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# Mapping Data Flows in the Home: A Scoping Review

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# A MESSAGE FROM PROFESSOR SUSAN DANBY, CENTRE DIRECTOR

In 2021, the Australian Research Council (ARC) funded a Centre of Excellence devoted to studying and researching 'the digital child'. The focus of this Centre is on very young children from birth to age 8, and describes and examines their everyday lives with and through digital technologies, their learning and their health in the family, and various kinds of kindergarten, childcare and early primary education experiences.

The Centre brings together six universities across Australia, as well as partner investigators from North America, Asia and Europe and a range of public bodies and civil society stakeholders, to focus on a holistic understanding of what it might mean to 'grow up digital' today.

The Digital Child Working Paper Series reports on our work in progress. There are five series of papers aimed at different audiences:

A **'how to'** series offers instructional papers aimed at early career researchers or those new to the principles and practices of structured review.

A **'discussion'** series consisting of discussion papers aimed at the scholarly community, raising larger conceptual challenges faced by researchers at the Centre and drawing on forms of literature review.

A **'reviews'** series consisting of scoping reviews, literature reviews and systematic reviews, all addressing specific research questions particular to any of the programme disciplines in the Centre.

A **'methods and methodologies'** series consisting of digital research capacity building resource-rich discussion papers, offering more technical support for the research community and allied scholarship. These are more focused on methods and methodologies.

A **'policy'** series consisting of more public facing, policy-oriented papers produced for stakeholder engagement.

Each of the working papers has been authored by members of the Centre and has been subject to review as explained in each paper. The arguments in each paper represent the view of the authors.

We hope that readers find each of these papers stimulating and generative and that all sections of society can draw on the insights, arguments and ideas within the papers to create healthy, educated and connected futures for all and every child.

*Professor Susan Danby*

*Director, Centre of Excellence for the Digital Child*

*June 2022*

## EXECUTIVE SUMMARY

This paper is part of a series consisting of scoping reviews, literature reviews and systematic reviews, all addressing specific research questions particular to any of the programme disciplines in ARC Centre of Excellence for the Digital Child.

This paper has been checked by an editorial team to ensure it meets basic standards around clarity of expression and acceptable and inclusive language. It has also been presented in a seminar held by the ARC Centre of Excellence for the Digital Child, and any feedback given has been considered.

The home is a crucial site of young children's early encounters with digitally connected technologies. It is here that their emerging digital footprints are being formed and where digital data about them is being produced then collected, analysed and commodified in varying ways. While much is speculated about the rise of intelligent assistants, baby monitors, connected toys and goods, there is little quantitative information available about what sorts of devices households with children actually contain. This scoping review outlines the various fields of research that have investigated digital technologies in the home.

Using materiality of information and domestication theory, the review outlines the different types of digital technologies in the home, as well as how they are domesticated into family life. It considers the different types of data that are both generated and circulating through the home and reviews the research in this area over the last 10 years. The findings highlight that most research has focused on issues of screen time and cybersafety with very few studies investigating how families negotiate data in their everyday life. The review concludes by outlining a research agenda for investigating data in the home.

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# INTRODUCTION

Australian families increasing rely on digital technologies to organise, communicate and document everyday life. In the home, digital data is generated from any connected device, good or toy as well as an increasing array of 'smart' appliances like fridges and security systems. The data that is generated through use can be collected and processed providing insights into the routines and rituals of the family and the individuals in it. This process is known as datafication. Datafication is the transformation of digital interactions into a record that can be collected, analysed and commodified (Mayer-Schoenberger & Cukier, 2013). Datafication is made possible by the capacity to capture and translate social phenomena into data points and signals an important shift in how we understand the world and each other. This scoping review examines datafication in the home and the impact it has on family life.

There are a number of reasons why contemporary societies should be concerned by datafication: the increasing dominance of data-driven epistemologies in social policy and marketing; the lack of control individuals have over how they are inscribed by data and the influence of this on their behaviours and interactions; and the intensification of social justice issues due to data-driven decision-making, governance and power in civil society. This review is concerned with the structural effects of digital technology primarily brought about as a result of the effects of datafication (van Dijck, 2014) and surveillance capitalism (Zuboff, 2019). Both of these terms describe the ways that our interactions with a series of platforms – from government (e.g. the tax office), welfare provision (e.g. health and education) through to commercial actors (e.g. retail/consumer purchasing) or data driven industries such as social media or information connectors – mean that our desires and actions can be recorded, turned into digital data, analysed and ultimately used as commodities.

## WIDER CONTEXT

This review is part of a larger project analysing how children and infants are datafied through everyday practices. The focus on the home, rather than the school or childcare centre, is a deliberate one. Given the capacity for data to transform the private practices and routines in the home into commodities within the digital economy, it is surprising how little empirical research there is on household data. While the majority of empirical work in media and communication, education and IT has tended to look at data in relation to standalone digital devices, software platforms and/or digital practices there is far less empirical work on how data flows through particular sites and the impact of domestication of technologies on this.

Data is always part of an assemblage (Kitchin & Lauriault, 2018). Using location as an organizing principle for this review and the project more broadly, provides a more comprehensive picture of how data flows and is managed by individuals and enables comparison across socioeconomic and geographic factors. In the home, the individual is socially situated so the interpretation of digital technologies occurs against the backdrop of everyday life (Bakardjieva, 2005). Furthermore, despite increases in opportunities for datafication in the home through the proliferation of connected devices, goods and toys (Sadowski, 2020), little is known about how families, particularly those with young children, negotiate and manage data (Holloway, Green, & Stevenson, 2015) factors.

Australia is a unique case when it comes to digital technologies and datafication due to its geography. While the majority of Australians live in urban settings, four in 10 Australians live in rural and remote areas where the provision of digital infrastructures, like broadband networks, pose logistical challenges (Ewing, Rennie & Thomas, 2015). For this reason, Australia has great variation in digital access and use and this has presented ongoing challenges for successive governments. For social research, however, Australia enables a unique insight into the effects of social, cultural, economic and geographic factors on the provision and use of digital technologies. However, this is not the only reason why Australian homes should be a site for datafication research.

The rise of mobile technologies has directed empirical attention away from specific locations, such as the home, school and workplace. Instead, a substantial body of research has emerged on mobile practices, investigating how geolocative media has impacted the cultural, social, political, and economic dimensions of life (see: Burgess, Hjorth, & Richardson, 2012; Goggin & Hjorth, 2009). It is important to note that mobile technologies have rendered the boundary between the home and school and/or work more permeable, leading to new ways of learning (see: Leander, Phillips, & Headrick Taylor, 2010) and working (see: Wajcman, Bittman, & Brown, 2008). However, as the number of smart devices in the home increases alongside the connections between devices, goods and platforms, home, like schools and workplaces have become important sites for data generation and capture. Furthermore, the individual is typically not in a permanently 'mobile' state – most often they are on their way to or from a location, such as home or school. Mobile technologies may help to permeate the boundaries between private and public lives, but focusing on how individuals and families control what passes through these boundaries and how they reconfigure boundaries *within* the home opens up new perspectives on datafication.

In this review, I have taken a material approach to understanding data flows. That is, I have investigated the different ways that data is materialized in the home from the digital infrastructures that *service* the home through to the devices and goods *within* the home. I also consider factors that are important during the domestication of digital technologies. However, this is only one way of thinking about data in the home. Alongside this largely technological approach, there are several others that are of equal use. For example, the review could be approached through practice theory (Bourdieu, 1977/2011; Nicolini, 2012), where what people do with data in the home and how they think about it is the focus, or infrastructure studies (Bowker, Baker, Millerand, & Ribes, 2010; Bowker & Star, 1999). However, these should be thought of as complementary, rather than contradictory, approaches. The purpose of this review is to examine and problematize issues of access and use as a frame for understanding data flows. This review cannot scope out all issues of significance when it comes to data in the home, but it can highlight what emerges from a material approach, as well as identifying and connecting with other theorisations that will be of use.

The article begins by arguing the importance of materiality to conceptualizing data flows in the home. The scoping review is organized into two sections. In the first section, I review the different ways that data is 'materialized' or perceptible in the family home. Based on this, I speculate on the differ types of data circulating in the home, formalizing these through a typology of data that could be both empirically tested and generative of future datafication studies. Of particular significance here, is the increasing amounts of 'interpersonal data' (Goulden et al., 2018) generated by shared devices and goods and acting on groups of individuals.

However, on its own, this theorisation culminates in a rather static, simplistic view of data. Not only do data flows change in the home due to family living arrangements, perceptions and practices, but data flows *beyond* the home are also changing in accordance with an array of social, political, technological and economic factors. With this in mind, to begin the second part of the review, I define three key concepts – family, home/ household and digital economy – that shape data flows *within* and *beyond* the home. These key concepts problematise a technologically determinist approach to understanding data flows. To build on this approach, I use domestication theory to organize and review what is known about how *families* shape data flows and frictions. Across the different stages of domestication, four categories of factors emerge as significant, including: structural factors (i.e. social and cultural background, education); contextual factors (i.e. living arrangements, geographic location); practical factors (i.e. parents monitoring of screen time). The review then explores parental control apps as a resonant case for the many issues raised throughout the review. The paper concludes with a detailed research agenda based on the gaps and omissions that have emerged throughout the review.

# THEORETICAL FRAMING

The review is framed within two theoretical fields: the materialities of data and the domestication of digital technologies. There are obvious points of difference between these two theories, however, when considering data in the home, they provide complementary perspectives. For example, the materialities approach draws attention to the technological dimensions of data, while domestication theory focuses on how family member negotiate these materialities. This provides a useful foundation for future empirical and theoretical work in this burgeoning field, as well as flagging an array of issues that are beyond the scope of this review.

### The materialities of data

Data is often thought of as immaterial – devoid of physical properties and without a tangible form. Imagined as immaterial, data is thought to be more responsive, adaptable and mutable and therefore ready to fulfil the demands of a datafied system, whether that system be in a school, business or home (Beer, 2019; Law & Mol, 2001). There is good reason for this logic. Greater mutability means fewer limitations to how data can be 'put to work' not only by users but also those who collect and commodify data. Seeing data as inherently mutable means it comes to be understood according to its function, rather than its physical properties or the methods of production.

More recently, a body of scholarly work has stressed the importance of understanding data as material. After all, even for non-specialists, data is only ever encountered in some kind of material form. In fact, data is continuously materialised across the datafication process – from the material production of the digital datum through to its representational form. In the home data is materialised through objects such as cables, networks and laptops and representations such as dashboards and mobile phone bills. Exploring the processes of materialisation enables us to critically examine the 'historical particularities, cultural specificities, and political consequences' (Dourish & Mazmanian, 2011, p.4) of data. Just as materialist approaches to philosophy emphasise the role of matter in all social phenomena, exploring the materiality of data enables the experiential, embodied and affective consequences of data to be critically examined.

In this scoping review, I begin by identifying how data is materialised in the family home, as this is entwined with the ways it is represented, interpreted and used. This requires understanding the physical properties of the data being collected and thinking through its purpose and representational form. Dourish and Mazmanian's (2011) conceptualisation of the materiality of information is a helpful way to begin this critical examination. They identify and describe five ways in which digital information is materialized, including: the cultural materiality of digital goods; the transformative materiality of digital networks; the material conditions of production; the material consequences of information metaphors and the materiality of information representation. Applying Dourish and Mazmanian's conceptualisation encourages us to see the *many ways* that data can be materialized, hence I refer to data *materialities* in the plural. Furthermore, materialising the many forms of data in the home is the first step in mapping data

flows. This enables greater attention to how the physical forms of data facilitate and create particular meanings, as well as identifying the opportunities for individuals, particularly non-specialists (in this case household members), to imagine and craft new meanings and interpretations.

### Domestication of media

A second theory to help organise and analyse the literature in this review calls attention to how media is domesticated in the home. The domestication of media is a particular strand within media and communication studies that avoids linear, technologically determinist approaches to conceptualising media objects in the home. Instead, domestication theory focuses on the complexity of digital technologies and how they are integrated within the rituals, routines and patterns of everyday life. Hirsch and Sliverstone's (1992) book on domestication theory drew attention to digital technologies as 'social and symbolic' and embedded in 'the structures and dynamics of contemporary consumer culture' (p.2). The integration and use of technology in the home is conceived as an iterative process that is influenced by a range of structural and personal factors, such as cultural and socioeconomic background of families as well as the potentialities of the media itself.

Silverstone, Hirsch and Morley (1992) distinguish four non-discrete phases in the dynamics of commodity and media relations. These can be summarised as: *appropriation*, where a media object is purchased and 'taken possession of by an individual or household and owned' (p.18-19); *objectification*, which can be defined as how the media object is integrated into the physical spaces of the home as both an aesthetic and cultural object; *incorporation*, which refers to how the media object is used in the home and is therefore shaped by the 'family's gendered culture of technology' (p.22); and *conversion*, which can be thought of as the extent to which the technology reflects the culture of the household and its status in society. This theory reflects the need to expand the analytical focus from the media object to the context of use (Berker, Hartmann, Punie, & Ward, 2006). Other scholarship in this tradition, such as that of Livingstone (1992) and Haddon (1992) adopt a qualitative, ethnographic approach to focus on users, particularly families, providing rich accounts of how and why technology is accommodated and resisted.

Quandt and Pape (2010) update domestication theory putting forward the triangular model of domestication of media. The triangular model has less focus on stages of adoption and instead incorporates three main components that are all interrelated, including: user characteristics; media/device characteristics; and household characteristics. Like earlier domestication theory, the affordances of media objects and the layout and features of the home are significant and determine how and where digital media is used.

More recently, domestication theory has focused on how digital technologies have turned the home 'inside out', so that it is no longer a self-contained node but has 'multiple, commercial, cultural and technical networks, all of which interact, and all with local implications and global reach' (J. Kennedy, Arnold, Gibbs, Nansen, & Wilken, 2020, p. 2). This research project and review continues this more recent approach by focusing on data flows in the home, which connect household members as consumers and products in the digital economy. However, it also picks up on the early echoes of domestication theory

which concentrate on the affordances of the media object and the physical layout of the home. While the proliferation of mobile media devices in the home overrides the need to examine the 'placement' of devices (as per traditional domestication theory), it does sharpen the focus on the strength and capacity of broadband networks. Devices like mobile phones, iPads and laptops are not 'placed' in a particular room but move with family members according to the daily routines of the household and the constraints of connection.

Perhaps most important is the fact that digital technologies in the home blur boundaries between public and private spheres. As Kennedy and colleagues (2020) explain, the contemporary home is now a site of surveillance, communication, production and subjectivation. This project seeks to explore the role of data in these processes accounting for how the family home becomes a node within a networked digital economy. Dataveillance, personal privacy and the commodification of digital data are relatively new issues to the private spaces of the home, highlighting the relational, economic and social justice issues associated with household data. With this in mind, the review will test out domestication theory to see what aspects need refinement to effectively theorise media use in the home in the age of datafication.

# METHODOLOGY

There were three research questions guiding this scoping review:

1. How is data materialised in the family home?
2. What factors influence how data is materialised in the family home?
3. What strategies do families use to increase data flows and friction in the family home?

The methodology involved a detailed review of previous literature that addresses aspects related to the three research questions. With the help of librarians, a number of searches were undertaken to establish lists of relevant literature to meet the review aims. There were two approaches: a) a systematic search of online citation databases, using multiple keywords relating to empirical studies conducted in the last 12 years (2008 -2020) on digital technologies used in the home or by families; and b) a snowball search in relevant academic literature.

Starting with the three research questions, I identified a series of key terms under three notional headings: what; who & where; how (see Table 1).

| What: | Who & where | How |
|---|---|---|
| Digital devices | Family | Practices |
| Data | Parents | Uses |
| ICT | Children | Integration |
| Internet of Things | Toddlers | Strategies |
| Personal & Intelligent Assistants/ Smart devices | Infants | Experiences |
| Computers | Teenagers | Perceptions |
| Broadband | Home | Motivations |
| Mobile devices | House | Parental controls |
| | Domestic | |

**Table 1**

The literature I identified through these processes was reviewed according to one principle inclusion criterion: does it report empirical research about digital data in the home and/or the practices household members engage in?

Through inductive analyses, I identified key themes, similarities, differences and issues of concern, that were relevant to the research questions. I have structured this review according to what emerged from this

process. I do acknowledge that my perspectives may lead to particular research priorities or to analysing results in particular ways.

# LITERATURE REVIEW

The literature review is broken up into two main sections. In the first section, I adapt Dourish and Mazmanian's (2011) framework for materializing information to organise findings. While I have remained true to the framework, I have appropriated it substantially to suit the goals of the project. Also, in this first section, I report on the different types of data that flow through the home (RQ 1). In the second section, I review literature on the factors that influence how people incorporate and convert digital technologies in the home, providing insight into what is known about how families 'domesticate' digital technologies and data flows (RQ 2 & 3).

## Materialisations of data in the home

While Dourish and Mazmanian (2011) propose five conceptualisations of materialising information, in this project I focus on four: infrastructures; devices and goods; representations; and metaphors. I have not included what Dourish and Mazmanian (2011) call the 'material conditions of information technology production' (p.6). Even though it is an important aspect of datafication, the focus tends to be *beyond* the home and on things like server farms, e-waste, mineral mining, government and corporate alliances and the human labour involved in data processing (see: Crawford & Joler, 2018). Aspects of material production that are useful for the scoping review are included in the infrastructures section. The section on devices and goods is most significant as this appears to be where household members can exert the most control over how data is materialised, generated and used.

### Infrastructures

The first and most fundamental way that data are materialised is through what Dourish and Mazmanian (2011) call the 'transformative materiality of digital networks' (p.6). Digital networks and infrastructures refer to the physical properties of digital technologies, such as those found in the built environment. In the home, these are things like broadband networks, routers, connection boxes, WiFi modems and sensors. The implementation of digital infrastructures are often influenced by things above and beyond the individual user, like government and urban councils and existing physical infrastructures (Alizadeh & Farid, 2017).

While some infrastructures like broadband cables are often buried underground invisible to users, modems, utility and connections boxes are visible and are an initial way that data becomes tangible for householders. However, digital infrastructures are highly variable across Australia, largely due to the distribution of the population. As Ewing, Rennie and Thomas (2015) explain Australia is one of the most sparsely populated countries in the world, but it is also one of the most urbanized, with six in 10 of Australian living in one of the five largest cities (Melbourne, Sydney, Brisbane, Perth and Adelaide). This 'geographic divide' has created particular challenges for 'Internet services to small populations across large geographical areas' (p.110). There is therefore great variation in the digital infrastructures available for Australian families to access the internet.

The Australian Digital Inclusion Index provides the most detailed picture of access, affordability and digital ability of Australians and has been measured yearly since 2016. In 2020, digital inclusion rates were reported as having clear social and economic contours, with income, age, education levels and employment all significant factors (Thomas et al., 2020). In particular, there is an emerging digital ability gap, with those in the city and those from higher economic backgrounds showing more advanced abilities and a greater sense of empowerment with digital technologies than those from country or from lower income backgrounds (Thomas et al., 2020).

In Australia in 2020 four million people accessed the internet solely through a mobile connection (i.e. a mobile phone or a mobile broadband device with a data allowance) (Thomas et al., 2020). These Australians experience the lowest levels of digital inclusion with compromised internet access, affordability and ability (Thomas et al., 2020). In remote indigenous communities, for example, few families have digital devices and the internet is accessed via satellite broadband (Rennie, Crouch, Wright, & Thomas, 2013).

Digital infrastructures therefore have significant consequences for Australians, not only in terms of data flows, but also in relation to the development of digital skills and abilities and the social and vocational opportunities that are made available as a consequence of internet access. Infrastructure inequality can intensify socioeconomic advantages and disadvantages within a society (Alizadeh & Farid, 2017). Specifically, digital infrastructure shapes what digital devices and goods household members can connect and use and therefore the types and amount of digital data that are generated and collected for datafication processes (Hintz, Dencik, & Wahl-Jorgensen, 2019; van Dijck, 2014). After all, households with a fixed National Broadband Network (NBN) broadband connection have an average data allowance that is 8% higher than other fixed broadbands (Thomas et al., 2020).

In Australia it has been argued that NBN rollout in regional centres provided a competitive advantage that other localities had to wait several years to catch up on (Alizadeh, 2015). As Halegoua and Lingel (2018) remind us identifying the different materialities and geographies of networks exposes the 'ideological excesses of urban broadband networks and the failures of Internet service providers, urban populations, and public officials to imagine all of the different ways that people incorporate Internet connection in their everyday lives' (p.4635). This point is significant to the current project as households across the nation will have different methods of accessing the internet and therefore different speeds of connection and capacity for data use. Recent reports explain that more than 10 per cent of Australian households are not getting the internet speeds they paid for and that fibre to the node is responsible for 'virtually all' underperforming NBN services (Rowland, 2020). Recently, the federal Liberal government has announced a billion-dollar upgrade to the NBN with six million homes to pay extra to access faster internet speeds (J. Taylor, 2020). This is likely to create further socioeconomic stratification, advantaging households that can pay, while disadvantaging those that cannot.

**Devices and goods**

The second and most obvious way that data are materialized in the home is through what Dourish and Mazmanian (2011) refer to as the material culture of digital goods. As they explain, 'Digital goods can have

symbolic meaning in terms of personal histories and local significance, but more broadly – as possessions, as objects of aspiration, as demonstrations of status, as elements of interpersonal relationships and as projections of self-identity – digital goods in and of themselves play a broader cultural role' (p.5). Throughout this project I refer to this conceptualisation as digital devices (including connected toys) and goods and think about this as the objects families *choose* to purchase and consume.

Many Australian homes today are filled with digital devices and goods. From laptops and computers through to security systems and smart toys, many aspects of domestic life have now become digitalized. There are three main categories to consider here: *devices*, which tend to be used personally and can be thought of as things like computers, laptops, mobile phones and iPads; *connected toys*, which are targeted at children and constitute a range of soft toys and connected devices that are increasingly 'media' like in their affordances (Berriman & Mascheroni, 2019); and finally, *goods*, which are used by all members of the household and include connected appliances like 'smart' TVs, fridges, heating, smart speaker assistants and surveillance system. Devices and goods generate huge swathes of data. In particular, some goods are designed to overshare data. Research by Popescul (2018), for example, found that smart TVs are one of the most common digital goods found in the family home and are designed to overshare data by default.

**Representations**

The third conceptualisation is the materiality of information representation. This refers to how data is represented to users through things like graphs, charts, metrics and dashboards – and in many ways reflects how digital designers and data scientists interpret data. This dimension in particular is key to how householders make meaning from data, as it 'shapes the questions that can be easily asked of it, the kinds of manipulations and analyses it supports and how it can be used to understand the world' (Dourish & Mazmanian, 2011, p.8). I refer to this conceptualisation as data representations.

As a new kind of utility, data is regularly represented to members of the household through monthly or quarterly bills from their internet service provider for homes and mobile phones. Often bills have graphs of usage and/or dials that show the amount of data for the billing period. Compared to other household utilities like electricity and water, data is allocated for a given period and presented as a kind of resource or allowance that is to be 'used up'. Structured in this way, internet service providers encourage customers to maximise their use of data (and concomitantly their potential for datafication) in order to 'make the most' of their plan. Yet whether all members of society need large data downloads is up for debate.

Data is also represented through dashboards and the creation of user profiles on apps and software, which connect devices (and users) to platforms and the digital economy. Through apps and software, toys become 'smart care toys' that are connected to wider 'digital material ecosystems' (Berriman & Mascheroni, 2019, p. 797). While they may appear fairly safe and secure, apps targeted specifically at children and families, such as the YouTube Kids app and the Fisher Price Smart Toy, corral young children into controlled spaces - codified and marketed to within the constraints of the app (Burroughs, 2017). These connected devices are able to collect information that can identify individuals, meaning children's toys and gadgets are now synonymous with dataveillance and commercialization that 'trouble the privacy

rights of the child and parent' (Smith & Shade, 2018, p. 8). Other sources of data representation can be found in the proliferation of education and work-related apps. These increased exponentially during the COVID-19 pandemic with families required to use particular apps and software in order to complete their work and schooling. This increases public and commercial access to the private space of the home (Maaslen & Dowling, 2020).

**Metaphors**

The final part of the framework refers to the 'metaphors' that are used to understand data. Dourish and Mazmanian (2011) explain this as 'consequential materiality', signalling an informational 'approach to seeing and understanding the world that diminishes some form of knowledge and authorizes others' (Dourish & Mazmanian, 2011, p.7). Metaphors are a short-hand way of understanding complex ideas and concepts and involve 'experiencing one kind of thing in terms of another' (Lakoff & Johnson, 1980). Common metaphors include 'the tree of life', 'argument is war' and 'she is a rose'. Mapping complex ideas to a pre-existent one enables us to understand 'abstract concepts in terms of more familiar and concrete ones' (Puschmann & Burgess, 2014, p. 1696). Metaphors have the potential to re-shape formalised domains such as biology and economics, as well as reorganise the corporate competitive landscape. Metaphors have also influenced what is taught in schools, as the rise of data and information has led to a focus on developing statistical and analytical skills (Halpern, 2014). It is therefore important to identify and examine popular metaphors as they shape how people and organisations think about, understand and work with data.

Most of the metaphors for data, particularly big data, map the concept to the source domain of natural resources. The most common of these is 'data is the new oil'. Implicit to this metaphor is the idea data is a resource with substantial economic value, likening those with ownership of data to wealthy oil barons. Nolin (2020) argues this is problematic because it has led to a major economic shift and new capitalist model based on behavioural modification. Furthermore, Puschmann and Burgess (2014) argue that likening data to a natural resource is inaccurate, because data is not naturally occurring at all, but typically 'created by users with intentions entirely unrelated to its use as a valued commodity' (p.1699).

Other metaphors that draw on the natural domain, describe data as a stream, lake or cloud. In more ominous descriptions, data is depicted as a flood, deluge or a tsunami that has the potential to 'drown us' (Lupton, 2013, n.p.). These metaphors may not be used by the general public but emerge in academic discourse and on social media. As Lupton (2013) explains, there are many benefits in adopting liquid metaphors – particularly in the economic domain – as they promote 'an economy of digital data and surveillance in which data are collected constantly and move from site to site in ways that cannot easily themselves be monitored, measured or regulated' (n.p.). Metaphors of data drawn from the natural domain suggest it is something that can be mined or extracted, which, in turn, supports the capitalist expropriation of data. This has a series of effects, as Mezzadra and Neilson (2017) explain, data extraction 'reconfigures property relations, working the boundaries of "privacy" while also testing and exploiting the differences, frictions, and connections between heterogeneous jurisdictions (p.194-195).'

Metaphors directly from the economic domain are 'data as currency' (Barratt, 2019) and 'data as an asset' (Laney, 2018). Texts drawing on this metaphor typically show how data can be monetized, with instructions on increasing its value at every step in the supply chain. Not only do economic metaphors paper over more critical readings of digital technologies, but framed in this way, data is seen as being incompatible with other forms of knowledge generation. It is important to note that the people to whom these economically derived metaphors are most applicable are those who own data or stand to benefit from monetizing it in some way. On the other hand, governments and international organisations like the OECD tend to liken data to a 'utility' (Andrews, 2015) or 'infrastructure' (Nolin, 2020), such as electricity or water. In this way, a citizen's access to data becomes a responsibility of the government. This metaphor contributes to open data movements, while at the same time deprioritising the notion that data should be privately owned and/or commodified.

## Types of data in the home

In reviewing the materialisations of data in the home, the different types of data and the direction of flow can be identified. In a typical Australian home, for example, data travels along the street via infrastructures such as the NBN, entering the home via a connection box. The connection box transmits data to the modem, which generates a WiFi signal to connect devices and goods in the home to the internet. Some devices, like a television or desktop computer, might plug directly into the modem to enable large data downloads. Either way data entering the home through these infrastructures is *downloaded* into the home.

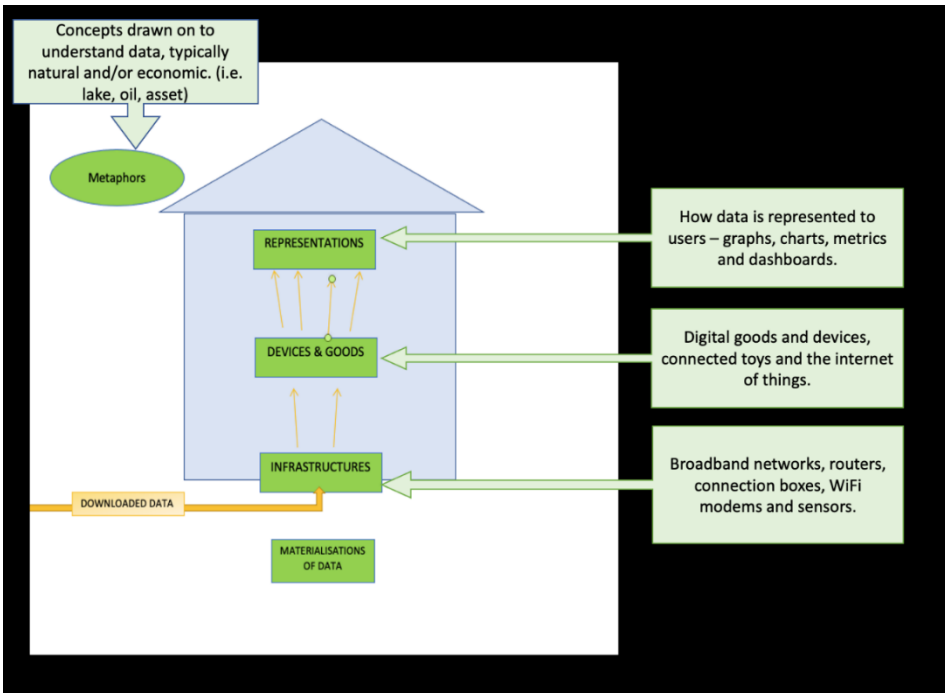


**Figure 1: A summary of the different materialisations of data in the home**

However, data also flows in the opposite direction. Any type of internet activity or web browsing requires two-way traffic between the local device and the remote computer (server) that hosts the information. In addition, individuals might actively upload content to a website or device as well. Collectively, the data that is sent back to servers in order to make hardware and software work, as well as digital content that individuals actively add to the internet, can be thought of as *uploaded* data. Further to this, a lot of uploaded data is *extracted* by third parties in order to draw inferences about the individual/s and the setting for selling, security or surveillance purposes. The amount of data uploaded to the internet is much smaller than the amount downloaded, however, *extracted data* provides detailed insights into the practices and routines of the household.

Data that is *extracted* from the home can be further broken into four different types: personal data; interpersonal data; domestic data; and metadata. Typically, any data that is generated from a personal device like a mobile phone or social media platform would be considered *personal data*. Personal data refers to any piece of information that can identify or be identifiable to an individual. It has particular value in the digital economy as data scientists can use it to model and predict human behaviour. However, shared devices and goods in the home, like televisions, intelligent personal assistants or a desktop computer, generate what Goulden and colleagues (2018) call *'interpersonal data'*. Interpersonal data is generated by and acting on the group rather than the individual. While data generated by smart devices like fridges and security systems could be considered interpersonal data, it is perhaps more appropriate to think of this as *domestic data*. Domestic data is not about a person or group of people, but rather the conditions of the home itself including ambient temperature, amount of a particular resource or the rhythms and routines of the home.

Finally, *metadata* is data about data and is typically produced automatically by a machine. For example, if an individual accesses Facebook from a friend's device, personal data will be generated through the individual actively logging on to the platform, but metadata will also be generated by the device itself. The metadata will provide information about what time the device was used and for how long the platform accessed. In many respects, metadata provides a trace or outline of internet activities and can sometimes be very difficult to differentiate from personal data. Indeed, both are used by data brokers to build a personal profile of an individual. However, in a landmark Australian case between the Privacy Commissioner and Telstra, metadata collected *about* a customer (IP addresses, URLs, specific cell tower information) was found *not to be* of a personal nature, but rather about the service it provides (Johnston, 2017). The findings of this case were controversial due to Australia's metadata retention laws, which require telecommunications companies to retain customer metadata for two years and which law enforcement can access without a warrant. Clearly, metadata can tell you a lot about an individual, however, for the purposes of the this review it should be distinguished (at least legally) from personal data.

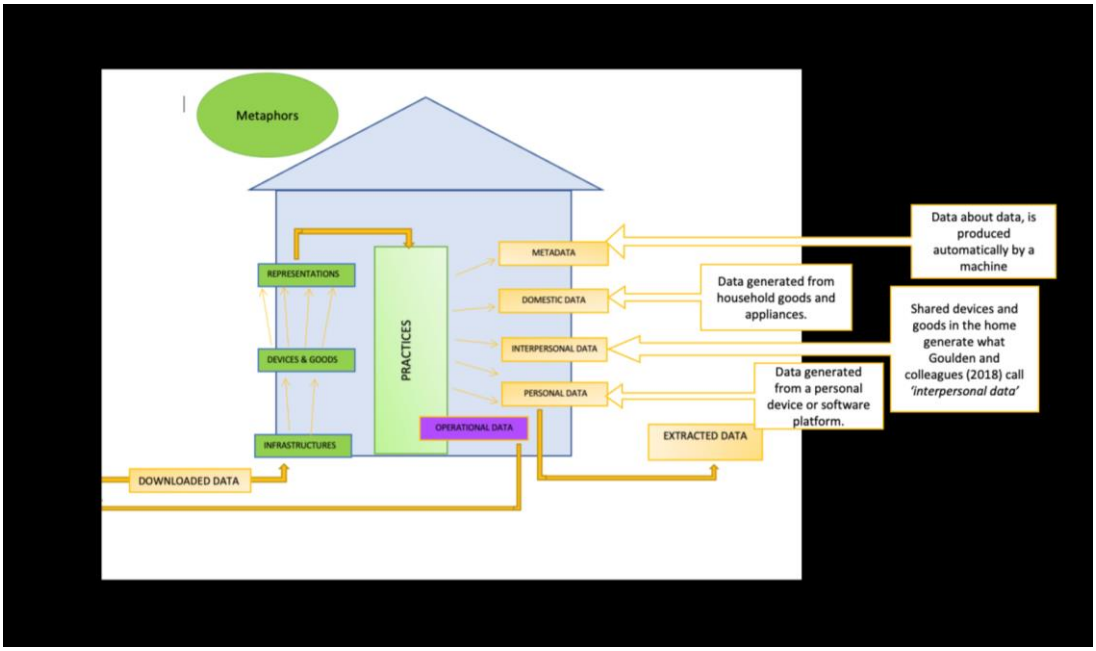


**Figure 2: The different types of data in the home**

In the contemporary home, there are *many* streams of data downloading and uploading into and out of an array of devices and goods. While this might sound complex, aside from any local Bluetooth connections, data flows in two main directions – into and out of the home. Even devices that appear connected locally - such as an individual's Apple MacBook and iPhone - are connected via data moving into and out of the home. All data must pass through the modem and connection box, which acts as a kind of bottleneck. Once uploaded data leaves the home and enters the network it is then used by a large array of second and third parties. Many of these data flows remain beyond the scrutiny of household members. In fact, household members generate data in the home through a huge array of conscious *and* unconscious activities. These data flows connect the home to the wider world and the digital economy.

## Domestication of digital technologies

In the previous section, I reviewed literature that focused on how data was made visible to household members and the types of data that are generated. However, this represents only one way of understanding data flows in the home. Data flows are not predictable or stable because data materialisations change and evolve, as does the perceptions and practices of family members. For example, the composition of the family and their living arrangements, as well as their values, beliefs and interpersonal relationships, all have an impact on how data is materialised and managed in the home. The first part of the review distilled data flows in the home into a series of materialisations and data 'types' in order to problematise assumptions about access to digital technologies and explicate the early stages of the datafication process. While this might seem simplistic or determinist in approach, the next section explores the nuances of context by scoping literature that explores how materialisations of data are domesticated. I begin by defining key concepts that demonstrate the complexity of the home context.

## Defining key concepts

### i) Family

Modern families are complex, with many different arrangements - from single parent, multi-generational and blended families sometimes living across multiple dwellings (Amato, 2005). While 'family' and 'household' are often used interchangeably, they are not the same thing. A family can live across multiple households and a household can contain more than one family (Cuccaro-Alamin et al., 2021). Defining these terms has consequences not only for social research, but also for the digital economy, which will be discussed later in this section.

Family is 'the basic unit of social and economic organization in society and the primary mechanism for human socialization, support, and development' (p.2). Official definitions of 'family' vary slightly in different countries, but the Australian Bureau of Statistics (ABS) defines family as:

> …two related people who live in the same household. This includes all families such as couples with and without children, including same-sex couples, couples with dependants, single mothers or fathers with children, and siblings living together. At least one person in the family has to be 15 years or over (ABS, 2020).

According to this definition, families have become far more complex in recent years. In 2020, there were 7.2 million families, but only 43.2% of these (or 2.6 million) were couple families with dependents. A 'couple family' may have opposite-sex or same-sex couples and a 'dependent' can be a step or foster child. 663,400 families were single-parent with at least one dependent (ABS, 2020).

Many children in Australia live in out of home care. Between 2000 and 2015 the number of children in out-of-home care doubled (ProductivityCommission, 2015). In 2020, '44 906 children were in out-of-home care, 17 979 of whom were Aboriginal and Torres Strait Islander children' (ProductivityCommission, 2020). Within this group there are different types of statutory care for children, including: home based care, such as foster care or relative/kinship care; family group homes, which are provided by a department or agency; residential care, where children are placed in a residential building and looked after by paid staff; and independent living including private board (Productivity Commission, 2015). While these children may not live in a traditional 'home,' most institutions and agencies involved in their care rely on datafied processes, making them one of the most heavily datafied groups in society.

### ii) Home and household

There is also overlap and confusion between the notions of 'home' and 'household.' According to the ABS, 'A household is defined as one or more persons, at least one of whom is at least 15 years of age, usually resident in the same private dwelling. Under this definition, all occupants of a dwelling form a household' (ABS, 2011, n.p.). 'Home' refers to the actual dwelling where a family live and this can take a variety of forms including, freestanding home, flat or apartment, caravan, cabin or houseboat, and even improvised dwellings such as tents fall under the broad category of 'home' (ABS, 2011). As this review is focused on digital infrastructures and other data materialisations that rely on some kind of permanent structure for

electricity and digital connection, it takes home to mean all of the above categories *except* improvised dwellings.

Many children live across more than one home and/or spend significant amounts of time with grandparents and other kin. In Australia, up to the age of about five years of age, 50% of children are in the care of a grandparent for at least one day a week, with about a quarter of this group cared for at least two days a week (LSAC, 2016). In addition, Aboriginal families are traditionally more complex and dynamic than non-Indigenous families and are composed of extended family and kin. It can be difficult to capture interpersonal relationships and family rituals and functioning through conventional academic systems, which are often at odds with Aboriginal knowledge systems (Lohoar, Butera, & Kennedy, 2021). For example, Aboriginal children and their families may place less emphasis on one physical site as 'home,' and instead move between multiple dwellings. While datafication processes are applied universally to populations, this review has highlighted the great variation in family and living arrangements in contemporary Australia. To date, little is known about how these different groups navigate and negotiate datafication processes and the assumptions that organisations and institutions make about them based on this information.

### iii) Digital economy

The 'digital economy' has been defined by the Australian Government as 'the global network of economic and social activities that are enabled by information and communications technologies, such as the internet, mobile and sensor networks' (ALRC, 2013). This involves a huge range of activities, such as communicating, learning, socialising and transacting, and has become fundamental across most domains in society, including schools, businesses, government and non-government organisations. As digital technologies advance and evolve, the digital economy is conducted through an ever-increasing array of devices, sensors and public infrastructures. It is an important backdrop to this review as how data is used *beyond* the home and what families know about how, why and where their data is being used will shape how they manage and protect their data in the home. For example, parents may be more inclined to share data with government institutions and medical organisations as it appears an ethical and worthy use of data.

While little is known about how families *as a group* understand and navigate the digital economy, the literature on how individuals understand data and dataveillance sheds some light on this matter. Research by Lupton and Michael (2017) revealed that individuals were well aware of the way their data was being used by commercial actors and to some extent government institutions. However, there was little understanding of how their data was being used in policing and cybercrime. Furthermore, individuals were found to recognise 'the value of both personal data and the big aggregated data sets that their own data may be part of, particularly for their own convenience' (Lupton & Michael, 2017, p.254). Matters of personal convenience and efficiency therefore intersect with understandings of the digital economy, meaning data management and protection often involves a series of compromises and trade-offs for individuals to negotiate.

Research into how young people understand data has also revealed some interesting assumptions about data processing and use. Australian teenagers report being *less* worried about more complex data processing like sentiment analysis and natural language processing than they do about being tracked through geolocational data (Pangrazio & Selwyn, 2018). Unlike the older participants in Lupton and Michael's (2017) study, teenage participants were rather unphased by targeted advertising, but were far more concerned about 'hackers', who could use that information against them (Pangrazio & Selwyn, 2018). Young people in the UK had a slightly different set of concerns and were reported as 'outraged' that companies use their data in ways they are unaware of (Livingstone, Stoilova, & Nandagiri, 2020). Despite these differences, in both the UK and Australia, young people are employing a variety of strategies to prevent data mining and protect their privacy, particularly when it comes to interpersonal data, however, often with varying effect (Gangneux, 2018; Livingstone et al., 2020; N. Selwyn & Pangrazio, 2018).

In considering data flows in the home, the literature highlights the fact that the effects of the digital economy will be viewed differently by different members of the family. What might be of concern to parents, may have little consequence to children and young people, which can lead to tensions amongst family members. However, in examining the impact of the digital economy on data flows, there is clearly a need for further research into how culture and politics shapes data understandings. Furthermore, little is known about the influence of context on data collection and use. This is significant as all data is generated and interpreted *locally* (Loukissas, 2019), so how the home – as opposed to the school or workplace – shapes data understandings is also significant.

## Stages of domestication

Regardless of living arrangements and family composition, digital technologies have changed the way most families communicate and relate to each other. First, digital technologies both integrate and disperse families. In particular, mobile phones have created a general sense of security for both parents and children (Christensen, 2009). For example, parents are more inclined to let their children walk to school or be left home alone if they know they can be contacted through mobile technologies. However, being 'tethered' to others via mobile technologies introduces new problems, particularly as independence is offset by surveillance and co-surveillance by parents and family members (see: V. Barassi, 2020; Pangrazio, 2019, p.90-94). Digital technologies can be a source of tension between family members due to divergent approaches in using digital technologies (Livingstone & Blum-Ross, 2020). In this section, I use domestication theory to organise the literature on data and digital practices in the family home.

### i) Appropriation

Based on the findings of Section 1, the devices and goods a family has in the home is directly related to the types and volumes of data flows. The more devices a family has, the more possibilities there are for both downloading and uploading data and therefore increasing data flows. Appropriation can be broken down into two stages. The first is to do with digital infrastructures, including what kind of internet access is available to the home, as well as the data plans the family can sign up to. The second stage is the actual acquisition of devices and goods. While families often have little influence over the digital infrastructures

that service their homes, they can choose the most appropriate data plan. There appears to be little empirical research exploring how families appropriate data plans, however, this has significant implications for materialisations of data and its flow, particularly as the number of connected goods and devices in homes are increasing. In many respects then, an inventory of family data plans, digital goods and devices, across socioeconomic, religious, cultural and geographic boundaries would be an important first step in identifying data materialisations in the home.

While a number of structural factors influence how digital technologies are appropriated, the literature suggests that socioeconomic and, to a lesser extent, religious background of families has significant influence. Lower income families tend to use more second hand devices (Lane, Follett, & Lindsay, 2018) and also share devices between family members more frequently (Yardi & Bruckman, 2012). Socioeconomic status is also a barrier to internet access (Ewing et al., 2015) and the appropriation of digital technologies, particularly in remote indigenous communities (Rennie et al., 2013). However, as Ewing, Rennie and Thomas (2015) explain other local and cultural factors also come into play. Research by de Oliveira and Oliveira (2019) showed that Catholic families were found to be more resistant to values promoted by digital technologies, such as individualism and consumerism and had more fixed principles about how technology should be used in the family home. For middle-class families, a different set of drivers is identified for technology appropriation in the home when compared with the school (Edwards, Henderson, Gronn, Scott, & Mirkhil, 2017). While education is important (particularly when it comes to children's use of apps), it is also important to be seen keeping up to date as well as using digital technologies for recreation and relaxation.

Children and young people also drive technology appropriation in the home. In a study by Taylor and colleagues (2018), home was the most significant domain for young people's use of technology, describing it as the 'hottest' spot for technology use, while school was considered 'a technology dead zone where devices were relegated to lockers or bags' (p.80). The trend in states and countries across the world to ban mobile phones in schools and classrooms will only increase the idea that schools are digitally 'different' from most other domains in young people's lives (see: Neil Selwyn & Aagaard, 2020). It is perhaps not surprising then that research by Correa (2016) shows that young people exert significant influence upon their parents in regard to purchasing devices and goods. Parents must weigh this up against other considerations such as cost, recommendations, ratings and reviews of software and devices before purchasing (Kervin, Verenikina, & Rivera, 2018).

In addition to structural factors, there are other factors that drive technology appropriation. Some of these are relatively easy to discern. For example, devices and platforms have become a necessity for working and studying at home during the COVID-19 pandemic. However, many other digital technologies reflect the personal choices and cultural expectations of householders and are the consequence of more diffuse metaphors and discourses circulating in society. Affect plays an important role here. The pleasure and joy that is derived from playing video games, connecting with others and digitally documenting everyday moments cannot be underestimated and is a strong motivator for buying new devices and platforms. However, fear and panic also drive the uptake of a range of digital devices and goods. For example, the increased uptake of surveillance and security technologies is driven by the desire to feel safe in the home

(Mäkinen, 2016). Similarly, the acquisition of parental control apps could be seen as a response to media panics around screen time and cybersafety.

These devices and goods prompt new routines and practices and, as Paasonen, Hillis and Petit (2015), argue lead to 'complex forms of agency' (p.2). The proliferation of self-tracking pregnancy apps (Veronica Barassi, 2017) is a good example of this. These apps are discursively constructed as the solution to many of the fears and anxieties that individuals feel about pregnancy and childbirth. Despite being constructed as a 'solution', research by Bert and colleagues (2016) shows that many pregnancy apps do not have adequate data protection measures in place and instead create different forms of knowledge that can contradict medical and scientific understandings. While these apps are appropriated for reasons of safety, agency and control, ultimately, they have the opposite effect by eroding privacy and even disseminating misinformation.

### ii) Objectification

While personal aesthetic preferences are clearly still important in the placement and use of devices and goods in the home, when it comes to data flows, perhaps most relevant is the living arrangements of families. For many Australian children, 'home' is across more than one dwelling or involves carers who are *not* a child's biological parents. Separated parents and families and a-typical living arrangements may lead to different digital infrastructures, internet plans, devices, goods, rules and routines that shape the way data flows through the home. However, even in a coupled family living together under the same roof, children are all too aware of which parent will allow what and can exploit this to suit their needs and interests (Livingstone & Blum-Ross, 2020).

Parents that are separated from family due to work also re-shape the digital routines and practices of the household (Yarosh & Abowd, 2011). Collocated and separated families are typical of the more complex living arrangements that make up the modern family (Amato, 2005) and highlight the need for empirical work to have a less fixed view on what constitutes home. Not only does this have implications for data flows, but also the digital economy as 'home' and 'family' are unmoored from traditional assumptions about living arrangements. A key question here is whether assumptions made by actors in the digital economy about 'home' and 'family' align with the realities. As data shapes our social realities (Beer & Burrows, 2013), how does it re-make notions of 'home' and 'family'?

Placement of digital technologies in the home also becomes significant when devices and apps are used to monitor family members, as well as fortify the 'boundary' of home. As mentioned in the appropriation stage of domestication, fear and anxiety are important drivers of technology acquisition. However, they also dictate where these devices will be placed within the home. For example, there is now an array of devices and apps on the market designed to monitor and control children and infant's behaviour. Leaver (2017) calls this 'intimate surveillance'. Devices like the 'Owlet' – a wearable sock for babies which tracks heart rate and oxygen levels – normalises 'the idea that digital surveillance of infants equates with care and good parenting' (Leaver, 2017, p.4). When considering the increasingly important role of digital technologies in surveillance and safety, the objectification phase of domestication theory has taken on a new purpose and relevance. From an early age babies and children are 'tethered' to their parents through

the placement of digital technologies. The implications this has on their sense of agency and independence is yet to be seen, however, is an important implication for what it means to be a 'connected' child.

### iii) Incorporation

The incorporation of digital technologies into everyday routines and practices is shaped by a range of factors including the educational attainment of parents, their socioeconomic background and the living arrangements of the family. A study by Scheerder, van Deursen and van Dijck (2019) found that Dutch families with higher educational attainment demonstrated a 'critical view toward the Internet, resulting in considered use and redefinition,' whereas families with lower educational attainment were 'less interested in Internet developments and overall have a less reflective stance' (p.2099). Socioeconomic status can also influence digital practices. Research by Velasquez (2018) into mobile phone interactions between parents and children found that families with financial constraints were less likely to interact with children during the day and were motivated by monitoring their child's movement, rather than communicating with them.

Aside from structural factors, it is important to note that household members demonstrate great variation in how they use digital technologies once they are appropriated into the home. Indeed, as the work of Quandt and Pape (2010) has shown individual characteristics are not only important in understanding how and why particular devices are acquired, but also have an impact on the 'choice, integration and definition of the end device' (p.332-333). Recent research into smart devices in the home exemplifies this point. For example, Brause and Blank (2020) showed that once purchased by consumers, smart speaker assistants are used for a variety of reasons beyond those advertised, including companionship, self-control, productivity and as a sleep aid. Similarly, Pridmore and Mols (2019) found that personal choice and interpretive flexibility was important when using intelligent personal assistants, showing that there is great variation in how these systems can be managed to restrict and increase data flows.

As with the objectification phase, the living arrangements of family members are also significant to the incorporation of digital technologies into family life. This is often overlooked as many domestication studies tend to focus quite narrowly on one 'home' (Scheerder et al., 2019). Yet many children now live across multiple homes and have different rules and routines for digital technology use in different homes. Most notably, in separated families digital technologies can become a 'nodal point' for disagreements and disputes, especially in regard to the way the child uses social technologies (Sjöblom, Franzén, & Aronsson, 2018).

Parental mediation is also important to how digital technologies are incorporated into children's lives. A meta-review of 14 national reports from a European scale study by Brito and colleagues (2017) found that parental mediation can be broken down into four styles: authoritarian; authoritative; permissive and *laissez faire*. The study found that the authoritative style – where 'parents set clear rules and explain them, in order to foster responsible behaviour and self-regulation; the most common rule is setting a specific amount of time for using digital media' (p.272) – was the most common. Another study by Livingstone and Helsper (2008) found that parents adapt strategies from mediating TV and gaming and apply these to their

children's internet use. The findings of these studies suggest that social rules and restrictions potentially decrease data extraction from the home. However, while parental mediation of screen time and digital media use is important in the early years, O'Hara (2011) found that as children get older they develop independence from parental restrictions and guidelines – and that this tends to follow a fairly typical pattern across demographics. From these studies, it could be assumed that there is a positive correlation between age and data generation.

### iv) Conversion

Once the process of domestication is complete, appropriated digital technologies no longer appear new and novel. However, this requires what is known as 'conversion' or how families discuss, manage and integrate these technologies into their everyday life. Through conversion, digital technologies sink into the routines and rituals of family life, setting a kind of precedent for future data flows in the home. So, what is significant when considering how digital technologies become routinised and normalised in family life? It is important to note that conversion is not just a pragmatic process, but also a discursive one as it involves how families think about and discuss their digital technology use *beyond* the home with others.

First, is the level of digital expertise of family members. Research by Kennedy and colleagues (2017) into what they call 'digital housekeeping' revealed the range of tasks and practices household members engage in to manage their digital lives. These tasks were often taken up by one designated 'expert' in the house who was responsible for managing digital content (downloading, storing) and digital networks (materiality and interoperability of devices, the ecology of the digital home), as well as seeking external expertise, such as reaching out to internet service providers, IT support and 'techy' friends. A significant proportion of the participants categorised as 'experts' were males and were often motivated by the need to know how systems function. Indeed, whether children perceive their parents as 'experts' can have implications for whether they follow rules around digital technology use, particularly when it comes to social technologies (Fletcher & Blair, 2016). In many respects then, conversion can be a protracted process as families negotiate and work out how to discuss and manage their routines for technology use.

The materialisation section of the scoping review identified the dominant metaphors of data circulating in society. Metaphors shape how people think about data and its role in society, as well as how it can be protected and managed, so are important in developing people's knowledge of datafication processing. It is therefore important to identify and understand the metaphors people draw on to understand such an abstract and complex concept as data, and what role these understandings play in the conversion stage of domestication. There appears to be little research into how metaphors data shape everyday digital practices and routines. An interesting point, is that of the metaphors reviewed connecting data to oil, clouds, lakes and the like, people do not feature (see: Hwang & Levy, 2015). Personal data is generated through *people's* use of digital platforms and devices, yet this very interpersonal and relational dimension to data does not appear in popular metaphors. What are the consequences of this? As Dourish and Mazmanian (2011) argue elements of the world that do not easily fit into popular metaphors, such as emotions, are 'either reframed or become invisible in public discourse' (p.7). With this in mind, prioritising people in metaphors of data becomes an important political and educational project.

## CASE STUDY: PARENTAL CONTROL APPS

To tease out the complex nature of data flows in the home, the review now turns to the special case of parental control apps. The case is complex for a number of reasons, including: the role of dominant discourses and media panics in shaping domestication processes; how data is materialised and interpreted by family members and the effect this has on practices and interpersonal relationships; and the role of the digital economy in commodifying data generated in the home and the implications this has for the privacy of family members.

Like adults, children are spending more and more time online. At home and school pre-schoolers now use an array of apps and platforms to learn, play and be entertained. While there are many reported benefits, popular media panics around 'screen time,' 'cybersafety' and 'internet addiction' have caused significant concern for parents. An increasingly popular technical solution is parental control apps. Parental control apps enable parents to monitor, filter and restrict children's online interactions and experiences. These apps are marketed as 'taking the battle out of screen time' and giving parents 'peace of mind' by blocking dangerous and explicit content. However, not only is this technical 'quik-fix' inadequate in addressing these complex social issues, but they also expose users to data marketisation.

Through data children's online activities can be captured and monitored. In this way, data becomes deployed as a 'solution' to what are ostensibly a range of legal and social issues (i.e. regulation, privacy, civility etc). 'Parental control' or 'other-tracking' (Gabriels, 2016) apps are apps that enable others, namely parents, to monitor, filter and restrict children's online interactions and engagements. Typically, these apps are marketed as giving parents 'peace of mind', blocking dangerous and explicit content online, as well as helping parents manage the supposed 'screen addiction' of their children. Although these issues are often social in nature and are thought to be best handled through self-regulation, critical reflection and resilience (see: Wisniewski, 2018), parental controls are seen by many, particularly computer scientists (see: Kuppusamy, Francis, & Aghila, 2013), as a valid solution to these complex problems. Most importantly for the purposes of this review, parental control apps have implications for data flows in the home.

With the rise of mobile technologies, parental control apps are typically designed to be downloaded onto a child's mobile phone, laptop or tablet enabling remote surveillance. Research into the number of downloads of these apps through app store data suggest they are widely used across the world (see: Feal, Calciati, Vallina-Rodriguez, Troncoso, & Gorla, 2020; Mannan, Youssef, Ali, Elgharabawy, & Duchaussoy, 2020), yet little is known about exact uptake of these apps across different social and economic contexts. In the US, Pew Research found that 16% of parents use parental controls to restrict their teens use of his or her cellphone, while 39% use parental controls for blocking, filtering or monitoring their teen's online activities (Anderson, 2016). Further research into the uptake of parental controls suggest that it is low autonomy granting parents that tend to favour these kinds of apps (Ghosh, Badillo-Urquiola, Guha, Jr, & Wisniewski, 2018).

Research to date reveals mixed responses to the effectiveness of parental control apps, with some studies suggesting that they may have a detrimental effect on parent/child relations. Two studies based on analysis of online reviews of the most popular parental control apps, reveal significant differences in children and parent's ratings. In a study by Ghosh and colleagues (2018), children felt that the apps were overly restrictive and invasive of their personal privacy, negatively impacting their relationships with their parents. Another study found that many reviews of parental control apps went beyond a description of the app and its performance, focusing more on the way they mediated relationships between parents and teens (Alelyani, Ghosh, Moralez, Guha, & Wisniewski, 2019, p.3). Indeed, research by Lee and Ogbolu (2018) on smartphone addiction in South Korea, found that parent controls on smartphones have the opposite effect on children and teenagers, leading to *increases* rather than decreases in smartphone use.

Perhaps, most troubling, are recent technological studies into the privacy of parental control apps. Feal and colleagues (2020) conducted an exhaustive study of 46 of the most popular parental control apps in the Google Play Store, and concluded that they were 'on average' more 'permissions-hungry that the top 150 apps' in the store with over '72% of the apps share data with third parties...without mentioning their presence in their privacy policies' (p.314). Similarly, in their 'Privacy report card for parental controls,' Mannan and Youssef (2020) reported that the 165 most popular parental control apps (used on network devices, Windows applications and Android apps) have extensive security and privacy vulnerabilities. They conclude that the 'majority of solutions broadly fail to adequately preserve privacy of their users (children and parents)' (p.3). Finally, a study in the US focusing on whether parental control apps complied with law that protects the privacy of children under 13 years (COPPA), found that roughly 57% of these apps were in violation of the law through their use of software development kits that collect personally identifiable information (Reyes et al., 2018). Contrary to earlier predictions that parental control apps may restrict data flows, they may actually have the *opposite* effect increasing data flows and breaching the privacy of families.

Bearing these findings in mind, it appears that it is the design of parental control apps that is the problem, rather than idea of a technical solution itself. Indeed, psychological research into social media use and the mental health of pre-teens suggest that there is benefit in parents mediating and restricting use (Fardouly, Magson, Johnco, Oar, & Rapee, 2018). However, the overwhelming majority of parental control apps dedicated to online safety encourage strategies that enable parents to monitor and restrict, rather than fostering the relationship between parent and child and supporting the development of teen self-regulation and critical reflexivity (Wisniewski, Ghosh, Xu, Rosson, & Carroll, 2017). Research from Badillo-Urquiola and colleagues (2020) concludes that most of the current parental control apps use surveillance-based mechanisms, however, working with young college students they showed that a more inclusive design could facilitate positive relationships and develop teen autonomy. Specifically, they highlight the need for parental control apps to be designed for 'safety, parent-teen communication, teen autonomy and privacy,' (p.165) enabling parental support and growth and youth-centric family values. Needless to say, it is also essential these apps are re-designed to protect user's data privacy.

# DISCUSSION

This review has drawn on a range of different literatures to scope the issue of data in the home. While materialities and domestication theory provided the theoretical frame, the literature reviewed was drawn from an array of disciplines and fields of study, including, critical data studies, digital literacies, educational technology, media and communication, parental mediation and screen time and sociology. The review also sought to identify phenomena that *cannot* be addressed through this framing, identifying areas such as digital practices and networked learning, as areas for future scoping reviews and empirical work. However, it is clear that much of what is relevant to the research questions is 'cobbled together' from papers where the focus is upon something quite different. For example, parental restrictions on their child's screen time might reduce data flows in the home, however, this is not the focus of the study or the intention of the parents. Nevertheless, there are several relevant points to note, and, perhaps more importantly, gaps in understanding data flows in the home.

First, there appears to be few, if any, studies on how infrastructures shape data flows in the home. There are different digital infrastructures across Australia with uneven access to the internet in different locations. While these geographic differences have been observed, how they play out in the everyday uses of digital technologies is not well understood. In particular, how people adjust their practices and routines to access data and how this affects the management and protection of their privacy is an area requiring further investigation. Also significant is how infrastructures such as the NBN impact the potential of the home as a site of communication and productivity (J. Kennedy et al., 2020). Related to this is that most studies focus on individual goods, devices and platforms, rather than investigating the ways data is materialized in different homes and the connections between these. Mapping data materialisations in the home is therefore an important foundation for future studies on digital data.

Related to this point, is the lack of empirical work into the different types of data circulating in the home. Great amounts of data are downloaded in the home, but the consumption patterns of different devices and goods and what these tell us about the daily routines and processes of the family is not well understood. While the amount of data downloaded is far greater than that which is uploaded, the data that is extracted has particular significance in the digital economy as the household and its members can be profiled and their behaviours predicted. The findings of this review have highlighted four main types of data in the home: personal data; interpersonal data; domestic data and metadata. This review has revealed a number of gaps in our understanding, including how different types of data in the home are produced, the volume of data each device and good creates and where uploaded data goes once it leaves the home. Related to this would be investigating how digital practices can be used to protect the privacy of the family in the home. For example, how does sharing a device protect or disrupt the way personal data is used for profiling individuals?

Second, while a lot was already known about the appropriation of older media objects in the home (i.e. television, computer etc), more recent articles reviewed here shed some light on what motivates the appropriation of smart devices and apps to quantify family life (i.e. baby monitors, parental controls etc).

While pleasure and social connection is clearly important, several articles point to fear and the need for security and reassurance as important drivers. This was noted in studies investigating security systems and intelligent personal assistants, as well as baby monitoring apps and devices. Media panics are another important driver for the appropriation of parental controls. An important marketing ploy is to raise people's fears and anxieties – all of which can be allayed with the installation of a 'smart device' or app. However, 'smart devices' also increase data flows in the home. As Sadowski (2019) points out this aligns with the logic of data accumulation so that an 'inert object' becomes 'a data producing, collecting and transmitting machine' (p.7). In a similar way, parental control apps are marketed as a way for parents to monitor their children's online practices and ensure their social and emotional welfare.

However, three recent reports reveal troubling findings. While these devices might block, monitor and filter dangerous content, they are also reported as violating the privacy of children and families through sharing personal identifiable information with an array of third parties (Feal et al., 2020; Mannan et al., 2020; Reyes et al., 2018). Like smart devices in the home, these apps are marketed as a technological solution to fears and anxieties that have been exaggerated and/or constructed. Not only do these apps introduce new data generating practices, but they are also found to be detrimental to the child/parent relationship. Investigating acquisition of different technologies in the home reveals interesting insights not only into data flows in the home, but also a range of cultural and social processes in the age of datafication.

Third, while digital devices are often marketed and used for particular purposes, the literature shows that during the incorporation phase of domestication (Silverstone et al., 1992), householders demonstrate interpretive flexibility around how these devices are used. While this is not a new finding, it has particular repercussions when it comes to smart devices and assistants, such as Amazon's Alexa. For example, the review highlighted that intelligent assistants were frequently re-purposed as sleep aids and digital companions, and not just relegated to managing the more mundane tasks of the home. However, as householders increase their dependency on smart devices, the generation of data will also increase. As Strengers and Kennedy (2020) argue in *The Smart Wife*, this process is aided by the fact that these intelligent assistants are 'feminised' appearing as an 'unthreatening female presence' whose role is to serve, thereby hiding 'the potential risks that they pose to their users' (p.194). Indeed, it is ironic that the studies reviewed note the soothing and comforting role played by intelligent personal assistants when in reality they are extracting and accumulating personal data from one of the last private spaces available to families – the home. Investigating the connection between the marketing of these devices, the assumptions householders have of their function as well as how they facilitate new digital routines would be useful. A further critical dimension to this would be identifying how the practices and by-products associated with connected devices are 'doubly articulated' (Langlois, McKelvey, Elmer, & Werbin, 2009) into the digital economy.

Fourth, one common way that data flows are restricted in the family home is through parental mediation of children's device use and screen time. As stated earlier, this is an inadvertent implication of digital practices and routines in the family home, as children's screen time appears to be a far more significant cultural concern than datafication and privacy (Livingstone & Blum-Ross, 2020). Indeed, there were so

many articles on parental mediation and screen time in the literature review that saturation was reached relatively quickly. Many articles were not included in the analysis as they were often similar to previous studies providing only marginal differences in the participant group or the digital device being focused on. Given the inordinate amount of theoretical and empirical studies on screen time, future research on families would be better placed to focus on the implications of data in the home and how routines and practices can optimize data flows. These studies are reflective of the sense of anxiety and panic associated with children going online and provide an explanation for the increasing reliance on parental control apps. Fear and panic associated with digital media is not only driving the purchasing of particular technologies, but also the research agenda.

The findings of this literature review highlight the need to extend upon existent frameworks to adequately theorise domestic data flows. While the materialisation of information (Dourish & Mazmanian, 2011) and domestication theory provide a useful starting point, this scoping review has brought new challenges and considerations to the fore. It is important to acknowledge that Dourish and Mazmanian's (2011) framework was not necessarily intended for the home, yet it has certainly provided a useful way of organising the literature and ideas reviewed. Dourish and Mazmanian's (2011) framework adopts a layered approach to understanding data materialisations – resonant of Bratton's (2015) 'stack' – where each builds vertically on the other from infrastructures to devices and goods to representations. What is missing however is how data flows between these layers and the factors that influence these flows. In the case of the family home, the generation of interpersonal data and the relational dimensions of data are (understandably) not a focus. Furthermore, materialisations higher up in the 'stack', such as representations in the form of apps and dashboards, actually influence materialisations beneath, like devices and goods, meaning the drivers for acquisition are complex and interconnected. This is where domestication theory might be able to help.

In its original instantiation domestication theory articulates four stages to the dynamics of media acquisition and use in the home: *appropriation*; *objectification*; *incorporation*; and *conversion*. More recent uses of domestication theory have drawn attention to the fact that digital media open up the home to the rest of the world, highlighting the need for a more ecological approach to domestication theory (J. Kennedy et al., 2020). This scoping review concludes with similar findings. In many respects, the contemporary 'smart home' can be thought of as a series of devices, goods and apps interconnected through digital data. However, what has not been properly theorised is the proprietorial nature of these ecologies. For example, smart devices in the home need to be able to 'talk' to each other, which not only drives the purchasing patterns of households, but also creates a series of 'walled gardens' within the home. Furthermore, the literature highlights that the acquisition of many smart devices and technical solutions in the home are in response to a set of fears and anxieties constructed through marketing and popular media. It is no longer a straightforward matter of appropriating a media device and converting it to the culture of the household. With the increasing importance of predictive analytics, it is perhaps the culture of the household that undergoes *conversion* through devices, rather than the other way around. While this process has been described as 'digital resignation' (Draper & Turow, 2017), creativity and

creative practice provide opportunities to reveal, disrupt and resist these technocratic processes (Pangrazio & Bishop, 2017).

At the same time, the review has drawn attention to the fact that there is some 'interpretive flexibility' in how people use smart devices, including smart speakers and intelligent personal assistants. Smart devices instigate new routines and practices that also generate data. However, what is done with this data and the implications of it are not currently a focus of domestication theory. Indeed, smart homes and devices suggest a far more circuitous and interconnected domestic media 'landscape'. This brings new challenges for families to negotiate. For example, the dynamics of domestic media in the age of datafication, mean families are faced with a series of compromises and trade-offs when considering media use. For example, to protect privacy in the home they might restrict data flows between devices to protect privacy, but this might also mean that the system does not work as well as a 'whole.' Ultimately, this boils down to a choice between privacy and efficiency. Clearly, families should have more than two options. On another level, the generation of personal data enables the surveillance of children and young people not only through parental control apps, but also because data flows can be centralised and analysed by the 'digital experts' (Kennedy et al., 2017) in the family. The digital experts are not necessarily a parent or 'head' of the household, meaning that the power dynamics in the home can also be shifted by the management of data flows. The relational, social and educational dimensions of family members is therefore an important consideration in theorising data flows, which points to the need for further elaboration of domestication theory.

### Toward a research agenda

Given the capacity for data to transform the private practices and routines in the home into commodities within the digital economy, it is surprising how little empirical research there is on household data. As this review has highlighted, the focus remains on singular issues or concerns, such as social media practices or children's screen time, rather than the nature of data flows and frictions in settings and across family groups. This may be due to the complexity involved in trying to disentangle, map and interrogate the motivations and practices that underpin data flows. Connected digital objects are 'active', capable not only of shaping new practices and routines, but also of producing and collecting data (Sadowski, 2019). Some of the issues identified in this scoping review have their origins in pre-digital times; others are completely new. It therefore makes sense to organize the research agenda around whether the issues raised by household data are completely new or whether they modulate or intensify pre-existent issues.

To begin, the increasing reliance of the digital economy on the generation and commodification of personal data has led to a range of *new* research questions that require investigation. As a starting point these might be:

- What types of data (i.e. personal, interpersonal, domestic, metadata) are generated and collected in the family home and what volume of each exists?
- Who or what is interested in this data and how it is mobilized in the digital economy?

- What current practices and strategies do families engage in that interrupt or minimize domestic data generation?
- Which public policies help regulate data extraction and to what extent are they successful at doing this?
- How do concepts like 'home' and 'family' get remade through the digital economy?

Household data also *modulates older* issues associated with media in subtle ways. For example, understanding domestic media as interconnected is not new (see: Morley, 2007), however, the functioning of these devices is increasingly dependent on digital infrastructures like the NBN. Furthermore, as Dourish and Mazmanian's (2011) work highlights there are a range of ways that digital information and media are apprehended and engaged with. Understanding data flows therefore involves identifying the different ways that data are materialised in the home and how this influences the expectations associated with the device and the meaning that is made from it. With these points in mind, future research might investigate the following:

- How do digital infrastructures like the NBN shape the practices and routines associated with data flows in the home?
- What materialisations of data exist in family homes and how do these different material forms influence meaning making processes?
- Which metaphors do household members draw on when conceptualizing data and why?
- How do families with children living across more than one home manage digital technologies and data flows?
- What expectations do household members have of connected devices? Do these expectations play out in reality and if not, how do household members adjust their routines and practices accordingly?

Data in the home also *intensifies pre-existent* issues associated with media. In particular, the proliferation of connected toys and devices intensifies the number of datafied objects and therefore raises the stakes for parents when it comes to the implications associated with commercial purchases. Parental control apps intensify the ability of parents to surveil their children thereby eroding the privacy and autonomy of young people. This set of questions therefore focus on how data intensifies a range of issues and tensions that exist between parent and child:

- What role do children play in driving the acquisition of toys and digital devices? How is the datafied nature of these toys and devices understood and negotiated by parents?
- What percentage of Australian parents use parental control apps and why do they do so?
- How does data intensify the surveillance capabilities of parents and other stakeholders?
- What are the most popular parental control apps in Australia? Do they protect the privacy of Australian families and how are they regulated?

Finally, the findings of this review suggest that further *theoretical innovation* is required in order to conceptualise the challenges that data in the home presents. While the two theoretical frameworks used in this review – materialization of data and domestication theory – have provided a useful starting point,

datafication introduces new challenges for researchers to grapple with. With this in mind, the last set of questions relate to theorising data flows and frictions in the home:

- What elements (i.e. data types, materialisations) of datafication need to be included in a conceptualisations of the family home?
- What relationships exist between different materialisations of data?
- How is everyday life shaped by data flows in the home and what theories best depict this conversion?

Addressing these research questions has significance when preparing families for adjusting to life in a datafied society. This review has analysed empirical and theoretical literature on data in the home. In doing so, a number of gaps have emerged that help shape the scope of a research agenda dedicated to understanding and conceptualising data in the home. Understanding what kinds of practices families are currently engaged in to manage and protect their data will help researchers identify strategies and tactics for data privacy that are practical and realistic. In articulating these issues, it is hoped that an evidence-based framework for critical studies of household data will soon follow.

## ABOUT THE AUTHOR

**Dr Luci Pangrazio** is an expert in datafication, young people's digital and data literacies, and digital cultures. Her role as Chief Investigator in the Connected Child program focusses on the datafication of young children's technology use – what data is being collected, how it's being used, and the implications.

Dr Pangrazio is currently Chief Investigator on an ARC Discovery Project examining the use of digital data in schools and ways to improve its capture and use. As an Alfred Deakin Postdoctoral Fellow, Dr Pangrazio is also working on a project to investigate new ways to understand digital data. Recent books include Young People's Literacies in the Digital Age: Continuities, Conflicts and Contradictions (2019, Routledge) and Learning to Live with Datafication: Educational Case Studies and Initiatives from Across the World with Julian Sefton-Green (2022, Routledge).

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