This is a post-peer-review, pre-copy edited version of an article published in *Families, Relationships and Societies*. The definitive publisher-authenticated version of Delicado, A., Mourão, C., Rowland, J. and Nunes de Almeida, A. (2025) Care and surveillance of children through domestic Internet of Things, *Families, Relationships and Societies*, Early View, is available online at: https://doi.org/10.1332/20467435Y2025D000000063

Care and surveillance of children through domestic Internet of Things (IoT)

Ana Delicado, Carolina Mourão, Jussara Rowland, Ana Nunes de Almeida

Instituto de Ciências Sociais da Universidade de Lisboa, Portugal

Introduction

From baby monitors to toys, from location trackers to gas detectors, the market is awash with devices connected to the internet that purport to assist parents and carers in providing safety and care for children. These Internet of Things (IoT) or smart devices perform household chores on their own and allow at-a-distance or monitoring and even intervention in case of danger, freeing parents for other tasks and commitments.

These technologies are marketed as indispensable tools for parents to have a more convenient and comfortable lifestyle and provide a safer and healthier childhood for their offspring, almost a pre-condition for being a 'good parent'. Nevertheless, risks of hacking, unlawful surveillance and misuse of data are also ever-present, conditioning the adoption and use of these tools.

This article aims to examine the role of IoT in domestic settings and particularly for the care of the young. It focuses on how IoT appliances are bought and used by parents for providing cleanliness, comfort and nourishment, but also monitoring and surveillance to their children. It deals also with the use of IoT devices by children and how that is framed and seen by parents. Based on a qualitative analysis of interviews, the article addresses family use of IoT from the adult/parents' perspectives, highlighting the specific way in which technology and family relationships are embedded. Throughout this article, we use the term IoT rather than 'smart home', because the empirical data was collected in households that had devices connected to the Internet but that were not necessarily integrated in an automated system.

This article is based on a research project, that aimed to understand how social actors (producers, consumers, regulators) engage with a new kind of technology (IoT), from the macro level of sociotechnical imaginaries to the micro level of practices of use. Regarding the later, we sought to examine how users of IoT incorporate this technology into their daily lives, how they interact with and appropriate objects, how they attribute them meanings, develop new skills, and transform practices.

Our study was conducted in a southern European country (Portugal), often characterized as an 'early adopter' of digital technologies. We ascertained (Delicado et al., 2024) that, even though most IoT products available in the Portuguese market are developed and produced by foreign companies, there is a small industry of telecommunication and technology manufacturers that develop their own products and services and are supported by higher education institutions that perform research and train highly skilled personnel. On the policy side, national

regulations are strongly dependent on European ones, so IoT is far from being a policy priority, other than in terms of cybersecurity, with a few, poorly disseminated, information campaigns on the risks of objects connected to the Internet. In terms of IoT use by the population, according to Eurostat,[1] in 2022, around a third of individuals in Portugal had used some kind of IoT device (a figure close to the European average). The most frequently found IoT device in Portuguese houses is the TV, since most TV sets on sale are now connected to the Internet to allow access to streaming services. Slightly less than a third of IoT users own wearable devices, such as smartwatches. Domestic appliances, such as robot vacuum cleaners or fridges, are found in less than 10% of the houses. Internet-connected toys are the type of IoT device least used in Portugal (2% of respondents). The profile of IoT users shown in these statistics is in line with previous findings (Scheeder et al., 2019; Graf, 2023): they are mostly young (25-44 years old), male, with higher levels of formal education and income, often working as Information Technology (IT) professionals, and living in a household with children.

Literature review

How families use and appropriate digital technologies has been a key topic for sociological research in the past few decades (see, for instance, Lally, 2002; Haddon, 2004; Bakardjieva, 2005). The Internet of Things (IoT), a range of technologies through which 'digitised everyday objects (or 'smart things') are able to connect to the internet and with each other and exchange information without human intervention, allowing for joined- up networks across a wide range of objects, databases and digital platforms' (Lupton, 2014: 9), is a fairly recent technological development whose domestic use has also garnered increasing attention.

We rely on Rosen's (2019: 80), definition of care for children as 'a broad, multifaceted set of practices' that include both 'the emotional and intimate' and 'practices that are messy, menial, and repetitive' (Rosen, 2019: 80). As such, IoT devices can have a double function of care in families with children. On the one hand, they are labour-saving devices that free-up time for parents from domestic chores; on the other, they are monitoring devices, used to exert surveillance over children.

As Schäfer et al. (2013) posit, everyday consumption is transformed in periods of life-changing events or life-course transitions, such as having a first child. Although it is disputed if appliances do in fact diminish the time spent in household chores (Bittman et al., 2004; Truninger, 2011), new parents buy technological devices both for specialised care of children (bottle warmers, baby monitors) and for domestic work in general, such as cooking or cleaning (Schäfer et al., 2013). IoT devices are seen as convenient, saving time in domestic work and reducing mental and physical effort, engendering an experience of productivity (Strengers et al., 2019).

Several studies have focused on particular IoT appliances that perform housework with a higher degree of autonomy or controlled at a distance. Such is the case of robot vacuum cleaners, whose acquisition is motivated by the perception that they provide an enhanced lifestyle, based on convenience and cleanliness (Nielsen et al., 2016; Nichols and Strengers, 2019; Strengers, 2019). Families, particularly with children, follow conventions of cleanliness

[1] Database on Information and Communication Technologies usage in households and by individuals. Online data code: isoc_iiot_use, DOI: 10.2908/isoc_iiot_use

and tidiness (associated with positive health outcomes) that robot vacuum cleaners help fulfil (Nichols and Strengers, 2019).

Other studies have focused on cooking devices such as the Thermomix, a digital kitchen robot that blends, chops, weights and cooks food (Truninger, 2011; Graf, 2023). Here again, research shows that having a first child is a strong motivator for buying these appliances, in order to reduce physical labour and increase certainty of success in preparing meals. Nevertheless, even technology assisted cooking requires expertise and human intervention, turning parents (particularly mothers) into 'cyborg cooks' (Graf, 2023).

Other IoT devices can also be included in the technologies of familial care. While exploring householders' desires for the smart home, Jensen et al. (2018) use the term nourishment (instead of care) to identify the traits of IoT that make everyday life more convenient, comfortable and secure. This includes smart cameras to ensure security in the house, smart blinds and thermostats to guarantee comfortable levels of temperate and light, and smart lighting to help children go to sleep or when they wake up during the night. Voice assistants free parents' hands to do other tasks and allow them to juggle parenting, housekeeping and professional roles (Strengers et al., 2019).

But familial care through IoT has also, perhaps mainly, a dimension of surveillance. Whereas 'surveillance capitalism' (Zuboff, 2019) or 'dataveillance' (Clarke, 1988) have usually a negative connotation, concerning the use of personal data by companies or governments to exploit or exert control over individuals, Lupton (2019) proposes the notion of 'careful' or 'caring dataveillance', or even 'benevolent surveillance' when the aim is to care for others, usually children (Lupton, 2019), the elderly (Hjorth and Lupton, 2021), or even pets (Lupton, 2023). Leaver (2017) introduces the idea of 'intimate surveillance' to describe parental monitoring and mediation. The author focuses on two types of surveillance over children: parental monitoring of babies and infants through wearables, and parental mediation through the example of the sharing practices in social media of celebrity and influencer parents. Though these surveillance practices can be invasive, by being normalised they become a 'necessary culture of care', and their absence is seen as a failure in parenting (Leaver, 2017: 2).

Strenger et al.'s (2019) typology of experiences afforded by smart homes includes protection as care for household members, especially children, which manifests in the use of surveillance cameras. The authors mobilise the concept of 'careful surveillance' to describe the practices of parents of monitoring children, especially those with special needs, but also pets. They also highlight the use of smart cameras and devices to protect the house from intruders. However, the authors acknowledge that surveillance devices raise concerns regarding privacy and safety among parents.

The adoption of digital technologies by mothers to monitor the health and wellbeing of children even before birth, if not conception, is becoming more common, almost deemed a requisite to being a 'good mother' (Lupton, 2019). Apps to track ovulation, foetal development, feeding and sleeping patterns of babies, cognitive development of children serve as technological aids for coping with the pressure and anxiety of having an infant child. They reassure new parents, especially mothers, that they are providing the best possible care while also lessening the burdens of caring labour, thereby transforming 'caring dataveilance' into a liberating practice.

However, several authors caution against the risks of 'datifying' children and the lack of instruments to safeguard children's rights. Lupton and Williamson (2017) describe the

multitude of devices and apps that track and monitor children, from before birth to their education path. While dataveillance can provide care and ensure their health and wellbeing, the authors underscore that it also carries the risk of being exploited by companies and used to restrict life opportunities, with far-reaching implications for children throughout their lives. Nash (2023) highlights the risks associated with collecting data about children and using it to make decisions about their lives. Data collection while always partial, 'gives the illusion of objectivity and neutrality while at the same time representing only the aspects of a child's life that a company has chosen to record' (Nash, 2023: 219). Nash underscores the risk that such 'data assemblages' pose if 'they come to substitute more holistic, personal, and situated knowledge of a child' (2023: 219). Parents and teachers may come to rely on these devices to make assumptions and decisions about children rather than their own observations and better judgment, potentially creating an 'algorithmic child' whose needs may differ from those of the 'real' child. Nash (2023) also underlines the lack of regulation in the IoT sector, leaving children more exposed to these risks.

This debate on the caring/surveillance affordances of IoT has been further repositioned by Sadowski et al. (2021) by mobilising the concept of 'Big Mother', 'a system that seeks to enact a commodifiable digital surveillance of the home under the guise of maternal care' (p. 3). The authors identify three main tensions in the relation between care and control: '1) outsourcing autonomy through enhanced control and choice, (2) increased monitoring for efficient management and (3) revaluation of care through optimisation of housework' (Sadowskiet al., 2021: 3). IoT technologies claim to enable better care for the family but also allow enrolling individuals and families in new markets and forms of surveillance. The authors describe how, not only cameras but also digital voice assistants provide care to family members, by remembering details, setting the mood with lights and music, providing conversation and assistance, and entertaining and educating children. But besides concerns with privacy and safety, these devices also raise the ethical debate on 'whether outsourcing and optimising care is a desirable pathway for societies' (Sadowski et al., 2021: 10). Conversely, these technologies generate additional domestic responsibilities, the so called 'digital housekeeping', involving the maintenance of hardware and ensuring that the systems are operating correctly, a task that is usually performed by male household members (Kennedy et al. 2015).

The use of IoT in 'caring surveillance' within households, often extends beyond children and babies to include pets or companion animals, which have become integral non-human elements of contemporary families (Policarpo et al., 2023). Once viewed as 'useful' or 'working' animals (fulfilling specific roles such as guard dogs or mouser cats), they have transitioned into fully-fledged members of the family, receiving care akin to that provided to children. Richardson et al. (2017), based on an ethnographic approach with Australian families, examined how smart technologies provide 'care surveillance' for both children and pets, enacting a 'digitally mediated kinship'. Webcams and pet tracking devices allow for monitoring and understanding pets' behaviour, contributing to the development of strategies to improve their well-being. The authors consider that this falls under the classification of 'friendly monitoring' or 'caring surveillance', eschewing 'uneven power relations within the digital kinship of human and non-human relations' (Richardson et al., 2017: 110)

Regarding animals, Lupton (2023) analyses how a wide array of IoT devices is being marketed at pet owners with arguments similar to self-tracking apps and devices for humans: promoting health and wellbeing by data-driven decision-making. Surveillance cameras can also be used to monitor pets and even interact with them when owners are not at home. Lupton concludes

that monitoring is perceived as a way of caring, facilitating the connection and the expression of love for companion animals that are considered beloved family members.

Although there is considerable research on children's Internet use (see Livingstone et al., 2018), the topic of children's engagement with IoT remains limited and heavily focused on potential risks. This securitary emphasis on risks is often seen in works examining how children play with IoT toys (Manches et al., 2015; Marsh, 2019; Giddings, 2019). For instance, Holloway (2019) discusses internet-connected toys as devices for surveillance capitalism, that collect data on children's bodies, play and social interaction for profit-making purposes. She describes several instances of data breaches in IoT toys and the need for regulation, already in place in some countries.

There have also been studies on children's use of voice assistants. Multiple studies examine how children interact with voice assistants, ask them questions, to play music, and to tell jokes (Druga et al., 2017; Lopatosvka et al., 2019; Oranç and Ruggeri, 2021; Sadowski et al., 2021, Wassmer and Schwarzenegger, 2022; Nash, 2023). Though some address how children can engage with the objects with suspended disbelief, imagining them to be actual beings (Wassmer and Schwarzenegger, 2022), the majority of studies are concerned with security and data breaches affecting children (Malkin et al., 2019; Nash, 2023).

However, less attention has been given to other aspects of children's engagement with IoT. Review articles such as those authored by Holmes et al. (2018) or Rosen (2019) assert that children are also providers of care to their families. Research indicates that, in various social settings, young children often engage in caring acts for others in the household, such as assisting with cooking or cleaning. However, there are currently no studies on how children use IoT to take part in domestic chores.

Methods

The project in which this article is based relied on a multi-method research approach, combining document analysis (for instance, of advertisement of IoT products, reports, and media articles), stakeholder interviews (with regulators, consumer associations and IoT companies) and interviews with households who own and use Internet of Things (IoT) devices at home.

We assembled the sample of families to be interviewed using various methods: personal contacts of the researchers (four interviews, two of which were conducted to test the interview protocol, with results also used in this article),[2] snowballing (seven interviews) and the use of a market research company, who recruited participants from their databases to further diversity the sample (ten interviews). In total 21 interviews were conducted, in all cases but one, by the early career researcher, under the close supervision of the PI (debriefings after each interview). The interviews took place between January and July 2023, in most cases (16) at the home of the interviewees (the remaining five were done online).

For the purpose of this article, we only considered the interviews of families with children and/or pets (15). Some interviews were conducted with only one adult member of the household and, in other cases with the couple. No children were interviewed, although some

[2] The interviewees were not known by the interviewer; the team members who provided the contacts had no access to the interview transcript.

were present during the interviews. Table 1 lists the characteristics of the families interviewed, whose data were used in this paper. The families are identified in the citations in this paper by a number and alias, in order to preserve anonymity. Names used within the citations are also aliases.

Table 1 here

The interview protocol was designed based on the literature review and a theoretical framework relying mainly on practice theory, that envisions practice as ''routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, "things" and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge' (Reckwitz, 2002: 249; see also Shove , Pantzar and Watson, 2012). The protocol also drew from the results of the document and media analysis. The questions focused on 1) the process of buying IoT devices; 2) practices of use and routines (eliciting differences by household member); 3) data management; and 4) benefits and risks.

All interviews were recorded and fully transcribed. The transcripts were subjected to content analysis (Bardin 2013), with the assistance of a specialised software (MaxQda 22). This task was performed by the PI and revised by other senior team members. The initial codebook was built based on the literature review and theoretical framework. The first order codes comprised: type of IoT device, buying process, practices of use, motivations for use, family roles, benefits, and risks. New codes were added to the codebook throughout the coding process, as new sub-topics, such as visions of the future and professional experience of users, emerged from the data (inductive approach). For this article, we focused on codes related to caring activities, intergenerational relations, children and pets.

The proposal submitted to the funding organisation included a detailed ethical justification which was followed thoroughly. All interviewees were asked to sign an informed consent form, which is stored in pdf format in a secure disk and will be deleted 5 years after the closure of the project. The host institution has an Ethics Committee that can be consulted but does not provide formal approval of individual research projects unless required by funders (which was not the case).

Findings

Care as providing through IoT

Some IoT devices can be used by parents to provide care, nourishment and comfort to children. As seen above, in practice theory 'life-changing events' are often crucial turning points for practice change. In the case of IoT practices, none is more so than having a child. The arrival of a child often motivates the acquisition of new IoT time-saving and convenience devices. For instance, parents report increase use of devices that can be operated from a distance, such as robots vacuum cleaners, food processors, or washing machines.

> *Bimby [kitchen robot] has been getting more use since Daniela was born because I've been making all the soups, porridge and everything else for her there.* (Isabel, family 9)

They also indicate using devices specifically tailored for caring for the young, like a remote-controlled bottle-warmer, that allow them to be up for shorten periods during night feeds, reducing their physical burden, while taking care of the needs of their child.

> *Or putting the bottle on overnight... When did we put the bottle on? With what? It was with a shelly socket, yes. We put the timer on* (Paulo, family 21)

Moreover, parents also buy devices to control the environmental conditions of the nursery, to ensure optimal comfort for their child. This includes the use of Internet-connected lightening, music, window roller shutters or air conditioning:

> *we have a little button that we use for our daughters, here on the mobile phone, which is: we press the nap button, and it turns on the air conditioning in their room, and closes the roller shutters to a certain level.* (José, family 20)

They also rely on medical devices, such as IoT thermometers, which help parents track their children's health by registering information into specific profiles:

> *We have a thermometer to measure fever, connected to my watch and to my phone. (…) I have a profile for every member of the family. (…) When they [the children] are sick, I take their temperature.* (…) *When I measure the fever with the thermometer, it goes directly to the profiles that are registered here. The rest of the things – weight, height, symptoms, medication – I register by hand.* (Rafael, family 2)

In addition, they also use devices, like sensors and alarms, to monitor their child and ensure their care and safety when parents are in different areas of the house.

> *every time the door is opened, we receive an alert, and as the eldest [daughter] already starts opening doors... supposing I'm upstairs and she's down here... when I receive this on my mobile phone and watch, I realise that she's opened the door.* (Júlia, family 21)

Conversely, the arrival of a child in the family can also result in a decreased use of some devices. With less time for household chores and more attention needed to be paid to the infant members of the family, new parents may change previous habits reprioritizing how they use this type of technology.

> *I think since... when the girls were born... it's been difficult, routines have changed, we don't have as much time to make jokes and turn on the music [in the voice assistant]. Sometimes we switch it on when they ask for it.* (Paula, family 20)

Caring as surveillance through IoT

Some IoT devices allow monitoring the inside of homes and the movements and behaviours of small children. Surveillance cameras, in particular, were mentioned as one of the primary reasons for IoT adoption upon the arrival of a baby:

> *at the beginning it was the fact that we had the baby upstairs sleeping and we could watch it on camera while we were down here, that was the main motivation, it was the birth of the baby, that was what challenged us to evolve.* (Paulo, family 21)

Cameras raise quite dissimilar attitudes among parents. In some families, internet-connected cameras were acquired specifically with the purpose of watching and hearing babies at a distance, replacing more traditional baby monitors.

> *We have a camera in the nursery that is also IoT. It works better than a baby monitor. For sound we use Alexa, we have the Alexa in the room, but the camera has a bit of Artificial Intelligence, it can detect animals, people, babies crying. Because the monitor (…), you see the image, you realise if the baby is crying and it has a constant sound. […] if the baby starts crying, you get a notification saying 'crying detected', in fact, here it is.* (Cesar, family 14)

For others, however, the thought of having a camera near their children raised significant privacy concerns. This was, for example, the case with family 9, which was gifted a IoT camera by a friend but refused to turn it on or even have it in their home. Privacy of the child are chosen over convenience for the parents.

> *Sometimes it's very useful, smartness, sometimes not so much. (…) the camera that has an internet connection (…) I can put my daughter to sleep and point the camera in her direction, and I go for a coffee in the street and I always have the camera available on the app. That bothers me, it's a problem, which therefore invalidates its use. (…) I think it's a very big risk for us to have images of our daughter exposed to possible intruders… any kind of hacking that could take place and they could intercept the footage of our daughter sleeping, or playing in her room, or whatever. So even if I wanted to put that camera in the house for video surveillance, I wouldn't do it, because that would be exposing myself.* (Isabel, family 9)

Children as users of IoT

As seen in the literature review above, children can also be users of IoT devices. However, regarding Internet-connected toys, none of the interviewed families owned such devices or showed an intention to acquire them, except for videogames consoles. Although some mentioned that the children already owned tablets or had access to their parents' phones (a long discussion which falls outside the remits of this article), most considered that it was 'too soon' to give them access to IoT devices or wearables (such as smartwatches) of their own.

> *my son has already asked me if he can have a watch that counts his steps. they've already asked to wear it so that they can have their own biometric record (…) [I haven't given it to him] yet… they're still very young and no, (…) for now I'm trying to keep it that way. They can borrow from mum from time to time, but no, I'm not quite at that stage yet.* (Carolina, family 11)

As children progress from infancy to school years and then to adolescence, we observe that while IoT caregiving functions persist, in parents' discourses children also gradually take on the role of users of IoT devices.

The most frequently used IoT device by older children is videogame consoles which can connect to the internet to participate in multiplayer games and to allow communication between players.

> *Playstation has internet connection, (…). So, basically, through that console, he's with his other friends, he plays with his friends, he talks to his friends, so he's just not there, he's just not physically together, but it allows them to be together.* (Julio, family 1)

Children also are keen users of voice assistants, which not only control other domestic objects such as light bulbs and roller shutters, but also facilitate communication within the household and respond to requests for information, music, weather forecasts. Parents recognise that these appliances have both an entertainment and educational value for children.

> *the kids play a lot with Alexa, with silly things like: 'Alexa farts', it's, I mean, it's laugh-out-loud funny. (…) my daughter says: 'Alexa, put Louie's songs on'. And Alexa starts: 'Yes, I've got a Louie playlist here' and starts playing the music in the kitchen or in the bath. And she thinks it's so funny (laughs)* (…) *First it was music, then it was the weather, then we started asking a wide variety of questions, like this virtual encyclopaedia, testing knowledge...* (Carolina, family 11)

Less frequent is the use of IoT devices by children for performing domestic labour and caring for others in the household. However, the ease of use and convenience of these devices make them more accessible to children, allowing them to develop new practices of housework. In the case of family 19, the nine-year old son already has access to the kitchen robot (Thermomix or Bimby, as it is called in Portugal, whose more recent versions are internet-connected, keeping track of user's practices and suggesting recipes) and cooks for the family:

> *it [Bimby] has the recipes, it has everything, you can look it up, it's intuitive, it makes our day-to-day life easier. Even the kids use it, Samuel uses it, he can already do some things. (…) At that age [9], he starts doing the dishes, the cooking... (…) There's no flame. He uses the cooker too, but Bimby is much easier.* (Rui, family 19)

Children's active use of IoT devices, however, does not come without concerns. Some parents (mainly IT professionals, with higher digital skills) indicated using different strategies to safeguard their children from the risks of using IoT and being connected to the internet. In some cases, parents resort to the traditional method of forbidding unsupervised digital equipment in the children's room.

> *Playstation is here [in the living room], the computer is here, the kids have always been here. There's nothing in the rooms, there are no televisions, there's nothing, so life is all done here, and I always see what they do. So nothing has ever worried me in terms of security, because I'm always watching what they do and what they don't do.* (Vitoria, family 15)

In other cases, parents restrict the functions of internet connectivity.

> *Our router also, incidentally, allows us to do this. (…) the availability of the time, even cutting off internet access, allows you to do that. Not just the content itself, but even the internet itself can be switched off.* (Jose, family 20)

More tech-savvy parents (parents who work in the IT sector or are highly familiar with digital technologies) also highlight the potential to mitigate risks associated with these devices by adjusting the default settings to prevent the automatic transmission of data to the manufacturing company.

> *Carolina's [wife] work gave him one(…) he doesn't use the smartwatch. (…) actually, I can format it and connect it to an application that doesn't need to connect to the internet. (…) but If Gustavo wanted to use it, I'd install a more neutral application that doesn't send the data to Huwaei.* (Rafael, family 2)

Caring for pets

As pets are increasingly seen as members of the household, IoT users we interviewed also mentioned using these devices to provide care to their pets, by supplying them with food, comfort or virtual company.

> *[we activate the roller shutters remotely] for the cats to be more at home, more comfortable, not to be in the dark* (Paula, family 20)

On the other hand, IoT devices are also used for surveilling pets, for monitoring their activity while ownerss are absent from home and even intervening in case of undesirable behaviour:

> *This is a little camera that we use when we're away from home for a longer period of time (…) because that way we can control what they [dogs] are doing when they're home alone (…) when they're barking, we can tell them to shut up because we can communicate via the camera, which is also very useful.* (Rita, family 8)

Also, much like children, animals can also be a motivation to buy IoT appliances, to lighten the load of housework:

> *It [the robot vacuum cleaner] was bought for this purpose because, well, with a dog in the house, there are times when there's too much hair, that they shed a lot. And I also didn't have time to go round vacuuming every day* (Sonia, family 18)

Again, much like in the case of children, IoT users report that the presence of domestic animals in the household can impose constraints on the use of these devices. Autonomous functioning can pose risks to the welfare of pets. Here again safety is valued above convenience.

> *you can control it remotely, but we've never used that... those features of the robot because as we have animals, we're not going to switch on the vacuum cleaner when we're not at home, are we? Because I don't know what the dogs are going to do to the vacuum cleaner, or what the vacuum cleaner is going to do to the dogs! I've seen many videos on the internet of dogs with their tails stuck inside the vacuum cleaner. So it's not something I want.* (Rita, family 8)

Discussion

Our analysis of Portuguese families' interactions with IoT devices in the context of everyday life sheds light on the diverse ways in which these technologies become integral components of domestic routines and family dynamics. The multifaceted nature of IoT adoption within households is evident in the convergence of practices, motivations, and concerns expressed by the families interviewed.

The interviews showed that families tend to own and use multiple IoT devices. The use of IoT at home can be considered as a 'bundle of practice', 'loose knit patterns based on the co-

location and co-existence of practices' when they mobilise several devices (vacuum cleaners, washing machines, coffee-makers) and even 'complexes of practices, 'stickier and more integrated combinations, some so dense that they constitute new entities in their own right' (Shove, Pantzar and Watson, 2012: 81). These can be present as more loosely structured or intricate complexes of practices, co-existing within the household. From smart home assistants to kitchen robots and security cameras, families integrate these technologies into their daily lives.

Life-changing events, particularly the arrival of children, stand out as pivotal moments influencing the acquisition and utilization of IoT devices (Schäfer et al., 2013). The study showcased how the demands of parenting often lead to the adoption of time-saving and convenience-focused IoT solutions. From remote-controlled bottle warmers to IoT-enabled environmental controls, families leverage these technologies to enhance childcare practices (Jensen et al., 2018). Sensors and cameras on the other hand are used to exercise what some authors have considered 'care surveillance' (Richardson et al., 2017; Strengers et al., 2019; Lupton, 2019). Medical devices such as IoT thermometers also have a caring function, by monitoring the health and wellbeing of children (Lupton, 2019).

The study's findings provide insights into the nuanced ways in which families integrate IoT technologies into their lives and caregiving responsibilities, shaping and reshaping their domestic practices. It also sheds light on the different configurations of IoT-related care that can take place within the family context: from assisting with household chores (such as preparing food and vacuuming), to facilitating data collection and data-driven decision-making related to the well-being of children or pets (Lupton, 2019, 2023). Furthermore, it extends to remotely controlling environmental conditions for babies, children, or pets (lights, shutters, air conditioning) and managing internet access for older children. These exemplify the diverse ways in which families leverage IoT technologies to perform their caregiving responsibilities and address the evolving needs of various family members at different life stages. In contrast to the imaginary of an entirely automated smart house, where automation seamlessly permeates every aspect of family life, IoT use often takes on specific configurations. Devices are adopted or rejected, manipulated and tinkered with to enhance safety and privacy. IoT weaves into distinct dimensions of family life, adjusting and evolving in response to the changing needs of the family and its individual members.

As children grow older, they transition from being mere recipients of caregiving facilitated by IoT devices to active users themselves. Videogame consoles and voice assistants emerge as prominent elements of older children's engagement with IoT technologies, fostering communication, and entertainment, but also control over domestic objects.

Our findings that pets also appear as integral members of the IoT-enabled household are concomitant with those of Policarpo et al.'s (2023). Families utilize smart cameras to monitor, communicate with, and care for their companion animals (Richardson et al., 2017; Lupton, 2023). The adoption of IoT devices is motivated by the desire to simplify pet care tasks, such as vacuuming pet hair, which is often seen as unhygienic and unsightly (Nichols and Strengers, 2019), while also introducing new challenges related to ensuring the safety and well-being of pets.

In line with previous works by Quigley and Blashki (2003), Aarsand and Aronsson (2009) or Livingstone et al. (2011), parents also expressed concerns regarding the risks associated with IoT, specifically in relation to their children's privacy (Leaver, 2017), the unsupervised use of

digital equipment (Lally, 2002; Haddon, 2004), and animal well-being (Lupton, 2023). These concerns are often addressed by taking specific measures to mitigate risks by performing 'digital housekeeping' (Kennedy et al., 2015; Strengers et al., 2019), supervising IoT use by children and putting in place safeguards.

One difference from the literature that does stand out from our data is the absence of IoT toys or wearables with tracking devices for children. The later may be justified by the fact that it is common for school-age children to have smartphones (which can easily be programmed to send their location to their parent's phones). The former may be due not to parents' deliberate choices of protecting their children from risks but rather to the limited availability of these products in the Portuguese market, due to language issues (these toys usually communicate with children in English). This goes to show the importance of context when analysing the adoption and practices of use of technological innovations.

We have also gone beyond traditional scholarship that focuses on a particular type to device (voice activated assistants, wearables, or cooking appliances) to address the interconnectedness of devices and explore the family dynamics of their use.

It is also relevant that we found minimal differences in the social profiles of IoT users. Large scale surveys had already shown that IoT users come mostly from highly educated, affluent backgrounds and often work in IT. The key difference in user practices, as revealed by our empirical data is that these IT professionals are able to contravene some of the more intrusive aspects of IoT devices. For families with children this ability translates into care practices that more efficiently safeguard their households from potential risks.

Conclusion

This paper has sought to examine how parents incorporate technological devices connected to the Internet in their care for children and animal companions. It shows how Internet of Thigs (IoT) appliances can be useful as labour-saving and care-enhancer devices, particularly for new parents, as well as fun and educational tools for children and monitoring devices for pets. However, the costs of these products and the digital literacy needed to operate them safely make them accessible only to a privileged few, reinforcing digital divides in society. Democratising access should be taken in consideration by policy-makers and product developers, by making more affordable appliances that have more social benefits.

Nevertheless, these devices are not devoid of risks. Hacking, data breaches, and invasion of privacy, particularly dangerous in the case of children, are not remote possibilities but rather problems that have already occurred across the world. Although these digitally skilled parents are aware of these risks and take mitigation measures, democratisation of access will increase the use by families that will not have these skills and upturn the risk of misuse. More stringent safety regulations for products and more training in digital skills for citizens are needed, again a task for policy-makers and product developers. Detailed labelling, safety instructions and opting out clauses for data collection should be made mandatory in products commercialised to the general public.

Furthermore, this research has focused solely on the discourses of parents, it would also be relevant to investigate the perspective of children on the use of IoT devices and to contrast it with that of their parents.

This article makes a contribution to the growing field of research on how technologies are being domesticized in the family sphere, by being incorporated in exiting caring practices but also generating new ones. It highlights the benefits of this domestication, but also its risks, thus issuing policy recommendations. Avoiding simplifications such as 'digital natives' and 'digital immigrants', the article does reflect on the affordances of technology to maintain/change the roles of different generations in a household. As more and more technologies (robotics, artificial intelligence, big data) penetrate households, it is crucial to ascertain the impacts over family dynamics and relationships.

Funding

This work was supported by the Portuguese Foundation for Science and Technology under Grant EXPL/SOC-SOC/1375/2021. DOI: 10.54499/EXPL/SOC-SOC/1375/2021.

The Authors declare that there is no conflict of interest.

References

Delicado, Ana et al. (2024). A Internet das Coisas em Contexto Doméstico: dimensões sociais, Research Brief, Instituto de Ciências Sociais da Universidade de Lisboa, http://hdl.handle.net/10451/65121

Aarsand, P. a., and Aronsson, K. (2009). Gaming and Territorial Negotiations in Family Life. *Childhood*, 16(4), 497–517. https://doi.org/10.1177/0907568209343879

Bakardjeva, M. (2005). *Internet Society: The Internet in Everyday Life*, London: Sage.

Bardin, L. (2013), L'analyse de contenu, Presses Universitaires de France

Bittman, M., Rice, J. M., and Wajcman, J. (2004). Appliances and their impact: the ownership of domestic technology and time spent on household work. *The British Journal of Sociology*, 55(3), 401-423.

Clarke, R. A. (1988). Information Technology and Dataveillance*, Communications of the ACM*. 31 (5): 498–512. https://doi.org/10.1145/42411.42413

Druga, S., Williams, R., Breazeal, C. and Resnick, M. (2017) 'Hey Google is it ok if I eat you?' Initial explorations in child-agent interaction, in *Proceedings of the 2017 conference on interaction design and children*. pp. 595-600.

Giddings, S. (2019) Toying with the Singularity: AI, Automata and Imagination in Play with Robots and Virtual Pets, in G. Mascheroni, D. Holloway (eds) *The Internet of Toys. Studies in Childhood and Youth*. Palgrave Macmillan, Cham. pp. 67-87. https://doi.org/10.1007/978-3-030-10898-4_4

Graf, K., 2023. Cyborg Cooks: Mothers and the Anthropology of Smart Kitchens. *Digital Culture & Society*, 9(1), pp.49-70.

Haddon, L. (2004). *Information and Communication Technologies in Everyday Life*, Oxford: Berg

Hjorth, L., Lupton, D. (2021) 'Digitised caring intimacies: more-than- human intergenerational care in Japan', *International Journal of Cultural Studies,* 24(4): 584–602.

Holloway, D. (2019) 'Surveillance capitalism and children's data: the Internet of toys and things for children', *Media International Australia*, 170(1): 27–36. https://doi.org/10.1177/1329878X19828205.

Holmes, M., Jamieson, L. and Koslowski, A. (2018) Social forms of care: changing relationships of support, *Families, Relationships and Societies*, 7 (1), 3–5, DOI: 110.1332/204674318X15172431967577

Jensen, R. H., Strengers, Y., Kjeldskov, J., Nicholls, L., and Skov, M. B. (2018) Designing the Desirable Smart Home: A Study of Household Experiences and Energy Consumption Impacts, in *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. pp. 1-14. https://doi.org/10.1145/3173574.3173578

Kennedy, J., Nansen, B., Arnold, M., Wilken, R., and Gibbs, M. (2015) Digital Housekeepers and Domestic Expertise in the Networked Home, *Convergence: The International Journal of Research into New Media Technologies,* 21(4): 408–22. https://doi.org/10.1177/1354856515579848.

Lally, E. (2002). *At home with computers*, Oxford: Berg.

Leaver, T. (2017) Intimate Surveillance: Normalizing Parental Monitoring and Mediation of Infants Online, *Social Media + Society,* 3(2). https://doi.org/10.1177/2056305117707192.

Livingstone, S., Haddon, L., Görzig, A., and Ólafsson, K. (2011). *Risks and safety on the internet The perspective of European children*. Full finding. LSE, EU Kids Online.

Lopatovska, I., Rink, K., Knight, I., Raines, K., Cosenza, K., Williams, H., Sorsche, P., Hirsch, D., Li, Q. and Martinez, A. (2019) Talk to me: Exploring user interactions with the Amazon Alexa, *Journal of Librarianship and Information Science*, 51(4), pp.984-997.

Lupton, D. (2019) Caring dataveillance: women's use of apps to monitor pregnancy and children, in L. Green, D. Holloway, K. Stevenson K et al. (eds.), *The Routledge Companion to Digital Media and Children*. Routledge. pp. 393–402.

Lupton, D. (2014) *Digital sociology*, London: Routledge

Lupton, D. (2023) *The Internet of Animals: Human-Animal Relationship in the Digital Age*, John Wiley & Sons.

Lupton, D. and Williamson, B., (2017) The datafied child: The dataveillance of children and implications for their rights, *New media & society*, 19(5), pp.780-794.

Manches, A., Duncan, P., Plowman, L. and Sabeti, S., (2015) Three questions about the Internet of things and children*, TechTrends*, 59, pp.76-83.

Marsh, J. (2019) The Uncanny Valley Revisited: Play with the Internet of Toys, in G. Mascheroni and D. Holloway (eds), *The Internet of Toys. Studies in Childhood and Youth*, Palgrave Macmillan, Cham. pp. 47-65. https://doi.org/10.1007/978-3-030-10898-4_3

Malkin, N., Deatrick, J., Tong, A., Wijesekera, P., Egelman, S., and Wagner, D. (2019). Privacy attitudes of smart speaker users. *Proceedings on Privacy Enhancing Technologies*, 4(4), 250–271. https://doi.org/10.2478/popets-2019-0068.

Nash, V. (2023) The Rise of the Algorithmic Child: Protecting Children in Smart Homes, in N. Dethloff, K. Kaesling, and L. Specht-Riemenschneider (eds), *Families and New Media: Comparative Perspectives on Digital Transformations in Law and Society,* Wiesbaden: Springer Fachmedien. pp. 215–225. https://doi.org/10.1007/978-3-658-39664-0_10

Nicholls, L., and Strengers, Y. (2019) Robotic Vacuum Cleaners Save Energy? Raising Cleanliness Conventions and Energy Demand in Australian Households with Smart Home Technologies, *Energy Research & Social Science* 50: 73–81. https://doi.org/10.1016/j.erss.2018.11.019.

Oranç, C., and Ruggeri, A. (2021). 'Alexa, let me ask you something different' Children's adaptive information search with voice assistants. *Human Behavior and Emerging Technologies*, 3(4), 595-605.

Policarpo, V., de Almeida, A. N., and Tereno, H. (2023) 'Warming the house': Children and animals 'doing family', *Childhood*, *30*(4), 434 - 450. https://doi.org/10.1177/09075682231197033

Quigley, M. and Blashki, K. (2003). Beyond the Boundaries of the Sacred Garden: Children and the Internet. *Educational Technology Review*, 11(1).

Reckwitz, A. (2002) 'Toward a theory of social practices: a development in culturalist theorizing.' European Journal of Social Theory, 5(2): 243–263

Rosen, R. (2019). Care as ethic, care as labour. In R. Langford (ed). *Theorizing feminist ethics of care in early childhood practice: Possibilities and dangers*. Bloomsbury Academic, 79-96.

Richardson, I., Hjorth, L., Strengers, Y. and Balmford, W. (2017).Careful Surveillance at Play: Human-Animal Relations and Mobile Media in the Home, in E. Gómez Cruz, S. Sumartojo and S. Pink (eds), *Refiguring Techniques in Digital Visual Research.* Digital Ethnography. Palgrave Macmillan, Cham. pp. 105–116. https://doi.org/10.1007/978-3-319-61222-5_9

Sadowski, J., Strengers, Y., and Kennedy, J. (2021) More work for Big Mother: Revaluing care and control in smart homes, *Environment and Planning A: Economy and Space*, 56(1). https://doi.org/10.1177/0308518X211022366

Schäfer, M., Jaeger-Erben, M., and Bamberg, S. (2012). Life events as windows of opportunity for changing towards sustainable consumption patterns? Results from an intervention study. Journal of Consumer Policy, 35, 65-84.

Scheerder, A.J., van Deursen, A.J. and van Dijk, J.A. (2019) Internet use in the home: Digital inequality from a domestication perspective, *New Media & Society*, 21(10): 2099–2118. https://doi.org/10.1177/1461444819844299.

Strengers, Y. (2019) Robots and Roomba Riders: Non-human Performers in Theories of Social Practice, in C. Maller and Y. Strengers (eds), *Social Practices and Dynamic Non-Humans*. Palgrave Macmillan, Cham. pp.215-234. https://doi.org/10.1007/978-3-319-92189-1_11

Strengers, Y., Kennedy, J., Arcari, P., Nicholls, L., and Gregg, M. (2019) Protection, Productivity and Pleasure in the Smart Home: Emerging Expectations and Gendered Insights from

Australian Early Adopters, in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. pp. 1–13. https://doi.org/10.1145/3290605.3300875.

Truninger, M. (2011) Cooking with Bimby in a moment of recruitment: Exploring conventions and practice perspectives*, Journal of Consumer Culture*, 11(1), 37-59.

Wassmer, M. and Schwarzenegger, C. (2022) Neither Friend, nor Device: The Role of Personal Epistemologies in Communication with Smart Speakers, *Publizistik,* 67(4): 579–99. https://doi.org/10.1007/s11616-022-00761-9.

Zuboff, S. (2019) 'Surveillance Capitalism and the Challenge of Collective Action', *New Labor Forum*, *28*(1): 10-29. https://doi.org/10.1177/1095796018819461

Table 1 Sociodemographic traits of families interviewed

Code	Family situation	Alias of the interviewee(s)
1	Couple, she in her 40s (clerical support worker, secondary education), he in his 50s (manager, secondary education), with a teenage son	Julio (M) and Diana (F)
2	Couple in their 40s, he is an IT professional (secondary education), she is a technician (higher education), with two children, a boy and a girl under 12 years old	Rafael (M)
3	Couple, in their 40s (professionals, higher education), with four daughters under 10 years-old.	Manuela (F)
5	Couple in their 40s (professionals, higher education), with two sons under 10 years-old	Rafaela (F)
8	Couple in their 20s (technicians, higher education), without children, with two dogs	Rita (F)
9	Couple in their 30s (professionals, higher education) with a baby daughter	Isabel (F)
11	Couple in their 40s (technicians, higher education), with two sons under 10 years-old	Carolina (F)
12	Couple, she in her 40s , he in his 50s (service workers, higher education), with a teenage daughter	Joao (M)
14	Couple in their 30s, she is a technician (higher education), he is an IT professional (higher education), with a new-born son and visiting grandparents	Claudia (F) and Cesar (M)
15	Couple in their 50s, he is a manager (higher education), she is unemployed (higher education), with two sons, a teenagervand another in his 20s	Vitoria (F)
16	Couple, she in her 40s, he his 50s (clerical support workers, secondary education), with two teenage daughters	Tania (F)
18	Woman in her 50s (divorced, clerical support worker, higher education), living with her grown-up son and daughter and a dog	Sonia (F)
19	Couple in their 40s (professionals, higher education), with a son under 10 years old and two toddler daughters	Rui (M)

20	Couple, she her 40s, he in his 30s (service workers, higher education), with two toddlers (daughters) and cats	Paula (F) and Jose (M)
21	Couple in their 30s, she is a service worker (higher education), he is a professional (higher education), with two toddlers and two cats	Julia (F) and Paulo (M)