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Can Prosuming Become Perilous? Exploring Systems of Control and Domestic Abuse in the Smart Homes of the Future

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In what ways can new, emerging digital technologies and energy business models such as "prosuming" become intertwined with troubling patterns of domestic abuse and violence? Domestic violence entails controlling, coercive or threatening behaviours, to gain or maintain power and control between intimate partners or family members regardless of gender or sexuality. The rapid development of digital communication services, smart homes, and digitalization processes such as prosuming create surprising threats related to technology-facilitated abuse. In this empirical study, based on a nationally representative survey of householders (n = 1,032 respondents) and three focus groups with the general public in different locations around the UK (n = 18 respondents), we explore the extent that prosuming technologies, smart grids and smart systems could act as potential enablers of domestic violence or systems of control. We also explore the use of smart systems as possible deterrents and mechanisms to reduce and address domestic violence and provide victim protection and recovery. In doing so, we explore user perceptions and preferences of smart systems, in relation to trust, monitoring, tracking, and surveillance. We finally discuss our results through the themes of duality and policy and provide conclusions with recommendations for further research.

Keywords: domestic violence, smart homes, smart home technologies, gender and technology, sexual exploitation and abuse

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1 INTRODUCTION

Access to the Internet is perceived as a key service to gaining efficient access to information (Butler and Abrahart, 1997), guaranteeing economic well-being, advancing social conditions and achieving convenience. Therefore, the Internet is increasingly perceived as a fundamental human right (Sandle, 2016). With this in mind, the number of Internet of things (IoT)[1] devices continues to grow rapidly (Mckinsey 2019), and in turn, smart systems have become a prominent area of study. For instance, extensive research has focused on the ability of smart systems to offer enhancements in many areas of life. These range from providing health and assisted living services (Balta-Ozkan et al., 2013), contribute to more energy efficient households (Sovacool, Furszyfer and Griffiths, 2021), to enhancing users' comfort and convenience (Sovacool and Furszyfer Del Rio 2020) with an

[1]The Internet of Things (IoT) consists of connected technologies and services, such as cloud computing services, social networks and smart home technologies, all of which collect and share data about how devices are used and in which environments.

overall aim of boosting productivity and improving citizens' well-being (OECD, 2018). In sum, smart devices possess the potential to transform human lives given the wide range of application these technologies offer (Hittinger and Jaramillo 2019).

In the energy arena, smart systems intersect with power networks via the deployment of smart grids, where traditionally, passive consumers are now becoming 'prosumers' (Morstyn et al., 2018; Bugden and Stedman, 2021). Prosumers are agents that consume and produce energy (Parag and Sovacool, 2016) and can monitor and share information on their energy usage to influence the operations of power systems (Darby and McKennab, 2012). The deployment of smart systems facilitates the transition towards a prosumers era and enables the integration of new business models such as peer-to-peer trading, electric vehicle-to-grid and demand response (Parag and Sovacool, 2016; Furszyfer Del Rio et al., 2020). However, we argue that with the emergence of smart systems and the entrance of novel business models, there is space to promote negative social interactions and iniquitous dynamics of control.

This paper explores whether smart and digital technologies could 1) act as potential enablers of domestic control and violence, and 2) operate as possible deterrents and mechanisms to mitigate such threats. Based on a nationally representative survey of householders (18 years and over) and three focus groups with the general public in the United Kingdom (UK), we explore users' perceptions and preferences of smart systems concerning trust, monitoring, tracking, and surveillance. We take this approach given that an increasing number of smart connected products are capable of tracking most users' activities in real-time (Neff and Nafus, 2016; Wajcman, 2019) and contain features of sharing and storing data which can have added negative implications (Zuboff, 2018; Wachter, 2019).

Unlike Furszyfer et al (2021), who explored smart systems via the lens of gender, our prime contribution consists in investigating how personal data, privacy and surveillance related issues with prosuming or digitalization could enable practices such as, but not limited to, smart monitoring and stalking, domestic violence, and parental control. To do this, we first offer a review of the literature in **Section 2**. We then infer connections between surveillance, violence and smart systems rather than directly state them, given our initial research design (see **Section 3**), and present our results in **Section 4**. In **Section 5**, we discuss our results through the themes of duality and sometimes competing functions and emotional reactions, as well as the promise of those technologies for mitigating domestic violence.

2 REVIEWING LITERATURE ON SMART ENERGY AND HOMES, TECHNOLOGY FACILITATED ABUSE, AND MONITORING

As both prosuming networks and smart systems become more deeply woven into all aspects of our lives, the discussion around the benefits of such technologies has often focused on values such as comfort, convenience and control (Strengers and Nicholls 2017; Marikyan, Papagiannidis, and Alamanos 2019). Previous research regarding the risks of smart systems has mostly explored users' privacy (Véliz and Grunewald, 2018; Wachter, 2019), whereas a still unattended area is the potential threats that could result from technology related abuse. These include, for example, smart enabled control of family members (Nansen and Jayemanne, 2016), and even domestic violence (Chatterjee et al., 2018; Freed et al., 2018; Henry and Powell, 2018). On the latter, Stark and Hester (2019) indicate that tech abuse can affect individuals psychologically, physically, sexually, financially and emotionally. To this, the Australian national independent regulator for online safety, (2020) has stated that "Technology-facilitated abuse has become ubiquitous in cases of domestic and family violence It ranges from low tech—like abusive text messaging—[to] smart home devices like their TV or fridge to exert fear and control." Indeed, misusing technology to perpetrate violent acts has been acknowledged as a social and economic global problem (UN Broadband Commission for Digital Development, 2015).

In this research, we work from the premise that digital technologies have historically been gendered by design and association and thus, the "cyberspace cannot escape the social construction of gender [Adams (1996) P. 162]." As such, we argue that other forms of violence towards women may persist. For instance, Cintron (2009) and Citron and Norton (2011), suggest that online social outlets (e.g. Twitter and blogs) represent common grounds to attack women, "destroy their privacy." and diminish their reputation. In consequence, online public debates have historically been dominated by males (Herring, 1999), with others arguing that the internet has often been a "frightening and toxic place for women" (Amnesty International, 2017). Salerno-Ferraro et al. corroborate this point and argue that women are key targets of violence in online spaces, online gaming and social media (Salerno-Ferraro, Erentzen and Schuller, 2021). For Wajcman, the perception that digitalization is a male-dominated field, is explained by constructing gendered identities and discourses produced simultaneously with technologies (Wajcman 2007). Thus, this suggests that technology and gender relations ought to be approached through a technofeminist perspective, where several dimensions involving material, discursive and social elements are considered to avoid excluding women (Wajcman, 2004).

2.1 Forms of Technology Facilitated Abuse

Before moving on to key concepts in technology facilitated abuse, we briefly define domestic violence as "any incident or pattern of incidents of controlling, coercive or threatening behaviour, violence or abuse between those aged 16 or over who are or have been intimate partners or family members regardless of gender or sexuality [Home Office (2013) P 2]". This could entail but is not limited to any form of psychological, physical, sexual, financial or emotional abuse (Leitão, 2018). Domestic violence impacts people and genders in all social, economic, ethnic, educational and cultural groups (Heise and Garcia-Moreno, 2002), but is particularly wide-spread against women and girls (United Nations, 2018). In 2017, UNOCD (2018) reported that 87,000 women were murdered, of which intimate partners or family members killed around 50,000. In the UK context, charity

TABLE 1 | Included and excluded terms of technology facilitated abuse.

Terms included	Terms excluded
Technology facilitated sexual abuse (TFSV)	Doxing
Digital dating abuse	Cyberbullying
Image-based sexual violence	Deep fakes
Cyber stalking	Digital gaslighting
Online harassment	Impersonating
Parental monitoring and control	
Femtech, menstruation and pregnancy	

This table also lists terms that have been excluded from our study, and although they are a form of technology facilitated abuse, they are not necessarily linked to domestic violence.

Refuge (2018) has estimated that one in four women have experienced domestic violence in their lifetime, while the Crime Survey for England and Wales reported in 2018 that 8.2% of women and 4% of men had experienced domestic violence (Office for National Statistics, 2019). Certainly, intimate partner violence is a complex issue and, as such, can take different forms, from physical and/or sexual violence with a variety of non-violent control tactics to couples' arguments that turn into aggression and acts of resisting violence (Johnson, 2011).

Research indicates (Henry and Powell, 2015; Woodlock, 2015; Diana Freed et al., 2018; Parkin et al., 2019), however, that domestic violence cases are on the rise, in part, as abuse facilitated by technology does not require face-to-face encounters between victim[2] and perpetrator (Marganski and Melander, 2018). Technology facilitated abuse does not recognize borders and boundaries, and its victims often feel hounded, under surveillance and harass by the abuse on their IoT devices and/or social media (Harris and Woodlock, 2019), since these technologies provide instantaneous communication, they enable quick access to methods of harassment and abuse (Melander, 2010; McManus et al., 2021).

There are many forms of technology facilitated abuse and the rapid development of ICTs generate ever-changing patters of these (see **Table 1**). These include *t*echnology facilitated sexual violence (TFSV), which uses "cell phones, email, social networking sites, chat rooms, online dating sites, and other communications technologies" to enable rape or sexual assault (Henry, Flynn, and Powell 2020; p 1836). Digital dating abuse, another serious offence, consists of a "pattern of behaviours that control, pressure, or threaten a dating partner using a cell phone or the Internet (Reed, Tolman, and Ward 2016; p 1556)" (see also Hinduja and Patchin 2020). For example, data from England and Wales indicate that dating apps have been linked to more than 500 crimes, and whilst the majority are sex offences, others range from murder and rape to child abuse (Kjellsson, 2016).

[2]Terminology note: Similar to Henry, Flynn and Powell (2020) we have decided to use the term "victim" in our article over "victim-survivor" although we recognized the latter is favoured when dealing with domestic violence issues. However, we used the term "victim" since in our study uses a number of conjoined terms such as but not limited to "technology-facilitated domestic, cyberstalking, and digital dating abuse". we have decided to simplify the language by using only the term "victim".

Image-based sexual abuse entails all forms of the non-consensual creation and/or distribution of private sexual images. These include abusive behaviours beyond "revenge porn", sexual extortion (or "sextortion"), "upskirting., voyeurism and many other similar forms of sexualised abuse (McGlynn, Rackley and Houghton, 2017)". Vinopal (2020), found that one in 25 people in the US has had a sexual video or image of themselves shared on the internet without their consent, and about 90% of them were women. However, image-based sexual abuse is not confined to adults only–more than 500 children were victims of such abuse in England and Wales last year (Webb and Weale, 2020), and Keller and Dance (2019) have found that child sexual abuse images have doubled in recent years.

Another prominent form of technology facilitated abuse focuses on cyberstalking, which involves the use of digitally connected devices to participate in a "pattern of repeated behaviour that causes the victim to fear for his or her safety (Nobles et al., 2014; pg 988).", also potentially affecting victims' creativity, concentration, and performance (Holland et al., 2020). Cyberstalking involves using hidden webcams, GPS devices, and spyware to monitor victims' activities, exert controlling behaviours (Reyns, 2019), and contact the victim under anonymity through fake online profiles (Smoker and March 2017). In comparison to other forms of stalking, cyberstalking victims are more likely to be intimate partners (Cavezza and McEwan, 2014). Linked to cyberstalking is online harassment, a complex concept that varies in expression and severity (Jones, Trott and Wright, 2020) from hateful insults and death threats to humiliating and/or unwelcome conducts of sexual nature (Henry and Powell, 2017; Vilk, 2020). Although this problem began with the arrival of the internet, it is pervasive and growing (Anderson, 2017; Vilk, 2020), with implications affecting the victims and wider communities when sharing the victim's identity traits (Nadim and Fladmoe, 2019).

2.2 Parental Monitoring and Control

Children born in connected homes tend to be very conscious of their need for privacy (Leaver, 2017). Particularly, in terms of what they share with their parents and family, rather than what they share with the outside world (Boyd, 2014). Surveillance technologies can create anxiety and hypervigilance (Monahan, 2010) without necessarily increasing children's health and safety (Hasinoff, 2017). Research also indicates that surveillance and tracking technologies within families may lead to a lack of trust and a reduction in children's independence and skills to evaluate and respond to risk in public places (Mayer, 2003; Fox, Osborn and Warber, 2014). Research, indicates that children's use of ICTs and online navigation is often negotiated in complex and nuanced ways (Livingstone and Sefton-Green, 2016). From an infants' perspective, Ghosh et al., note, after revising 736 reviews of 37 mobile online safety apps, that children's ratings towards monitoring apps were significantly lower than those from parents, with 76% of children's reviews giving apps a one star. Children, in their study, felt that the apps were restrictive and invasive of their privacy (Ghosh et al., 2018).

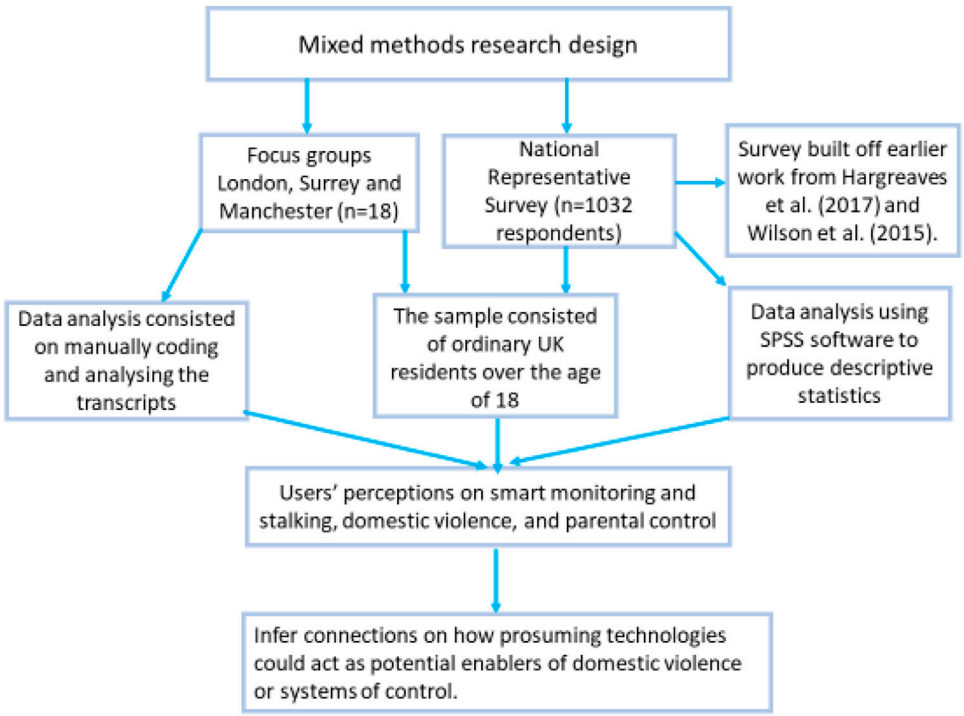

FIGURE 1 | Visualizing our research design and dataset flowchart.

Risks, however, are not limited to power dynamics but also practices of data misuse (Holloway, 2019). Children's wearables (i.e. Owlet) can collect intimate private data about biological activities, oxygen levels, sleeping patterns and children's peace of mind (Leaver, 2018). These devices are not certified as medical tools (King, 2014) and support the idea that good parenting requires data surveillance practices as a form of care without parents knowing that biometrics infant data is being recorded and monetized. Under these contexts, Grimes (2014) calls for critical awareness of the ideological and political dimensions of infants' technologies.

2.3 Femtech and Menstrual/Health Surveillance

Our final category of literature discusses a class of technology known as "femtech." In the context of smart systems, both Google Play Store and iTunes Store display countless numbers of pregnancy and menstruation-related apps. There is little doubt this market is on the rise, with femtech products and services valued at $17 billion in 2018 and estimations suggesting this market will increase to $50 billion by 2025 (Statista, 2020). Johnson (2014) indicates that pregnancy apps belong to the datafication space contemplating pregnancy as "an administrative and calculable activity, valuing data over subjective experiences and changing the meaning of what is be a mother (2014 p. 346).". Moreover, research indicates that pregnancy apps have failed in protecting users' data and their records with information being sold to third parties (Bert et al., 2015). Leaver (2017), in a similar vein, notes that leading pregnancy apps (i.e. Glow) have several vulnerabilities where third parties could access private/intimate information.

Monitoring the health of users in domain of smart homes is not limited to apps. For instance, smart health devices (i.e. Withings Wireless Blood Pressure Monitor or Beddit) could retrieve users' private data and share it with brokers for profiling and advertising purposes. Such practices contribute to inform decisions and "punish." users by insurance companies (Furszyfer Del Rio et al., 2020) leading, to some arguing that "smart systems have shifted society from one of disciplined to one of control [having] a normative effect on producing 'good' household occupants (Maalsen and Sadowski 2019 p.123 p.123).".

3 MIXED METHODS RESEARCH DESIGN

Our sources of primary data for the study were twofold: a nationally representative survey (with quantitative and qualitative questions) distributed in the United Kingdom, alongside three focus groups. To be clear, both of these instruments were empirical, and had the advantage of collecting data inductively in a grounded manner (rather than nudging respondents or connecting our questions explicitly to any sort of dominant conceptual theory or framework). **Figure 1** visually depicts our research design.

Our survey instrument was built off earlier work examining user perceptions of smart homes conducted by Hargreaves and

TABLE 2 | Demographic Attributes of Focus Groups in London, Manchester, and Surrey(n = 18). Source, authors.

Age	Gender	Ethnicity	Social grade	Gross household income	Smart devices owned	Current property
Focus group 1 london (urban)						
18	Female	White and Black African	B	£60,000 to £69,999 per year	1	Rented from private landlord
21	Female	Chinese	C1	£10,000 to £14,999 per year	1	Rented from private landlord
24	Female	White and Asian	C1	£100,000 to £149,999 per year	1	Rented from private landlord
54	Female	English/Welsh/Scottish/Northern Irish/British	E	Prefer not to answer	3	Buying leasehold/freehold on a mortgage
56	Male	Any other ethnic group	D	£20,000 to £24,999 per year	4	Buying leasehold/freehold on a mortgage
62	Male	English/Welsh/Scottish/Northern Irish/British	C1	£10,000 to £14,999 per year	1	It belongs to a Housing Association
73	Male	English/Welsh/Scottish/Northern Irish/British	A	£50,000 to £59,999 per year	3	Own the leasehold/freehold outright
Focus Group 2 Greater Manchester (Rural)						
66	Male	English/Welsh/Scottish/Northern Irish/British	C1	£10,000 to £14,999 per year	1	Own the leasehold/freehold outright
65	Male	English/Welsh/Scottish/Northern Irish/British	B	£35,000 to £39,999 per year	4	Own the leasehold/freehold outright
73	Male	English/Welsh/Scottish/Northern Irish/British	C2	£45,000 to £49,999 per year	2	Own the leasehold/freehold outright
59	Female	English/Welsh/Scottish/Northern Irish/British	B	Prefer not to answer	2	Own the leasehold/freehold outright
Focus Group 3 Surrey (Rural)						
21	Male	English/Welsh/Scottish/Northern Irish/British	B	£100,000 to £149,999 per year	5	Own the leasehold/freehold outright
29	Male	English/Welsh/Scottish/Northern Irish/British	A	Prefer not to answer	1	Rented from local authority
33	Male	English/Welsh/Scottish/Northern Irish/British	A	£70,000 to £99,999 per year	5	Rented from private landlord
40	Female	Any other Mixed/Multiple ethnic background	E	£35,000 to £39,999 per year	4	Own the leasehold/freehold outright
49	Female	English/Welsh/Scottish/Northern Irish/British	B	Prefer not to answer	3	Buying leasehold/freehold on a mortgage
52	Male	Arab	B	£100,000 to £149,999 per year	2	Buying leasehold/freehold on a mortgage
58	Male	English/Welsh/Scottish/Northern Irish/British	D	£20,000 to £24,999 per year	1	Own the leasehold/freehold outright

Wilson (2017) and Wilson et al. (2015). It was designed to take 10–15 min to complete, and it consisted of twenty questions across four sections. The first section explored the socioeconomic and demographic attributes of respondents. The second section investigated adoption patterns and knowledge of smart home technologies, including smart energy systems and prosuming elements such as peer-to-peer trading or home energy management. The third section examined preferences in smart technology as well as trust and perceived risks. The fourth had open-ended questions asking respondents to share experiences about smart homes and their willingness to be contacted for future research. Most questions used a 5-point Likert Scale (1 = strongly disagree, 5 = strongly agree), with the survey implemented online by a market research company, Dynata, using a respondent panel representative of the UK household population (homeowners and those who rent). Dynata scripted an online version of the survey instrument using their proprietary software. Once checked by the research team, Dynata sent unique person-specific links to the survey to individuals in their respondent panel who have agreed previously to take part in survey research in exchange for incentives. The sampling frame consisted of householders, in the UK, who had to be over the age of at least 18 years old.

A total of 166 respondents were screened out based on quality checks. These quality checks included 'flat-liners,' straight-line responses on blocks of questions; 'rushers,' those who gave incomplete, contradictory or unrealistic responses (e.g., the respondent who claimed to have 99 children); and 'speeders,' those who had unrealistically fast survey completion times. The final sample comprised 1,032 respondents.

To triangulate the findings from the survey, we also conducted three focus groups in the last quarter of 2019 across London (n = 7), Greater Manchester (n = 4), and Surrey (n = 7). This included two urban locations (London and Surrey) and one rural (Manchester). The Focus Groups were organized and managed by a separate market research company, YouGov. The focus

groups lasted 90 min and involved a mix of different demographic respondents with the details summarized in **Table 2**. The focus groups followed a similar structure to the survey, examining general knowledge of smart home technologies, experience and usage patterns, perceived benefits and disadvantages, trust, and values. Even though they were recorded and fully transcribed by YouGov, at least one member of the research team observed all of the focus groups.

We analysed our data using SPSS software to produce descriptive statistics on our quantitative data, which was supported by inductive thematic analysis of the qualitative data from focus groups and the survey. To ensure anonymity, focus group participants are referred to in our results as follows: London male (FGLM), London female (FGLF); Manchester male (FGMM), Manchester female (FGMF); Surrey male (FGSM) and Surrey female (FGSF). The survey respondents are reported as male/female and respondent number (e.g. MXX, FXX).

Our study has some limitations, mainly the way our survey and focus group questions were designed. Our study was mostly focused on the general risks and benefits smart systems. Therefore, we did not directly ask about abuse or domestic violence, whether participants had experienced technology abuse. Given the sensitivity of this topic, we did not think that it was appropriate to ask about it among a more general survey on smart systems or to raise it as a question in a public focus group setting.

4 RESULTS: VIOLENCE, STALKING, SURVEILLANCE AND PRIVACY IN THE SMART PROSUMING HOME OF THE FUTURE

This section presents our results that fall into the following themes: knowledge as an enabler of domestic violence; smart monitoring and stalking; parental control and surveillance of children; femtech, menstruation and pregnancy.

4.1 Knowledge as an Enabler of Domestic Violence

Our first question explores users' knowledge of smart systems. Here, we asked survey respondents: How much would you say you know about smart systems? We were interested in participants' answers in this area since being knowledgeable regarding the use of smart systems may facilitate perpetrators tools to enact cyber abuse or victims to respond to it. For instance, Dimond et al. (2011) indicate that victims of technology abuse felt they were less tech savvy than their abusers. Whilst Freed et al. (2018), show that due to victims' lack of knowledge, abusers can typically access victims' digital accounts and devices and use them to control them. We argue that smart systems that undermine victims' data, privacy, and autonomy should raise serious surveillance concerns related to cyberstalking and even micromanagement.

Our results indicate that most men 60.5% have a good idea to a very good idea of what smart systems are, in contrast to 49.2% of women (see **Figure 2**).

Based on the evidence presented above and findings from Dimond et al. (2011) and later work by Chatterjee et al. (2018), female victims of domestic violence felt that they were less tech savvy than their abusers. We infer from our results that women could be in a more vulnerable position than men. Particularly, since many female participants in our survey stated, for example: "I have very little experience of smart home technologies." (F288) and "I haven't used any" (F307). In one of our focus groups, a female participant (FGMF) stated that "I don't use any smart stuff for anything" when discussing smart systems used for energy monitoring. In a further discussion on whether systems were gendered, one female participant noted that they were "caveated with boys and toys." (FGSF). More specifically, lack of knowledge was mentioned by one male focus group participant when discussing potential surveillance equipment such as cameras in the house: "I think there are issues that could arise especially in unhealthy relationships where one person is more tech savvy than the other. You don't know quite what monitoring equipment they might be putting on, let's say, the bedroom or even the bathrooms." (FGSM).

However, lack of knowledge not only remains on the victims' side. A growing body of research (Chayn, 2017; Raptis et al., 2017; Bowles, 2018; Lopez-Neira et al., 2019) suggests that the deficient expert knowledge needed to advise victims about safety and security along with the lack of resources in the legal framework. Due to the lack of expertise in this area, pressure is placed on victims to resolve issues, many of whom feel that they do not possess the knowledge to identify, cope or manage technology abuse.

Indeed, in our own focus groups, participants raised serious concerns regarding lack of knowledge from manufactures. For instance, FGLM commented: "If you are not tech savvy, you are stuck with the problem until helpdesk decides to help you and sometimes, they do not have an immediate remedy to your problem. There are other worse cases where helpdesk do not even know how to fix your problem". FGSM elaborated that "I'm tech savvy myself and huge believer of this technology, I installed all the cameras in my house and I can control everything from my phone... unfortunately, as many of these technologies are new and they keep having endless new updates, customer service will not have an answer to all of our problems". Other male and female participants also noted how these technologies are not easy-to-use, are hard to set-up, and how lack of expertise from manufacturers could lead to trouble. On these subjects, focus group participants stated: "frankly, none of them are easy to set up. I am a geek, and none of them work in the way that they promise they will." (FGSM) and "it is too complex for some people to contemplate and set up' (FGSM). In our survey, one respondent emphasised that smart systems were "incredibly complex to set up." (F977).

4.2 Smart Monitoring and Stalking

As shown in **Figure 3**, women and men have different views regarding smart systems used for monitoring. Our findings indicate that women have a stronger preference for smart systems compared to men to monitor aspects related to health, energy/heat use, household security, entertainment preferences, young children, elderly/ill, household objects, clothing/laundry,

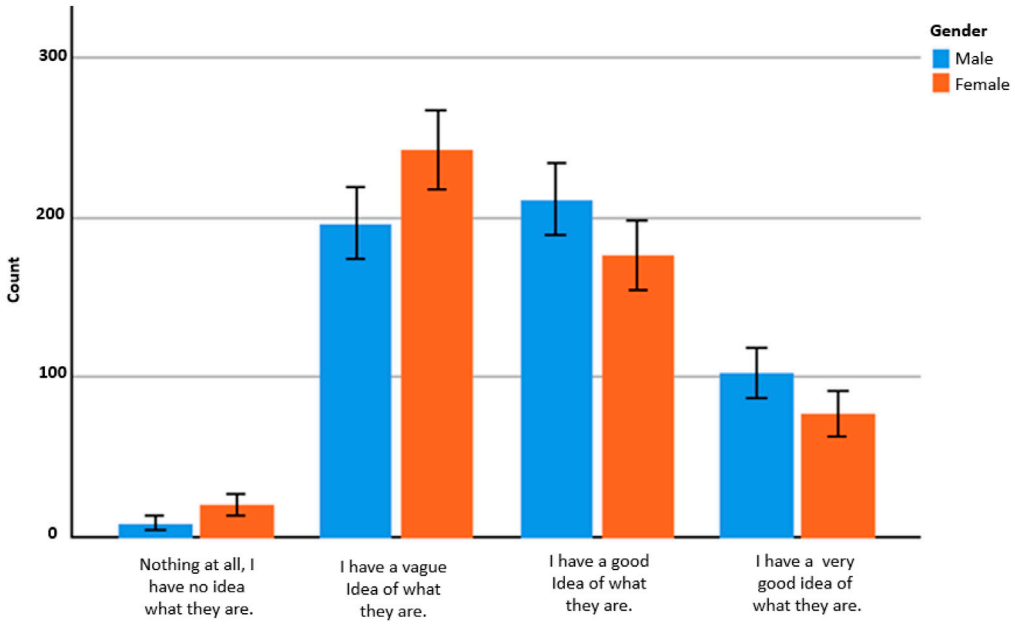

FIGURE 2 | Differences in knowledge about smart systems.Source, authors. Error bars indicate 95% confidence interval.

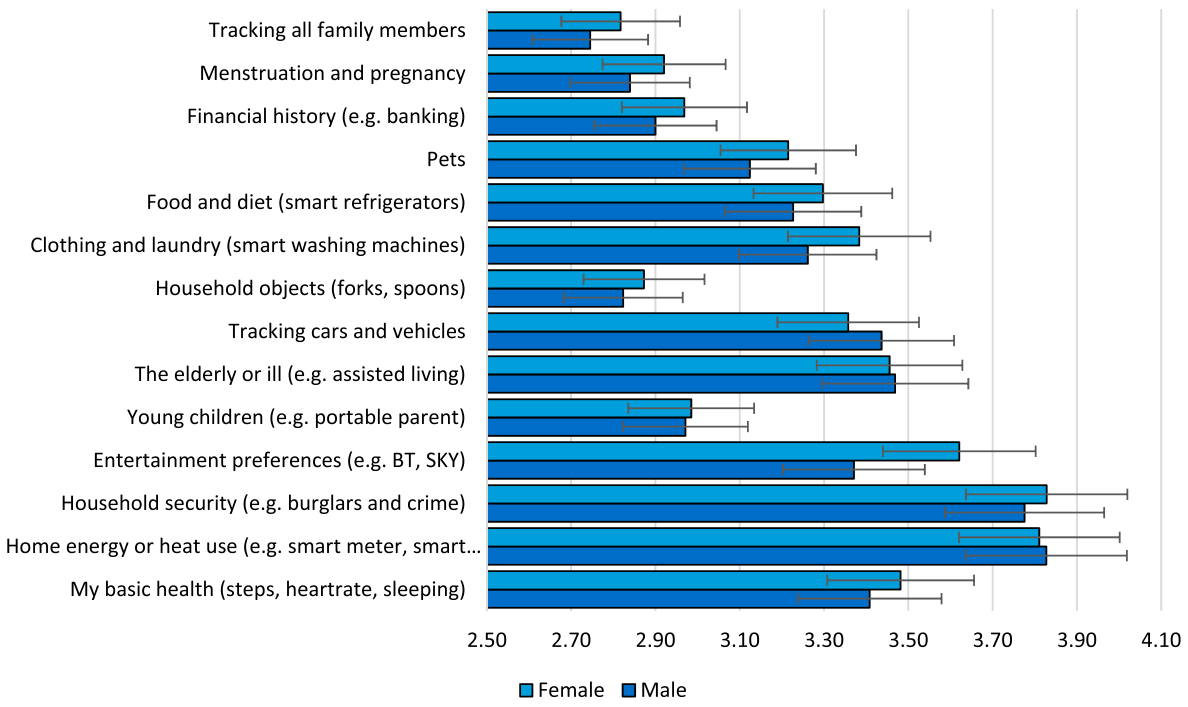

FIGURE 3 | Differences in mean scores for the 'I am comfortable with smart systems monitoring' (Likert scale of 1–5, with 5 = strongly agree).Source. authors. Error bars indicate 95% confidence interval.

food/diet, pets, financial history, menstruation and pregnancy and family members. Men, in contrast, would only have preferences to monitor cars/vehicles.

For instance, our survey results indicate that 33% of women and 29.5% of men agreed that one of the purposes for smart systems could be to monitor family members (see **Figure 3**).

Indeed, in the cyber domestic violence dimension, strangers are not the primary culprits but partners or family members often are the ones that initiate security breaches, look to enhance control and stalk partners (Refuge, 2018; Leitão, 2019). Observations on this matter were brought, respectively, by survey respondent F996 and focus group participant FGMF, as they expressed: "Sometimes couples use it to spy on each other" and "I don't know if you watch Coronation Street. . . a gentleman and his partner have split up and he left a camera in her house, so he's been watching her from his house, so that goes on.". Research in this area has explored how certain technologies could facilitate constant surveillance on partners through tactics such as digital monitoring and tracking to enable perpetrators varied forms of control (Dragiewicz et al., 2018; Harris and Woodlock, 2019). Simultaneously, these provide perpetrators with quicker access and methods to harass and abuse (Melander, 2010).

For Stark, stalking is "the most dramatic form of surveillance used in coercive control fall in a continuum with a range of surveillance tactics whose aim is to convey the abuser's omnipotence and omnipresence (Stark, 2012; p 25)". Therefore, digital technologies can provide the sense of being ever-present in the victim's life. Fraser et al. corroborates that "one of the most terrifying tactics used by stalkers is to make the victim feel that she has no privacy, security, or safety and that the stalker knows and sees everything (Fraster et al., 2010; p 44)". In this sense, although a victim might be separated from his/her partner, they have not been able to completely escape their presence in their lives (Dimond et al., 2011). Similar to these sensations, feelings about being observed, also emerged in both of our qualitative methods. For instance, FGLF stated "Who knows who is going to be listening to you or watching you. I would constantly feel unease knowing that someone is sitting in the back just watching me." FGLM commented that "For me, when looking at surveillance, it's like you'd say there are the good aspects and aspects where it could be open to abuse." And M512 expressed: "It's like Big Brother watching all the time. Potentially, very dangerous.". In addition, participants in our focus groups mentioned how these technologies could facilitate being stalked. For example, FGMM said: "[Nest camera] You could use it when somebody doesn't really know is been watched. I'm following you and you don't know that I'm following you' and FGMF: "Stalking is the only use I can see in Ring Cameras.".

Certainly, within the smart technologies universe, each device could be used for monitoring purposes. For example, Interval House (2019) found common means to carry out stalking through technology. For instance, perpetrators could slip small tracking devices into their victim's clothes or use smart security locks to either lock out or lock in their victims. Abusers could use location-based services (such as find my iPhone), parental tracking or other safety services (e.g. Find my Friends) to track their victims, which could result in potentially dangerous physical stalking (Freed et al., 2018). Other forms of stalking are facilitated by apps. For example, abusers could use the geolocation posts on Facebook, Instagram or Snapchat to track their victims' activities and show up in person or let their victims know where they are (Woodlock, 2017).

For example, the Washington Post (2019) and Thebault (2019) reported that an Australian woman's ex-boyfriend stalked her for months by using smartphone apps linked to her Land Rover. With this, the perpetrator was able to control her windows and stop the car remotely. Besides hacking connected devices, cyberstalking can also be conducted through the use of stalkerware and/or spywares[3]. The use of such applications grew by 40% in 2019, according to 67,000 users having stalkerware apps installed on their phones in 2019 (Webb, 2020). Recurrent forms of monitoring and violence have victims report that they feel constantly unsafe as they cannot truly escape from their abusers, regardless of their physical location (Dimond et al., 2011). Indeed, results from the National Network to End Domestic Violence found that 50% of victim service providers report that offenders constantly use digital platforms and mobile apps to stalk victims and another 41% reported that abusers use GPS tracking devices (Young and Saxena, 2019). Based on this, the New York Times reported that centres for domestic violence have noted that abusers were monitoring victims' activities or remotely controlling smart home appliances and smart systems. Whilst other victims report that they had their "thermostats kicked up to up to 100 degrees" or their "smart speakers turned on in the middle of the night (Bowles, 2018).".

Certainly, participants in our survey noted that "smart systems are invading privacy and over-monitoring users" (M18) and that they are an "invasion of privacy as they are listening all the time" (F582). Another survey respondent felt uncomfortable around such technology: "I don't like the idea of AI listening into my conversations." (F995). Overall, 54.5% of male and 60.6% of female respondents agreed that smart systems could be intrusive (see **Figure 4**). Pertaining to one of our themes on domestic violence, features of digital communications such as storage, synchronicity, replicability and mobility (Baym, 2011) enhance abusers' ability to persist intruding on their targets regardless of their location. In turn, perpetrators' dimension of control goes beyond previous spatial boundaries and become more intrusive. According to FGLF, "smart systems are intrusive, it's full of cameras or devices always watching you, microphones that are always listening to you." The intrusiveness of smart devices was not only brought in our focus groups, but also, results from our survey indicate that users perceive these technologies as an invasion of their privacy. This view is illustrated in **Figure 4**, below.

Working from the premise that smart systems do not require face to face encounters and acts of violence can be perpetrated regardless of the user and perpetrator location, we argue that these devices could facilitate domestic violence to occur 24 h a day. Indeed, (Stark, 2012) identified that victims in this situation felt a condition of "unfreedom entrapment", which key feature was to micro-regulate victims' everyday behaviours in private and public spheres, restricting access to both (Stark, 2007; Woodlock, 2017). It is under this context where discussion of coercive control has emerged. For instance, (Stark, 2007) argues that coercive control is a theoretical framework that entails physical abuse that occurs not only within the settings of domestic violence but also includes tactics that are not traditionally considered as serious forms of abuse. To this, Reed et al.,

[3]Software that enables someone to monitor activities on another user's device without their consent.

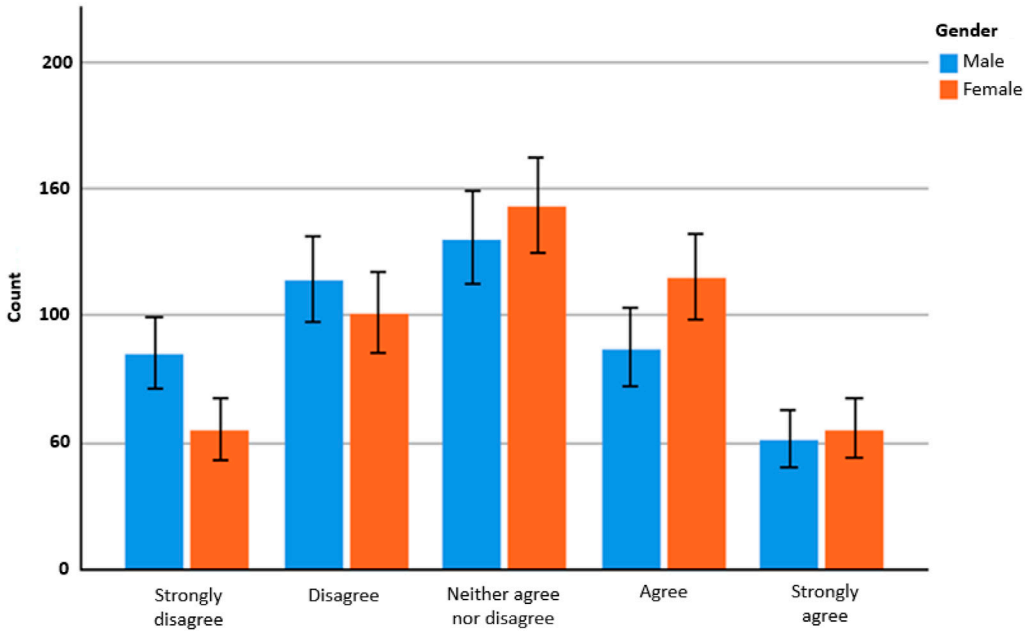

FIGURE 4 | Differences in survey counts for 'There is a risk that smart systems are intrusive'. Source, authors. Error bars indicate 95% confidence interval.

(2016) add that digital technologies belong to a "constellation of tactics" within abusive relationships to allow the perpetrator to achieve certain goals, such as sexual gratification, coercion, retribution, humiliation, and exert control. Woodlock (2017) and Stark (2007), thus, concurred that although women can be abusive in intimate relationships, men often are the main perpetrators of coercive control, due, in part because it is a form of violence rooted in systemic inequality, which affords men a sex-based privilege (Woodlock, 2017). Given the rising number of coercive control offences (Stark, 2018; Stark and Hester, 2019) the UK has recently passed a Domestic Abuse Bill, which provides a new definition of domestic abuse and controlling and manipulative non-physical abuse. The Bill aims to enable everyone to understand what constitutes abuse and thus, encourage more victims to come forward (Home Office, 2019). In addition, the UK government has passed a legislation that positions coercive behaviour in an intimate or family relationship as part of a Serious Crime Act. The offence applies when: "A repeatedly or continuously engages in behaviour towards another person, B, that is controlling or coercive; and At time of the behaviour, A and B are personally connected (The Crown Prosecution Service 2017, Section 76, p.n/a).".

4.3 Parental Control and Surveillance of Children

Figure 5 shows noticeable differences in smart systems attributes. For instance, men value privacy and comfort more than women. However, females were more concerned with aspects related to control, trust and the environment. Convenience, however, was almost equally rated. For this section, we note that surveillance occurs in many settings of our lives, in different relationships and zones, and is not confined to abusive relationships. For instance, Taylor and Rooney (2019), Hasinoff (2017) and Leaver (2017) discuss the role of digital technologies in parental surveillance (as we later present). Whilst others study the role of digital technologies in governmental surveillance (Marwick, 2012; Gallie et al., 2016; Han, 2017; Kendall Taylor et al., 2020; Mello and Wang, 2020), which may lead to denial of services and even destruction of property (Kleinrock, 2004). In sum for Zuboff, (2018) "nearly every product or service that begins with the word "smart." or "personalised.", every internet-enabled device, every "digital assistant.", is a simply supply-chain interface for the unobstructed flow of behavioural data on its way to predicting our futures in a surveillance economy.".

Tension in our survey and focus groups emerged when discussing using smart systems to monitor young children. As represented in detail in **Figure 6**, results from our survey indicate that only 29.8% of men and 31.7% of women agree to use these technologies with this end.

However, most participants in our focus participants felt comfortable monitoring young children. To illustrate this point, FGMM said: "Baby monitors, when they're sleeping. Definitely not a problem with that That would be the only camera I would have inside my house." On this, FGLM expressed: "if you have children, you may want to be watching what they're up to." For some, invading baby's privacy was not an issue, as elaborated by FGLM: "It's a very helpful baby monitor. And if somebody wants to track the behaviour of my two-year-old grandson, they're welcome to it." Another FGLM stated that it was "completely acceptable to monitor a young child upstairs while you are downstairs." and that "smart systems have great potential to stop kidnappers and alert the police or others about kidnapping from a remote location." Indeed, we

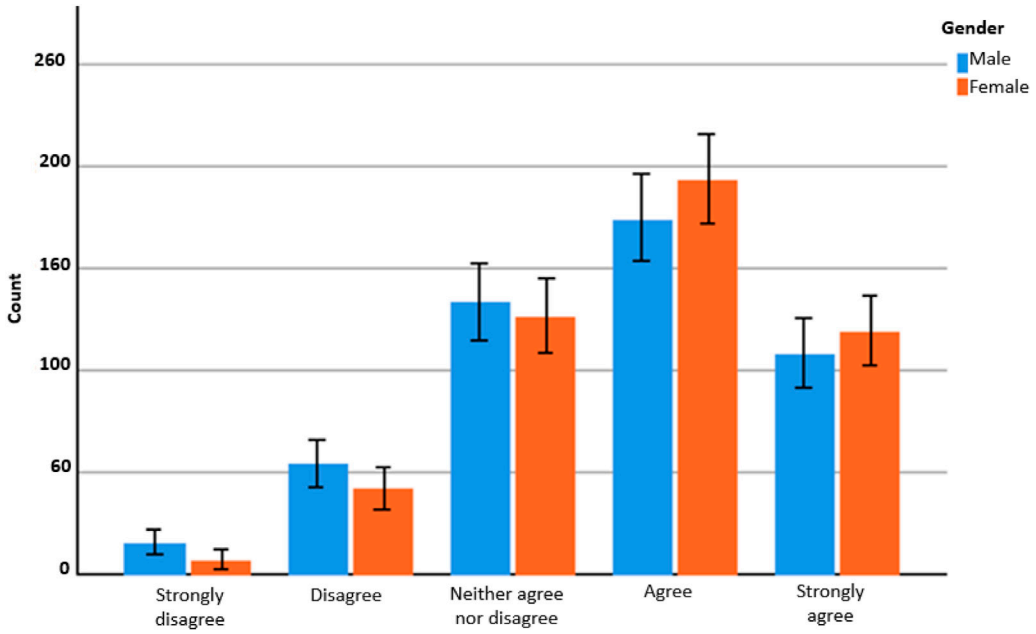

FIGURE 5 | Different in mean scores from the focus group of smart syetms attributes by gender (*n* = 18). Source, authors.

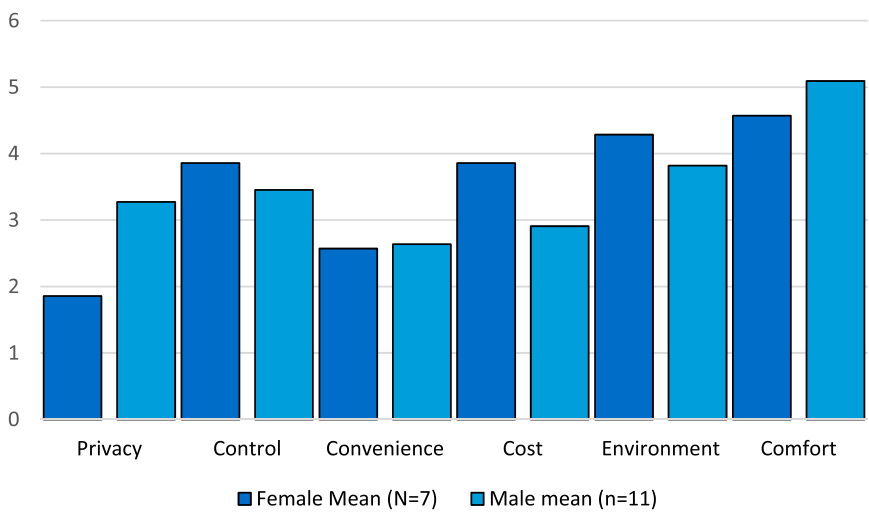

FIGURE 6 | Difference in survey counts for 'Comfortableness of using smart sysemts to monitor children'.Source, authors. Error bars indicate 95% confidence interval.

will return to this point about smart systems possibly stopping abuse in **Section 5**.

Nonetheless, reasons to distrust technologies designed for children should be on parents' radars given the 45 million online photos and videos of children been sexually abused and, in some cases, tortured. Keller and Dance (2019) found an insatiable criminal underworld that has exploited the flawed and insufficient efforts to contain these horrific imaginaries, given that criminals are using advanced technologies like encryption to stay ahead of the police. Similar experiences are noted by Chiu, (2019), who reported that through a Ring camera, an eight years old girl not only was subject to racial slurs, she was also told to break her television by a hacker—he continued pestering and harassing the little girl until the parents disconnected the device. On this, FGSF commented: "there are some horrible people out there absolutely vile people, they will definitely take advantage of some of these things". FGLF added that "I want to trust smart systems more, I would love to trust them more. But I don't."

For Madden, (2016), regardless of users undergoing negative experiences, "smart" parental tracking is the logical result of a

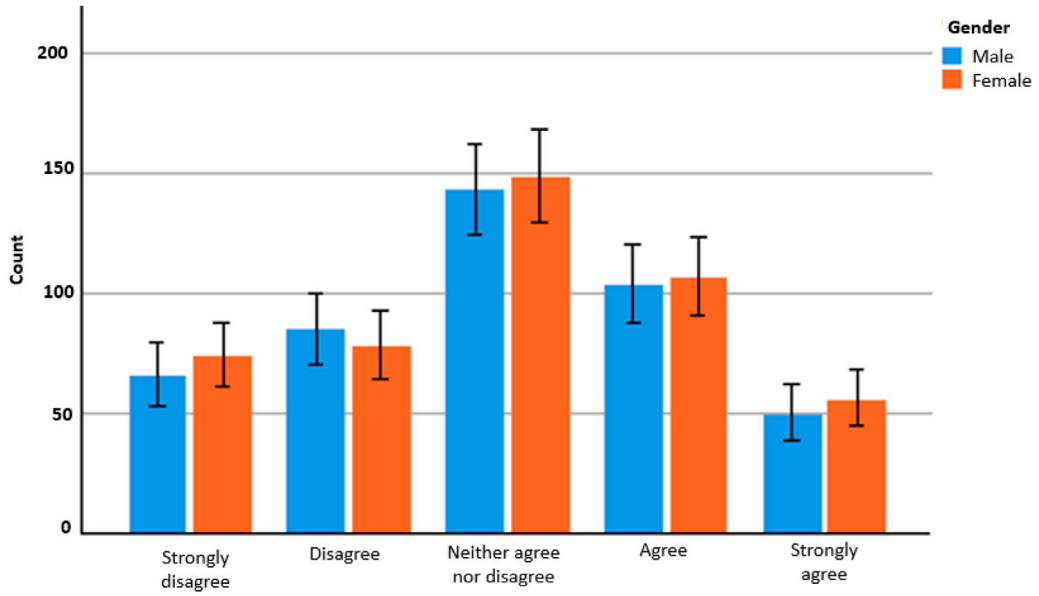

FIGURE 7 | Survey counts for 'Comfortableness of using smart systems to monitor menstruation or pregnancy'.Source, authors. Error bars indicate 95% confidence interval.

world where children spend a significant part of their lives in the digital arena. Nonetheless, over-monitoring children could lead to negative outcomes, as shown by Hawk et al., (2009) when they reveal that if parents engage in highly intrusive behaviours over their children, it may backfire on them, as children may adopt more secretive behaviours, thus, unbaling parents to know less about their children's activities and whereabouts. Given that the technology of parental control has evolved so rapidly, there are not yet clear norms of what is acceptable or even healthy in demarcating monitoring boundaries (Weir, 2016).

Ironically, in some cases, children themselves ask for smart systems that could be used to monitor them. Focus group participant FGLM said.

It's so I can keep in contact with my children. Our kids said we needed them [smart systems]. Children's schools they wanted to have constant contact with parents and having a reliable way they could be contacted.

FGSF noted that:

When you join school now, you're generally expected to do some element of your homework using Google or exploring online. So, children are encouraged from an early age to use digital technologies. Because if they do not, they are going to be excluded from the world.

Parents observations on this matter were apt, given that the UK government, through the Education Technology (EdTech) program, seeks to tackle day-to-day challenges faced in the education sector, including reducing teacher workload, increasing efficiency, improving accessibility and inclusion and improving teaching and students' outcomes. The program seeks to tackle these challenges by using tablets, laptops and/or other digital devices (Department of Education, 2019). Demonstrating how much the industry has grown so far, investments in EdTech have reached £90.9 million–a 140% increase in the amount invested in 2016 (Robins, 2019).

4.4 Femtech, Menstruation and Pregnancy

Another set of concerns arise through the monitoring of smart systems related to menstruation and pregnancy.In our survey, as **Figure 7** illustrates, 28.9% of women and 20.3% of men agreed to use these technologies for that purpose. Yet, people could have reasons to distrust technologies accessing personal data to monitor menstruation and pregnancy cycles.

Given the potential scenarios for misusing personal information, focus group participant FGSM expressed being distressed on where their data in general was going: "For me, the biggest fear, it's the data that they're colleting that I don't know about. I think it's the analytic data that they're generating on you. They can tell what you like, what you don't like, they even can tell what your personality is.". These concerns were not far from reality, as many manufacturers of smart devices base their primary business model on collecting household data (Naughton, 2019). Not only that, Zuboff, (2019) notes that consumers are unaware of the value of the data they are giving away, which is not only extremely valuable but also can be profitable to generate predictions about preferences and future behaviours. Focus group participant FGLM shared a similar perspective when he stated: "The people who are benefiting now, and will do so more in the future, are the people who own the data that's generated by smart technology, and then use that data to influence others' behaviour".

In this way, although participants seemed to be aware of some of the instruments that regulate smart systems, many still did not know what sort of personal information they were giving away

when accepting terms and conditions. To this, focus group participant FGMF stated: "all these are signed up to GDPR, aren't they? but it concerns me that maybe there are hidden ways of, I'm not saying that there's any subterfuge going on, but sometimes you might not have ticked a box, so that inherently gives them permission to use your data in certain ways. I find myself checking more carefully now.". Indeed, most participants were unaware of what information users are giving away when agreeing to terms and conditions. Focus group participant FGMM concurred and asked in the room: "how many of us actually read all the documentations and terms and conditions?." Certainly, most consumers are not reading them properly, for example, Amazon states that users have given permission for human verification and allows to use data "to train our speech recognition and natural understanding systems (Hern, 2019).".

Focus group participant FGLF explained in her experience why this could happen: "Basically, they designed the interface to make you just click through and ignore and just give them all they need.". This vision could be accurate given that study conducted by McDonald and Cranor (2009) calculated that users would take up to 76 working days to read through all the privacy polices encountered in a year. In this sense, LifeHacker provides the internet users with the criteria for skimming through privacy policies. They advise users to look at statements related to data sharing, storage and collection or phrases such as "store' and encrypt.". Additionally, they advise users to search for terms such as "deletion" or "retention." to learn about how long platforms keep their information (Grauer, 2019).

5 DISCUSSION: SMART SOLUTIONS TO COMPLICATED PROBLEMS

This section builds on our results to discuss three prominent qualitative themes: a duality of smart systems functions and emotions, the political economy of knowledge production, and the promise of smart systems for actually deterring and inhibiting abuse and violence.

5.1 A Plurality of Functions, Beliefs, Attitudes, and Emotions

Results from our study indicate that there are discrepancies in users' beliefs and attitudes towards smart systems. For instance, although most participants knew about the risks these technologies entail and expressed being afraid of these concerns, participants still stated seeing the potential by which smart systems could ease their lives. We thus argue that the feelings and attitudes users have towards smart systems are complex, with a duality of positive and negative dimensions. Below we further elaborate on this thought.

First, our data was not uniformly critical of smart systems. In some instances, smart surveillance fulfilled its purpose. For instance, survey respondent F898 avoided being robbed by monitoring his/her property: "Caught a burglar in my home on Canary camera but police still don't have any one arrested as yet." Monitoring has also helped to avoid food waste as noted by survey respondent M350: "As by-product, we noticed while on holiday our hive wasn't active–we asked a family member to check, and there had been a power-cut which tripped the breakers. Saved us at least £300 in freezer food". FGMF said that smart systems helped her to keep in touch with family: "I use technology for a range of applications but mainly to keep in touch with younger members of my family.". Whereas survey respondent M703 perceived smart systems as a mean of enhancing relationships: "They can provide a way of aiding relationships".

Focus group participant (FGLM) captured a possible explanation of the duality of feelings, when he elaborated: "Despite my nightmare scenarios, I'm positive about it. It may seem really odd, but I am. I hope that we're going to get the built in, we're going to get to a point where we start to legislate more personally, and people are going to legislate for us, so we can get more control over these things.". Or focus group participant FGMF, who regardless of discussing risks, still felt optimistic: "There are some reservations, which we've discussed, but I think it's healthy to questions things and not just to accept them blindly, but yes, on the whole, I feel positive towards smart technolog.". Another FGLM was even more explicit about the duality of smart systems, stating that "smart systems have a duality to them, they can turn into a 'can do' technology, they can become tailored to actually help those who have been disadvantage before, the old and frail, the victimized, tailored to their needs. They can become empowering."

Others discussed dual or at least mediated uses for their smart systems. FGLF stated that their approach to navigating the risks of smart systems was to use them when out of the home. As they said:

Yes, I would use smart systems to monitor and survey my home. I am going to get a high view camera. Take it offline when I am home. I do not want it to surveil me, but I do want it to surveil intruders. But I don't trust it enough to have it on all the time, so my solution is to unplug it when I am home.

This suggests one possible way of managing smart systems to not overly force trade-offs over privacy or surveillance.

5.2 The Political Economy of Smart Homes and Knowledge Cocreation

Moreover, our findings indicate knowledge about smart homes has its political economy, it is distributed unevenly and sees some groups advantaged and other groups disadvantaged. Companies and providers may know very well about the parameters of smart homes, but many users and prospective adopters do not know what smart systems are. Hence, it is hard for users to identify how benefits are delivered and quantified and how risks affect their lives. On this matter, FGMF commented: "I think if there was a definition of smart technology it might help with understanding it better. Now it feels quite broad and vague.". The fact that even within literature, there is a plurality of definitions and concepts of smart systems and to date, we do not have an accepted definition also makes it hard for policymakers to regulate them, not only in terms of privacy and data but also in terms of energy consumption and waste.

Finally, this lack of knowledge extends to manufacturers and authorities to advise victims of technology abuse. Where not only victims have had to deal with this situation on their own, but also demands immediate action to enhance their regulatory framework. Beyond technology abuse, industries' lack of expertise has also led users to feel these technologies are hard to fix and thus leading to over consumerism and disposable culture. Supporting this sentiment, FGLM commented: "Most of the items are designed to discourage you from repairing them, and most of the perceived wisdom is that you can't repair them, or you're told culturally that you're not to repair it". FGLM concurred: "The built-in obsolescence of all the smart technology we are purchasing some apps after a year will no longer update".

5.3 The Promise of Smart Systems Inhibiting Violence and Abuse

In other cases, smart systems have helped prevent domestic violence. Indeed, there are an increasing number of personal safety apps that are designed to make users feel safer, in particular for women (Maxwell et al., 2020) whilst other technologies target children's safety (Hasinoff, 2017). For example, in New Mexico a man was arrested for beating his girlfriend and threatening to kill her. During the assault, he asked: "did you call the sheriffs?." The question was picked up by Amazon Alexa and recognized as a command, prompting to call 911 (Miller, 2017). In addition, many smart speakers have unobtrusive recording features that could provide evidence of abuse. Other app-based bottoms or Bluetooth trackers can allow victims to send silent messages calling for help or record dangerous situations.

In order to prevent domestic violence, Brignone and Edleson (2019) review the quality and potential use of smartphone apps to intervene in intimate partner violence either in domestic settings or through an app. This study takes upon more relevance when research has shown that meeting online had finally overtaken meeting through friends, with around 40% of US couples first connecting through an app (Kjellsson, 2016). Their work (Brignone and Edleson, 2019), found that higher rating apps such as Tech Safety, Over the Line and Youth Pages often had accessible user interface, updated and functional links to keep victims informed. In addition, such apps possessed technical capabilities that were mindful to the victim's safety, such as turning off location tracking and the safe and secure storage of user data and developers. After an exhaustive review, Maxwell et al., (2020) found a common trend within the safety apps world, where the majority offered interventions either at the time of the event or post-event. Their results suggest that they may reduce a user's fear of crime; however, such applications have limited usefulness in reducing vulnerability to victimization (Maxwell et al., 2020)

A similar approach is taken by Freed et al., (2017) They refer to the works of (Arief et al., 2014) and (Emms et al., 2012) to better design platforms to help victims. The first lays out a vision for 'sensible privacy'. Their app would erase information about visits to victims-relevant websites by a user and record potential abuse associated with the device. The second suggests tools to help victims of domestic violence erase their browsing history. Other digital platforms, such as GuardDV, (2019), aim to protect victims of domestic violence with real-time information about the safety of their environments through the use of smart monitoring and facial recognition technology. Other apps for victims of domestic violence have been developed, including BrightSky developed by Vodafone and Hestia (Vodafone, 2019) TechSafety app (Safe Chat Silicon Valley, 2019) and others. Given the constant pressure from users to protect them, Tinder released some new safety features such as a panic button that alerts authorities and a photo verification feature. However, research indicates that these measures are inadequate it puts the onus on women, rather than the app itself and Tinder's' poor reaction to act and suspend users with aggressive behaviours.

The prevention of domestic violence is not limited to smart systems apps. Ogilvy, for instance, is developing an e-textile technology that keeps a record of events. The smart clothing device is known as 'The Dress for Respect', and for some, it will bring sexual harassment into the limelight. These dresses have sensors sewn into them that record contact and pressure. In this sense, when contact happens, the same area lights up on the dress on the control unit's computer screen. This technology can also keep track of events (e.g. time and location) and even notes the intensity of the touch, as the sensors record the presence of touch and pressure (Murphy, 2018).

Governments provide other security measures. For instance, the Australian Office of the ESafety Commissioner, (2019) provides useful advice to users on what to look out for when purchasing smart devices. The guide's contents explain how to be safe when using these technologies in a clear and friendly format in addition to age recommendations. Alternatively, the FBI, recently warned users about features that come with enhanced televisions and guard questionable data collection, could be used for monitoring purposes and as a gateway for hackers to come into users' homes. The FBI warns about the range of threats smart devices could entail, from changing channels and showing children inappropriate content, to turning the bedroom TV's camera and microphone and silently cyberstalk users (FBI, 2019).

However, although efforts from the government are made to address cyber abuse, others suggest that to address domestic violence is necessary, first, that victims understand the nature of shared devices ecosystems; whilst manufacturers ought to be more transparent in terms of who access users' accounts (Parkin et al., 2019). Whilst Webb (2020) is more determine when she suggests that "Stalkerware shouldn't exist at all, because it's unethical.". A middle point is suggested by researchers indicating that a feminist approach should be developed considering values and views from domestic violence victims that embed their views, values and experiences in the apps design and innovation (MIT Technology Review, 2020). On this point we note that to further mitigate technology facilitated abuse, victims should contribute and actively participate in the development of technologies and apps that prevent abuse. Like Diaz-Gorfinkiel et al. (2021) we argue that technologies alone do not represent a permanent solution to the problem of domestic

violence; instead, users should rely on them as a medium to achieve safety and avoid dependence on technology.

6 CONCLUSION AND FUTURE RESEARCH

In sum, smart systems being facilitated by energy decentralization and prosuming do not exist in a vacuum; our results show that knowledge, preferences, and perceptions remain mediated by gender as well as opportunities for abuse and violence. At the simplest level, smart systems are gendered, with men being more aware of them, and men also often the perpetrators of domestic violence and abuse. Women report or state within our data to being more ignorant or 'clueless' about how the technologies function, or even that they may exist, and seem to lack the knowledge that they can track and monitor things as intimate as personal movements, clothing, menstrual cycles, and pregnancy. From our findings, we also infer that because of this lack of knowledge and awareness, fewer women may be able to utilize smart systems to prevent domestic violence and abuse or cope with it in case it occurs. We thus argue that the ability to control smart systems is not universal and whoever user is more tech savvy, holds the potential to exacerbate unequal dynamics of power and control within households.

Our results also reveal some interesting findings concerning the acceptability of surveillance and monitoring. Almost one-third of all survey respondents, or 33% of women and 29.5% of men when broken down by gender, agreed that one of the purposes for smart systems should be to monitor family members. Many discussed monitoring children, a concern not only if those parents abuse their children (the most often perpetrator of abuse is a family member or relative), but also opening up vulnerabilities to hackers and third parties with the remote access that can facilitate cyber stalking.

Contrary to the glossy and optimistic accountings of smart systems in its promotional material, our findings suggest that users of smart systems although they did not vividly state been victims of technology abuse, they recognized their dark side and dystopic ends; including their potential to exacerbate domestic violence as well as companies "sinister" means for data manipulation and intrusiveness. Moreover, unlike conventional forms of abuse, the ubiquity of digital technology and our online environment may make it difficult to ever truly escape such abuse once it begins, with smart systems making possible abuse 24 h of the day and independent of the victim or perpetrator's physical location. It may create future hostile digital environments that track, control, and abuse people—especially women and children—from the earliest stages of their life, from inception and pregnancy in some circumstances. Under this context, we make an imperative call to further advance the understanding of surveillance, control, and domestic and sexual violence in the smart systems dimension, where devices are tools of entertainment and security and instruments of harassment, coercion, and abuse. We also call on those designing smart home and prosuming systems, especially analytical protocols and software algorithms, to be more aware about cultural sensitivity and gender issues (Sovacool and Griffiths, 2020) as well as data sensitivity and algorithmic justice (Rahwan et al., 2019; Panetta, 2021)

Nonetheless, our findings were not entirely negative. Like many tools, smart systems possess a duality to them, there are configurations and options where they can prevent and inhibit abuse, via smart clothing that automatically detects a physical assault, to cameras or systems that offer real time assistance to the police for catching criminals and documenting abuse, to apps and devices that help the victim recover from abuse, too. Which pathways smart systems proceed down will depend greatly on how the technology is governed in the next few critical years shaping its evolution.

Furthermore, given that women are not only victims of domestic violence, for instance, recent research has indicated that women are just as likely, if not more so, to engage in more covert forms of stalking such as cyberstalking (Berry and Bainbridge, 2017; Smoker and March 2017). Moreover, the works from Hine et al. (2020), Perryman and Appleton (2016) and Lysova et al. (2020) identify women as the perpetrators of domestic violence we encourage future research to look at other groups of domestic violence and further analyse what the role of technology abuse is in gay couples, for instance. Lastly, our work points the way towards fruitful future research. Although the dominant lens we utilized to view our results was grounded in domestic violence, feminist, especially energy feminism, offers a notable alternative framework for other researchers to pursue. For instance, Bell et al. (2020) suggest that themes of feminist political control over energy systems, systems that priorate welfare or the environment over profit, efforts to mitigate violence and promote a culture of care, and efforts to promote community-directed and collaborative energy systems would yield deeper insights than a "gender only." lens.

Furthermore, we call on researchers to consider more intersectional forms of gender and energy or smart technology that go beyond many of the simple binaries implicit within current research, e.g. gender (male and female), income (rich and poor), or race (black and white) (Crenshaw, 1991). Ground-breaking work in this regard focusing on technology includes that of Mulvaney (2013) (examining justice and solar commodity chains), Adams et al. (2012) (examining justice and whole systems analysis of microgeneration technologies), and Healey at al., 2019 (embodied energy injustices). Ground-breaking work approaching it from the intersectional angle includes Lennon (2017) (intersections of race, ethnicity, and gender), Ryder (2018) (intersections of feminism, class, and power), and Lieu et al. (2020) (intersections of indigenousness and gender). Perhaps when these more integrated, reflexive, and intersectional approaches are utilized, we can better understand and begin to resist the forms of patriarchy and violence that are at risk of being embedded into the smart energy systems, grids and prosuming practices within the homes of tomorrow.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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REFERENCES

Adams, C. J. (1996). ""This Is Not Our Fathers' Pornography": Sex, Lies, and Computers," in *Philosophical Perspectives on Computer-Mediated Communication*. Editor C. Ess (Albany: University of New York Press), 147–170.

Adams, C., Taylor, P., and Bell, S. (2012). Equity Dimensions of Micro-generation: A Whole Systems Approach. *J. Renew. Sust. Energ.* 4 (5), 053122. doi:10.1063/1.4759454

Amnesty International (2017). Amnesty Reveals Alarming Impact of Online Abuse against Women. Available at: https://www.amnesty.org/en/latest/news/2017/11/amnesty-reveals-alarming-impact-of-online-abuse-against-women/.

Anderson, M. (2017). Key Takeaways on How Americans View – and Experience – Online Harassment, Pew Research Center. Available at: https://www.pewresearch.org/fact-tank/2017/07/11/key-takeaways-online-harassment/ (Accessed October 30, 2020).

Arief, B., et al. (2014). "Sensible Privacy: How We Can Protect Domestic Violence Survivors without Facilitating Misuse," in Proceedings of the ACM Conference on Computer and Communications Security, Scottsdale Arizona USA, 3 November 2014 (Scottsdale, Arizona: ACM), 201–204. doi:10.1145/2665943.2665965

Balta-Ozkan, N., Davidson, R., Bicket, M., and Whitmarsh, L. (2013). Social Barriers to the Adoption of Smart Homes. *Energy Policy* 63, 363–374. doi:10.1016/j.enpol.2013.08.043

Baym, N. K. (2011). *Personal Connections in the Digital Age*. 2nd edn. Malden, MA: Polity Press.

Bell, S. E., Daggett, C., and Labuski, C. (2020) Toward Feminist Energy Systems: Why Adding Women and Solar Panels Is Not Enough, *Energ. Res. Soc. Sci.* 68, 101557. doi:10.1016/j.erss.2020.101557

Berry, M., and Bainbridge, S. (2017). Manchester's Cyberstalked 18–30s: Factors Affecting Cyberstalking. *Adv. Soc. Sci. Res. J.* 18. doi:10.14738/assrj.418.3680

Bert, F., Passi, S., Scaioli, G., Gualano, M. R., and Siliquini, R. (2015). There Comes a Baby! what Should I Do? Smartphones' Pregnancy-Related Applications: A Web-Based Overview. *Health Informatics J.* 22, 608. doi:10.1177/1460458215574120

Bowles, N. (2018). Thermostats, Locks and Lights: Digital Tools of Domestic Abuse. *The New York Times*. Available at: https://www.nytimes.com/2018/06/23/technology/smart-home-devices-domestic-abuse.html.

Boyd, D. (2014). *It's Complicated: The Social Lives of Networked Teens*. Yale University Press.

Brignone, L., and Edleson, J. L. (2019). 'The Dating and Domestic Violence App Rubric: Synthesizing Clinical Best Practices and Digital Health App Standards for Relationship Violence Prevention Smartphone Apps', International Journal of Human-Computer Interaction. *Taylor & Francis* 00, 1–11. doi:10.1080/10447318.2019.1574100

Bugden, D., and Stedman, R. (2021). Unfulfilled Promise: Social Acceptance of the Smart Grid. *Environ. Res. Lett.* 16, 034019. doi:10.1088/1748-9326/abd81c

Butler, J. C., and Abrahart, B. (1997). Internet Benefits-An Organization's Perspective. *Comput. Geosciences* 23 (2), 221–223. doi:10.1016/S0098-3004(97)85446-5

Cavezza, C., and McEwan, T. E. (2014). Cyberstalking versus Off-Line Stalking in a Forensic Sample. *Psychol. Crime L.* 20 (10), 955–970. doi:10.1080/1068316X.2014.893334

Chatterjee, R., Doerfler, P., Orgad, H., Havron, S., Palmer, J., Freed, D., et al. (2018). "The Spyware Used in Intimate Partner Violence," in *IEEE Symposium on Security and Privacy* (San Francisco: IEEE), 441–458. doi:10.1109/SP.2018.00061

Chayn, S. (2017). Tech vs Abuse: Research Findings. Available at: https://docs.wixstatic.com/ugd/f86f13_366b6514c8fc4e9488fc15edf2148d52.pdf.

Chiu, A. (2019). *She Installed a Ring Camera in Her Children's Room for "Peace of mind." A Hacker Accessed it and Harassed Her 8-Year-Old Daughter*. Washington D.C: The Washington Post. Available at: https://www.washingtonpost.com/nation/2019/12/12/she-installed-ring-camera-her-childrens-room-peace-mind-hacker-accessed-it-harassed-her-year-old-daughter/?arc404=true.

Citron, D. K. (2009). Cyber Civil Rights. *Boston Univ. L. Rev.* 89, 61–125. Available at: https://ssrn.com/abstract=1271900.

Citron, D. K., and Norton, H. (2011). Intermediaries and Hate Speech: Fostering Digital Citizenship for Our Information Age. *Boston Univ. L. Rev.* 91, 1435. Available at: https://ssrn.com/abstract=1764004.

Crenshaw, K. (1991). Mapping the Margins: Intersectionality, Identity Politics, and Violence against Women of Color. *Stanford L. Rev.* 43 (6), 1241–1299. doi:10.2307/1229039

Darby, S. J., and McKenna, E. (2012). Social Implications of Residential Demand Response in Cool Temperate Climates. *Energy Policy* 49, 759–769. doi:10.1016/j.enpol.2012.07.026

Department of Education (2019). *Realising the Potential of Technology in Education*. London. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/791931/DfE-Education_Technology_Strategy.pdf.

Díaz Gorfinkiel, M., Díaz Gandasegui, V., and Gómez García, M. V. (2021). New Technology Proposals for Tackling Intimate Partner Violence: Challenges and Opportunities. *Tech. Soc.* 67, 101714. doi:10.1016/j.techsoc.2021.101714

Dimond, J. P., Fiesler, C., and Bruckman, A. S. (2011). Domestic Violence and Information Communication Technologies. *Interacting Comput.* 23 (5), 413–421. doi:10.1016/j.intcom.2011.04.006

Dragiewicz, M., Burgess, J., Matamoros-Fernández, A., Salter, M., Suzor, N. P., Woodlock, D., et al. (2018). Technology Facilitated Coercive Control: Domestic Violence and the Competing Roles of Digital media Platforms. *Feminist Media Stud.* 18 (4), 609–625. doi:10.1080/14680777.2018.1447341

Emms, M., Arief, B., and van Moorsel, A. (2012). *Electronic Footprints in the Sand: Technologies for Assisting Domestic Violence Survivors*. Springer. Annual Privacy Forum, 203–214.

ESafety Commissioner (2019). Be Smart and Secure when Choosing Tech Gifts for Children and Young People, Australian Government. Available at: https://www.esafety.gov.au/parents/gift-guide (Accessed December 26, 2019).

FBI (2019). Oregon FBI Tech Tuesday: Securing Smart TVs. Available at: https://www.fbi.gov/contact-us/field-offices/portland/news/press-releases/tech-tuesdaysmart-tvs/?=portland-field-office (Accessed December 26, 2019).

Fox, J., Osborn, J. L., and Warber, K. M. (2014). Relational Dialectics and Social Networking Sites: The Role of Facebook in Romantic Relationship Escalation, Maintenance, Conflict, and Dissolution. *Comput. Hum. Behav.* 35, 527–534. doi:10.1016/j.chb.2014.02.031

Fraser, C., Olsen, E., Lee, K., Southworth, C., and Tucker, S. (2010). The New Age of Stalking: Technological Implications for Stalking. *Juvenile Fam. Court* 61 (4), 39–55. doi:10.1111/j.1755-6988.2010.01051.x

Freed, D., Palmer, J., Minchala, D., Levy, K., Ristenpart, T., and Dell, N. (2017). Digital Technologies and Intimate Partner Violence: A Qualitative Analysis with Multiple Stakeholders. *Proc. ACM Human-Computer Interaction* 1, 22. doi:10.1145/3134681

Freed, D., Palmer, J., Minchala, D., Levy, K., Ristenpart, T., and Dell, N. (2018). ""A Stalker's Paradise": How Intimate Partner Abusers Exploit Technology," in Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, Montreal QC Canada, April 21 - 26, 2018 (Quebec: ACM.). Available at: https://dl.acm.org/citation.cfm?id=3174241.

Furszyfer Del Rio, D. D., Sovacool, B. K., Bergman, N., and Makuch, K. E. (2020). Critically Reviewing Smart home Technology Applications and Business Models in Europe. *Energy Policy* 144, 111631. doi:10.1016/j.enpol.2020.111631

Furszyfer Del Rio, D. D., Sovacool, B. K., and Martiskainen, M. (2021). Controllable, Frightening, or Fun? Exploring the Gendered Dynamics of Smart home Technology Preferences in the United Kingdom. *Energ. Res. Soc. Sci.* 77, 102105. doi:10.1016/j.erss.2021.102105

Gallie, J., Weidmann, N. B., Benitez-Baleato, S., Hunziker, P., Glatz, E., and Dimitropoulos, X. (2016). Digital Discrimination: Political Bias in Internet Service Provision across Ethnic Groups. *Science* 353 (6304), 1151–1156. doi:10.1126/science.aaf5062

Ghosh, A. K., Guha, S., and Wisniewski, P. J. (2018). "Safety vs. Surveillance: What Children Have to Say about mobile Apps for Parental Control," in Conference on Human Factors in Computing Systems - Proceedings, Montreal QC Canada, April 21 - 26, 2018 (Monreal, QC: ACM.), 1–14. doi:10.1145/3173574.3173698

Grauer, Y. (2019). How to Skim a Privacy Policy, LifeHacker. Available at: https://lifehacker.com/how-to-skim-a-privacy-policy-1839488010 (Accessed December 29, 2019).

Grimes, S. M. (2014). Configuring the Child Player. *Sci. Technol. Hum. Values* 40 (1), 126–148. doi:10.1177/0162243914550253

GuardDV (2019). GuardDV Smart Monitoring. Available at: https://www.guarddv.com/ (Accessed December 28, 2019).

Han, B.-C. (2017) Psychopolitics: Neoliberalism and New Technologies of Power. Verson.

Hargreaves, T., and Wilson, C. (2017). *Smart Homes and Their Users*. Switzerland, Cham: Springer. doi:10.1007/978-3-319-68018-7

Harris, B. A., and Woodlock, D. (2019). Digital Coercive Control: Insights from Two Landmark Domestic Violence Studies. *Br. J. Criminology* 59 (3), 530–550. doi:10.1093/bjc/azy052

Hasinoff, A. A. (2017). Where Are You? Location Tracking and the Promise of Child Safety. *Television & New Media* 18 (6), 496–512. doi:10.1177/1527476416680450

Hawk, S. T., Keijsers, L., Hale, W. W., and Meeus, W. (2009). Mind Your Own Business! Longitudinal Relations between Perceived Privacy Invasion and Adolescent-Parent Conflict. *J. Fam. Psychol.* 23 (4), 511–520. doi:10.1037/a0015426

Healy, N., Stephens, J. C., and Malin, S. A. (2019). Embodied Energy Injustices: Unveiling and Politicizing the Transboundary Harms of Fossil Fuel Extractivism and Fossil Fuel Supply Chains. *Energ. Res. Soc. Sci.* 48, 219–234. doi:10.1016/j.erss.2018.09.016

Heise, L., and Garcia-Moreno, C. (2002). *World Report on Violence and Health*. Geneve. Available at: https://www.who.int/violence_injury_prevention/violence/world_report/en/full_en.pdf.

Henry, N., Flynn, A., and Powell, A. (2020). Technology-Facilitated Domestic and Sexual Violence: A Review. *Violence Against Women* 26 (15–16), 1828–1854. doi:10.1177/1077801219875821

Henry, N., and Powell, A. (2017). *Sexual Violence in a Digital Age*. UK: Palgrave Macmillan.

Henry, N., and Powell, A. (2015). Beyond the 'sext': Technology-Facilitated Sexual Violence and Harassment against Adult Women. *Aust. New Zealand J. Criminology* 48 (1), 104–118. doi:10.1177/0004865814524218

Henry, N., and Powell, A. (2018). Technology-Facilitated Sexual Violence: A Literature Review of Empirical Research. *Trauma, Violence, & Abuse* 19 (2), 195–208. doi:10.1177/1524838016650189

Hern, A. (2019). Amazon Staff Listen to Customers' Alexa Recordings, Report Says, the Guardian. Available at: https://www.theguardian.com/technology/2019/apr/11/amazon-staff-listen-to-customers-alexa-recordings-report-says (Accessed November 8, 2020).

Herring, S. C. (1999). The Rhetorical Dynamics of Gender Harassment On-Line. *Inf. Soc.* 15 (3), 151–167. doi:10.1080/019722499128466

Hinduja, S., and Patchin, J. W. (2020). Digital Dating Abuse Among a National Sample of U.S. Youth. *J. Interpersonal Violence*, 1–21. doi:10.1177/0886260519897344

Hine, B., Bates, E. A., and Wallace, S. (2020). "I Have Guys Call Me and Say 'I Can't Be the Victim of Domestic Abuse'": Exploring the Experiences of Telephone Support Providers for Male Victims of Domestic Violence and Abuse. *J. Interpersonal Violence*. doi:10.1177/0886260520944551

Hittinger, E., and Jaramillo, P. (2019). Internet of Things: Energy Boon or Bane. *Science* 364 (6438), 326–328. doi:10.1126/science.aau8825

Holland, K. J., Cortina, L. M., Magley, V. J., Baker, A. L., and Benya, F. F. (2020). Don't Let COVID-19 Disrupt Campus Climate Surveys of Sexual Harassment. *Proc. Natl. Acad. Sci. USA* 117 (40), 24606–24608. doi:10.1073/pnas.2018098117

Holloway, D. (2019). Surveillance Capitalism and Children's Data: the Internet of Toys and Things for Children. *Media Int. Aust.* 170 (1), 27–36. doi:10.1177/1329878X19828205

Home Office (2019). *Domestic Abuse Bill 2019-21*. London: Parliament. Available at: https://services.parliament.uk/bills/2019-21/domesticabuse.html.

Home Office (2013). *Information for Local Areas on the Change to the Definition of Domestic Violence and Abuse*. London. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/142701/guide-on-definition-of-dv.pdf.

Johnson, M. P. (2011). Gender and Types of Intimate Partner Violence: A Response to an Anti-feminist Literature Review. *Aggression Violent Behav.* 16 (4), 289–296. doi:10.1016/j.avb.2011.04.006

Johnson, S. (2014). "Maternal Devices", Social Media and the Self-Management of Pregnancy, Mothering and Child Health. *Societies* 4 (2), 330–350. doi:10.3390/soc4020330

Jones, C., Trott, V., and Wright, S. (2020). Sluts and Soyboys: MGTOW and the Production of Misogynistic Online Harassment. *New Media Soc.* 22 (10), 1903–1921. doi:10.1177/1461444819887141

Keller, M., and Dance, G. (2019). The Internet Is Overrun with Images of Child Sexual Abuse. What Went Wrong. *The New York Times*. Available at: https://www.nytimes.com/interactive/2019/09/28/us/child-sex-abuse.html.

Kendall Taylor, A., Frantz, E., and Wright, J. (2020). The Digital Dictators How Technology Strengthens Autocracy. *Foreign Aff.* Available at: https://www.foreignaffairs.com/articles/china/2020-02-06/digital-dictators.

Kjellsson, L. (2016). *Tinder and Grindr Linked to More than 500 Crimes, Figures Show*. London: The Telegraph. Available at: https://www.telegraph.co.uk/news/2016/12/31/tinder-grindr-linked-500-crimes-figures-show/.

Kleinrock, L. (2004). 'The Internet Rules of Engagement: Then and Now', Technology in Society. *Pergamon* 26 (2–3), 193–207. doi:10.1016/j.techsoc.2004.01.015

Leaver, T. (2017). Intimate Surveillance: Normalizing Parental Monitoring and Mediation of Infants Online. *Soc. media Soc.* 3, 150–160. doi:10.1177/2056305117707192

Leaver, T. (2018). *Leaver_2015_Born_Digital_Presence_Privacy_and_Intima*. SocArXiv, 149–160. doi:10.31235/osf.io/ay43e

Leitão, R. (2019). "Anticipating Smart Home Security and Privacy Threats with Survivors of Intimate Partner Abuse," in Proceedings of the 2019 on Designing Interactive Systems Conference, San Diego CA USA, June 23 - 28, 2019 (San Diego, CA: ACM). doi:10.1145/3322276.3322366

Leitão, R. (2018). "Digital Technologies and Their Role in Intimate Partner Violence," in Conference on Human Factors in Computing Systems, Montreal QC Canada, April 21 - 26, 2018 (San Diego, CA: ACM.). doi:10.1145/3170427.3180305

Lennon, M. (2017). Decolonizing Energy: Black Lives Matter and Technoscientific Expertise amid Solar Transitions. *Energ. Res. Soc. Sci.* 30, 18–27. doi:10.1016/j.erss.2017.06.002

Lieu, J., Sorman, A. H., Johnson, O. W., Virla, L. D., and Resurrección, B. P. (2020). Three Sides to Every story: Gender Perspectives in Energy Transition Pathways in Canada, Kenya and Spain. *Energ. Res. Soc. Sci.* 68, 101550. doi:10.1016/j.erss.2020.101550

Livingstone, S., and Sefton-Green, J. (2016). *The Class: Living and Learning in the Digital Age*. New York: New York University Press.

Lopez-Neira, I., Patel, T., Parkin, S., Danezis, G., and Tanczer, L. (2019). "Internet of Things": How Abuse Is Getting Smarter. *SSRN Electron. J.* 63, 22–26. doi:10.2139/ssrn.3350615

Lysova, A., Hanson, K., Hines, D. A., Dixon, L., Douglas, E. M., and Celi, E. M. (2020). A Qualitative Study of the Male Victims' Experiences with the Criminal Justice Response to Intimate Partner Abuse in Four English-Speaking Countries. *Criminal Justice Behav.* 47 (10), 1264–1281. doi:10.1177/0093854820927442

Maalsen, S., and Sadowski, J. (2019). The Smart Home on FIRE: Amplifying and Accelerating Domestic Surveillance. *Surveill. Soc.* 17, 118. doi:10.24908/ss.v17i1/2.12925

Marganski, A., and Melander, L. (2018). Intimate Partner Violence Victimization in the Cyber and Real World: Examining the Extent of Cyber Aggression Experiences and its Association with In-Person Dating Violence. *J. Interpers Violence* 33 (7), 1071–1095. doi:10.1177/0886260515614283

Marikyan, D., Papagiannidis, S., and Alamanos, E. (2019). A Systematic Review of the Smart home Literature: A User Perspective. *Technol. Forecast. Soc. Change* 138, 139–154. doi:10.1016/j.techfore.2018.08.015

Marwick, A. (2012). The Public Domain: Surveillance in Everyday Life. *Ss* 9 (4), 378–393. doi:10.24908/ss.v9i4.4342

Maxwell, L., Sanders, A., Skues, J., and Wise, L. (2020). A Content Analysis of Personal Safety Apps: Are They Keeping Us Safe or Making Us More Vulnerable. *Violence Against Women* 26 (2), 233–248. doi:10.1177/1077801219832124

Mayer, R. N. (2003). Technology, Families, and Privacy: Can We Know Too Much about Our Loved Ones. *J. Consumer Pol.* 26, 419–439. doi:10.1023/a:1026387109484

McDonald, A. M., and Cranor, L. F. (2009). The Cost of Reading Privacy Policies. *L. Pol. Inf. Soc.* 4. Available at: http://www.is-journal.org/.

McGlynn, C., Rackley, E., and Houghton, R. (2017). Beyond 'Revenge Porn': The Continuum of Image-Based Sexual Abuse. *Fem Leg. Stud.* 25 (1), 25–46. doi:10.1007/s10691-017-9343-2

Mckinsey (2019). *Growing Opportunities in the Internet of Things*. New York, NY. Available at: https://www.mckinsey.com/industries/private-equity-and-principal-investors/our-insights/growing-opportunities-in-the-internet-of-things.

McManus, S., Bebbington, P. E., Tanczer, L., Scott, S., and Howard, L. M. (2021). Receiving Threatening or Obscene Messages from a Partner and Mental Health, Self-Harm and Suicidality: Results from the Adult Psychiatric Morbidity Survey. *Soc. Psychiatry Psychiatr. Epidemiol.*, 1–11. doi:10.1007/s00127-021-02113-w

Melander, L. A. (2010). College Students' Perceptions of Intimate Partner Cyber Harassment. *Cyberpsychology, Behav. Soc. Networking* 13 (3), 263–268. doi:10.1089/cyber.2009.0221

Mello, M. M., and Wang, C. J. (2020). Ethics and Governance for Digital Disease Surveillance. *Science* 368 (6494), 951–954. doi:10.1126/science.abb9045

Miller, J. R. (2017). Alexa Calls Cops on Man Allegedly Beating His Girlfriend. *New York Post*. Available at: https://nypost.com/2017/07/10/alexa-calls-cops-on-man-allegedly-beating-his-girlfriend/.

MIT Technology Review (2020). Humanitarians They See Technology as a Way to Bring about a Safer, Healthier, and More Equitable World, MIT Technology Review. Available at: https://www.technologyreview.com/innovator/hera-hussain/ (Accessed November 2, 2020).

Monahan, T. (2010). *Surveillance in the Time of Insecurity*. Rutgers University Press.

Morstyn, T., Farrell, N., Darby, S. J., and McCulloch, M. D. (2018). Using Peer-To-Peer Energy-Trading Platforms to Incentivize Prosumers to Form Federated Power Plants. *Nat. Energ.* 3, 94–101. doi:10.1038/s41560-017-0075-y

Mulvaney, D. (2013). Opening the Black Box of Solar Energy Technologies: Exploring Tensions between Innovation and Environmental Justice. *Sci. as Cult.* 22 (2), 230–237. doi:10.1080/09505431.2013.786995

Murphy, N. (2018). *"Smart Dress" Shows How Women Are Groped over a HUNDRED Times in Club*. The Mirror. Available at: https://www.mirror.co.uk/news/world-news/smart-dress-shows-how-women-13666772.

Nadim, M., and Fladmoe, A. (2019). *Silencing Women? Gender and Online Harassment*. Social Science Computer Review, 1–14. doi:10.1177/0894439319865518

Nansen, B., and Jayemanne, D. (2016). Infants, Interfaces, and Intermediation: Digital Parenting and the Production of "iPad Baby" Videos on YouTube. *J. Broadcasting Electron. Media* 4, 587–603. doi:10.1080/08838151.2016.1234475

Naughton, J. (2019). *"The Goal Is to Automate Us": welcome to the Age of Surveillance Capitalism*. London: The Guardian. Available at: https://www.theguardian.com/technology/2019/jan/20/shoshana-zuboff-age-of-surveillance-capitalism-google-facebook.

Neff, G., and Nafus, D. (2016). *Self-Tracking*. Massachusetts: The MIT Press Essential Knowledge series.

Nobles, M. R., Reyns, B. W., Fox, K. A., and Fisher, B. S. (2014). Protection against Pursuit: A Conceptual and Empirical Comparison of Cyberstalking and Stalking Victimization Among a National Sample. *Justice Q.* 31 (6), 53–65. doi:10.1080/07418825.2012.723030

OECD (2018). *Bridging the Digital Gender Divide*. Paris. Available at: https://www.oecd.org/going-digital/bridging-the-digital-gender-divide-key-messages.pdf.

Office for National Statistics (2019). Intimate Personal Violence and Partner Abuse, Intimate Personal Violence and Partner Abuse. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice/compendium/focusonviolentcrimeandsexualoffences/yearendingmarch2015/chapter4intimatepersonalviolenceandpartnerabuse (Accessed September 2, 2019).

Panetta, K. (2021). *A Data and Analytics Leader's Guide to Data Literacy*. Gartner. Available at: https://www.gartner.com/smarterwithgartner/a-data-and-analytics-leaders-guide-to-data-literacy (Accessed October 9, 2021).

Parag, Y., and Sovacool, B. K. (2016). Electricity Market Design for the Prosumer Era. *Nat. Energ.* 1, 16032. doi:10.1038/nenergy.2016.32

Parkin, S., Patel, T., Lopez-Neira, I., and Tanczer, L. (2019). "Usability Analysis of Shared Device Ecosystem Security: Informing Support for Survivors of IoT-Facilitated Tech-Abuse," in International Conference Proceeding Series, San Carlos Costa Rica, September 23 - 26, 2019 (ACM), 1–15. doi:10.1145/3368860.3368861

Perryman, S. M., and Appleton, J. (2016). 'Male Victims of Domestic Abuse: Implications for Health Visiting Practice'. *J. Res. Nurs.* 21 (5–6), 386–414. doi:10.1177/1744987116653785

Rahwan, I., Cebrian, M., Obradovich, N., Bongard, J., Bonnefon, J.-F., Breazeal, C., et al. (2019). Machine Behaviour. *Nature* 568, 477–486. doi:10.1038/s41586-019-1138-y

Raptis, D., Bruun, A., Kjeldskov, J., and Skov, M. B. (2017). Converging Coolness and Investigating its Relation to User Experience. *Behav. Inf. Tech.* 36 (4), 333–350. doi:10.1080/0144929X.2016.1232753

Reed, L. A., Tolman, R. M., and Ward, L. M. (2016). Snooping and Sexting. *Violence Against Women* 22 (13), 1556–1576. doi:10.1177/1077801216630143

Refuge (2018). The Facts, Refuge. Available at: https://www.refuge.org.uk/our-work/forms-of-violence-and-abuse/domestic-violence/domestic-violence-the-facts/ (Accessed October 25, 2019).

Robins, E. (2019). EdTech – Time for a Revolution in UK Schools. Available at: https://www.growthdeck.com/the-network/articles/article/411/EdTech-–-time-for-a-revolution-in-UK-schools.

Ryder, S. (2018). Developing an Intersectionally-Informed, Multi-Sited, Critical Policy Ethnography to Examine Power and Procedural justice in Multiscalar Energy and Climate Change Decisionmaking Processe. *Energ. Res. Soc. Sci.* 45, 266–275. doi:10.1016/j.erss.2018.08.005

Safe Chat Silicon Valley (2019). About Tech Safety, Safe Chat Silicon Valley. Available at: https://techsafetyapp.org/ (Accessed September 5, 2019).

Salerno-Ferraro, A. C., Erentzen, C., and Schuller, R. A. (2021). Young Women's Experiences with Technology-Facilitated Sexual Violence from Male Strangers. *J. Interpersonal Violence*, 1–26. doi:10.1177/08862605211030018

Sandle, T. (2016). UN Thinks Internet Access Is a Human Right. *Business Insider*. Available at: https://www.businessinsider.com/un-says-internet-access-is-a-human-right-2016-7?r=US&IR=T.

Smoker, M., and March, E. (2017). Predicting Perpetration of Intimate Partner Cyberstalking: Gender and the Dark Tetrad. *Comput. Hum. Behav.* 72, 390–396. doi:10.1016/j.chb.2017.03.012

Sovacool, B. K., Furszyfer, D. D., and Griffiths, S. (2021). Policy Mixes for More Sustainable Smart home Technologies. *Environ. Res. Lett.* 16, 054073. doi:10.1088/1748-9326/abe90a

Sovacool, B. K., and Furszyfer Del Rio, D. D. (2020). Smart home Technologies in Europe: A Critical Review of Concepts, Benefits, Risks and Policies. *Renew. Sust. Energ. Rev.* 120, 109663. doi:10.1016/j.rser.2019.109663

Sovacool, B. K., and Griffiths, S. (2020). Culture and Low-Carbon Energy Transitions. *Nat. Sustain.* 3, 685–693. doi:10.1038/s41893-020-0519-4

Stark, E. (2018). "Coercive Control as a Framework for Responding to Male Partner Abuse in the UK Opportunities and Challenges," in *The Routledge Handbook of Gender and Violence*. Editor N. Lombard (Routledge).

Stark, E. (2007). *Coercive Control: How Men Entrap Women in Personal Life*. New York, NY: Oxford University Press.

Stark, E., and Hester, M. (2019). Coercive Control: Update and Review. *Violence Against Women* 25 (1), 81–104. doi:10.1177/1077801218816191

Stark, E. (2012). Looking beyond Domestic Violence: Policing Coercive Control. *J. Police Crisis Negotiations* 12 (2), 199–217. doi:10.1080/15332586.2012.725016

Statista (2020). Worldwide Femtech Market Size 2018 vs 2025 Forecast Published by Matej Mikulic, the Total Global Market for Femtech Products and Services Stood at Some 17 Billion U.S. Dollars in 2018. It Is Forecasted that This Value Will Increase to Nearly. Available at: https://www.statista.com/statistics/1125599/femtech-market-size-worldwide/ (Accessed November 19, 2019).

Strengers, Y., and Nicholls, L. (2017). Convenience and Energy Consumption in the Smart home of the Future: Industry Visions from Australia and beyond. *Energ. Res. Soc. Sci.* 32, 86–93. doi:10.1016/j.erss.2017.02.008

Taylor, E., and Rooney, T. (2019). "Surveillance Futures Social and Ethical Implications of New Technologies for Children and Young People,". Editors E. Taylor and T. Rooney (New York, NY: Routeledge).

The Crown Prosecution Service (2017). Controlling or Coercive Behaviour in an Intimate or Family Relationship, Legal Guidance, Domestic Abuse. Available at: https://www.cps.gov.uk/legal-guidance/controlling-or-coercive-behaviour-intimate-or-family-relationship (Accessed November 1, 2020).

Thebault, R. (2019). *A Woman's Stalker Used an App that Allowed Him to Stop, Start and Track Her Car*. Washington D.C: The Washington Post. Available at: https://www.washingtonpost.com/technology/2019/11/06/womans-stalker-used-an-app-that-allowed-him-stop-start-track-her-car/.

UN Broadband Commission for Digital Development (2015). Cyber Violence against Women and Girls: A World- Wide Wake-Up Call. Available at: https://www.unwomen.org/-/media/headquarters/attachments/sections/library/publications/2015/cyber_violence_gender report.pdf?vs=4259&vs=4259.

United Nations (2018). New York, NY: Global Action: Orange the World. International Day for the Elimination of Violence against Women.

UNOCD (2018). *Global Study on Homicide*. Vienna.

Véliz, C., and Grunewald, P. (2018). Protecting Data Privacy Is Key to a Smart Energy Future. *Nat. Energ.* 3 (9), 702–704. doi:10.1038/s41560-018-0203-3

Vilk, V. (2020). You're Not Powerless in the Face of Online Harassment, Harvard Buisness Review. Available at: https://hbr.org/2020/06/youre-not-powerless-in-the-face-of-online-harassment (Accessed October 30, 2020).

Vinopal, L. (2020). *The Horrifying Reason Women Are Searching for Their Own Cities on Pornhub*. Mel Magazine. Available at: https://melmagazine.com/en-us/story/the-horrifying-reason-women-are-searching-for-their-own-cities-on-pornhub (Accessed April 5, 2020).

Vodafone (2019). The Technology Helping Survivors of Domestic Abuse, Vodafone. Available at: https://www.vodafone.com/content/index/what/connected-she-can/technology-helping-survivors-of-domestic-abuse.html (Accessed September 5, 2019).

Wachter, S. (2019). Data protection in the Age of Big Data. *Nat. Electron.* 2 (1), 6–7. doi:10.1038/s41928-018-0193-y

Wajcman, J. (2004). *Technofeminism*. Polity Press.

Wajcman, J. (2007). From Women and Technology to Gendered Technoscience. *Inf. Commun. Soc.* 10 (3), 287–298. doi:10.1080/13691180701409770

Wajcman, J. (2019). The Digital Architecture of Time Management. *Sci. Technol. Hum. Values* 44 (2), 315–337. doi:10.1177/0162243918795041

Webb, C. (2020). What Happens when the Internet of Things Becomes an Accomplice in Domestic Abuse? Xd Ideas. Available at: https://xd.adobe.com/ideas/perspectives/social-impact/internet-accomplice-domestic-abuse/ (Accessed June 29, 2020).

Webb, C., and Weale, S. (2020). *More than 500 Child Victims of "Revenge Porn" in England and Wales Last Year*. The Guardian.

Weir, K. (2016). Parents Shouldn't Spy on Their Kids. *Nautilus*. Available at: http://nautil.us/issue/35/boundaries/parents-shouldnt-spy-on-their-kids.

Wilson, C., Hargreaves, T., and Hauxwell-Baldwin, R. (2015). Smart Homes and Their Users: a Systematic Analysis and Key Challenges. *Pers Ubiquit Comput.* 19 (2), 463–476. doi:10.1007/s00779-014-0813-0

Woodlock, D. (2015). *ReCharge: Women's Technology Safety, Legal Resources, Research, and Training*. Melbourne: Australia. Available at: https://www.dvrcv.org.au/.

Woodlock, D. (2017). The Abuse of Technology in Domestic Violence and Stalking. *Violence Against Women* 23 (5), 584–602. doi:10.1177/1077801216646277

Young, R., and Saxena, K. (2019) Domestic Abusers Are Weaponizing Apps and in-Home Devices to Monitor, Intimidate Victims, WBUR.

Zuboff, S. (2018). *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power*. London: Profile Books.

Zuboff, S. (2019). *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power*. New York, NY: Profile Books.

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