given the opportunity to give consent. P19 reflected that there is a risk around *"feeling that you’re always being monitored",* which extended from the person inside the vehicle to everyone else on the road and pavement.

5.3 Theme 3: Participation Incentives

Participants felt that the treatment of data and the scope of the data collection is important to the acceptability of data gathering for design research. Specifically, that data gathered should not be subsequently sold on or used for targeted advertising, and that data generated as part of the

function of the device is personal and private unless explicit permission is given for use in design research. Other data collected which do not directly support the function of the device, was seen as problematic because the purpose of the data collection is less clear: *"Even if things are anonymous, it could still be used in a harmful way, I guess if anything goes beyond the scope of what a product's purpose is then that would make me very nervous"* (P17).

Participants recognised that they could be positively affected immediately from taking part in the process if they are informed what impact their data makes. P16 identified that although aspects of the software can improve, such as the speech recognition of a home assistant, the hardware of the device that you own would not change, requiring you to buy the next version of the product in order to experience the design benefits you have contributed to. Meanwhile P20 felt more positively towards the idea that years down the line when her product is broken there would be a better designed version she could purchase.

Altruism was important: *"If I knew that the stuff I was sharing was going to make the product better or solve an issue that I had, that would be enough for me"* (P14). P13 felt that data-driven design might have wider reaching societal benefits, such as transport optimisation and support smart city initiatives, and P10 hoped that the process would lead to more sustainable design practice.

Participants saw data collection as part of a larger research process, with power *in "using that [data collection] in conjunction with asking people about the products"* (P12), so that users can take on an active role by providing feedback regarding the design of the device. This active role gave them a further opportunity to feel in control of the research (P20), while also allowing them to have a greater understanding of the types of information the design team is looking at and interested in investigating. Despite the positives of active engagement, providing feedback may be frustrating and annoying to some users, and *"In theory, I would rather it asked each time. But, in practice, I would tell it to leave me alone"* (P6). This fits with *"[a] mental image of the Windows paperclip popping up and saying, `I can see you're slightly frustrated.' [...] It's not necessarily going to help at that point, although from a designer's perspective, I can understand why they want to get that key moment with the things that irritate you about the product"* (P8).

5.4 Theme 4: Value to Companies

Participants wondered about the true value of the data they generate, and felt a focus on profit led to a misalignment of values between consumers and producers. Would companies support informed opt in consent? Would data-driven design manipulate users? Questions were raised by the participants about what it would mean to utilise a data-driven design approach for the Echo Dot, which can be used as a shopfront for Amazon, which is an ethical tension as *"There's no clear distinction between [improving] its usability and improving its ability to milk the user for money"* (P4).

It is interesting to note that ubiquitous surveillance could be seen as more acceptable than data gathering for design research depending on the value proposition. P19 and P1 felt that with CCTV *"… the purpose is for security, for all of our personal security. Whereas these types of observations are ultimately for profit"* (P19). P11 recognised that being the subject of data-gathering after you have purchased an IoT product was *"working for free. It doesn't feel like work for me, as a burden, but ultimately I am producing something that's being used"* (P11).

Most participants expressed ethical concerns of some sort, especially around digital services. Recent news about human transcribers at Amazon was not treated uncritically, with opinions that it was *"scaremongering"* (P14) alongside worries about how to understand the implications of news stories. Again, values were balanced, as e.g. Googles vast amounts of personal data, despite causing concern was weighed against the convenience of its services. In contrast, the majority of participants reported that they trust Apple and their smart watches and phones. Generally, there was a sense that *"At the heart of all that then is really the ethical standards of these companies"* (P17).

5.5 Theme 5: Broader data collection perceptions

The participant's views on the acceptability of data-gathering for design research are influenced by their experiences regarding other types of data-gathering, such as government surveillance, targeted ads, online scams, and big data scandals like Cambridge Analytica. Participants often focused on targeted advertisements, which were seen as invasive and creepy, degrading trust in digital platforms. P5 and P7 felt that targeted ads were so precise that *"Instagram is literally just listening to my conversations"* (P5), even though P5 was less worried about her Amazon Echo. Many participants had general sense of correlation between adverts and their lives that led to a feeling of surveillance, so it is unsurprising that all except P14 felt that data from a physical device should not be used for tailored ads.

We observed an intricate tension between the discomfort with data gathering generally, and the wish to be part of modern society. Participants felt that there are risks involved around data collection, including hacks and leaks, and *"If you want to be completely safe and secure and private, just don't use any [digital devices]"* (P16). Meanwhile there was an observed level of acceptance that data-gathering is now a part of life that we cannot do without (Affective attitude, Table 2, P12), and that *"You're worried about the information [...] but, at the same time, it's so convenient."* (P10) Participants identified that personal compromises in the handing over of data are inevitable, but that *"I don't understand how websites work and things in the back-end, I don't understand where that information is going, it is quite hidden to me, obviously it is not very transparent"* (P20), and bluntly *"if I don't understand it then I distrust it"* (P20). Others were less concerned, feeling that *"in general, I don't really mind my data being collected"* (P14), and some looked at techno-utopian futures: *"Look at sci-fi movies and everything, we all are amazed and so on when people walk into the room, lights on, and so on. We are getting there, but because there is that big thing about data, suddenly we don't want to"* (P1).

6 Discussion

Participants were mostly positive towards data gathering solely for design research but we observed degrees of comfort, from those that are happy to share their personal data in the hope of a techno-utopian future, to those who saw data collection as exploitation. Here we argue that all of those views should be accounted for when implementing a data-driven product design approach in order to make the research and development process acceptable and beneficial to all stakeholders.

6.1 Informed Consent in Complex Contexts

The different connected devices we discussed highlighted that the context the device is situated in and what data it collects led to different attitudes about the use of data. This has implications on the way that consent is gained because few of the participants reported that they read the Terms and Conditions (T&C). Participants felt that ethical data collection requires the awareness and

understanding of users. While this might be achieved through well designed T&C, such as those developed by Pierce et al. (2018) where the terms of use are re-designed in an engaging visual and clear form, T&C are not enough when discussing products which can exist in shared spaces, where they may capture the activity of non-consenting individuals, such as in the Waymo and Echo Dot examples.

One way to help consumers be more aware and understand how and why data is gathered that is particular to data-driven design is through more active engagement with the design/research team through feedback requests, as discussed in *Participation incentives*. However, the participants were unsure of the level of which they would personally be willing to provide feedback, and there a strong possibility that feedback makes users identifiable. Within the study we saw that participants were confused and at times concerned by the IMU data collected by our Bluetooth speaker provocation and prompt, echoing the findings of McMillan et al. (2013) that collecting data not connected to function was likely to be surprising and upsetting to users. One way to ensure a limited scope of data collection is to only collect data that is required for the function of the device. Another way to limit scope, is to gather data relevant to a currently explored research question. For example, in the case of the iWatch, if we are interested in the question of how battery life affects the use of the watch, the design team might want access to battery level data, the top level apps/functions used, and times and duration of use, rather than gathering location, heart rate or other data.

These devices work in complex situations, and draw on connected ecologies of institutions and infrastructures to function, so the question of how to audit and manage data for positive development requires cooperation and big-picture thinking. A flexible hybrid of paternalistic data regulation alongside privacy self-management can help make data gathering more consistent and manageable, such a system is discussed by Solove (2012), which take into account socially desirable outcomes of downstream data usage. We see great potential for the HCI community to work closely with policymakers internationally in order to support healthy data gathering practices (Rogers et al., 2019).

6.2 Data-Driven Design Mistrust and How to Address It

Participants were aware of their limitations in understanding what their devices were collecting, as well as noticing that gradual change can acclimatise users to negative effects until it is too late to react to the threat that might be posed (c.f. Oulasvirta et al., 2012). These reflections raise concerns that data-driven design practices may normalise otherwise unacceptable surveillance and give opportunities for leaking data and unwanted surveillance, as discussed by Pierce (2019).

The pervasive use of data for advertising (c.f. Apthorpe et al., 2018) soured participants on possibilities for data use in the design process. Stories around data misuse can be deeply worrying and shocking for members of the public, some of whom (e.g. P5 & P7) now believe their phones are listening to them in order to feed them creepy targeted ads. This level of mistrust and worry about data collection may have proliferating negative effects for the adoption of IoT technology. While tailored experiences are a key selling point for connected products, there may be a danger that continuous optimisation can create user experiences that feel "creepy" in a similar fashion to the participants reported experience of ads.

Participants were sensitive to the value that flowed from data-enabled design. When the data collection was tied in with a perception of high personal value, such as the quantified self data of an

iWatch, participants were accepting of the data being used for design research. In contrast participants were more sceptical of data gathering by the Echo, which was seen as a shopfront. Further complexities emerge when considering who benefits from subsequent design iterations, while a software update can reach all existing users, a physical design change might require users to purchase a new device in order to benefit from a better design. A pre-emptive rather than reactive approach to dealing with thorny ethical issues can in turn foster and rebuild trust within consumers, articulating the models of value exchange and ownership. Nonetheless, we see enormous potential to facilitate data-driven ethnographic research around such IoT devices in order to support HCD and co-creativity.

6.3 Implications for Acceptability of Data-driven Design

The results of the TFA indicate that data-driven product design has the potential to be seen as acceptable in ways that general data collection are not, if people are given sufficient agency over the process and they understand the purpose of data gathering. Key requirements for developing data driven design practices include:

- An opt-in data gathering policy combined with live engagement, that is careful with participant attention and energy.
- Gaining informed consent that is suitable for complex contexts, and protecting the anonymity and privacy of others capture (Apthorpe et al., 2018).
- Giving users control over data gathering, including stopping collection and deleting backlogs.
- Rewarding participation: while making the individual's contribution to design explicit can be rewarding in itself, others found the process more acceptable alongside compensation, countering practices seen as prosumption.
- Participants' imaginaries of data collection are antagonistic - creepy targeted ads dominate, lots of mistrust and misunderstanding, so designers need to address this when thinking about the interactions with end users.
- Participants were sensitive to dark design patterns and behavioural nudging, and likely to be turned off if they felt manipulated, so design research should be open and transparent.
- Users need to understand both what the device *can* do, and what it *is* doing, in terms of collection and interpretation, in line with Amershi et al.'s AI design guidelines (Amershi et al., 2019).
- Designers need to recognise the burden of participation, and be careful with user effort, creating meaningful, positive interactions around feedback.
- Limit the scope of data collection by gathering data exclusively relevant to research questions under investigation.

6.4 Limitations

This study is an example of attitudinal research that relies on the participants drawing on their current experiences with technology in order to gauge how they feel about data gathering for design research. The discussions were speculative and further research is required in order to scope the behaviours that might emerge when IoT devices gather and transmit data for design research. Furthermore, these findings are situated at a time when the market is increasingly becoming flooded by IoT technology but it is not yet ubiquitous, meaning that with time perceptions will change, however those designing connected product may find these perceptions useful in informing their current data gathering practices.

7 Conclusion

The question of when data collection is acceptable to end users is nuanced, driven by combinations of personal attitudes, levels of knowledge and personal experiences. In this paper, we have disentangled a part of this puzzle – whether the purpose to which collected data is put makes a difference to end users. From interviews conducted around scenarios based on IoT devices, we found a collection of attitudes and sensitivities towards the use of data. Many of these were predictable – dislike of advertising, imaginaries around surveillance, privacy, security and so on. The findings around the specific use of data for product design were more nuanced, with altruism and desire for better products balanced against a sense of exploitation – some users were more concerned about the company profiting from their data than its use in profiling and surveillance. From this we highlight that there are opportunities to build engaged user communities who willingly both share and reflect on data to improve product function. However, this requires an open and transparent commitment from the company, a care with user effort and the avoidance of antagonistic or underhand data practices.

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