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Baby Apps: Mapping the issues

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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 of review papers aimed at stimulating discussion and debate amongst scholars about key themes, concepts, and theories underpinning research into digital childhood and what it might mean to be a digital child. These reviews draw on recent and relevant academic literature and aim to ask and frame new questions for research.

This paper has been checked by the sub-series 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 use of baby apps for everyday parenting remains a contentious issue despite changing understandings of their design, uses and implications. This paper defines the field of *baby app studies* that has emerged over the past decade. It maps the field itself as a critical area of enquiry exploring the intersection of digital parenthoods and childhoods, and situating baby app studies within, and in relation to, the multi-disciplinary study of digital childhoods.

The use of mobile applications to track, monitor and manage ever-more intimate and personal aspects of everyday life – from our steps, heart rate and mental states, to becoming a parent – has become a mundane practice. *Baby apps* are mobile applications designed to help parents manage the transition to parenthood, from family planning to infant care, focussing specifically on tracking-tools and informational support. Baby app use is likely to become even more integrated into parents' and children's lives: as an everyday practice of health-monitoring and self-care, a routine parenting practice, a way to commodify the transition to parenthood, and as a tool for public health promotion. This paper details four key issues that are central to a better understanding of the social and cultural roles and impacts of baby apps. These issues include the *datafication* of childhoods and family life; the role of baby apps as *disciplining* tools for institutional-level risk management and self-governance; the social and individual impacts of the *gendered design and use of baby apps*; and the necessity to investigate how baby apps can play an increasing role in *empowering* parents and families.

As the first research centre of excellence globally that is dedicated to the exploration and improvement of the (digital) childhoods of young children from birth to eight, the *Digital Child* is well-placed to investigate, respond to, and drive conversations about, controversial issues in baby apps. The paper therefore provides context to the issues and implications of baby app use in the hopes of providing a roadmap to guide future research approaches and translation. Additional insight is urgently needed to put popular anxieties into perspective and enable parents and stakeholders in industry and government to recognise how baby apps may facilitate practices that empower parents, without compromising children's digital futures.

Table of Contents

Glossary

Baby apps: An umbrella term used in this article to describe any mobile application designed specifically for the purpose of supporting users through one or more stages of the transition to parenthood. Examples include fertility-, pregnancy-, and baby-tracking apps that provide tracking features and informational support to help users achieve conception, manage pregnancy, and perform caregiving in infancy. Also see section 2 on *'Defining baby apps'* for a more detailed explanation.

Datafication: The process of turning aspects of everyday life, including complex bodily sensations or social interactions, into a simple – often numerical – representation. The term is most commonly used to describe processes facilitated through digital tools and technologies (e.g. self-tracking apps), that allow further processing and visualisation of data to identify trends and aid decision-making. A commonly-used academic definition is provided in section 3.1 on Datafication.

Data privacy: The ability to retain control over what happens to data, such as the ability to decide what data is being collected, who it can be accessed by or shared with, how data can be used and processed, and for what purposes.

Digitalisation: Describes the process of moving from analog processes of collecting, processing and storing data (e.g. through physical filing systems and representations) to the digital processing and storing of data through machines (e.g. computers and the internet), and the integration of digital processes into workflows. A contemporary example would be the collection of digital patient records by health professionals, which can be shared between different health services to improve treatment, and with government health services to provide rebates etc. Not to be confused with the similar term *Digitisation*, which simply refers to the conversion of analog data into digital data formats.

Digital traces: Any evidence of digital activities, including obvious and easily visible information such as the content of a facebook post (i.e. an image and a text posted), but also the associated meta data – information automatically recorded and stored through 'invisible' background processes (e.g. the IP address of the device used, exact time of post, location). These can also include behavioural data, such as which posts a user likes, who their online 'friends' and connections are, what a user clicks on or searches for, and many other 'traces'. This information can be algorithmically processed to make inferences and predictions about users, and to categorise them. Digital traces are also referred to as *digital footprints*.

mHealth: Abbreviation for 'mobile health'; specifically referring to the provision of health information and services via wireless mobile technologies such as mobile phones. Mobile health services are commonly delivered through mobile health applications or *mHealth apps*. Similar terms include the more general *eHealth* (electronic health), which refers to the provision of health services via any electronic communication, and *uhealth* (ubiquitous health) which commonly refers to continuous electronic health monitoring (e.g. through devices used in hospital settings, but also continuous health tracking technologies including wearable tools such as fitness trackers).

Personal data: Any information that is or can easily be linked to a person. Also referred to as *personal information* or *personal identifiable information*. Examples include a wide range of more and less obvious personal information such as a name, image, address, date of birth, and contact information, as well as health and financial information, education and employment information. It can also include digital traces and sensitive data such as health-related online searches, websites visited, and many more. Personal data is different to digital traces, in that the latter are not always identifiable or easily linked to a particular person.

Medicalisation: When human conditions, such as bodily states and experiences that did not used to be considered as requiring medical attention and management, become understood as requiring medical treatment, monitoring or intervention.

Responsibilisation: The attribution or shift of the responsibility for a task or function from the state to the individual.

Transition to parenthood: The period or stages of the life-course that individuals or couples move through in the process of becoming parents, including family planning (may include conception), expecting a baby (may include pregnancy), and caring for a newborn.

1. Introduction

This section provides a high-level introduction to public and academic conversations about baby apps. It includes short summaries of the four *key issues in the study of baby apps* that are discussed in-depth in the main body of the paper. The issues identified are reflective of the most prominent themes in media and communications research on baby apps to date, according to a review of the literature over the past decade. To complete this introductory overview, the final segment of the section situates the field of baby app studies within the multi-disciplinary study of digital childhoods more broadly.

1.1 Baby apps' role in parenting culture and public health

At the level of popular culture, the use of baby apps is predominantly presented as part of a desirable 'modern' lifestyle. Australian website news.com.au for instance presents '10 awesome apps' helping "modern mums […] keep track of feeds and routines" as opposed to "old-school mums [who] used to attach a nappy pin to their bra so they could remember which breast was due to use next" (Walsh, 2020, para 1). Best known for its lists ranking billionaires, media company Forbes now also ranks pregnancy and baby-tracking apps, heralding them as tools to "aid you in tracking and monitoring your baby's development" (Davis & Hall, 2024). High-profile women's magazines like *Vogue* and *Cosmopolitan* similarly present fertility and pregnancy tracking as part of everyday self- and healthcare (Garcia, 2014), going beyond a focus on women's uses, by promoting baby apps as essential tools for 'dads-to-be' (Hsieh et al., 2022). Yet, these techno-enthusiastic framings are also challenged by concerns around 'obsessive' baby tracking (big city moms, 2024), that may increase rather than reduce parental anxiety (Ugolik Phillips, 2021), and a general unease around personal data safety (Godwin, 2019).

As digital tools, baby apps facilitate the easy sharing of users' data with others – including unknown third parties – and users are often unaware of what data is being shared, who it is being shared with, and how it may it be used (Kemp, 2023; technavio, 2024). These are particularly important considerations for young children today, whose first digital traces and identities frequently emerge prior to birth, through their parents' digital practices (Mascheroni & Siibak, 2021; Tiidenberg & Baym, 2017), and who are often too young to consent or object to these practices of data generation and sharing (Leaver, 2017). Despite concerns around data privacy – especially in baby apps that are 'free to download' (Kemp, 2023; Song et al., 2024) – commercially-designed baby apps are by far the most popular and commonly used mobile apps for family-planning, pregnancy and early parenting (Rampazzo et al., 2022; technavio, 2022; 2024). By 2030, the current market of 'parenting apps' is forecast to almost double from a value of around 700 Million USD, to nearly 1.3 Billion USD, not counting the use of fertility apps, which are part of an even faster-growing multi-billion dollar market of Women's Health apps[1] (technavio, 2022).

[1] For instance, at the time of writing, popular period and pregnancy tracker *Flo* has exceeded 100 million downloads via the Google Play app store alone (Flo Health Inc., 2024).

Simultaneously, government interest in baby apps as mobile health (mHealth) technologies to support maternal and child health continues to rise (Bailey et al., 2022; Till et al., 2023). In countries of the global North – including the United Kingdom, North America, Canada and Australia – this interest corresponds with growing investment in the digitalisation of public health services, considering a high level of mobile use, an aging population, and a shrinking workforce of health professionals (ADHA, 2024; Thualagant & From, 2018). In the United Kingdom for instance, the app *Baby Buddy* (best beginnings, n.d.) was "developed as part of the shift towards mHealth […] in the third and public sector" (Thornham, 2019, p. 174), and has been integrated into public health service delivery[2]. Currently, similar tools are being trialled in in Cyprus, Greece, and Australia (Bernard van Leer Foundation, 2024).

1.2 Overview of the key issues in the study of baby apps

Considering their prolific integration into mundane and institutional contexts, the roles and usefulness of baby apps needs to be urgently investigated, to better understand how these everyday technologies construct and shape how parenting is performed and experienced, and how family life and childhoods are lived. To this end, this paper details four key issues as starting points for further investigation:

1) **Datafication:** This term is commonly used to describe processes in which complex embodied, social or relational experiences are converted into "online quantified data" (van Dijck, 2014, p. 198). Baby apps promote and normalise exactly these processes – turning the lived experience of the transition to parenthood into digital data and contributing to the digitalisation of the earliest stages of family life, including today's 'datafied childhoods' (Mascheroni & Siibak, 2021). The section outlines how app-promoted datafication can impact children's data privacy and shape their digital identities in lasting and problematic ways – pointing to the role of app design and the cultural drivers that normalise datafication.
2) **Discipline:** The concept of discipline refers to practices of purposeful training and correction to establish desirable behavioural patterns. As core components of baby apps, the self- and health tracking features included serve to discipline and train users into behaviours (e.g. fertility-promoting practices; healthy eating during pregnancy; establishment of breastfeeding and other infant care routines; etc). While the tracking of everyday life is an established practice long pre-dating digital tools, this section explores how the digital nature of baby app use gives rise to new disciplinary practices that can be experienced as (dis)empowering, depending on specific contexts and tracking modes. It draws on established texts and theories that introduce the underlying institutional norms which provide the cultural milieu that promotes understandings of baby app use as a part of 'good' contemporary parenthood. The section applies a selection of theoretical

[2] Baby Buddy is owned by the charity Best Beginnings but is a government-endorsed mobile application that was first trialled within, and then adopted by, the National Health Service.

framings that could be usefully employed by scholars from a range of disciplines, interested in studying the cultural significance of baby apps.

3) **Gender:** The visual, discursive and functional design elements of baby apps frequently cater specifically to users of a specific gender – namely women/mothers and mothers-to-be – as the 'envisioned' primary users. Their gendered design promotes gendered patterns of use. Baby apps can therefore perpetuate gendered stereotypes and role divisions in caregiving throughout the transition to parenthood. This section outlines how long-standing social and cultural norms become baked into app design, and provides insights into the impact of these patterns in the context of the parenting team. It prompts reflection on the outcomes of the design choices in everyday technologies, which are often taken-for-granted.
4) **The struggle for empowerment:** Being *empowered* is defined as "having the knowledge, confidence, means, or ability to do things or make decisions for oneself" (Merriam-Webster, 2024). Despite the many critiques and problematics raised by media and communications scholars in their study baby apps, as discussed in the key issues sections 1-3, many parents in recent qualitative studies on baby app use, recount experiences of app use befitting definitions of empowerment. While the concept of 'empowerment' itself is as complex as the associated experiences described by users of baby apps, this final section asserts that the field of baby app studies to date has paid insufficient attention to user experiences of 'empowerment' through app use. To begin to address this 'gap', the section offers alternative approaches to the study of baby apps – including a number of applied examples, that sample the work of members of the ARC Centre of Excellence for the Digital Child.

1.3 Introducing and situating the field of baby app studies

Media and communications disciplines have been leading scholarly engagement with baby apps and similar everyday digital media technologies that have come to define and shape how the earliest period of parenting and childhood are constructed, experienced and practised. Scholars from this discipline have been drawing on critical technology and data studies (Couldry & Mejias, 2023) to better understand the social impacts of an increasingly data-driven approach to the governance of populations at the systems level, as well as at the level of mundane technology use (Neff & Nafus, 2016) and everyday data cultures (Burgess et al., 2022). Regarding the study of digital childhoods specifically, the study of baby apps is closely related to research into the platformization of family life (Sefton-Green et al., 2024), and the datafication of childhood (Mascheroni & Siibak, 2021), which provide new directions for established research into the domestication of technologies within the home (Silverstone & Hirsch, 1992). Yet, despite the strong interest in technology, these approaches articulate well with the child-centred focus of the new sociology of childhood (Pugh, 2014) that acknowledges children "as active, competent and social actors, and childhood as diverse and varied" (Mascheroni & Siibak, 2021, p. 29-30). Hence, the field of baby app studies provides essential contextual insights into the socio-technical cultures and environments that children are born into, and that significantly shape their social and

individual identities, and their opportunities throughout the life-course, serving as a common denominator to all disciplines studying digital childhoods.

Baby apps have been a particularly popular subject of study in two distinct disciplines: the health sciences and the social sciences. Studies on baby apps that originate in the health sciences primarily focus on the potential efficacy of these tools in public health promotion, by supporting parents – most often mothers – to better adhere to public health recommendations and improve individual, family, and ultimately population health. Social sciences' examinations of baby apps – specifically those grounded in Science and Technology Studies (STS) [3]– have focussed on baby apps' social implications, including how they perpetuate and shape cultural norms. As outlined in greater detail in section 2.3, an increasing number of studies on baby apps is being published in digital health journals that integrate both health- and social sciences perspectives, taking a user-focussed approach – reflected in the use of qualitative methods, and the critical analysis of mobile health technologies. Building on the work of established cross-disciplinary scholars (Lupton & Pedersen, 2016), a momentum is building in the field. This invites further collaboration between the different disciplinary branches of the field of baby app studies.

At the ARC Centre of Excellence for the Digital Child, the importance of multi-disciplinary work to the comprehensive and nuanced exploration of a wide range of aspects of digital childhoods, is a well-recognised challenge. This recognition is illustrated in the establishment of its three core research streams: the healthy child, the educated child, and the connected child (Digital Child, 2024) representing the discipline areas of health, education, and media and communication. Yet, researchers from these streams constantly strive to resist the temptation to operate in silos, and the centre encourages and practices collaborative cross-, and multi-disciplinary work wherever possible. The relevance of baby app studies to the centre's research agenda is therefore reflected not only in its inherent cross-disciplinarity, but also in the range of current centre projects from different disciplines outlined in 3.4.2, that draw on and contribute to the field of baby app studies.

2. Defining baby apps

2.1 What are baby apps?

In the context of this paper, *baby apps* are mobile applications designed to facilitate the transition to parenthood; in other words, any apps used with the intention of achieving conception, to manage pregnancy, or to support the practical performance of early parenting and infant care.

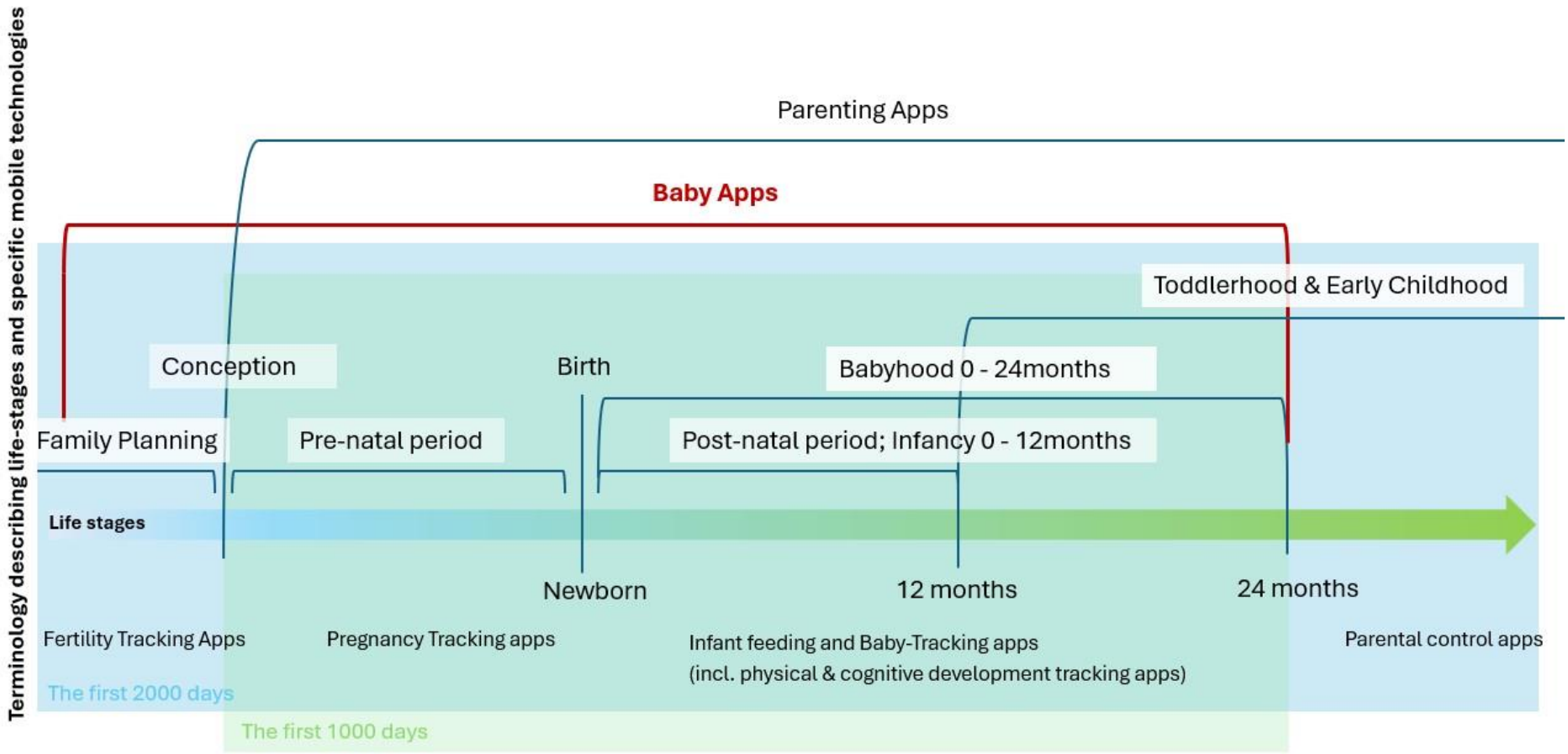
[3] Science and Technology Studies (STS), (also referred to as 'Science, Technology, and Society') is an interdisciplinary field that promotes explorations of how science, technology, and cultural practices, are interconnected and shape each other (Rohracher, 2015). For instance, section 3.3 provides observations on how gendered (western) cultural norms regarding parental role divisions are frequently reflected in the design of baby apps. App design subsequently promotes (or prevents) uses that perpetuate (or challenge) these cultural norms, thereby shaping cultural practices in return – which can give rise to the development and adoption of new technologies etc.

The term 'baby apps' works as an umbrella term, encompassing both mHealth tools that fall under this category, while also describing a particular period of the life-course during which these apps are particularly relevant (see Figure 1.1 below).

Baby apps fall into three categories, including *reproductive health and fertility tracking apps* (family planning) (see 2.2.1), *pregnancy tracking apps* (pre-natal period) (see 2.2.2), and *infant feeding and baby-development tracking apps* (post-natal period) (see 2.2.3): each is described further below. The period of baby app use maps onto the public health concept of "the first 1000 days", which describes the period of a child's life from conception to two years of age (Darling et al., 2020). This time is considered "a crucial window of opportunity for interventions that improve child and population health", since according to studies into the determinants of children's health "the infant brain is particularly susceptible to influences" and "parents are especially receptive to advice and support" (Darling et al., 2020, p. 1). This 'window of opportunity' has recently been adjusted to include "the first 2000 days", (Queensland Health, 2023), to acknowledge the importance of pre-conception health, and the formative years of early childhood, up to a child's fifth birthday.

The study of baby apps specifically focusses on how apps designed to support parents throughout the transition to parenthood might mediate these life-stages. A similar category of 'parenting apps' encompasses apps used from pregnancy onwards, but extending beyond babyhood, including parental control apps to mediate children's own technology use. How parents and young children negotiate the use of digital technologies throughout toddlerhood and childhood is explored in detail elsewhere (see for instance Mascheroni & Zaffaroni, 2023; Livingstone & Blum-Ross, 2020; Green et al., 2019; Jaunzems et al., 2017) and goes beyond the focus of this paper. Figure 1.1 below shows how each term is conceptualised, and the life-stages and types of mobile technologies they encompass.

Figure 1.1: Life stages and terms used to describe life-stage-specific mobile technologies



2.2 Categories of baby apps

2.2.1 Fertility tracking applications

The category of fertility tracking apps (FTAs) includes any mobile applications that may be used to track reproductive health for the purposes of achieving conception. Most apps available to track fertility fall under the *FemTech* category (Rosas, 2019) – designed to monitor menstruating bodies (Song et al., 2024). Hence, these apps commonly include features to track menstrual cycles, predict ovulation, and record additional data points such as "moods, symptoms, sexual activity and medications" (Gambier-Ross et al., 2018). There are comparatively few apps that track aspects of male fertility (Lynley, 2015; Lupton, 2015; Fox, 2017). Male involvement in fertility tracking commonly takes the form of female users opting for app-facilitated data-sharing from their FTA (Lupton, 2015), to "make trying to conceive more of a team effort" (Flo Health Inc., 2024; Hamper, 2022).

The majority of studies on FTAs to-date have explored these apps as tools for family planning, rather than for women's health management (Zwingerman et al., 2020; Blair et al., 2021; Earle et al., 2021; Duane et al., 2022; Wise et al., 2023). While these associations align closely with developers' intentions for these apps (Figueiredo et al., 2021), critical perspectives point to their gender essentialism – reinforcing and legitimising traditional understandings of women's social roles as reproductive citizens (Lupton, 2016; Hohmann-Marriott, 2021).

Although some of these tracking tools offer voluntary data-sharing with a partner, a key issue in fertility tracking app use remains unanticipated data-sharing with unknown others (Ziegler, 2021; Song et al., 2024). The impending arrival of a child is a particularly valuable piece of information for advertisers and other commercial actors (iab.Australia, 2015; Johnsons baby, 2021) and a time during which parental identity is significantly shaped through consumer choices, which can be directed by baby apps (Hamper, 2024). As tools used for family planning, apps can predict and 'diagnose' pregnancies, and share this information with third parties even prior to a user realising they are pregnant (Mascheroni & Siibak, 2021; Barassi, 2020). Consequently, menstruation and fertility trackers can produce the first digital traces of children, even prior to the use of pregnancy apps, or the sharing of ultrasound images (Tiidenberg & Baym, 2017; Leaver, 2017). Therefore, concerns around fertility apps' data safety – including sharing data with others – are also concerns about children's data safety.

2.2.2 Pregnancy tracking applications

Pregnancy tracking applications commonly offer features to track foetal growth and maternal health week-to-week; they provide health information, encourage mothers to bond with their unborn child, and to connect with others for peer-support (Lupton, 2017). They are designed to be informative and entertaining (Thomas & Lupton, 2016), and most mothers voluntarily take up pregnancy tracking (Lupton, 2017). However, the highly gendered nature of most pregnancy tracking apps also excludes male partners

as primary users, perpetuating gendered stereotypes of men as less interested, secondary parents (Thomas et al., 2018). These assumptions also exacerbate gaps in knowledge and expertise regarding foetal development, pregnancy, and early parenting (Hiebert et al., 2021). Pregnancy tracking apps make explicit and reinforce often implicit expectations of 'traditional' gender essentialist parental role divisions, that construct mothers-to-be as the 'natural' primary caregiver (Bowden & Mummery, 2014).

As some of the most pervasively used baby apps, pregnancy trackers make for important objects of study, since their design and use is shaped by a range of agendas beyond the support needs of parents-to-be. For example, commercial actors benefit from mothers' often extensive engagement in data generation and sharing practices in pregnancy (Tiidenberg & Baym, 2017), including through pregnancy app use, from which value can be extracted – through targeted advertising of baby products for example (iab. Australia, 2015). Additionally, there is significant public health interest in app-based tools to encourage mothers to follow health-promoting behaviours in pregnancy and beyond, to optimise foetal development – as in the example of the *Baby Buddy* app, designed for perinatal maternal and child health promotion (Daly et al., 2016).

Since the use of pregnancy tracking apps aligns well with both mothers' preferences in accessing information and support, and commercial actors' desire to collect consumer data, as well as with public health promotion interests, they provide highly attractive, accessible, and platformed opportunities for: 1) the promotion of health behaviour change by institutions; 2) attempts to shape parental consumer identities and behaviours by commercial actors; 3) the sharing and performance of the transition to parenthood throughout the perinatal period by parents-to-be.

2.2.3 Infant feeding and baby-tracking applications

The category of infant feeding and baby-tracking applications includes mobile apps designed to support parents in feeding and caring for their children throughout infancy – roughly the first 12-24 months of a child's life and early parenthood. These apps commonly include features to record and track basic aspects of caregiving, such as infants' feeds, nappies, and sleep, with some providing informational support, such as breastfeeding education (Dienelt et al., 2019; Sidhu et al., 2019). A key difference between apps from this last category, and fertility and pregnancy tracking apps, is that they are designed for use *after* birth, when – for the first time – both parents can be involved in hands-on caregiving. Nevertheless, similar to fertility and pregnancy trackers, app design commonly focusses on mothers as primary users – especially when apps include informational support on embodied aspects of infant care, such as breastfeeding.

Similar to pregnancy tracking apps, public health interests and parental practices overlap in the use of these mHealth tools. New parents are routinely encouraged by health professionals to initiate baby-tracking and record infants' feeds, nappies and sleep as indicators of normal development and breastfeeding success (Langton, 2024; CHQ, 2022; Thornham, 2019). Hence, baby-tracking app use can be experienced as a *pushed* tracking practice (Lupton, 2014a) rather than a self-motivated one. Examples

include when health professionals monitor maternal infant feeding practices to discipline[4] women into breastfeeding. These practices can be experienced as problematic, when quantified data – such as the frequency and duration of breastfeeds, tracked through infant feeding app use – is perceived as being valued over women's own accounts of their lived experience of early parenting and breastfeeding struggles (Thornham, 2019). Yet, when baby-tracking apps are used for *private* tracking (Lupton, 2014a) in the context of the family and the parenting team, the sharing of baby-tracking data between caregivers can also become a tool for communication, aiding in the coordination of care, and becoming usefully embedded into the practice of everyday parenting (Langton, 2024). In these everyday contexts, caregivers are commonly aware of each other's lived experience and early parenting struggles, meaning that infant feeding and baby-tracking apps that focus on the provision of tracking features only, are less likely to be experienced as reductive. In fact, when used as a complement to parents' embodied, situated knowledge of family life, data from tracking-focussed apps can make knowledge about caregiving routines and practices more accessible to all members of the parenting team (see section 3.4.3).

This category can be extended to include mobile applications designed to track and promote aspects of infant development beyond mundane caregiving practices, such as milestones in physical growth and cognitive development, which are becoming increasingly popular with new parents, although they have received little attention in studies of baby apps to date. Similarly underexplored are the data privacy risks of infant feeding and baby-tracking applications, although a lack of clarity in these apps' privacy policies has been raised as a concern[5].

[4] As briefly defined in 1.2, and explained in detail in 3.2, *disciplining* as a practice describes processes of repeated instruction and correction, to train someone into the establishment of, and adherence to, desired behavioural patterns. The context of public breastfeeding promotion illustrates some of the complexities in using this term, as disciplining by health professionals (i.e. provision of instruction and correction of maternal behaviours to support the establishment and maintenance of breastfeeding) can be experienced as helpful scaffolding when it aligns with and supports mothers' own ideas and practices of what constitutes a desirable behaviour in their specific circumstances. Yet, it can also be experienced as unhelpful surveillance that diminishes mothers' agency and self-determination, when mothers' own experiences and wishes are not taken into account.

[5] Thornham (2019) for instance has drawn attention to the 'sliding scale of data privacy' (p. 174) between free and paid versions of baby apps, which users may not be aware of, but which can significantly impact how big a range of data is being collected, and who it is shared with. Langton (2024) also observes that baby apps' privacy policies are often unnecessarily long, are written in inaccessible language, and do not name the 'third parties' they may share users' data with (even if deidentified) making it near-impossible for users to give meaningful and informed consent.

2.3 Baby apps as an academic field

The study of baby apps began about a decade ago, when mobile applications designed to support parents throughout the transition to parenthood became a regular object of study (Johnson, 2014; McCartney, 2014). Such academic focus developed from earlier interests in studying parenting blogs, websites, online forums and social media as sources of parenting information and support (Pedersen & Smithson, 2013; Lupton et al., 2016; Chalklen & Anderson, 2017; Van Cleaf, 2020). To date, baby apps have predominantly been explored by researchers from the health sciences (Dienelt et al., 2019; Cheng et al., 2020) or the social sciences (Johnson, 2014; Thornham, 2019), often with little recognition of research synergies between the two disciplines.

Health sciences scholars initially focussed on the evaluation of baby apps (Davis, 2017; Cheng et al. 2020), determining their 'quality' through the development of quantitative tools such as the mobile app rating scale (MARS) (Stoyanov et al., 2015). This tool assesses how well the informational content in baby apps aligns with public health recommendations (Taki et al., 2015; Virani et al., 2019). Studies then shifted towards exploring how the affordances of mobile apps could help to effect behaviour change according to established health behaviour change theories (Glanz, n.d.) – particularly social cognitive theory (Bandura, 1986; Sidhu et al., 2019) – and from there to the development and evaluation of the next generation of baby apps (often designed by public health aligned developers (White et al., 2016; Wang et al., 2018; Deave et al., 2018)). The latest development in health sciences' studies of baby apps has been the exploration of how baby apps may be better adapted and integrated into public health service delivery in different cultural contexts (Musgrave et al., 2021; Till et al., 2023): see the example of the UK's *Baby Buddy* in 1.1.

Within the social sciences, the study of baby apps builds on well-established Cultural Studies and Science and Technology Studies concepts that recognise culture and technology as mutually shaping (Rohracher, 2015; Williams, 1974; also see footnote on p. 7, and section 3.3.1). From the turn of the millennium, these ideas were increasingly applied to the rapidly proliferating range of digital technologies, resulting in the development of methods to conduct *digital ethnographies* – qualitative methods to study the social and cultural significance of technological infrastructures (Star, 1999; Møller & Robards, 2019), including the study of mobile applications as socio-technical artefacts (Lupton, 2014a; Light et al., 2018). Hence, while health sciences scholars were trying to understand how to employ baby apps to educate and correct parental behaviour to align with public health recommendations (i.e. how to assert behavioural change through baby apps), social sciences scholars were investigating how the design and affordances of baby apps reflected cultural norms – and thus revealed attempts by developers to discipline users into certain behaviours (Johnson, 2014; Thomas et al., 2018; Thornham, 2019).

The health- and social sciences branches of the field of baby app studies therefore developed somewhat in parallel to each other, but rarely overlapped due to their differing research agendas. More recently however, scholars in digital health and health informatics have begun to integrate more user-focussed, qualitative and exploratory research methods – specifically interviews and focus groups – into their investigations of baby apps' utility, which has resulted in a more critical investigation of baby apps (Hall et al., 2023; Hiebert et al., 2021; Dienelt et al., 2019). Critical, yet user-focussed approaches to the study of

baby apps and similar digital health tools have been demonstrated by scholars such as Deborah Lupton (2016; 2017; 2019a; 2021). Considering the momentum that has been building in this space, this paper also seeks to provide a timely prompt for the media and communications scholars working in baby app studies and adjacent fields, to engage with the academic work from other disciplines, capitalising on opportunities for cross-disciplinary collaboration (also see recommendations in section 4.1).

3. Four key issues in the study of baby apps

To guide further investigation into baby apps, this main section introduces four key issues that represent important dimensions to understanding digital childhoods more broadly. These key issues are: Datafication, Disciplining, Gender, and Empowerment. Even though these areas of investigation are presented under distinct headings for clarity, in practice they are deeply interconnected.

3.1 Datafication

A widely used definition of datafication stems from Mayer-Schönberger and Cukier's work (2013), paraphrased by van Dijck (2014) as "the transformation of social action into online quantified data, thus allowing for real-time tracking and predictive analysis" (p. 198). This definition captures the generation and sharing of data in the context of *Big Data* flows. The concept of datafication is of central relevance in explorations of digital childhoods in general (Mascheroni & Siibak, 2021) and specifically in the context of baby app use. These apps are essentially datafying technologies that facilitate the digital representation and processing of intimate aspects of family life. Through datafication, aspects of identity and social life are abstracted and flattened into individual data points, vast numbers of which can be aggregated into Big Data streams – to be analysed, and to make visible patterns and trends that would otherwise remain unknown – enabling responsive action to try to exercise control over what data can make knowable (Beer, 2019). The sense of 'power' inherent in data – to make things knowable and available for control and optimisation – is one of the main drivers of datafication (Beer, 2019), not only for 'big tech' companies and other commercial entities (e.g. advertisers), but also for governments (e.g. public health departments), and individuals (e.g. parents).

On the level of individual use, baby apps may facilitate the tracking of menstrual cycles, or infants' sleep – uses in which the data-driven knowledge, and the potential to act on this knowledge, are confined to and situated within the family context. However, the digitalisation of intimate aspects of users' everyday lives through datafication also facilitates the sharing of personal data beyond these contexts. This de-contextualisation leads to a reduction of many relational aspects of family life that cannot be represented through data. As outlined further in 3.1.1, the sharing of personal data from baby apps, and its combination with other online data, can have significant and often unpredictable consequences for users, and potentially their children. What can and cannot be datafied about identities and social lives, along with issues of data privacy – who is able to access, analyse, and act on the kinds of knowledge produced through data – are key issues of concern in the study of baby apps.

3.1.1 Datafication and children's data privacy risks

For the majority of baby app users – women, and mothers-to-be – *who* is able to access data on their reproductive health and fertility can carry risks to their individual health and reproductive freedoms (Harwell, 2019; Rosato, 2020), particularly in national contexts in which women's rights remain contested[6]. Aside from risks to baby app users' own data safety however, the data traces generated through baby app use also put children's data safety at risk. Parents are often unconcerned about the data privacy of baby apps[7] (Lupton, 2017; Mascheroni & Siibak, 2021), as the datafication and tracking of mundane events and everyday practices – menstruation, foetal development, dirty nappies – seem to hold little value for others, but make many aspects of everyday parenting easier (Dienelt et al., 2019; Langton, 2024). However, the extraction and aggregation of large amounts of user data holds significant value for tech companies, who can sell this data on to data brokers, for subsequent uses such as user profiling and targeted advertising by commercial actors (Crain, 2018). Through a lack of concern about known or unanticipated data-sharing with third parties, parents can lose control over their own and their children's digital data traces (Lupton, 2020; Barassi, 2020).

Even prior to a child's birth, baby app use can generate data on "conception date, weight, number of kicks in the womb, possible names [and gender], cultural background, heart rate, diet before conception, parents' thoughts, family ties, family medical history, complications during pregnancy, and due date" (Barassi, 2020, p. 35). Through digital traces generated during parents' baby app use, in Google searches, and information shared on social media, data from different sources can be assembled into online profiles that come to speak for and about parents, as well as children (Barassi et al., 2018). Specific future impacts on children's lives of constant data extraction from parents' online activities are difficult to anticipate. However, Mascheroni and Siibak (2021) argue that these data traces provide the first opportunities for children's profiling and categorisation, and that children's algorithmically assembled data and profiles can be collated into what Montgomery (2015) terms *digital dossiers*. These are collections of data that follow children throughout the life-course, and that could be used to algorithmically determine their access to educational and job opportunities, insurance or financial credit. Far from being theoretical *potential* harms, algorithmic profiling and predictions are known to shape what adults and children see online, and the information and choices that are presented to them (Ito et al., 2021; Bivens & Haimson,

[6] A recent and topical example in a cultural context similar to Australia (post-industrial, western), has been the US Supreme Court's decision to overturn the constitutional right to abortion, in June 2022, leading to "an alarming deterioration in access to sexual and reproductive health care" (United Nations, 2023). The decision led many users of fertility tracking apps to stop using these tools, as the data collected can be used to "detect pregnancy and abortion, hence putting women at risk of being prosecuted" (Cao et al., 2024).

[7] What is commonly of far greater concern to parents than the sharing of mundane data traces through baby app use, are their own and other family and friends' *sharenting* practices (Blum-Ross & Livingstone, 2017). This term describes the sharing of children's identifying information – such as their image, full name, date of birth, home address or daycare details – in online spaces such as on social media platforms, as part of caregivers' own identity performance. However, the amount and detail of intimate information on mothers' and children's bodies, behaviours, development, and other personal details that is collected through baby app use, can go well beyond these more recognisable sharenting practices.

2016) – including search results (Noble, 2018), content, and purchase recommendations. Algorithmic prediction is also being used to assess children's learning (Williamson, 2017), and in a recent UK example replaced students' final exams during the pandemic, to determine their suitability for tertiary education – resulting in biased outcomes that disadvantaged students from lower socio-economic backgrounds (Hao, 2020). Because the data that is being assembled into children's digital profiles can be temporarily aggregated from a wide range of digital repositories, they are difficult to locate – allowing little opportunity to review, adjust or amend them. Nevertheless, these digital data assemblages of children's identities may be taken as stand-ins for children themselves – no matter how inaccurate and biased – and work in the background to shape children's lives in unknown and unimaginable ways (Barassi, 2020).

3.1.2 Data privacy: the role of app design and transparency

The wide range of baby apps available to support parents through the different stages of their transition to parenthood means there are significant variations in apps' functional design, including how any data generated during use is stored, accessed, and shared. Consequently, distinctions should be made regarding how particular apps manage user data, what kinds of data flows they may contribute to, for what purpose, and to whose benefit. Some fertility-, pregnancy-, or baby-tracking apps offer their users significant control over the data that is generated and stored, by offering a range of data storage options for instance, or through the provision of succinct, accessible, and transparent data privacy policies (Song et al., 2024; Langton, 2024). Some baby apps comply with data protection and transparency regulations such as the Health Insurance Portability and Accountability Act (HIPAA) – which ensures informed consent for the sharing of health data (U.S. Department of Health & Human Services Office for Civil Rights, n.d.), or the European General Data Protection Regulation (GDPR) – which stresses the importance of providing transparent privacy policies (Burgess, 2020), to ensure users' meaningful consent. These regulations are frequently referred to in app promotions, to signal trustworthiness and suggest that app providers take users' data privacy seriously. In Australia, the Australian Privacy Act 1988, which incorporates the Australian Privacy Principles, and "governs the regulation of personal information in Australia" (Lander & Rogers, 2022), is considered outdated regarding the protection of personal data in digital environments (Dreyfus, 2024). Although guidelines such as 'better practice guides' exist for Australian app developers, adherence to these by developers outside of the context of government agencies is optional. Hence, adherence to the GDPR and HIPAA as recognisable privacy-oriented regulations, are also referred to by a number of Australian app developers aiming to instil a sense of confidence in their apps (Langton, 2024). However, the practical application of privacy principles and regulations is often inadequate, with many apps' privacy policies remaining opaque, due to vague or jargon-laden language, and excessive length (Langton, 2024; Thornham, 2019). Through the provision of inaccessible privacy policies, baby apps that seem otherwise desirable and useful to parents, contribute to what Draper and Turow (2019) have termed *digital resignation.* This term describes situations when parents resign themselves to having to give up control over their family's personal data, to be able to access app-based parenting support. There is a balance between the immediate and tangible benefits of receiving timely support, compared to a vague

future risk through data-sharing, and parents commonly opt in favour of surrendering their data (Langton, 2024; Hargittai & Marwick, 2016).

3.1.3 The fetishisation of data-driven knowledge

Van Dijck (2014) coined the term of *dataism* to describe the contemporary fetishisation of data-driven knowledge[8], and a faith in the ability of quantified data to accurately represent even the most complex social phenomena. A belief and trust in quantified data as an objective and trustworthy source of knowledge (Moretti & Maturo, 2018) – especially when compared to other forms of more tacit knowledge such as parents' embodied experience – can mean that quantifiable aspects of parents' and children's lives are highlighted over non-quantifiable aspects, which are thereby presented as less important. Since baby apps predominantly datafy – and therefore reduce – the bodies and behaviours of women and children, how this data is used has particularly powerful implications for these groups. As discussed in the example of baby app use in breastfeeding promotion contexts in section 3.3.3, when baby app data is interpreted outside of the context of the lived experience of the 'subjects' of datafication, this use of data can be experienced as profoundly disempowering.

An understanding of quantified data as able to deliver otherwise inaccessible, unknowable insights through data analytics (Beer, 2019), is also presented in promotional blurbs of the envisioned uses of baby apps like *Feed Baby*, *BabyTracker*, and *Huckleberry*. These blurbs promote their 'powerful controls' (Penguin Apps, n.d.), or their ability to "quickly identify data patterns, habitual trends or abnormalities" (Nighp Software LLC, 2024); enabling parents to "know exactly" (Nighp Software LLC, 2024) about their children's routines, behaviours and development, through "helpful predictions" (Huckleberry Labs, 2024). However, these perspectives fail to recognise the shortcomings of data as abstractions of relational, embodied practices, thus constructing parents' own knowledge as lacking, and parenting that is not based on data-driven knowledge as inferior (Leaver, 2017).

The process of datafication that 'transforms social action into online quantified data', is invariably a reductive process that flattens the complexity of the lived experience of family life. Hence, rather than predominantly relying on quantified data as a representative source of knowledge on family life, it is important to recognise the existence of *data shadows* (Leonelli, 2017) – the many relational and affective components of parents' and children's experiences and practices, which cannot (yet) be accurately represented in data. However, as further discussed in section 3.4.1., when data-based knowledge is used as a supplement, rather than a replacement of the experiential, embodied knowledge of caregiving, it can also be used to enhance parental self-efficacy and involvement, and become an expression of intimacy and affection. The practices of *caring dataveillance* (Lupton, 2021) for instance – data-based monitoring of others as part of caregiving – facilitated through baby app use, are often motivated by genuine concern

[8] Mascheroni and Sibaak (2021) also refer to this fetishisation as akin to a "data religion" (p. 4)

and love, rather than in terms of a desire for control, surveillance, or optimisation, which is outlined further in section 3.2.2.

3.2 Discipline

The term *discipline* and what it means to *be disciplined* carries an inherent tension – being either associated with the imposition of power by authoritative others, or with autonomous self-governance. *Being disciplined* by others is commonly understood as disempowering, marked by a fundamental power imbalance between an authority figure who administers control or punishment onto a less powerful subject (e.g. when parents discipline children). However, when described as an individual disposition, *being disciplined* is also connected with a sense of *virtue* and accomplishment[9]. Hence, any disciplinary effects and practices of baby app use discussed in this section are not inherently problematic or 'bad', nor are they inherently desirable. They can, however, be analysed and described to uncover the underlying power dynamics that can lead to experiences of disciplinary practices as disempowering/repressive, or as empowering/increasing agency. Additionally, how disciplinary practices are experienced is also contextualised by contemporary social ideals. Individuals in late modern societies for instance depend on disciplinary practices to develop effective ways of self-governance, to cope with their 'obligation' to be free, self-determined citizens in neoliberal democracies (Rose, 1999). Notably then, much of the disciplinary power operationalised through baby apps is achieved implicitly, through reinforcement of taken-for-granted cultural norms and understandings, such as the achievement of good health as an individual responsibility. For women in the transition to parenthood, this individual responsibilisation for one's health is also entangled with gender norms and parenting ideologies that moralise their caregiving practices through the "responsibilisation of the self-for-others" (Johnson, 2014, p. 332). How contemporary Western forms of life and social organisation influence experiences and practices of self-tracking is further outlined in sections 3.2.2 and 3.2.3 below.

App-facilitated self-tracking practices are not 'new' themselves, but frequently replace established analog practices, such as pen-and-paper tracking – recording food intake, exercise, menstruation – or other non-digital 'tracking' methods like the earlier example of nappy pins indicating which side to breastfeed from (Neff & Nafus, 2016; Rampazzo et al., 2022). What is a relatively recent trend, however, is the cultural normalisation of the digitalisation of ever-more intimate aspects of everyday life – now routinely facilitated through mobile applications (Lupton, 2014b). A key distinguishing feature of the self-tracking practices facilitated through baby apps are the additional affordances that result from the digital nature of app-based datafication. These include the improved convenience and practicality of tracking – often increasing its duration and frequency, and therefore the completeness and usefulness of datasets, which can then be employed to chart and track progress over time, and to algorithmically sort and organise data to show trends and patterns. Datafication and the trust in data-driven knowledge described in section

[9] Similar to Aristotle's idea of a virtuous person as someone who actively cultivates their ability to make choices that allow them to reach their goals – through practice, reflection, and sacrifice (Kraut, 2001).

3.1.3, open up new ways of disciplining, since data itself is imbued with authoritative power, as a source of superior knowledge. Additionally, digital datasets can also be synced or shared with others, distributing access to this 'powerful' data, and turning self-tracking from an individual (self-disciplining) practice to a disciplinary tool accessible to others. The tensions between self-tracking as a self-determined, empowering activity, or as a tool through which individuals can be disciplined by others in ways that are experienced as disempowering, are explored throughout this section, and further exemplified throughout 3.3, in the discussion of gendered experiences of baby apps.

3.2.1 Private and pushed self-tracking in baby app use

As outlined in section 2.2, baby apps commonly include tracking features that promote practices of self- and health-tracking. These inform everyday parenting practices but are also used to visibly demonstrate and perform 'good' parenting to others. Self- and health-tracking practices that are initiated voluntarily have been described as *private* self-tracking (Lupton, 2014a), when individuals "[use] the information they collect on themselves to achieve self-awareness and optimise and improve their lives" (Lupton, 2014a, p. 5). This can be experienced as "a pleasurable and playful mode of selfhood" (p. 6). Essentially, self-tracking technologies facilitate self-surveillance with the intention to highlight aspects about oneself that subsequently become a focus for improvement. There are many elements of private, pleasurable and playful self-tracking practices in baby app use – for instance when fertility trackers are used in ways that increase women's self-awareness and appreciation of their bodies (Levy & Romo-Avilés, 2019), when mothers-to-be track how their body changes during gestation, or use a pregnancy tracker to tell them what size fruit their foetus' body is closest to this week (Lupton, 2017), as a kind of gamification of health-tracking practices (Thomas & Lupton, 2016). However, the cultural contexts and expectations in which self- and health-tracking through baby apps takes place, blur the lines between *private* and *pushed* self-tracking modes (Lupton, 2014a) – moving it from a self-initiated, voluntary, *private* practice, to a practice that is *pushed* – 'nudged' or expected by others (e.g. health professionals), who can use self-tracking data to evaluate and hold parents accountable for their caregiving practices. In these contexts, self-tracking is frequently experienced as disempowering, as caregivers are 'being disciplined' by others into performative "tracking-as-care" regimes (Thornham, 2019), further outlined in section 3.2.3.

3.2.2 Social trajectories constructing good parenting as risk management

The transition to parenthood is:

> "A change in a significant life role [as] marked by a transitional or liminal period during which (a) personal identities are suspended, producing significant psychological consequences, and (b) symbolic consumption may be used to facilitate the transition to the new role." (Noble & Walker, 1997, p. 32)

The 'new' identity of a parent emerges through substantial physical and emotional upheaval, leading parents to seek a sense of control and stability – in how new parenting *should be done*, and in *who they are* as parents – aspects of identity which are interlinked. In this context, baby apps play an important role in facilitating parental identity construction, through their mediation of everyday parenting – providing a temporally and culturally situated example of how the identity of the 'good' parent is constructed and made accessible through these everyday self-tracking technologies.

Aside from any pleasurable or playful aspects of autonomous self-tracking for self-knowledge and awareness, in the (post-industrial, western, capitalist) minority world, tracking to improve and optimise health is also promoted through a set of deeply embedded cultural trends. These include a structural reliance on what Rosa (2020) terms *dynamic stabilisation* – the necessity for year-on-year *growth* and *improvement*, to maintain the normal functioning of 'modern' societies. At the level of individual citizens, this cultural drive for constant improvement requires self-optimisation as part of the performance of 'good' neoliberal citizenship, coupled with a minimisation of the risk of anything untoward happening (Rosa, 2020; Krüger, 2018). A constant sense of needing to minimise risk also engenders a feeling of being constantly *at risk* (a hallmark of Beck's theory of a contemporary *risk society* (1992)). In the context of contemporary parenting culture, this permanently heightened risk awareness finds expression in an intensified parental *risk consciousness* (Lee et al., 2023) – a sense of children as being constantly *at risk* – including from their parents' sub-optimal or 'risky' parenting practices (Lee et al., 2010). Against this cultural backdrop, understandings of 'good' parenting no longer focus on parental practices of "nurturing, stimulating and socialising children" (Furedi, 2002, p. 5); instead, good parenting is equated with the management and prevention of risk, and the optimisation of health and life opportunities, in line with public health concepts such as 'the first 1000 days' (Darling et al., 2020). These associations exemplify the logic of *parental determinism* that holds parents accountable for their children's health and successes throughout the life-course (Furedi, 2002, p. 45) – a responsibility disproportionately placed on mothers.

3.2.3 Institutional norms of good parenting as digitised (reproductive) citizenship

Self-tracking for the optimisation of self, health and fitness is a practice commonly performed by everybody (Lupton, 2019a). Yet, many fitness tracking apps are designed with a universal male user in mind (Langton, 2024; Mellor, 2019; Quinn, 2014). The overwhelmingly gendered design of baby apps on the other hand, firmly places the responsibility for self-tracking throughout the transition to parenthood with women (Langton, 2024).This responsibilisation of women's own health management has also been analysed in terms of a more general performance of good (neoliberal) citizenship through self-optimisation where women bear the responsibility to perform good (digitised) *reproductive* citizenship (Lupton, 2016) (in line with observations of performing 'good' parenting and citizenship in 3.2.1 and 3.2.2).

As part of ensuring the health (and productivity) of the next generation, public health recommendations provide guidance on minimising health risks and optimising child development – specifically during pregnancy and a child's infancy (NHMRC, 2013; Department of Health and Aged Care, 2021). Improvements and optimisation can be measured against concrete health markers, such as maternal weight gain,

adherence to dietary recommendations, expected foetal and child growth, the number of wet nappies, or the frequency and duration of breastfeeds. While these markers are commonly evaluated in routine health-checks during the perinatal period, baby apps promote a shift of these practices to individual parents – usually mothers. Through the provision of app features that facilitate the generation of such health data, baby apps train parents in quasi-health-professional practices (Langton, 2024), to become 'digitally engaged' and expert patients (Lupton, 2013; Fox & Ward, 2006). The app-based tracking of women's and children's bodies thereby becomes part of performing 'good' parenthood through "tracking-as-care" (Thornham, 2019). Practices of maternal self-management and optimal caregiving are understood as a mothers' moral responsibility to their children (Johnson, 2014; Lee et al., 2023; Lee, 2018). Johnson (2014) describes this responsibilisation of mothers, to optimise their children's health through extensive self-management and tracking of their own bodies and behaviours – including through baby app use – with the concept of "being-for-intimate-others" (p. 332). This way of *being* a good parent and mother has become part of the social expectations against which parenting is evaluated (Símonardóttir, 2016; Lupton, 2017). The cultural trends and expectations outlined above, as well as the institutional efforts to guide and regularly assess adherence to normative health standards, work to discipline mothers through repeated monitoring, training and evaluation.

3.2.4 Disciplining through baby apps – a positive medicalisation?

Section 3.1.3, explained how a faith in the power and potential of data has become entrenched as a prominent socio-technical imaginary (van Dijck, 2014; Beer, 2019). In an era of constant parental vigilance to prevent and manage risks to children's health, baby apps seem to allow users to control and contain risk. A sense of control and containment of risk during the comparatively volatile period of new or impending parenthood is what makes baby app use particularly attractive to new mothers (Lupton, 2017; 2019b). As outlined in the previous section (3.2.3), women are commonly responsibilised to track and monitor their own bodies and behaviours, as well as those of their children, to minimise risk and optimise health outcomes. Through their tracking features and datafying functions, baby apps promise a way to cope with, and somewhat offload the pressures of risk management to a digital tool, designed to enable users to meet the ideals of performing 'good' (data-informed) parenting, also described in section 3.1.3. The proliferation and popularity of these tools can thus be interpreted as a direct response to the recent establishment of socio-technical imaginaries around datafying technologies, which baby apps both exemplify and exacerbate.

Still, despite the critical lens through which these developments are presented in this section, experiences of a 'positive medicalisation' (Moretti & Maturo, 2018) are not uncommon (Lupton, 2019a, 2017) but have received little attention in research to date. The term 'positive medicalisation' refers to instances when health monitoring and management through mHealth apps is experienced positively by their users, through actual or perceived improvements in health and quality of life. These experiences are discussed further in section 3.4 and should be explored in further research (see 4.1) to determine the designs and contexts of baby app use that can enhance and support parents' practices of caregiving. Nonetheless,

what is also important to raise in this context is not only the role of the digitalisation of healthcare and the adoption of mHealth technologies in the responsibilisation of parents for children's welfare, but also whether this process may lead to the increased withdrawal of the state from providing analog health services and the potential implications of this shift – specifically the accessibility of health care, and who may be left behind.

3.3 Gender

3.3.1 Constructions of gender-differentiated parenting through baby apps

From the time that women begin to monitor their cycles with the intent of falling pregnant, they become the 'envisioned users' of baby apps (Light et al., 2018) – who developers expect their app will be used by – which subsequently becomes the user that is implied by the decisions made on the visual, discursive, and functional elements of app design. Rather than solely engaging in health-tracking to monitor and promote their own health, women are now expected to monitor their bodies to optimise their children's health outcomes (Johnson, 2014; Thornham, 2019). The use of baby apps for this purpose is often experienced as genuinely helpful, and as facilitating a sense of agency and control during a demanding life-stage (Dienelt et al., 2019; Lupton, 2019a, 2017). However, outside of this envelope of envisioned use (Ash, 2015), we know that women are also frustrated by how the gendered nature of baby apps' design individualises parenting labour (Hiebert et al., 2021), through visual and discursive design that excludes any caregivers other than the mother/birth-parent as potential users, or constructs them as less competent, less interested caregivers (Thomas et al., 2018). Additionally, many baby apps assume a traditional family constellation – specifically a coupled, heterosexual user (Byrt & Dempsey, 2020). This replication of idealised Western cultural norms of the nuclear family, traditional gender stereotypes and gender-differentiated parenting roles no longer aligns with how parents today envision their parenting identities (Doucet, 2009; Thomas et al., 2018; Langton, 2024), or indeed live in increasingly diverse contemporary family constellations (Dempsey, 2013; Blackwell et al., 2016; Prout, 2021).

3.3.2 Gendered agendas in baby app design

The design of most baby apps reflects an expectation of women as their main 'envisioned' users. These expectations both reflect and perpetuate established patterns of online information seeking for health and parenting support (Stern et al., 2012; Lupton, 2019a). Gendered app design that targets women as the main user group also has advantages for commercial and institutional actors. For instance, the gendering of digital environments allows platforms to advertise to (and shape) a specific segment of app users as consumers – optimising targeted advertising (Bivens & Haimson, 2016; iab. Australia, 2015). Institutions such as public health departments similarly seek to target those members of the population whose behaviours are deemed to have the most impact on child health (i.e. mothers), to increase their adherence to desirable health behaviours (e.g. breastfeeding) (Darling et al., 2020; Rollins et al., 2016). Hence, whether apps are designed by commercial actors, or government institutions or non-profits (e.g.

Breastfeeding Associations), they are likely to perpetuate established gender-differentiated roles in the responsibility and performance of caregiving. These agendas add another layer of complexity to considerations of parental motivations for baby app use, in addition to cultural ideals of good citizenship and parenthood discussed in sections 3.2.3 and 3.2.4.

The gender-differentiated roles that are promoted in the context of baby app design and use, also reflect more deeply rooted cultural notions of masculinity and femininity, in which men are the designers, and women the users of technology (Wajcman, 1991). Scholars have noted that this trend is also reflected in many baby apps, with male product designers creating a wide range of technologies for women to track and datafy their reproductive health and behaviours (Quinn, 2014; Teoh, 2017; Levy, 2018; Tiffany, 2018; Godwin, 2019; Danielthinks, 2020). These role and power divisions mean that men – even if well-intentioned – continue to design the 'envisioned users and uses' of baby apps. Furthermore, women as primary users of baby apps are also dependent on male developers to make changes to or 'fix' these technologies (Wajcman, 1991). Baby apps are therefore also contemporary examples of long-standing male dominance in technological design. Not only does the task of creating these technologies effectively substitute increased male involvement in the domestic labour of reproduction and caregiving, the disproportionate level of control over baby apps' design and affordances also confirm that, still, "it is men on the whole who are in control of women's domestic machinery and domestic environment" (Cockburn, 1985, p. 220).

3.3.3 Implications of gendered design and uses of baby apps

Baby apps are predominantly designed for – and used by – women, in part as a continuation of existing patterns of online health information seeking, commonly performed by women as the 'keepers of kin' (Stern et al., 2012). In the context of the family, these disproportionate divisions of labour in seeking and accessing information on health and caregiving, result in a significant gap in knowledge and expertise between mothers and fathers. This unevenness in parenting expertise has significant knock-on effects regarding divisions of parenting labour, which frequently become entrenched during the early parenting period (Doucet, 2009). For example, mothers frequently perform additional labour as educators to their partners, when relaying child health information to them (Hiebert et al., 2021; Langton, 2024). Mothers are also more likely to assume additional responsibility in caregiving tasks, to avoid having to spend additional time having to instruct their partners – who are also more likely to defer to their expertise, and to rely on receiving instructions. Ultimately, this situation leads parents to easily fall into patterns of 'least resistance', in which mothers assume the role of the obvious primary caregiver – performing not only the majority of hands-on caregiving and the mental labour of 'thinking about the baby' (Walzer, 1998), but also the digital labour of health information seeking and digital monitoring through baby apps. Baby apps that promise to make parenting easier, are also attractive to women because they allow them to better cope with the pressures and expectations of *intensive motherhood* (Hays, 1996) – specifically the intensive labour component.

As a consequence of baby apps' gendered design, and the unevenness in the responsibility for, and performance of (digitally-facilitated) caregiving, mothers' use of baby apps results in the disproportionate and detailed datafication of their bodies and caregiving practices – and with that, much of young children's lives, and everyday family routines, as detailed in sections 2.2 and 3.1.1. Consequently, mothers also make themselves accountable for any potential negative outcomes of their caring dataveillance (Lupton, 2021). This pattern leads many women to assume additional roles and responsibilities as managers of their family's data privacy and online safety (Langton & Zhao, 2024; Peng, 2022).

Notably, even though baby apps promote and facilitate the extensive and detailed datafication of women's bodies, they only highlight those aspects of women's bodies and behaviours that are important to achieve conception, or to maximise children's health, while other experiences remain hidden. In the context of *private* tracking (Lupton, 2014a), when this data is generated by women for their own use, it can be interpreted within the lived experience of caregiving. Quantified data of the number of breastfeeds for instance becomes part of a larger assemblage of different types of knowledge – such as what breastfeeding *feels like* (physically and emotionally) and observations of children's behaviour (e.g. content, unsettled). Thornham's (2019) work on women's experiences of health-professional-prompted infant feeding app use, provides an illustrative example of how the interpretation of app-generated data by health professionals highlighted only those aspects of women's bodies and caregiving routines that could be quantified and used to determine breastfeeding 'success'. Even though this data does not reflect women's physical pain and exhaustion, or their stress and mental health challenges, the quantitative, datafied representations of their feeding practices were treated by health professionals as more reliable than women's own accounts, rendering these mothers 'algorithmically vulnerable' (Thornham, 2019). Evidently, problematic experiences of baby app use arise when their data is decontextualised and disembodied, to discipline women into desirable caregiving practices, rather than recognising this data as only one facet of women's embodied experience.

3.4 The struggle for empowerment

The meanings associated with the term 'empowerment' have evolved over time, and it means different things to scholars from different disciplines. Social sciences scholars like Aaron Schutz (2019) for instance are critical of the apparent loss of the term's "earlier, more radical meanings" (p. 2). In the 1960s, the term 'empowerment' was commonly used in reference to collective social movements, when oppressed groups self-organised to advocate for systemic change and emancipation, by challenging the status quo[10]. Conversely, in the health sciences the term is frequently used in contexts of individual 'patient

[10] For example the US civil rights movement, 'second wave' feminism of the 1960s and 70s (National Women's History Museum, 2020), and the more intersectional black feminist writings and movements that recognised the complexities of oppression of different aspects of identity, expressed for instance in Patricia Hill Collins' concept of the *Matrix of Domination* (Hill Collins, 2009; Goodwill et al., 2021).

empowerment', to describe an enabling force that allows individual patients to exercise greater control over their bodies, to better manage a health condition for example (Pescosolido et al., 2011; Schutz, 2019).

In the latter conceptualisation, empowerment is experienced within a reference frame of dominant socio-cultural constructions of health and illness, and of (neoliberal) ideals of enabling autonomy (and also individual responsibility) in managing one's health. Hence, while the earlier use of the term suggests a goal of achieving structural change through collective action, being empowered as an individualised experience effectively contradicts these meanings. Understandings of what constitutes empowerment and under what circumstances a group, or an individual, could be described as *empowered* are therefore likely to differ substantially between different disciplinary traditions. Despite this very simplified overview of the disciplinary differences in conceptions of empowerment, I do not mean to imply a binary of empowerment as being either systemic or individual, which would bely the complexity of the many levels at which empowerment may be effected or experienced. The references to two different contexts of app use throughout this paper (e.g. public health settings vs the individual/family context) may also falsely reinforce this impression. I would therefore like to make explicit here, that everyday experiences and practices of baby app use can certainly be empowering (or disempowering) at multiple levels, even at the same time. For example, baby app use may be disempowering in how it can contribute to the systemic responsibilisation of mothers for caregiving, but it can simultaneously be experienced as empowering when it allows women to challenge health professional expertise, thereby reducing the influence of health professional authority and the medicalisation of women's bodies and infant care. While baby app use may give a mother a sense of empowerment by helping her to establish breastfeeding, it may make her feel disempowered by highlighting her lack of sleep. The point I am trying to make here, is that of all the issues and terms discussed in this paper, experiences of empowerment may be the most slippery and complex – which I hope will come through in the following sub-sections. Previous observations of the tensions in different understandings of the term 'empowerment', are briefly discussed in sections 3.2 and 3.2.1 on *Discipline.*

3.4.1 Feminist tensions in baby app research

The discussions of baby apps in this paper have situated these tools within broader cultural contexts that explain their continued popularity with mothers, and uptake in public health contexts. This perspective echoes the approaches of many social sciences scholars to date, who have predominantly focussed on critiquing mHealth tools as disciplinary – rather than 'empowering' – technologies (Johnson, 2014; Leaver, 2017; Thornham, 2019). Nevertheless, in qualitative explorations of users' perspectives on baby app use, participants often describe experiences of increased agency and what is described as *a sense of* empowerment (Madge & Connor, 2006). A *sense of empowerment* has previously been described in contexts of women accessing online communities for informational, social- and emotional support throughout the transition to parenthood (Madge & O'Connor, 2006; Van Cleaf, 2020). Specifically, participants in Madge and O'Connor's (2006) study examining women's uses of "the first UK-based parenting website *Babyworld"* (p. 203, italicisation added) reported that access to knowledge and support

online enabled them to feel "more in control" by increasing their ability to make "informed decisions and choices" (p. 207) during a physically and emotionally challenging life-stage. Yet, 'empowerment' remained a contested term for Madge and O'Connor (2006) since the feelings and experiences described by participants stemmed from respondents in mostly 'traditional' family structures, using a website presuming users to be "heterosexual, white and middle class" (p. 205). While perceived positively on the individual level, the 'empowerment' facilitated in this online environment may have done little to challenge structural "patriarchal power relations" (p. 213) in line with radical, emancipatory conceptions of empowerment.

Although some include features for community connection, many baby apps are designed for individual use, or for use within the parenting team – seemingly precluding opportunities for collective social action as 'true' empowerment. Yet, baby app users still describe a wide range of positive experiences, which often exceed conceptions of individual 'patient empowerment', by promoting emancipation from health professional advice – challenging traditional doctor-patient power hierarchies of medical expertise. Positive accounts of baby app use include better self-knowledge (e.g. of menstrual (ir)regularities and symptoms) (Levy & Romo-Aviles, 2019), improved awareness of embodied and observational cues (e.g. infants' feeding cues, physical changes during pregnancy) (Langton, 2024; Lupton, 2017), and an overall appreciation of their embodied selves and experience (Riley & Paskova, 2022). Additionally, users frequently report an increased sense of self-efficacy in coping with the challenges of early parenting (Dienelt et al., 2019), including a sense of control and confidence in health decision-making (Levy & Romo-Aviles, 2019; Dienelt et al., 2019), allowing them to challenge health professionals' status as authoritative experts on their own and their children's bodies (Wang et al., 2019; Langton, 2024; Rampazzo et al., 2022). Still, feminist scholars frequently question the validity of these experiences in western cultural contexts. They argue that such claims can be explained by the internalisation of neoliberal values that promote self-monitoring as part of its disciplinary surveillance practices, to enable performances of 'good' (reproductive) citizenship – encouraging women to cope with, rather than challenge gender essentialist social norms (Della Bianca, 2022; Fotopoulou, 2016).

While critical feminist perspectives offer valid and important criticisms, they also seem to neglect to make sense of parents' own rationales for continuing baby app use. These omissions contribute to an overall impression of women as rather naïve, gullible and helpless, and invalidates users' experiences, rather than trying to address the question of whether women may actually feel less 'algorithmically vulnerable' than originally thought (Thornham, 2019). In the context of period and fertility tracking for instance, Hohmann-Marriot (2021) outlines how experiences of app use are often multi-faceted, including both disempowering forces (e.g. extensive datafication) with uses that promote a sense of empowerment that may go beyond the individual (e.g. challenging stigma and promoting 'period positivity'). Also, contemporary critiques of baby apps rarely account for experiences of app use beyond those of women, excluding the perspectives of other caregivers and thereby minimising the visibility of alternative experiences that may challenge gendered conceptions of baby apps as reductive and disempowering. Scholars like Van Cleaf (2020) thus suggest that digital spaces that recognise and validate a plurality of mothering and caregiving experiences can still be described as 'empowering'. In line with earlier arguments by feminist scholars such as Teresa

De Lauretis (1987), even subjective experiences and self-representation of gendered parenting in digital spaces "affects its social construction [and] leaves open a possibility of agency and self-determination at the subjective and even individual level of micropolitical and everyday practices" (p.9). Considering the high prevalence of their use, baby apps may contribute to experiences of empowerment in lasting ways and on multiple levels, by facilitating small and mundane acts of resistance at the level of everyday practice. These are the experiences and practices of mundane empowerment that have remained underexplored in research into baby apps to date.

3.4.2 Alternative paths to studying baby apps

As illustrated throughout this paper, users' experiences of baby app use as part of everyday practice are diverse, and dependent on a range of individual and contextual factors. Media and communication scholars have predominantly explored baby apps from a critical feminist perspective. These tend to frame user experiences of increased agency and a sense of empowerment through app use as resulting from the internalisation of external disciplinary structures – the cultural and institutional norms discussed in 3.2. These approaches are important in drawing attention to the persistence of gendered inequalities in caregiving work. However, in the absence of alternative perspectives, they also risk invalidating caregivers' experiences and seem to reject any intrinsic orientation towards relational caregiving work, as a practice that can be experienced as rewarding and pleasurable in its own right. These framings de-value practices of caring for others through the repeated association of caregiving work with gender essentialist social norms that exploit women.

The inclusion of additional perspectives in investigations of baby apps can add nuance to the existing body of scholarship, by 1) drawing attention to problematic social inequalities in caring labour, while 2) re-framing caregiving work as universally valuable, and 3) providing insights into how these inequalities may be challenged, including through adaptations in the design of baby apps and contexts of use. Examples of alternative perspectives include:

- **Investigations of baby app use that take an intersectional, digital inclusion-focussed approach, and actively seek out the perspectives of caregivers of a diversity of backgrounds and identities;** these could include explorations of the experiences of parents of a range of genders and family structures, as in the recent work by Langton (2024), to highlight user experiences and practices that challenge assumptions of the envisioned users and uses of baby apps (i.e. women/mothers who are middle-class, heterosexual, and coupled), and explore how baby app use shapes role divisions and caregiving practices within the family unit, rather than focussing on women's individual experiences only; future works should go even further, and move towards a more intersectional approach to studying issues of digital inclusion in baby apps, including considerations of not only gender, sexuality, economic status and family constellation, but also of race, ethnicity and other parts of parents identities that are often overlooked. Speaking from an Australian perspective, this should include considerations of cultural appropriateness and safety in baby apps used by members of Indigenous communities for example.

- **Explorations of practices and experiences of baby app use from a 'care in practice' perspective** that extends the concept of 'tracking-as-care' (Thornham, 2019) which describes baby-tracking as part of an individualised surveillance practice, by building on the works of feminist STS scholars such as Mol and colleagues (2010), who explore the use of health-tracking technologies as a form of 'care in practice'. A similarly useful concept is *caring dataveillance*, which describes data-based surveillance practices for the purposes of caregiving, based on genuine affection and a desire to care, rather than a desire to control[11] (Lupton, 2021; Mascheroni & Siibak, 2021)
- **Applications of theoretical approaches that are sensitive to embodiment, agency, and the relational dimensions of everyday technology use**, including new materialist approaches such as Feminist New Materialism (FNM), which are sensitive to relational aspects in self-tracking for health, including the resulting affects and agential capacities (Lupton & Smith, 2018; Lupton, 2018), and to different ways of knowing, including embodied experience. These approaches have been extensively applied by Lupton (2020a; 2019; 2019c) in her study of mHealth apps, and could be complemented with other materialist approaches that foreground the importance of 'mundane data' in the context of everyday life (Pink et al., 2017; Fors & Pink, 2017).

Notably, health sciences scholars focussing on the field of digital health are increasingly taking a more reflexive approach to their own analysis of mHealth technologies, informed by critical feminist perspectives (Hiebert et al., 2021), and by cross-disciplinary scholars such as Lupton (2020a) whose work contributes to both health and social sciences disciplines. A recognition of the importance of cultural norms on health behaviours has led to the increased incorporation of qualitative research methods, such as explorative user interviews (Dienelt et al., 2019) or STS-informed methods such as app walkthroughs (Light et al., 2018) into their work (MacLean & Hatcher, 2019).

3.4.3 Applied examples

In a recent study exploring parents' experiences with infant feeding and baby-tracking applications (Langton, 2024), these approaches were usefully employed alongside critical perspectives, to show why parents initiated and continued tracking. In contexts of 'pushed' tracking for instance, such as when mothers used baby app data to demonstrate and account for their efforts of 'making breastfeeding work', app use was experienced as disempowering. These experiences were tied to mothers feeling like they had to 'backup' their accounts of breastfeeding struggles with data – echoing findings of previous studies in which data is deemed more trustworthy than women's accounts, and embodied and experiential

[11]A 'desire to control' in this context can be understood to work at multiple levels, including the individual parent who may want to increase their sense of control over family routines and their life (a common challenge in early parenthood (Virani, 2021)). Additionally, however, it can also work to make a distinction between individual users' agency and the desire to use baby apps in ways that express affection and enable care, versus the structural/institutional desire for control (e.g. through disciplining into desired health behaviours; see section 3.2.3), or corporate control over users' data and consumer choices.

knowledge are de-valued (Lupton, 2017; Thornham, 2019). However, when baby app data was used within the context of the parenting team, parents also described instances when baby app data was combined with parents' experiential and embodied knowledge of their child. This led to increased parental confidence and self-efficacy in health decision-making, challenging health-professional 'expert' authority. Additionally, for parents who were physically separated from their babies due to work commitments, and for male parents in particular, data as an additional source of knowledge on caregiving and family routines provided a way to stay connected with family life while away from their infants. Baby apps' data sharing affordances promoted involvement in practices of 'thinking about the baby' (Walzer, 1998), which meant that partners could be more equally involved in the mental labour of caregiving, and in sharing the responsibility for parenting and infant care. Rather than exploring baby apps as tools that sit separately from parents' embodied, experiential, and situated practices of caregiving, these examples illustrate the integrated nature of baby apps as extensions of parents' physical and mental caregiving practices.

A wide range of research projects and collaborations at the Digital Child research centre, as well as the work of affiliated scholars, contribute to the field of baby app studies, including:

- *The parent-child communication implications of infant feeding apps*, led by Professor Lelia Green from Edith Cowan University, Perth, Western Australia.
- *First-time mothers' perspectives on how everyday mobile device use mediates interactions with their babies,* a doctoral research program led by Philippa Amery from the Queensland University of Technology, Brisbane, Queensland.
- *A day in the life of data for Australian children,* led by Professor Sue Benett from the University of Wollongong, Wollongong, New South Wales.
- *Dashboarding Childhoods*, led by Professor Tama Leaver, Curtin University, Perth, Western Australia.
- *Datafied Childhoods (2021)*, led by Professor Giovanna Mascheroni, Catholic University of the Sacred Heart, Milan, Italy, and Professor Andra Siibak, University of Tartu, Tartu, Estonia.

More information on these projects and the contact details of the lead scholars can be found on digitalchild.org.au.

4. Conclusion

This paper has argued that baby apps continue to be an important area of study with significant implications for digital childhoods and parenthoods alike, and with relevance at many levels of culture and society.

These include:

- mundane practices of parenting and caregiving
- commercial agendas of data extraction for profit
- institutional interests in digital health 'solutions'
- long-term societal trajectories depending on optimisation and risk reduction

*Theoretical Insight*s. Baby apps provide a useful lens through which the mutual shaping of technology and culture can be traced, as well as the power dynamics between providers and users of technology, offering insights into how the use of digital health technologies can genuinely enhance people's health, and their autonomy in health-promoting decision-making and practices.

Equity Challenges. As datafying technologies that focus on tracking, analysing, and optimising children's health through the datafication of women's bodies and behaviours in particular, the key issues and implications of baby apps predominantly revolve around social equity issues for these groups. The design and features of baby apps frequently work to reify the persistently gendered power dynamics, socio-cultural norms and expectations of contemporary parenting and the use of technology in domestic work – at the same time as they hold the potential to challenge them.

For instance, as illustrated in 3.1.1, datafication through baby app use can produce data from which value can be extracted, and that can be used to monitor, discipline and optimise. Yet, baby apps can also be used as tools to enhance self-efficacy, partner involvement, and an openness to bringing together different sources of knowledge for caregiving – both in the context of family life, and in collaborative decision-making with health professionals. The seeming incompatibility of these observations illustrate the complexity of the roles, impacts, and experiences of baby app use in different contexts, and how even controversial datafying practices can have benefits in specific circumstances.

Future Research. Considering the diverse range of unresolved concerns arising from the everyday, commercial, and institutional uses of baby apps, there is a sense of urgency both in progressing research on baby apps, and in communicating research findings. For instance, at the institutional level of public health promotion, the issues raised in this paper emphasise the importance of slowing the progressive integration of baby apps and similar digital health tools into the workings of everyday family life, to enable better-informed decision making in the design, implementation, and appropriate uses of these technologies.

4.1 Making new connections

While the field of baby app studies is not 'new', it is still emerging, with established ideas being currently challenged or re-interpreted, and scholars from different disciplines contributing new perspectives and insights. The paper outlines several areas in the field of baby app studies that remain underexplored, or where new connections need to be made:

The datafication of children from before birth facilitates the generation of children's data selves through online profiling, which may result in iniquitous automated decision-making on children's behalf, well before they purposefully engage with digital environments themselves. Notably, examples of technological design and regulations that could address and improve these issues already exist, although their implementation and meaningful use in the context of baby apps remains underexplored. For instance, what *better* options for 'privacy by design' (Donnelly, 2021; Office of the Information Commissioner, 2014), governance, and contexts of use could we draw attention to? Who might be the audiences and stakeholders who need to be made aware of our work?

While media and communications scholars must work on providing constructive critique and collaborate more to make their feedback actionable, health sciences scholars investigating the utility of baby apps for effective health behaviour change, should look to the work of their communications colleagues. Those aiming to provide mobile health tools that 'empower' parents and improve self-efficacy, need to become familiar with parental concerns around both data privacy and the extractive and reductionist implications of app-driven datafication. Questions to ask include: How can baby apps be employed in ways that complement and enhance parents' experiences and practices of caregiving? What aspects of design and contexts of use are appropriate in supporting these goals (if any)?

The design and use of baby apps remains gendered, and while baby apps are designed to support mothers, many public-health-aligned baby apps continue to focus on promoting public health ideals over parents' support needs and preferences. Future qualitative work investigating baby apps should seek out the perspectives of parents from a wider range of genders and family structures. Considering the experiences and practices of contemporary parenthood that do not fit the mould of the traditional family and envisioned user of baby apps, can provide useful insights into appropriations of digital parenting tools, that demonstrate what alternative interpretations and uses can look like. Questions to ask include: How are baby apps employed in family contexts in which there is no default 'mother/father' role division to fall into? What can the experiences and practices of baby app use by caregivers other than mothers tell us about their role in parents' lives? How do these experiences confirm, challenge, or complicate assumptions of baby app use as linked to internalised socio-cultural norms and values?

Overall, scholars contributing to the exploration of key issues in the field of baby apps studies and similar mHealth technologies need to reflect on what they can learn from the questions their colleagues in other disciplines are asking, to progress the field and inform meaningful change.

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