Curtin School of Allied Health

An Exploration of Family Mobile Touch Screen Device Use and Parent-Child Attachment

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Human Ethics

The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated March 2014. The research studies received human research ethics approval from Joondalup Health Campus Human Research Ethics Committee (Approval Number: 1804) (Appendix A) and the Curtin Human Research Ethics Committee (Approval Number: HRE2018-0065) (Appendix B).

Rebecca Hood

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Abstract

Introduction

The ownership and use of mobile touch screen devices (such as smartphones and tablet computers) has increased considerably in recent years among many families with young children. To help guide appropriate technology use, health-related guidelines have been made available to families to provide some advice around the use of screen devices by children. However, these guidelines are based on evidence that has some limitations such as focusing on the amount of time children use devices, with less consideration of content and context of use. There is also a focus on older technologies such as television viewing, and there is limited research exploring device use among very young children. In addition, while some evidence does exist on associations of device use by adults and children with various outcomes, these are often not considered within the context of the broader family system. Relevant theoretical frameworks such as parent-child attachment, family systems theory, the bioecological model, and human-computer interaction models suggest that family context is likely to be important.

An association to consider within a family systems context is the use of mobile touch screen devices and parent-child attachment, including prenatal attachment. As device use requires time and attention by the user, there is the potential for it to influence the flow of interactions between the parent and child. The reverse relationship may also be true, where attachment security may influence device use. Exploring device use and attachment across multiple layers of the family system (the parent-child dyad, the wider family, and the community) will provide a more comprehensive understanding of family device use and will better inform guidelines.

The first aim of this thesis is to investigate associations between time using mobile touch screen devices and parent-child attachment via a systematic review (Study 1). The second aim is to expand on the concept of time and consider the nature of device use and parent perspectives on how device use influences parent-child attachment and family relationships, with a series of three qualitative studies (Studies 2A, 2B and 2C). These will provide parent perspectives of device use during pregnancy and in infancy, including during the COVID-19 pandemic. The third aim is to develop a conceptual model that considers the complexities of family mobile touch screen device use. Each qualitative study will explore additional layers of the family system from the parent-child dyad, to the wider family, and the community.

Methods and results

Study 1

Study 1 aimed to systematically review the evidence pertaining to time spent using mobile touch screen devices and associations with parent-child attachment. The electronic databases EMBASE, ScienceDirect, PsychINFO, PubMed, Medline, Cochrane, CENTRAL and ProQuest were searched from papers published from database inception to January 2021.

Three studies met the inclusion criteria. The first supported a negative association between duration of adolescent mobile phone use and perceived closeness to parents, and the other two supported a negative association between duration of parental smartphone use and parent-child attachment/maternal sensitivity. The quality scores of the studies ranged from 2 to 6 (out of 7) with an average score of 4.

Although the quality of evidence of the three included papers was mixed, they demonstrated that longer durations of smartphone use may be associated with poorer parent-child attachment outcomes. A narrative synthesis on two groups of surrounding literature found associations between child time using any screen technology (including television viewing) and child 'problematic' internet, mobile phone, gaming and social media use and attachment outcomes. Currently there is limited direct evidence on any association between the time parents or children spend using these devices and parent-child attachment to support time guidelines for families and professionals working with families.

Study 2A

Study 2A aimed to explore how parents use mobile touch screen devices during pregnancy, and how device use influenced parents' thoughts, feelings and behaviours towards their baby while in utero. Twenty-seven families were recruited from The ORIGINS Project, a large prospective longitudinal birth cohort study, using convenience sampling. Participants were in their third trimester of pregnancy or within 8 weeks post birth at the time of their interview.

A semi-structured qualitative interview was conducted which included device use questions (based on findings from previous research on screen technology use as well as in consultation with experts in the field) and attachment questions (adapted from the Maternal Antenatal Attachment Scale and the Maternal Fetal Attachment Scale). Interviews were conducted face-to-face or by audio call depending on the preference of

the participant and were audio-recorded and transcribed verbatim. Thematic analysis of the data was conducted and a summary of themes was presented to participants for member checking purposes.

Overall, participants described emotions, perspectives and behaviours that demonstrated affection and commitment towards the foetus. All described using mobile touch screen devices routinely throughout their typical day for up to several hours per day. Key reasons for device use were maintaining connections, assisting daily life tasks, aiding relaxation, and enabling a better understanding of pregnancy. When asked about the influence of device use on prenatal attachment, three themes emerged: enhanced connectedness (by accessing pregnancy-specific online resources and by enabling visualisation of the baby in utero), disrupted connectedness (by distracting the parent from thinking about their baby) and increased parental stress (due to reading online material about adverse pregnancy outcomes). Overall, participants described more advantages than disadvantages of device use during pregnancy.

The findings highlight ways in which devices can be used during pregnancy to optimise prenatal attachment. A model of human-computer interaction between the parent-child dyad was proposed.

Study 2B

Study 2B aimed to explore how parents with infants use mobile touch screen devices and how device use influenced parents' thoughts, feelings and behaviours towards their infant as well as interactions within the wider family (siblings and marital). Thirty families were recruited from The ORIGINS Project using convenience sampling. These families were different to those recruited in Study 2A. Participants were parents of infants aged around 12 months (9 to 15 months) at the time of the interview.

A semi-structured qualitative interview schedule was conducted which included device use questions (based on findings from previous research on screen technology use as well as in consultation with experts in the field) and attachment questions (adapted from the Maternal Postnatal Attachment Scale). Interviews were conducted by audio or video call depending on the preference of the participant and were audio-recorded and transcribed verbatim. Thematic analysis of the data was conducted and a summary of themes was presented to participants for member checking purposes.

Overall, participants described emotions, perspectives and behaviours that demonstrated affection and commitment towards their infant. Two-thirds of infants were routinely involved in family video calls via mobile touch screen devices, and one-third of infants used devices for other purposes (these figures are not mutually exclusive). Three themes relating to parent-child interactions emerged: enabled a better understanding of infancy (by accessing information about child development and ideas for infant activities), enhanced interactions (by playing music for the infant, capturing and viewing photos together, and connecting to parent at work), and disrupted interactions (by taking the parents' attention away from their infant, disrupting the flow of interactions, and affecting mood/behaviour). Two themes relating to interactions within the wider family of siblings and the marital relationship emerged: enhanced interactions (by enabling shared experiences) and disrupted interactions (by disrupting communication and leading to conflict). Overall, participants described both advantages and disadvantages of device use among families with infants.

The findings highlight an opportunity for how device use guidelines could support families to maximise benefits and reduce detriments of device use to optimise parent-child attachment and child development within a family context. The model of human-computer interaction between the parent-child dyad was expanded on to include an additional layer of the wider family.

Study 2C

Study 2C aimed to explore how the use of mobile touch screen devices by parents with infants influenced their interactions within the wider community (workplaces, childcare and family overseas) in the context of the COVID-19 pandemic. Participants were the same families as those interviewed in Study 2B. While interviewed for Study 2B, additional questions were asked relating to parent perspectives of the impact of COVID-19 on technology use and family relationships, and thematic analysis of these data was conducted separately for Study 2C.

Families described staying home and stopping all external activities during the first wave of the COVID-19 restrictions in Western Australia. Three themes relating to the influence of COVID-19 restrictions on family interactions and well-being emerged: enhanced family relationships (by having more time at home together), prompted a reflection on family schedules (by stopping all usual activities), and increased parental stress (by being concerned about health and financial implications of the pandemic).

Two themes related to family device use emerged: enabled connections to be maintained (by enabling communication and continuation of activities), and a source of disrupted interactions within the family unit (by increasing distraction from family). Overall, participants described more advantages than disadvantages of device use during COVID-19.

The findings highlight an opportunity for how device use guidelines could support families, health professionals and government advisors during future pandemic-related restrictions. The model of human-computer interaction between the parent-child dyad was expanded on to include an additional layer of the community.

Discussion

The systematic review in this thesis found some limited evidence that both increased time and problematic use of mobile touch screen devices by parents and children are likely to be associated with poorer parent-child attachment outcomes. However, the quality of this evidence was mixed which limits confidence in the findings.

In addition, the qualitative studies in this thesis found that how, why and when devices are used during pregnancy and by parents and children during infancy is important in whether it enhances or detracts from perceived parent-child attachment. The qualitative findings were in line with prior studies but provide a richer understanding of the differential influence of device use on parent-child attachment, whereby use of devices in a purposeful way and for child/parenting specific purposes (e.g. visualising the baby while pregnant or seeking information about child development) led to perceived enhanced connectedness, whereas use of devices without a specific intention (e.g. scrolling through social media while in the company of the child) led to perceived disrupted connectedness.

Amongst wider family members such as siblings and the marital relationship, perceived benefits and disadvantages were also related to the nature rather than simply the amount of screen use. For example, device use was perceived as positive when used collaboratively or for specific relationship purposes (e.g. by enabling shared experiences) or negative when used independently in the company of each other (e.g. by disrupting interactions and leading to conflict). In relation to the community, device use was perceived as generally positive as it enabled communication and continuation of activities during the COVID-19 pandemic.

The model of human-computer interaction within a family system context developed throughout this thesis makes an important contribution to theoretical development. It demonstrates that there are likely to be multiple mechanisms or pathways by which the use of devices may be associated with parent-child attachment, including across layers, and that the context of the wider family system and community should be taken into consideration when exploring technology use and the parent-child dyad. There are also practical implications that can be drawn from this model that will be useful for planning future research or developing improved screen use guidelines.

A strength of this thesis was the use of best practice methods for the systematic review, including the prior publication of the protocol. In addition, the qualitative approach provided rich and detailed information about family device use and enabled the development of a comprehensive model of device use within a family systems context. Limitations include the potential for social desirability and recall bias, and the use of convenience sampling which may influence generalisability of the findings.

Future high quality cross-sectional and longitudinal research into the relationship between family mobile touch screen device use and parent-child attachment would further contribute to a stronger evidence base for current guidelines on family mobile touch screen device use.

Conclusion

This thesis demonstrates that how, why, and when devices are used is important in whether it is perceived by parents to enhance parent-child attachment or not. It also demonstrates that it is important to consider the context of the wider family and the community when providing guidance to families with young children. These findings are represented in a staged model of family mobile touch screen device use in an integrated family system.

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List of Abbreviations

App	Application
AUD	Australian dollar
COREQ	Consolidated Criteria for Reporting Qualitative Research
COVID-19	Coronavirus disease
ECA	Early Childhood Australia
GRADE	Grading of Recommendations Assessment Development and Evaluation
IQ	Intelligence quotient
MTSD	Mobile touch screen device
NO.	Number
PPT	Participant
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROSPERO	International prospective register of systematic reviews
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
TV	Television
WA	Western Australia
WHO	World Health Organization

List of Publications and Research Outputs

Multiple aspects of this thesis have been published in peer-reviewed journals, presented at scientific and community conferences, and made available to the general community through media interviews and online articles, as listed below.

Publications

Chapter 3

Hood, R., Zabatiero, J., Zubrick, S.R., Silva, D. & Straker, L. (2021). The association of mobile touch screen device use with parent-child attachment: a systematic review. *Ergonomics, 64*(12), 1606-1622. doi: https://doi.org/10.1080/00140139.2021.1948617

Chapter 4

Hood, R., Zabatiero, J., Zubrick, S.R., Silva, D. & Straker, L. (2022). 'There's good and bad': parent perspectives on the influence of mobile touch screen device use on prenatal attachment. *Ergonomics, (in press)*. doi: https://doi.org/10.1080/00140139.2022.2041734

Chapter 6

Hood, R., Zabatiero, J., Zubrick, S.R., Silva, D. & Straker, L. (2021). "Coronavirus changed the rules on everything": parent perspectives on how the COVID-19 pandemic influenced family routines, relationships and technology use in families with infants. *International Journal of Environmental Research and Public Health,* 18(23), 12865. doi: https://doi.org/10.3390/ijerph182312865

Submissions

Chapter 5

Hood, R., Zabatiero, J., Zubrick, S.R., Silva, D. & Straker, L. (2022). "It helps with our bonding together". Parent perspectives on how the use of smartphones and tablet computers influences parent-infant attachment. Submitted to *International Journal of Child-Computer Interaction*

Presentations

Ramsay Three Minute Thesis Competition 2022, Online

'Family device use and parent-child attachment'
Pre-recorded video presentation to health care workers and researchers

Hillarys Community Kindergarten 2022, Perth, Australia

'Family device use: what does the research say?'
Oral presentation to parents of Kindergarten children

Digital Health Research Week 2022, Online

'The role of digital technology use among families with infants during the COVID-19 pandemic'.
E-poster presentation to digital health researchers

InVIVO Symposium 2021, Online

'The impact of COVID-19 on family technology use and relationships'
Pre-recorded video presentation to health professionals and researchers

Joondalup Health Campus Inaugural Research Week 2021, Perth, Australia

'How does smartphone and tablet computer use influence prenatal attachment?'
Oral presentation to health professionals and researchers

Mark Liveris Seminar 2021, Perth, Australia

'How has COVID-19 influenced family relationships and technology use?'
Oral presentation to Curtin University researchers and staff

Vice-Chancellor Showcase of Curtin Research 2021, Perth, Australia

'Wired but NOT connected: Device use during pregnancy" Presentation on prenatal qualitative study findings.'
Oral presentation to Curtin University Vice-Chancellor and members of the University Council

Virtual Brown Bag Lunch Meeting 2021, Online

'Smartphone and tablet use in pregnancy: How does it influence prenatal attachment?'
Oral presentation to members of the Centre for Excellence for the Digital Child

InVIVO Symposium 2020, Online

'Expecting a baby in a digital era: The influence of device use on prenatal attachment'
Pre-recorded video presentation to health professionals and researchers

ORIGINS Project Quarterly Meeting 2020, Perth, Australia

'Oral brief update on prenatal qualitative study'
Oral presentation to health professionals and researchers

Joondalup Health Campus Inaugural Research Week 2020, Perth, Australia

'Parent use of smartphones and tablet computers and prenatal attachment'
Poster presentation to health professionals and researchers

Curtin University 3 Minute Thesis Competition 2020, Online

'Wired but NOT connected: Device use during pregnancy'
Pre-recorded video presentation to research students, staff and the community

ORIGINS Project Quarterly Meeting 2019, Perth Australia

'Brief update on prenatal qualitative study'
Oral presentation to health professionals and researchers

Valuing Children's Initiative Roundtable 2019, Perth, Australia

'Overview of thesis methodology and literature review'
Oral presentation to child health professionals

Media interviews

Channel 9 Evening News Segment 2022, Perth, Australia

'How parent use of smartphones and tablet computers influences prenatal attachment'
Pre-recorded interview to the general community

ABC Drive Radio 2022, Perth, Australia

'Expecting a baby in a digital era: How the use of devices influences the parent-child bond'

Live radio interview to the general community

Article published in The National Tribune, Medical Xpress and Mirage News Article 2021, Online

'Curtin study finds mobile devices a lifeline for families during lockdowns'

Online article available to the general community

Awards

Winner of both the Judge's Vote and People's Choice Award for the Ramsay Three Minute Thesis Competition 2022

For presenting: 'Family device use and parent-child attachment'

Finalist of the 3 Minute Thesis Competition, Curtin University, 2021

For presenting: 'Wired but NOT connected: Device use during pregnancy'

Finalist of the Joondalup Health Campus Inaugural Research Week 2021

For presenting: 'How does smartphone and tablet computer use influence prenatal attachment?'

Statement of Contributors

I declare that I was responsible for all aspects of the research presented in this thesis, including acquisition of funding RTP stipend grant, study design, data analysis, interpretation, reporting of results and the process of submitting manuscripts.

Rebecca Hood

Candidate
September 2022

We, as co-authors, endorse that this level of contribution indicated by the candidate above is appropriate.

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On a personal note, I commenced my PhD when our youngest child was 10 weeks old and resigned from my work research role to focus on my studies. To be home with my children during their early years while working on my PhD is something I'll always have fond memories of. Although challenging at times, I am grateful to have had such an interesting and contemporary topic that has sparked many thought-provoking conversations and discussions with those around me.

I would not have been able to achieve my goals without the help from my family who have encouraged and supported me every step of the way. I am thankful to my husband Nathan, my daughters Charlotte, Isabelle and Jasmine, my Mum and Dad and my parents-in-law. Thank you for always being there for me and for believing in me.

Chapter One

1

Introduction

1.1 Background

For many parents and children, mobile touch screen devices (such as smartphones and tablet computers) are a routine part of their lives. For example, a survey of 2,031 Australian residents aged 18 to 64 years in 2022 found that 97% of households owned a smartphone and 66% a tablet computer (Statistica, 2022). Device ownership is not limited to adults, with a 2019 American survey finding that more than two-thirds of children owned their own smartphone by age 12 (Rideout & Robb, 2019). Very young children also use devices, with a study of Irish children aged 12 months to 3 years finding that 71% had access to touchscreen devices with a median usage time of 15 minutes per day (Ahearne, Dilworth, Rollings, Livingstone, & Murray, 2016).

Although families and early childhood health and education providers are excited about the benefits that technology can provide to children, they also have concerns about potential effects on children's health, learning and development (Velicu, Chaudron, Dias, Brito, & Lobe, 2019; Zabatiero, Mantilla, & Danby, 2018). To help guide appropriate technology use, public health guidelines were developed in Australia (Australian Department of Health, 2017) and around the world (American Academy of Pediatrics Council on Communications and Media, 2016; World Health Organization, 2019). These guidelines, however, are based on evidence that has some limitations relating to how

devices are defined, how device use is defined and measured, and a focus on older children and older technologies such as television viewing.

While some evidence does exist on associations of device use by adults and children with various outcomes, including some evidence claiming to demonstrate causal pathways or mechanisms, often this has been considered within a narrow conceptual framework that is focused on the individual and their use of devices (Cho, 2015; Grant, Lust, & Chamberlain, 2019; Toh et al., 2020). There is likely to be merit in considering associations within the broader family system rather than examining associations between technology use and outcomes in isolation. This is because the experiences and actions of one individual can be intertwined with those of other family members (White & Klein, 2008).

Exploring how, why and when parents and young children interact with technology within a family systems context could provide important information to help guide families on how to use devices in a more optimal way. Much of the existing literature has focused on associations between child screen technology use (which was mostly television viewing) and developmental outcomes (for example cognitive outcomes (e.g. Walsh, Barnes, Tremblay, & Chaput, 2020), physical outcomes (e.g. Fang, Mu, Liu, & He, 2019) and socio-emotional outcomes (e.g. Raman et al., 2017). However another potentially important association to consider is the use of technology by parents and/or children and parent-child attachment (Bowlby, 1980). In addition, a focus on mobile touch screen devices specifically would provide evidence on more contemporary devices, which differ to older technologies in terms of their portability, functionality, and ease of use (Robb, 2017).

Secure attachment is characterised by the parent being sensitive and responsive to their child's needs and signals for attention (M. Ainsworth, Blehar, Waters, & Wall, 1978). As device use requires time and attention by the user, there is the potential for it to influence the interactions that are necessary for the formation of a secure attachment between a parent and their child. The reverse relationship may also be possible. For example, higher quality mother-child interactions at 18 months have been found to be positively associated with less child device exposure (including television, tablets, smartphones and computers) at 2 and 3 years of age (Detnakarintra, Trairatvorakul, Pruksananonda, & Chonchaiya, 2020).

Device use during pregnancy may also be important to explore, because evidence suggests that a secure attachment prior to birth is predictive of attachment security in early childhood (Trombetta et al., 2021), and secure attachment during childhood is linked to better child developmental outcomes (McCormick, O'Connor, & Barnes, 2016; Zimmer-Gembeck et al., 2017).

Applying a family systems context to consider multiple layers of device use and attachment (the parent-child dyad, the wider family, and the community) offers a more multifaceted and comprehensive approach to understanding family device use. In addition, considering global contexts such as the COVID-19 pandemic could be of value in better understanding the role that device use has in parent-child attachment under different circumstances.

1.2 Statement of the problem

Mobile touch screen devices are an important part of many parents' and children's lives, and the use of these devices has increased dramatically in recent years. While research has mostly looked at associations between device use and child developmental outcomes, parent-child attachment may be another important construct to consider. In addition, the current evidence base around family mobile touch screen device use has some limitations relating to how devices are defined, how device use is defined and measured, and a focus on older children and older technologies such as television viewing. Exploring device use and attachment within a broader family systems framework will enable a more thorough understanding of the problem to better inform guidelines.

1.3 Thesis aims

This thesis addresses three aims by a series of studies including a systematic review (Study 1) and three qualitative studies (Studies 2A, 2B and 2C).

1. As time has been established as a key construct in the literature, the first aim is to investigate associations between time using mobile touch screen devices and parent-child attachment via a systematic review (Study 1).
2. The second aim is to expand on the concept of time and consider the nature of device use and parent perspectives on how device use influences parent-child attachment and family relationships, with a series of three qualitative studies (Studies 2A, 2B and 2C). These will provide parent perspectives of device use during pregnancy and in infancy, including during the COVID-19 pandemic.
3. Finally, the thesis will aim to develop a conceptual model that considers the complexities of family mobile touch screen device use. Each qualitative study will explore additional layers of the family system from the parent-child dyad, to the wider family, and the community.

1.4 Structure of the thesis

This thesis comprises eight chapters:

Chapter 1 provides an introductory overview of mobile touch screen device use by young children and their families, limitations in the related literature and guidelines, the importance of exploring associations of device use with parent-child attachment within a family systems framework, and an overview of the thesis aims and structure.

Chapter 2 provides a review and synthesis of the related scientific literature, beginning with the evidence on mobile touch screen device use among families with young children. It provides a review of the literature that was available at the time of designing the thesis studies regarding the association of device use with various outcomes including parent-child attachment and child developmental outcomes. Conceptual limitations of the prior research, including that which underpins public health guidelines on technology use, are discussed. Lastly, theories and frameworks that guide the research in this field will be reviewed.

Chapter 3 describes a systematic review of time using mobile touch screen devices and associations with parent-child attachment. This study was reported in an article published in *Ergonomics* (Hood, Zabatiero, Zubrick, Silva, & Straker, 2021) and is repeated verbatim here.

Chapter 4 describes a qualitative study of parent perspectives on how the use of mobile touch screen devices during pregnancy influenced their thoughts, feelings and behaviours towards their baby. This study developed a human-computer interaction model illustrating proposed mechanisms by which parent use of devices and attachment to the foetus (the parent-child dyad) may be associated. The study was reported in an article published in *Ergonomics* (Hood, Zabatiero, Silva, R Zubrick, & Straker, 2022) and is repeated verbatim here.

Chapter 5 describes a qualitative study of parent perspectives on how the use of mobile touch screen devices influenced their thoughts, feelings and behaviours towards their infant (aged 9-15 months) as well as the influence on other wider family interactions including siblings and marital relationships. This study added an additional layer to the proposed human-computer interaction model of the wider family, to explore the parent-child dyad within the context of siblings and the marital relationship. A manuscript reporting the study is under review at a peer-reviewed journal and is repeated verbatim here.

Chapter 6 describes a qualitative study of parent perspectives on how the first wave of the COVID-19 pandemic influenced family routines, relationships and mobile touch screen device use among families with infants. This study added a further layer to the proposed human-computer interaction model to explore the parent-child dyad in the context of the community (e.g. workplaces, childcare and family overseas). The study was reported in an article published in *The International Journal of Environmental Research and Public Health* and is repeated verbatim here (Hood, Zabatiero, Silva, Zubrick, & Straker, 2021).

Chapter 7 presents a discussion of the main findings of the thesis, detailing what this study adds to existing literature on mobile touch screen device use and parent-child attachment, including literature published after the thesis studies were designed. The proposed human-computer interaction model of parent-child device use within a family systems framework is discussed. The strengths and limitations of the thesis studies are discussed, suggestions for future research made and theoretical and practical implications outlined.

Chapter 8 summarises the key conclusions of the thesis.

Chapter Two

2

Literature Review

2.1 Technology use among families with young children

2.1.1 Ownership of devices

There has been a major social change in recent years in the use of technology, with mobile touch screen devices, such as smartphones and tablet computers, increasingly becoming an integral part of many parents' and children's lives, particularly since the release of the first iPhone in 2007 and iPad in 2010. For example, in 2021, 85% of American adults reported owning a smartphone and 53% a tablet computer, up from 35% and 8% respectively in 2011 (Pew Research Centre, 2021).

Smartphone ownership has also risen dramatically among children, with 41% of Americans aged between 8-12 years owning their own smartphone in 2019 compared with 24% in 2015 (Rideout & Robb, 2019). An 2017 Australian Child Health Poll of 3,797 children found that 17% of children aged 2 years and under, and 36% of children aged between 3 and 5 years, owned their own tablet or smartphone (Rhodes, 2017).

In addition to potentially owning their own device, children often use their parents' mobile touch screen devices and start engaging with devices at a very early age. For example, a 2015 American study found that most children of families surveyed (92%) commenced using a mobile device before the age of 1 (Kabali et al., 2015). The same

cross-sectional study, which included 350 children aged 6 months to 4 years in an urban, low-income, minority community, found that by age 4, two-thirds (64%) owned their own tablet and 7% owned their own smartphone (Kabali et al., 2015). In a contrasting study of 715 British families from a high sociodemographic background, 21% of toddlers aged 3 years were reported to own their own touchscreen (Bedford, Saez de Urabain, Cheung, Karmiloff-Smith, & Smith, 2016), highlighting the breadth of the social change with device ownership and access not being limited to particular socio-economic demographics. However, it is worth noting that there is likely to be a small proportion of many societies with no or very restricted access to any technological devices.

2.1.2 Time using devices

Both adults and children spend a considerable amount of time engaging with digital technology. For example, American adults have been found to spend on average 4 hours and 46 minutes a day watching television, and 3 hours and 9 minutes using a smartphone or tablet computer (The Nielson Company, 2018). Devices are used by parents in everyday situations such as during mealtimes (Radesky et al., 2014) and while supervising children (Hiniker et al., 2015). For example, an observational study of parents of children aged 5 years and under found that over three-quarters (76%) used their mobile device while supervising and caring for their child in playgrounds, with device use extending to 17 minutes of the 20-minute observation period (Mangan, Leavy, & Jancey, 2018). Although the sample for this study was relatively small (n=50), the results provide a valuable insight into parent mobile device use while caring for children in a natural setting.

In relation to child device use practices, a study of American children aged 8-12 years found they spend an average of 4 hours and 44 minutes per day using screen media for non-school work purposes, and teenagers an average of 7 hours and 22 minutes (Rideout & Robb, 2019). This figure combines interaction with social media, online videos, television sets, video game consoles, mobile games, browsing websites and e-reading.

Among younger Australian children, parents reported the average weekly number of hours using screen-based devices was 14 hours for children aged less than 2 years, and 26 hours for children aged 2 to 5 years (Rhodes, 2017). This poll did not differentiate between device type and combined the use of televisions, computers, laptops, gaming consoles, smartphones, and tablet computers. One of the few studies that has explored time using mobile touch screen devices by children found that German children aged 2 to 5 years spent an average of 5.4 minutes per day specifically using mobile phones (excluding for

listening to music) (Poulain, Ludwig, Hiemisch, Hilbert, & Kiess, 2019). The socioeconomic status of participants of this study (based on parent education, parent occupation and household income) was very high and may not be representative of all German families.

A British study of 715 families found average daily touchscreen use (tablet computers as well as mobile phones) to be 24 minutes among children aged 6 months to 3 years, which increased from 9 minutes per day for children aged 6-11 months to 44 minutes per day for children aged 2-3 years (Bedford et al., 2016). Again, the sample's socioeconomic status was high with 86% of mothers surveyed holding a university degree. No other demographic information about the families was provided.

An American study of 2,326 families with children aged 0-8 years found that children's time spent using smartphones or tablet computers was highly associated with parents' time using these devices (Lauricella, Wartella, & Rideout, 2015), indicating that the family screen technology environment should be examined rather than parent or child screen technology use in isolation.

2.1.3 Limitations of the available literature on technology use among families with young children

For the limited studies that provided evidence specific to child mobile touch screen device use, there may be sampling bias as the socioeconomic status of families was high, and the measure of device use was the parent's estimate of time during a 'usual' or 'typical' day, which may be subject to recall bias or social desirability bias. In addition, research on child screen practices focuses predominantly on time and there is limited research exploring the content and context of family device use.

Another key limitation is that at the time of planning this thesis, there were inconsistencies in how devices and technology use were defined in the available research. Definitions varied across studies, with much of the literature reporting on television viewing only or providing an aggregate measure of all types of devices (e.g. combining television viewing and use of computers, laptops, gaming consoles, smartphones and tablet computers). There are likely to be key differences in newer technologies (e.g. smartphones and tablet computers) versus older technologies (e.g. televisions and desktop computers) in terms of their portability, interactivity and ease of use (Robb, 2017), particularly for young children.

The varied and inconsistent measures used to assess technology use have been acknowledged by other researchers and there is current academic and public debate around how technology use is measured and conceptualised (Kaye, Orben, Ellis, Hunter, & Houghton, 2020). When definitions of technology use vary, and when measures do not differentiate between non-mobile and mobile touch screen devices, there are potential issues in comparing and interpreting findings. This has further implications for assimilating knowledge and for applying evidence to practical uses such as providing recommendations on technology use for families. Therefore, it is important to have consistent definitions of technology use and valid and reliable measures so that high-quality evidence on associations with outcomes can be made, especially in light of the rapid increase in mobile touch screen device use by young children and their families.

Although the focus of the review is on mobile touch screen devices, some evidence on television viewing will be included due to the nature of technology use definitions and measurement. This review will state how studies defined their concept of technological devices when discussing their findings, to provide more context.

2.2 Conceptualisation and measurement of technology use

2.2.1 Measurements of 'screen time'

Technology use is often measured in terms of 'screen time'. Although this is a commonly used term, definitions of screen time vary. For example, some definitions focus on the issue of sedentary screen time such as the American National Library of Medicine: "Screen time is a term used for activities done in front of a screen such as watching TV, working on a computer or playing video games. Screen time is sedentary activity, meaning you are being physically inactive while sitting down."(MedlinePlus, 2021) (p 1). This definition does not include active screen-based activities where physical movement is involved, such as the use of YouTube to access exercise videos for fitness purposes.

Others, however, do not stipulate whether there is movement involved while engaging with the device. For example, Early Childhood Australia defines screen time as "the time you spend watching TV or DVDs, using the computer, playing video or hand-held computer games, and using a mobile phone." (Early Childhood Australia, 2015) (p 1). Another potential inconsistency is the purpose of use, with some research finding differential effects depending on type of screen activity. For example, playing peer videogames may provide a context for socialising and creativity whereas channel surfing and solitary reading may not (Przybylski & Weinstein, 2017). An assumption that 'screen

time' is a universally agreed upon term is incorrect and discrepancies between definitions may lead to heterogeneous approaches to how it is measured and conceptualised.

In addition, measuring technology use in terms of screen time may not enable more nuanced ways of device use to be assessed. For example, a systematic review of 622 articles that assessed screen time in children aged 0 to 6 years found that most (60%) consisted of only one to three items related to screen time duration on a typical day, and only a small proportion measured content (11%) or co-viewing (7%) (Byrne, Terranova, & Trost, 2021). This indicates the need for measures to better capture the complexities of screen use. Also, only a small number of the studies (11%) reported the psychometric properties of measurement tools, highlighting the need for the use of reliable and validated measures.

2.2.2 Measurements of 'problematic use' of screens

As well as 'screen time' being a key focus of screen use measures, outcomes are also often explored in association with 'problematic use'. 'Problematic use' of screens is conceptualised as a dependence on and excessive use of screen technology that interferes with a person's ability to function (Domoff et al., 2019), and is often measured in terms of specific technology use such as internet, mobile phone, gaming or social media use.

Measuring simple associations between 'problematic use' of screens and outcomes does not factor in the complexity of individual, family and social factors (which may already impact on everyday functioning). As definitions of 'problematic use' of screen technology include impacts on everyday functioning, there is a likely intertwining of 'problematic use' with outcomes such as parent-child relationships, making it a circular argument. Also, 'problematic use' of screens only considers an extreme type of use which may not be typical of many families. As most parents and children use devices to some extent but do not necessarily meet the conditions for 'problematic use', research findings relevant to the general population and real-world implications may be missed. Further, a focus on 'problematic use' does not include the potential to explore any associations of device use with positive outcomes.

2.2.3 Limitations of technology use definitions

Thus, there are several shortcomings of the current literature, as focusing on certain aspects of device use such as 'screen time' or whether users meet criteria for 'problematic use' may miss nuanced effects of general technology use and potentially important features of technology use behaviour.

If research is to be translated to guidance for families, then it is imperative that definitions of technology use by families and young children are more consistent and include a consideration of individual and social contexts.

2.3 Associations of technology use with child development outcomes

2.3.1 Negative associations of technology use with child development

Research has typically focused on the downsides of technology use, and there is substantial evidence to suggest that technology use by children may be associated with poorer cognitive, physical and socio-emotional development. Proposed mechanisms for these associations include that child technology use may take time from other activities that are pertinent to child development, including outdoor play (Hinkley, Brown, Carson, & Teychenne, 2018) and imaginative free play (Zimmerman & Christakis, 2005). The reverse pathway may also be possible, where parents may provide children with screen devices as a 'pacifier' for their behaviour (Bar Lev, 2020), and this may occur more frequently when children have lower scores of emotional well-being (e.g. lower self-control and emotional stability) (Twenge & Campbell, 2018).

Cognitive outcomes that have been associated with child technology use include literacy and numeracy outcomes (Pagani, Fitzpatrick, & Barnett, 2013) and short term memory (Zimmerman & Christakis, 2005). For example, a cross-sectional study of 1,000 infants aged 7 to 16 months found that for each hour of television watched, children knew on average six to eight fewer words (Zimmerman, Christakis, & Meltzoff, 2007). These studies however were based on television viewing only. Among high school students, a South Korean longitudinal study found that mobile phone 'dependency' negatively predicted language and mathematics performance (Dong, Yujeong, Min Kyung, & Jaekook, 2016) and a meta-analysis of studies from 14 countries and regions also found a negative relationship between mobile phone use and student academic performance (Kates, Wu, & Coryn, 2018).

Physical outcomes that have been associated with child screen use include excess weight and less physical activity (Dutra, Kaufmann, Pretto, & Albernaz, 2015), more sedentary time (O'Connor, Chen, Baranowski, Thompson, & Baranowski, 2013), poorer sleep (Cheung, Bedford, Saez De Urabain, Karmiloff-Smith, & Smith, 2017) and musculoskeletal implications (Kwok, Lee, & Lee, 2017). For example, a laboratory study found tablet computer use, when compared to playing with toys, to be associated with

poorer neck postures, more sitting and less physical activity among 3-5-year-olds (Howie, Coenen, Campbell, Ranelli, & Straker, 2017).

Socio-emotional outcomes that have been associated with child screen use include emotional symptoms and peer relationship problems (Zhao et al., 2018), poorer self-concept of attractiveness (Suchert, Hanewinkel, & Isensee, 2016) and hyperactive behaviours (Ansari & Crosnoe, 2016). For example, a study of 210 female caregivers of children aged 12-36 months found that children at risk for social-emotional delay were six times more likely to have at least five daily routines (e.g. meal times, bath time and bedtime) occurring with a screen (including TV/DVD, tablet, cell phone or computer) as compared to children not at risk of delay (Raman et al., 2017). However, it is important to note that there was also a significant difference in the education level of the parents with children at risk for delay compared to those not at risk, indicating that other family variables may play a key role in associations between child technology use and outcomes.

Family factors other than parent education level that may influence associations between child technology use and outcomes also include parenting style (e.g. authoritative or permissive) and parent perceived family type (e.g. 'media-savvy' or 'outdoor') (Howe, Health, Lawrence, Galland, & Gray, 2017), maternal depression (Bank et al., 2011), and parent use of digital technology (television, computers, smartphones and tablet computers) (Lauricella et al., 2015). In addition, in a study of adolescent digital technology use that found a small negative association between technology use and well-being, the authors suggested that this finding is best understood in terms of other human behaviours such as drug use, bullying, sleep, and regularly eating breakfast which all had much larger associations with adolescent well-being than technology use (Orben & Przybylski, 2019). Thus, when looking at associations between child technology use and outcomes, it is crucial to consider the family context and other factors rather than associations in isolation, and future interventions and guidelines may benefit from considering other family factors when guiding families on wise technology use.

Limitations of these studies are that most included television viewing in their measurement of technology use (with some focussing only on television viewing), which does not enable clear conclusions to be drawn specific to mobile touch screen device use. Also, studies in this field were typically focused on the length of time of screen use, which does not consider other contextual factors (such as type of content accessed or co-use with an adult) that may be more relevant when compared to time alone.

2.3.2 Positive associations of technology use with child development

Although much of the research has focused on associations of technology use with negative outcomes, there is some evidence on positive cognitive, physical and socio-emotional outcomes. A proposed mechanism for these associations are that the interactive features of mobile touch screen devices may serve to engage the attention of young children by stimulating multiple senses (Roskos, Burstein, Shang, & Gray, 2014), which may lead to improved learning experiences and motivation when used appropriately. Combining this multi-sensory engagement with high quality content and co-use with an adult has been purported as providing benefits to young children (Kucirkova, Messer, Sheehy, & Flewitt, 2013).

Cognitive outcomes that have been associated with child screen use include improved learning outcomes in a school context (Papadakis, Kalogiannakis, & Zaranis, 2018) and gains in numeracy performance while interacting with mathematical apps on touch screen devices (Moyer-Packenham et al., 2015). For example, a randomised controlled study found that the use of iPads by children aged 2-5 years for 9 weeks (30 minutes a week) led to significantly improved letter name and sound knowledge compared to the waitlist control group (Neumann, 2018), providing support for the practical benefits of literacy apps on emergent literacy skills. However, the type of device use has been shown to be more important than simply just time in whether it is associated with improved outcomes. For example, a small quasi-experimental study of 16 preschool children aged 3-5 years found that using scaffolding-like tablet applications in a school context had a greater association with improved vocabulary than free use of devices (Vatalaro, Culp, Hahs-Vaughn, & Barnes, 2017) indicating that intentionally chosen apps may support learning over open-ended apps. The generalisability of these results is limited by the low number of participants and most of the children were from low-income households in a disadvantaged community.

Physical outcomes that have been associated with child screen use include improved visual motor coordination (Price, Jewitt, & Crescenzi, 2015) and faster attainment of fine motor skills (Bedford et al., 2016). For example, a cross-sectional study of 78 children aged 24-42 months found that the fine motor skills of children with previous frequent tablet-use exposure was significantly better than those without previous tablet-use exposure (Souto et al., 2019). It is important to note that most of the children in tablet-use exposure group engaged in both passive and active tablet activities, were usually accompanied by their parents, and did not exceed time recommendations for their age. This suggests that tablet

use may act as a beneficial tool in the development of fine motor skills when used in certain conditions such as under close adult supervision and for a limited duration.

There are few studies that have determined positive associations between child screen use and socio-emotional functioning. One cross-sectional study of 1,774 South Korean children aged 0-5 years found that child television viewing for 1 to less than 3 hour per day was associated with higher emotional skills (the child's ability to manage, express and control their feelings) compared with television viewing for less than 1 hour per day (E. Lee & Carson, 2018). The authors of the study state that this may imply that television viewing in moderation may be favourable to young children developing emotional skills, but that the findings should be confirmed using more rigorous study designs (e.g. experimental or longitudinal).

This combined evidence demonstrates that there is the potential for child technology use to provide developmental opportunities when used in appropriate ways. However, there are limitations to consider, such as the unknown status of children's touchscreen device use prior to participation in the studies, the focus on structured device use in classroom settings rather than general use in home and community environments, and the limited evidence on associations between child device use and positive outcomes among children aged less than 2 years. A further limitation is that there is a focus in the literature on cognitive attainments rather than investigating potential physical or socio-emotional benefits. As many children commence using devices at a very young age within the home setting, it would be prudent to explore associations of device use (by parents as well as children) with family interactions and relationships.

2.4 Associations of technology use with parent-child attachment

2.4.1 The theory of parent-child attachment

Exploring associations between child or parent device use and family interactions and relationships is likely to be important in providing further insight into the complexities of family device use, which would better inform guidelines aimed at positive device use.

At the core of the family unit is the parent-child dyad. The theory of parent-child attachment proposes that children develop an emotional bond with their primary caregivers during their first years of life which serves to make the child feel and be safe, secure and protected (Bowlby, 1980). Infants and young children require consistent and attentive caregiving to form this parent-child bond that meets the child's developmental

needs. In the presence of a secure parent-child attachment relationship, the parent is sensitive and responsive to their child's needs and signals for attention, and the child is able to use the caregiver as a secure base from which to explore their environment (M. Ainsworth et al., 1978).

As devices require time, attention and a level of absorption by the user, there is the potential for device use to influence the quality and consistency of interactions between parents and their children.

2.4.2 Negative associations of technology use with parent-child attachment

The use of technology by parents in the company of their child has been negatively associated with parent-child attachment outcomes by the following proposed mechanisms: by causing parents to be less responsive and sensitive to their child's signals for attention, when parents use mobile touch screen devices (Beamish, Fisher, & Rowe, 2019; Kildare & Middlemiss, 2017); by interrupting the flow of playing with their child, when parents use mobile phones, televisions, computers and tablets (McDaniel & Coyne, 2016), and by lowering family relationship satisfaction, when parents use mobile phones, tablets or computers (McDaniel, Galovan, Cravens, & Drouin, 2018). In the reverse direction, it has been suggested that individuals with insecure attachment may use technology more frequently as a way of replacing and compensating limited affection from those around them (D'Arienzo, Boursier, & Griffiths, 2019), indicating the potential bi-directionality between the two constructs.

Negative associations between parent technology use and parent-child attachment have been found in settings outside the home including playgrounds and family outings (Mangan et al., 2018) indicating the broad range of settings in which devices may influence parent-child interactions and relationships. For example, an American observational study found that over 70% of observed parents of young children in fast food restaurants used mobile touch screen devices during their meal, with increased time spent absorbed with their device being linked to more limit-testing behaviour by the child, and parents responding more harshly to this behaviour (Radesky et al., 2014). This study did not measure attachment directly, but the behaviours of the children and parents could be considered as proxy measures of the parent-child interactions and relationship.

Among children, time spent using any screen technology (including television viewing, computers, mobile phones, video games and internet browsing) has been found

to be negatively associated with outcomes related to parent-child attachment including communication quality (Richards, McGee, Williams, Welch, & Hancox, 2010; Santana-Vega, Gómez-Muñoz, & Feliciano-García, 2019) and family conflict (Rhodes, 2017). For example, an American cross-sectional study of parents of children aged 2-5 years found a modest negative association between child screen time and parent perceived measures of parent-child attachment (Przybylski & Weinstein, 2019). This study defined screen time as television viewing, and the use of computers, mobile phones and video games.

The purpose and nature of device use is important to consider as well as time. For example, a study of children's internet use found that playing online games was associated with decreased time communicating with family members and total time spent with the family, whereas completing schoolwork online did not significantly influence family relationships (S.J. Lee & Chae, 2007). A systematic review of 76 studies of child television viewing found that television viewing reduced the quality and quantity of parent-child interactions (Kostyrka-Allchorne, Cooper, & Simpson, 2017). The findings of the review highlighted the complexity of the association between television viewing and child outcomes, with the viewing content, child characteristics, and the family and social context all being key moderators. This suggests that considering the association between television viewing and parent-child interactions within the context of other family factors is important.

Altogether, the findings suggest that parent and child use of technology may be negatively associated with parent-child attachment and related outcomes. However, much of the research combines television viewing and there is limited research on mobile touch screen device use specifically. In addition, contextual factors such as the content accessed, different family contexts and circumstances, and the degree of immersion of device use (e.g. scrolling through social media versus answering a phone call or text message) have not been well explored.

Expanding the research on associations of device use with parent-child relationships, while also considering the context of device use in the wider family and community will help inform current guidance for families with young children on how to use devices in positive ways.

2.4.3 Positive associations of technology use with parent-child attachment

There is minimal research demonstrating that device use can be positive for family interactions, and the research that is available has focused on older children. For example, among college students the use of mobile phones has been positively associated with attachment to parents (Lepp, Li, & Barkley, 2016) as they provide a means of communication via phone calls, video calls, text messages, e-mails and social media platforms. Among adolescents aged 13-16 years, greater amounts of parent-child communication via mobile phones and co-playing of digital games have been linked to higher perceived levels of family connection (Padilla-Walker, Coyne, & Fraser, 2012). A proposed mechanism for developing and maintaining social relations, is that the use of devices enables enhanced feelings of belonging and relatedness (Ahn & Shin, 2013).

However, there is no available evidence exploring this potential association among parents and young children. This is a significant limitation of the available literature, as there is merit in considering both potential benefits as well as downsides to best inform family technology use guidelines. If devices can be used in a positive way to enhance interactions and relationships between older children and their parents, it could be hypothesised that technology use in families with young children (and even prior to birth) could also lead to gains in parent-attachment outcomes.

2.5 Associations of technology use with prenatal attachment

The potential for device use to influence the relationship between a parent and baby during pregnancy (prenatal attachment) is important to consider, as expectant families often use mobile touch screen devices extensively during pregnancy (Xu et al., 2018).

The theoretical concept of prenatal attachment (the relationship between a parent and their baby during pregnancy) proposes that the development of an emotional bond between the parent and their baby begins prior to birth, and is characterised by the parents' emotions, behaviours and perspectives that demonstrate affection and commitment to their foetus (Bowlby, 1980; Brandon, Pitts, Denton, Stringer, & Evans, 2009; J. Condon, 1993; Pisoni et al., 2014).

Attachment in the third trimester of pregnancy has been found to be stable from pregnancy until 24 months postpartum (de Cock et al., 2016; Trombetta et al., 2021). Therefore, there is value in considering factors that may be pertinent to establishing

attachment security during pregnancy, such as how to use mobile touch screen devices in a manner that enhances the bond with the baby rather than detracts from it.

Although there is some evidence on time spent using devices and use of Apps by expectant parents (Kraschnewski et al., 2014; Mo, Gong, Wang, Sheng, & Xu, 2018), little is known about their in-depth device use practices and how it relates to prenatal attachment. Further research exploring family device use practices is needed to better understand mechanisms by which device use influences formation of attachment prior to birth and in infancy. This would also extend the current conceptual thinking on the implications of technology use to consider the pre-birth stage.

2.6 The importance of secure parent-child attachment for child development

2.6.1 Associations of parent-child attachment with child development

As discussed, there is evidence in the literature for associations between technology use and child developmental outcomes, and technology use and parent-child attachment. However, there is also considerable research on the associations between parent-child attachment security and child developmental outcomes. Much of the available research on attachment and child development demonstrates associations between lower scores of attachment security and poorer child outcomes, which may also reflect a focus on and bias toward negative outcomes.

In terms of cognitive outcomes, insecure parent-child attachment has been found to predict lower levels of reading and maths skills in middle childhood (West, Mathews, & Kerns, 2013), and a longitudinal study of 1,023 children found that those who are less securely attached at 24 or 36 months had poorer school performance and lower IQs in middle childhood (McCormick et al., 2016).

Physical outcomes related to insecure parent-child attachment include higher risk of obesity and lower levels of physical activity. For example, in adolescents, those with insecure attachments to parents and friends have been found to perceive themselves as having poorer physical condition, which in turn predicted lower engagement in physical activity (R. Li, Bunke, & Psouni, 2016). Among pre-schoolers, insecure parent attachments have been associated with less healthy eating behaviours and therefore an increased obesity risk (Powell, Frankel, Umemura, & Hazen, 2017).

Socio-emotional outcomes related to insecure parent-child attachment include poorer emotional self-regulation, coping skills and behaviour. For example, in infants, insecure

mother-infant attachment has been found to be predictive of greater social withdrawal, sleep problems and aggressive behaviour in early childhood (Ding, Xu, Wang, Li, & Wang, 2014). Among toddlers, children and adolescents, a review of 23 studies of attachment found that all but one reported a significant relationship between insecure attachment and poorer emotion regulation or coping (Zimmer-Gembeck et al., 2017).

Together these studies highlight the importance of establishing a secure attachment in early childhood. A limitation of these studies is that most are cross-sectional in design and do not enable temporal consideration of potential causal pathways. The potential for parent or child device use to influence the formation of attachment is important to explore, given the significance of establishing a strong bond between the parent and child.

2.6.2 Technology use, child outcomes and attachment may be related

Although there is limited research that simultaneously examines mobile touch screen device use, parent-child attachment, and child developmental outcomes, it is likely that the three constructs are interrelated, and attachment may act as a mediator. For example, a cross-sectional study conducted in China with 20,324 children aged 3-4 years found that that lower levels of parent-child interaction significantly accounted for the association between excessive screen time and poorer scores of psychosocial wellbeing (Zhao et al., 2018). However, the measurement of screen use for the study included television viewing as well as the use of electronic games, computers and mobile touch screen devices.

Among toddlers, a home observational study of 25 Canadian mothers found less interaction between parents and children who jointly played with electronic toys versus non-electronic toys, which the authors suggested may affect children's language and socio-emotional development (Wooldridge & Shapka, 2012). In addition, greater levels of marital conflict is associated with less secure parent-child attachments (Frosch, Mangelsdorf, & McHale, 2000), increased negative emotions in toddlers (Frankel, Umemura, Jacobvitz, & Hazen, 2015) and increased internet addiction amongst teens (T. Gao et al., 2018) indicating that the development of secure attachments, child development and technology use may be interrelated.

Although there is some indication that technology use, attachment and child outcomes are linked, more evidence in this area is needed. As mobile touch screen devices are portable and can be used anywhere and at any time, it is important to extend research specific to these newer devices, especially as they have the potential to be associated with parent-child interactions in a variety of settings, both inside and outside of the home.

2.7 Guidelines on child digital technology use

2.7.1 Guidelines relating to screen time

Health-related guidelines to families provide some advice around the use of screen devices by children. These mostly advocate for limiting the amount of time that very young children use screen devices, with exceptions for video calls.

The American Academy of Pediatrics recommends that screen devices not be used by children younger than 18 months (except for video-chat), and are used for no more than 1 hour per day of quality programming for children aged 2 to 5 years (American Academy of Pediatrics Council on Communications and Media, 2016). The World Health Organisation recommends no sedentary screen time for infants less than 1 year and no more than 1 hour of sedentary screen time for children aged 1 to 4 years (World Health Organization, 2019). Similar public health guidelines have been developed by Canada: no screen time for infants less than 1 year, no more than 1 hour sedentary screen time for children aged 1 to 4 years and "less is better" (Tremblay et al., 2017). In Australia, the recommendations are based on the assumption that sedentary screen time during early childhood can have long-term negative impacts on child development. It is recommended that children aged under 2 years have no screen time, and children aged 2 to 5 years have no more than 1 hour per day of screen time (Australian Department of Health, 2017). The guidelines state that if parents allow screen time, it should be educational, such as co-watching with the child and talking about the content.

While screen time recommendations do exist for families to refer to, it is important to note that the evidence informing these recommendations is incomplete, mostly based on television viewing, often of low quality, usually based on child screen time only, and including little to no research on context and content of screen use.

2.7.2 Guidelines relating to context and content

Although much of the guidance on screen use continues to typically focus on time, recently there has been some consideration of context and content by several organisations with the provision of guidance on device use. For example, the Early Childhood Australia (ECA) national statement on young children and digital technologies was released in 2018 and advocates for considering the individual child and family when making digital decisions in early childhood education settings (Early Childhood Australia, 2018). These guidelines provide advice for using devices in a manner that promotes young children's

relationships with adults and peers, their health and wellbeing, their citizenship and their exploration and learning.

In addition, the first British guidelines for child screen use were released in 2019 (after the design of this thesis) and are a substantial shift away from time-based guidelines (Royal College of Paediatrics and Child Health, 2019). The British guidelines state that there is not enough evidence to confirm that screens are harmful to child health and suggest that parents adjust their child's use of screens based on their developmental age and individual needs. Parents are encouraged to consider whether screen time is controlled and if screen use interferes with family activities and sleep. If a family is satisfied with their answers to these questions, then it is considered that they are likely to be handling family screen use well.

The ECA and British guidelines are also a first in providing recommendations for parents' own screen use, advising them to set a good example in modelling digital technology use and to ensure that they prioritise face-to-face interactions with their child.

2.7.3 Need for more evidence to support future guidelines

Given the limitations of the current evidence base, and differing perspectives of education and health authorities (Straker, Zabatiero, Danby, Thorpe, & Edwards, 2018), there is a need for more comprehensive and relevant recommendations that are useful and relevant to families with young children. Although newer guidelines are considering broader aspects of screen use other than time, there is still limited evidence and guidance available on parent and wider family use, potential benefits, and the influences on parent-child relationships (including during pregnancy). This highlights the need for studies of young children to consider technology use in the context of the wider family and the community.

2.8 Theories and frameworks that guide the research in this field

To ensure that the research underpinning guidelines is exploring appropriate concepts and the relationships between these concepts, it is important to consider the key theories and frameworks in the area. In addition to the theory of parent-child attachment (Bowlby, 1980), family systems theory (White & Klein, 2008) and the bioecological model (Bronfenbrenner, 2006) provide frameworks for investigating human-computer interactions within a family setting, where the entire family is considered, along with their reciprocal influences on each other's actions and experiences.

At the core of the family system is the parent-child dyad. Family systems theory extends on this dyad by highlighting the importance of viewing it within an emotionally connected family unit where individuals cannot be understood in isolation of each but instead as part of their family interactions. This theory also considers the influence of the surrounding environment on family interactions, which in this instance is the integration of mobile touch screen device use in family dynamics.

The bioecological model can be used to consider the influence of mobile touch screen device use on an individual's development across contexts (from the parent-child dyad to the wider family, and the community) and time (e.g. during the global COVID-19 pandemic). The model views child development as a complex system of relationships that is affected by varying levels of the surrounding environment, and is not restricted to a single setting or environment (Lundqvist & Sandström, 2019). This is highly relevant to the use of mobile touch screen devices, which can be used anywhere and at any time.

The consideration of wider social environments is important in this field of research, because there are external factors outside of the parent-child relationship that may influence device use, such as device use policies in child-care centres. In addition, the concept of time is important as the ways with which children and family members use devices is likely to change depending on what is happening at that stage in their life (e.g. for a mother during pregnancy versus after the baby is born) and depending on what is happening in the world (e.g. the COVID-19 pandemic).

In relation to mobile touch screen device use specifically, previous models of human-computer interaction provide a framework for considering influences of device use within the family system (Straker, Abbott, Collins, & Campbell, 2014; Straker & Pollock, 2005). These models depict the relationship between people and computers and illustrate mechanisms by which they may influence each other.

As discussed previously in this literature review, there is a number of potential mechanisms for the use of mobile touch screen devices to be associated with child development and parent-child attachment. For example, the use of devices may be negatively associated with child development by replacing other activities such as outdoor play and imaginative free play, or may be positively associated with child development by engaging and motivating young children to learn. The reverse relationship may also be true, where personality characteristics and emotional state of the child may influence their use of technology. Also, the use of devices may be negatively associated with parent-child attachment by interrupting the flow of playtime or distracting the parent, or may be

positively associated with parent-child attachment by enhancing family connectedness. Again, the reverse relationship may also be true, where individuals with low levels of attachment may use devices more frequently to replace and compensate for a lack of affection or enhance a feeling of belonging.

Considering the parent-child dyad within a broader family framework and in the context of human-computer interaction will extend evidence in this field by exploring some of these potential mechanisms. This will then help to inform more comprehensive advice for families. With the rapid uptake in mobile touchscreen device use among parents and children, it is imperative to consider human-computer interactions within families to both understand the implications on behaviour and development and to ensure they are used in a positive way.

2.9 Summary of the literature

Digital technology ownership and use has increased considerably in recent years among many families with young children. However, there are conceptual shortcomings in the literature relating to how devices are defined, and how technology use is defined and measured. For example, there are inconsistencies in what the term 'devices' refers to e.g. television viewing only or use of all screen devices such as desktop computers, gaming consoles, laptops, smartphones and tablet computers. In addition, there is no clear consensus on how technology use is defined and measured, with many studies focusing on 'screen time' or 'problematic use' which have their own issues relating to terminology and conceptualisation. Further, the complexity of family and social factors is typically not considered, there is limited research focusing on very young children, and context and content of device use are not well explored.

Research has primarily focused on and demonstrated the downsides of child technology use. However, some studies have demonstrated associations with positive cognitive, physical and socio-emotional outcomes. Another potentially important association to consider is the use of technology by families with young children and parent-child attachment, including prenatal attachment. The literature indicates that parent use of technology may have a negative association with attachment outcomes by causing parents to be less responsive and sensitive to their child's signals for attachment and interrupting the flow of interactions with them and is mostly negatively associated with child developmental outcomes. Although there is limited research that simultaneously

examines mobile touch screen device use, parent-child attachment, and child developmental outcomes, it is likely that the three constructs are interrelated.

Health-related guidelines available to families provide some advice around the use of screen devices by children. These mostly advocate for limiting the amount of time that very young children use screen devices (with exceptions for video calls), with limited consideration of device use context and content. Key frameworks in this area of research include parent-child attachment, family systems theory, the bioecological model, and human-computer interaction models.

If research is to be translated to guidance for families, then it is imperative that there is a better conceptualisation of technology use by families and young children that includes consideration of individual and social contexts and other factors that may also be important.

Chapter Three

3

Study 1:

Systematic Review

Ergonomics

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The association of mobile touch screen device use with parent-child attachment: a systematic review

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Abstract

Mobile touch screen devices (smartphones and tablet computers) have become an integral part of many parents' and children's lives, with this interaction linked to physical, mental and social outcomes. Despite the known importance of parent-child attachment, evidence on the association between device use and attachment was yet to be reviewed. Following protocol pre-registration, databases were searched, papers screened, and methodological quality assessed. Three papers met the inclusion criteria, and reported some negative associations between duration of parent/child smartphone use and attachment outcomes. A narrative synthesis on two groups of related papers found child time using any screen technology (including television viewing), and child "problematic" internet, mobile phone, gaming and social media use, was negatively associated with attachment outcomes. Currently there is limited direct evidence on any association between time parents or children spend using these devices and parent-child attachment to support time guidelines for families and professionals working with families.

Practitioner summary

Many parents and children regularly spend time using smartphones and tablet computers. This systematic review found limited evidence evaluating associations between child/adolescent or parent time using devices and parent-child attachment. Until quality evidence exists, practitioners should be alert to potential impacts of device use on family relationships and child outcomes.

Keywords: mobile touch screen device use; parent-child attachment; screen time; technology use, children

3.1 Introduction

Mobile touch screen devices (e.g. smartphones and tablet computers) are widely owned and used by parents and children for a variety of purposes and often for substantial amounts of time. Across many countries where data are available, most adults report ownership of smartphones. For example, the proportion of people aged 18-34 years who reported owning a smartphone in 2018 was 97% in Australia, 95% in America, 97% in France, and 96% in Japan (Pew Research Centre, 2019b). Tablet computers are also commonly owned. Available reports show that 66% of Australian households (Australian Bureau of Statistics, 2017) and 52% of American adults (Pew Research Centre, 2019a) owned internet-connected tablets in 2016-17 and 2019 respectively.

The use of mobile touch screen devices is not limited to adults. For example, over 80% of children aged 9 to 16 years in 11 European countries reported using a smartphone to access the internet at least once a day (Smahel, 2020). A 2019 American survey of more than 1,600 young people found that by age 12, more than two-thirds (69%) had their own smartphone (Rideout & Robb, 2019). Even very young children commonly use devices, with the 2017 Australian Child Health Poll finding that 17% of children aged 2 years and under, and 36% of children aged 3 to 5 years, owned their own tablet or smartphone (Rhodes, 2017).

Children and adults spend considerable periods of time on their devices. A recent American study found that 8 to 12 year olds spend an average of four hours and 44 minutes a day using screen media (for non-school work purposes), and teenagers an average of seven hours and 22 minutes (Rideout & Robb, 2019). Among young children aged 2 to 5 years, a German study found that they spend an average of 5.4 minutes per day specifically using mobile phone devices (Poulain et al., 2019). Adults also spend a great deal of time using devices. For example, American adults have been found to spend on average four hours and 46 minutes a day watching television, and three hours and nine minutes using an app or the internet on a smartphone or tablet computer (The Nielson Company, 2018). Research indicates that parents also commonly spend time on their devices while supervising children (Moran, 2009). For example, an observational study of 50 parents/carers caring for children aged 5 years and younger in playgrounds found that the majority (76%) used their mobile device, with usage time extending to 17 minutes of the 20 minute observation period (Mangan et al., 2018).

The international prevalence and duration of screen use has led to public health concerns about the potential for detrimental effects on child physical and mental well-being (Ansari & Crosnoe, 2016; Cheung et al., 2017; Zhao et al., 2018). In response, national and international guidelines have been promulgated (American Academy of Pediatrics Council on Communications and Media, 2016; UK Department of Health, 2019; World Health Organization, 2019). These guidelines have mainly focussed on limiting the time of exposure to any screen device. Typical recommendations are that children under 2 years of age should not use screens at all, that children 2-5 years should be limited to 1 hour exposure each day and children older than 5 years should be limited to 2 hours exposure each day (Australian Department of Health, 2017; Tremblay et al., 2017). These guidelines are the primary source of authoritative guidance for families and professionals working with families.

However, the current guidelines have been criticised as not being evidence-based, as they have typically not taken into consideration other aspects of use and the potentially different impacts of different content, context and devices (Houghton et al., 2015; Straker et al., 2018). For example, the usability, portability and functionality of mobile touch screen devices creates unique opportunities for screen use. How they are used, where, for what purpose, by whom, and in what context can be very different to how other screen technologies such as television and desktop computers are used (Bentley, Turner, & Jago, 2016; Rideout & Robb, 2019), with some evidence that use of handheld devices has differing impacts such as altered posture movement, and muscle activity while playing with tablet computers compared to TV viewing (Howie et al., 2017). Given the potential differential effects of mobile touch screen device use compared with other screen devices, guidelines and the evidence reviews which underpin them, should be device specific.

Like prior generations of screen technology (Straker et al., 2014; Straker, Maslen, Burgess-Limerick, Johnson, & Dennerlein, 2010; Tran & Subrahmanyam, 2013) current evidence suggests that time spent using mobile touch screen devices can have both positive and negative associations with child outcomes (Howie et al., 2017; Straker et al., 2018; Toh et al., 2019). An important influence on outcomes for children is the interactions within their family, and parent-child attachment in particular.

There is evidence that time using mobile touch screen devices is associated with family interactions. For example, greater amounts of parent-child communication via mobile phones and co-playing of digital games are linked to higher perceived levels of family connection(Padilla-Walker et al., 2012). However, child device use has been

reported by parents to be a source of family conflict, tension or disagreement (Rhodes, 2017). In addition, device use by parents has also been reported to have the potential to displace parent-child interactions in a multitude of settings due to the portability and ease with which devices can be used (Kildare & Middlemiss, 2017; McDaniel et al., 2018). For example, increased frequency and duration of parent device use has been found to interrupt playtime between parents and children while at home (McDaniel & Coyne, 2016), can result in parents being less responsive to their children while eating out at restaurants (Radesky et al., 2014), and has been associated with signifcantly lower attachment quality when used while infant-feeding (Gutierrez & Ventura, 2021).

It is also important to note the possibility of a bi-directional association between mobile touch screen device use and parent-child relationships. For example, poor family relationships may lead to increased child use of internet-connected devices as a way to avoid conflict and emotional distress, or to replace social support (Bernardi & Pallanti, 2009). Research suggests that child mobile touch screen device use is highly associated with parents' own use of these devices, indicating that the family screen technology environment should be examined, rather than parent or child screen technology use in isolation (Lauricella et al., 2015).

An important aspect of family interactions is parent-child attachment, which may be understood as an enduring emotional closeness between parents and their children that prepares children for future development and independence, and is characterised by parents being sensitive and responsive to the signals of their children (M. Ainsworth et al., 1978; Rees, 2005). The establishment of secure parent-child attachment throughout childhood is critical, as there is substantial evidence to suggest that it is predictive of future cognitive development such as higher levels of literacy and numeracy (McCormick et al., 2016; West et al., 2013), social and emotional development such as higher levels of emotional regulation and coping skills (Ding et al., 2014; Zimmer-Gembeck et al., 2017), and physical development such as lowered obesity risk and increased physical activity (R. Li et al., 2016; Powell et al., 2017). Interactions between parents and children characterised by sensitive and responsive parents contributes to the development of a secure attachment relationship, where the child is able to use their parent as a secure base from which to explore the environment and to feel, and be, safe and protected (M. Ainsworth et al., 1978; Bowlby, 1980). Therefore, the potential for time spent on devices to displace the time that parents and children spend engaging with each other to form secure attachment is an important topic to explore, as there are likely implications for future child developmental outcomes. In addition, the potential for the possible opposite

direction effect of security of attachment to influence time spent using devices is also important to consider.

Researchers have primarily explored the implications of the recent increase in screen technology use (smartphones, tablet computers, the internet, social media and gaming) on parent-child attachment using different constructs related to "problematic" technology use. For example, some research has investigated associations between parent-child relationships and "problematic" smartphone use (Hefner, Knop, Schmitt, & Vorderer, 2019), mobile phone "dependency"(Lim & You, 2019) and smartphone "addiction" (Kwak, Kim, & Yoon, 2018). Others have explored associations between parent-child relationships and the "excessive" use of the internet in general with any device (Floros & Siomos, 2013; Hsieh et al., 2018), "excessive" use of social applications such as Facebook (Assunção & Matos, 2017; Badenes-Ribera, Fabris, Gastaldi, Prino, & Longobardi, 2019), and internet gaming "disorder" or "addiction" (Bonnaire & Phan, 2017; King & Delfabbro, 2016).

Definitions of "problematic" screen technology use refer to impacts on the user's life and on their immediate relationships, such as: preoccupation with the device or application, feeling anxious or lost without it, inability to control usage, using it as a way to withdraw and escape problems, decreased productivity, and jeopardizing or risking the loss of significant relationships with others as a result of their screen technology use (S. Chen, Weng, Su, Wu, & Yang, 2003; Hormes, 2016; Lemmens, Valkenburg, & Peter, 2009; Leung, 2008; Young, 1998). As definitions of "problematic" screen technology use include impacts on relationships (including parent-child attachment relationships), these two concepts are intertwined. Thus, it is a circular argument to consider 'associations' of "problematic" technology use with parent-child attachment. Further, "problematic" device use only considers an extreme type of screen technology use, rather than the broad range technology use which may be typical of families. As a large proportion of parents and children routinely use mobile touch screen devices to some extent and do not necessarily meet the criteria for "problematic" use, some of the more nuanced effects of general technology use may be missed. In addition, a focus on "problematic" use does not include the potential to consider any positive implications of device use by families.

Given the current limitations of the evidence base for national and international guidelines, this systematic review focussed on time (given its pre-eminence in guidelines and its lack of conceptual intertwining with outcomes), mobile touch screen devices (given the potential differential effects of different devices and ubiquitous use

by parents and children) and parent-child attachment (given it is a well-defined construct of known importance for child development) by addressing the following question: Is time spent using mobile touch screen devices associated with parent-child attachment in contemporary families?

3.2 Methods

3.2.1 Search strategy

The protocol for this systematic review was published in the International Prospective Register of Systematic Reviews (PROSPERO CRD42019136746: *The associations of mobile touch screen device use with parent-child attachment: A systematic review*.[1] (Appendix C). The systematic review was conducted in accordance with the PRISMA statement using the electronic databases EMBASE, ScienceDirect, PsychINFO, PubMed, Medline, Cochrane, CENTRAL and ProQuest for papers published from database inception to January 2021. To provide a comprehensive search of articles on this topic, a combination of search terms related to mobile touch screen device use, parent/child and attachment was used (Table 3.1).

Table 3.1
Key search terms used in the electronic search strategy

Mobile Touch Screen Device Use		**Parent/Child**	**Attachment**
Digital technolog*	Information technolog*	Caregiver*	Attachment*
Mobile technolog*	Information communication	Parent*	Parent child relation*
Mobile device	Screen us*	Child*	Mother child relation*
Tablet comput*	Screen based activit*	Mother*	Mother fetus relation*
Slate comput*	Screen activit*	Maternal	Mother foetus relation*
Handheld device	Screen time	Father*	Father child relation*
Touch screen	Screentime	Paternal	
Touchscreen	Social media	Famil*	
Touch interface	Facebook		
Touch technolog*	Internet		
Smart phone	Online		
Smartphone	Social network site		
Cell* phone	Social networking		
Mobile phone	Portable comput*		
IPad	Portable device		

[1] Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42019136746)

Results from the search of articles were uploaded to Covidence for screening purposes. Two reviewers independently screened all titles and abstracts for eligibility, then independently screened the full texts of studies considered potentially eligible, to finally determine the studies to be included in the review. Any disagreement was resolved through a consensus meeting with a third reviewer.

This systematic review included papers that: examined both the use of mobile touch screen devices and associations with parent-child attachment outcomes (including prenatal attachment outcomes), measured time spent using the mobile touch screen device by children and/or parents, had child participants under the age of 18, used a cross-sectional or longitudinal design, were reported following peer-review and were written in English. Case reports, reviews, editorials and conference proceedings were excluded. Articles that did not differentiate the use of mobile touch screen devices from non-mobile touch screen devices, and articles that examined attachment relationships that did not include parent-child attachment (e.g. marital or peer attachments) were also excluded. A search of the reference lists of the included study was completed.

3.2.2 Data extraction and methodological quality assessment

In accordance with the PROSPERO registration, a structured narrative synthesis was undertaken due to the finding of only three papers meeting all inclusion criteria. The following data were extracted from the included studies: study population, study purpose, study design, mobile touch screen device use measure, parent-child attachment measure, statistical analyses and main findings.

Relevant data from the included studies were extracted and methodological quality of each study was independently appraised by two reviewers using adapted criteria from the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (von Elm et al., 2007). The quality checklist used for this review (Appendix D) consisted of seven items as follows: (i) Did the study clearly state the research objectives, including any pre-specified hypotheses? (ii) Was the study design well described and appropriate? (iii) Were participants randomly selected? (iv) Was the mobile touch screen device use measure reliable and valid? (v) Was the parent-child attachment measure reliable and valid? (vi) Are statistical methods well described and appropriate? (vii) Are results well described and reported in sufficient details? For each item, a score of "1" (yes) or "0" (no) was assigned and an overall score out of 7 was tabulated. Additionally, overall quality of evidence was assessed using the Grading of Recommendations Assessment

Development and Evaluation (GRADE) approach (Dijkers, 2013), a formal process to rate the quality of scientific evidence in systematic reviews. Consensus between the two reviewers was reached through discussion.

Surrounding literature that did not meet the inclusion criteria but provided information about the broader context was noted during the search process and used in the Discussion to provide context.

3.3 Results

3.3.1 Search results

A total of 6,488 records were identified through the initial search of the databases using the key search terms. More than half were duplicate records and were removed. The titles and abstracts of the remaining 3,162 articles were screened for eligibility by two independent reviewers, who agreed on 130 of these being eligible for full text review (Figure 3.1).

Of these, 127 were excluded due to wrong study design (e.g. studies that were not cross-sectional or longitudinal such as literature reviews and systematic reviews, or studies that did not assess the association between attachment and technology use outcomes); wrong outcomes (e.g. studies that did not measure parent-child attachment or time spent using a mobile touch screen device); or the child population was aged over 18 years.

A total of 3 papers met the inclusion criteria of the systematic review. A detailed summary of these articles is provided in Table 3.2.

Figure 3.1
PRISMA flow chart for selecting relevant articles

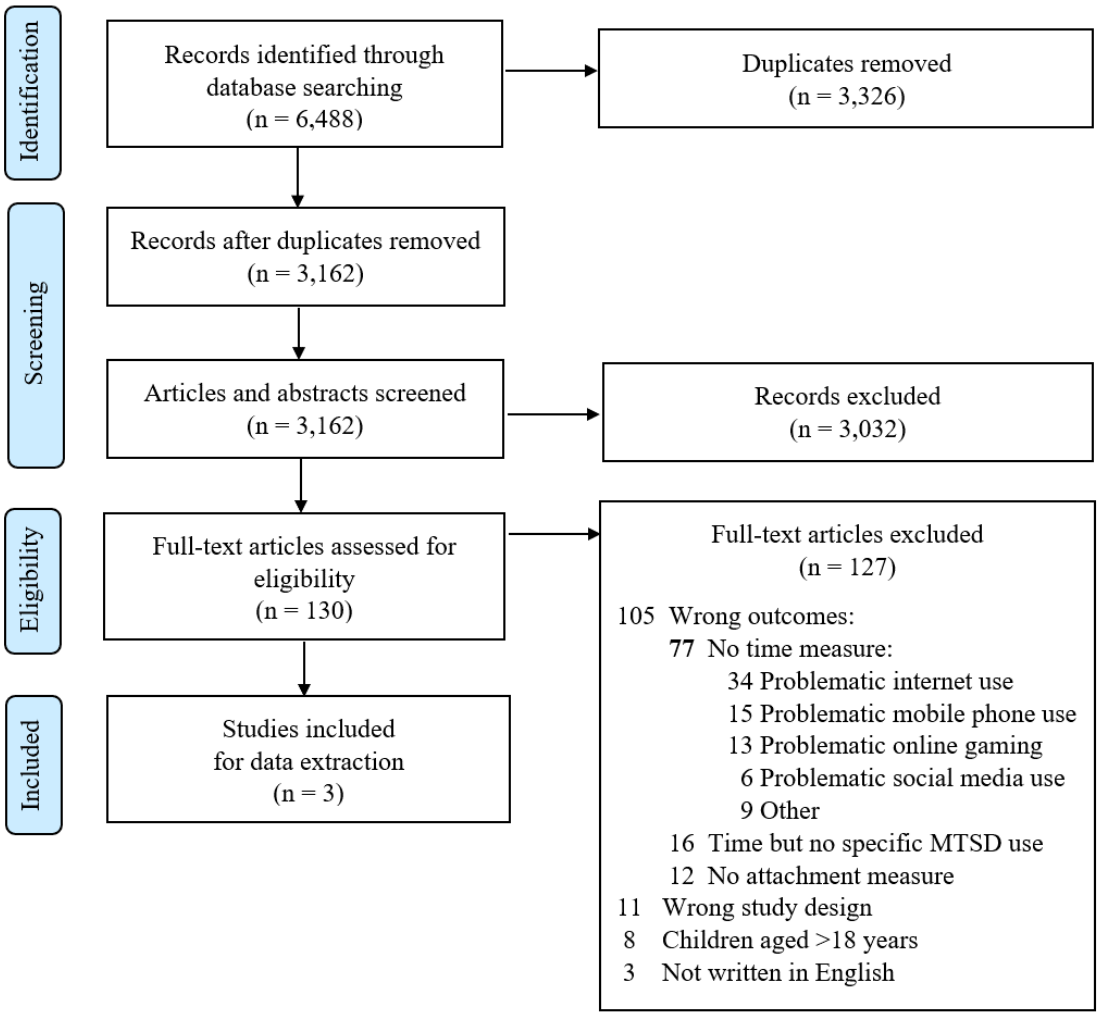

Table 3.2
Summary of the included articles on associations between time spent using mobile touch screen devices and parent-child attachment

Author (year)	Country	Participants	Study purpose	Study design	MTSD use measure	Attachment measure	Statistical analyses	Main findings	Quality score /7
Moawad & Ebrahem (2016)	Egypt	n = 230 school students Age: 12-18 years (M=16, SD=1.8)	To investigate the relationship between adolescent use of technology and parent-adolescent social relationship	Cross-sectional design (self-report question-naire)	Hours spent by adolescent using a mobile phone	Single item answered by the adolescent on their perceived closeness with their parents	T-test (although authors reported conducting a correlation analysis)	The authors reported a significant correlation between adolescent mobile phone use and closeness with parents ($t=26.69$, $p<0.001$)	3
Modecki et al, (2020)	Australia	n = 3,659 parents Age of children: 0-18 years (M=8, SD=5.5)	To assess associations between smartphone use and parenting	Cross-sectional design (online survey)	Time spent using smartphone in the last 24 hours except listening to music	Single item measuring level of agreement with: “I get upset easily around my child” taken from R-IPA	Logistic regression	Time using smartphone was associated with attachment item but not associated with warmth item (various effect sizes and p values reported).	4
Wolfers et al, (2020)	Germany	n = 89 mother-child dyads Age of children: 7-36 months (M=20, SD=8)	To explore how smartphone use while taking care of children is related to maternal sensitivity	Observations and interviews	Duration of smartphones use by mother within 20 minute observation period	Mini-Maternal Behavior Q-Sort	Linear regression	Duration of smartphone use was significantly related to mothers' situational sensitivity ($\beta = -0.51$, $p < .001$)	6

3.3.2 Key findings and methodological quality

Three articles met the inclusion criteria. The first supported a negative association between duration of adolescent mobile phone use and perceived closeness to parents (Moawad & Ebrahem, 2016). The other two supported a negative association between duration of parental smartphone use and parent-child attachment/maternal sensitivity (Modecki et al., 2020; Wolfers, Kitzmann, Sauer, & Sommer, 2020). The quality scores of the studies ranged from 2 to 6/7 with an average score of 4. Further details of quality assessment scoring are provided in Appendix E.

Moawad & Ebraham (2016) reported a cross-sectional study of 230 Egyptian school students aged 12-18 years who completed self-report questionnaires on technology use and perceived closeness to parents. The study reported finding a "high positive correlation between adolescents' technology usage and social interaction with their parents. The more that the adolescents used technology the more their social interaction with their parents will be affected or decreased… ($t=26.69$, $p<0.001$)". The strength of the reported correlation was not able to be ascertained from the results reported. The quality of this study was rated as low due to no standardised measures of acceptable quality used to assess mobile touch screen device use or attachment to parents. In addition, although the authors described conducting a correlation analysis, they did not report results from a correlation analysis but rather the results of a t-test.

Modecki et al (2020) reported a cross-sectional study of 3,659 parents of 0-18 year olds. The study reported mixed results, including a small negative association between parent duration of smartphone use within the last 24 hours for all uses other than listening to music and parent-child attachment. The quality of this paper was rated as moderate as although it provided a strong rationale for using a multiverse approach, a clear study design and well described results, weak measures were used. The measure used to assess smartphone use may introduce bias where participants do not accurately recount their exact usage time, and the reason for attempting to validate time on smartphone with participants' reports of relationships and stress was not justified. For parent-child attachment, one item from the 30-item Revised Parental Attachment Inventory (R-IPA) was used ("I get upset easily around my child"). Although the R-IPA is a reliable and valid scale when used as a complete assessment tool, the reliability and validity of using one item in isolation to determine parent-child attachment was not provided. Further, analysis of the association of parent smartphone time with a similar item ("I am easy going and

relaxed around my child") considered by the authors to characterise 'parental warmth' rather than attachment, showed no significant association. Further, a positive association was reported between smartphone use (for social network sites) and high quality parenting in some analyses. The authors therefore considered their results to be "fragile". Although the paper had some potential limitations, the multiverse approach reduced the likelihood of publication bias and the authors raised some interesting points around the value of exploring different family contexts and circumstances, and degree of immersion of smartphone use (e.g. using social networking sites versus calling and texting).

Wolfers et al (2020) reported on a multi-method study where data were collected from 89 mother-child dyads (children aged 7 to 36 months) in German playgrounds by observations and a questionnaire to assess smartphone use and maternal sensitivity. The study reported a negative association between duration of maternal smartphone use and maternal sensitivity, with mothers who had longer duration of smartphone use having lower sensitivity ratings ($\beta = -0.51$, $p < .001$). The study was rated as high quality as it had a specific and clearly stated purpose and design that were well described and appropriate and the measure of maternal sensitivity (Mini-Maternal Behavior Q-Sort) is a standardised and acceptable measure of attachment quality that has been found to be valid and reliable. However, as the researchers were familiar with the research goal it is possible that observer bias could have been introduced. In addition, the sample was self-selective as only mothers and children who visited playgrounds were observed. Smartphone behaviours and maternal sensitivity may differ for mothers who do not visit playgrounds and results may not be generalisable to other contexts. Further, immediate effects on sensitivity may not predict long term effects on attachment. The authors discussed the importance of extending future research to other situational contexts and other caregivers (e.g. fathers, nannies), and examining potential positive effects of smartphone use on parent-child interactions.

Overall, there is low certainty evidence that time spent using mobile touch screen devices by parents or children is negatively associated with security of attachment. The quality of the evidence is low due to inconsistencies in study populations, study methods and outcomes across the three studies. Furthermore, the overall evidence was imprecise and indirect due to device use and attachment not being assessed using validated tools, or attachment being indirectly measured via maternal sensitivity. The results may not be broadly applicable to wider populations due to studying specific age-groups and contexts (e.g. mothers attending playgrounds) which also contributes to the overall certainty of the evidence being rated as low.

3.4 Discussion

This study systematically reviewed the evidence concerning time spent using mobile touch screen devices by parents and/or children and associations with parent-child attachment. Despite many papers reporting related research, only three papers met the inclusion criteria. All three papers yielded somewhat consistent findings, whereby duration of smartphone use was negatively associated with measures of parent-child attachment. This was found for both child use of smartphones as well as parent use of smartphones. Collectively, the findings spanned a wide range of child ages, with one study focussed solely on children aged three years and under, another reporting a mean child age of 8 years, and a third with a sample of adolescents aged 12 to 18 years. Although the quality of evidence provided by these three papers was mixed, overall they demonstrated that longer durations of smartphone use may be associated with poorer maternal sensitivity and parent-child attachment outcomes.

Two groups of related papers not meeting the inclusion criteria were identified. The first was comprised of papers that measured parent-child attachment or related constructs and time spent using *any* screen technology, but did not differentiate between mobile touch screen device use (smartphones and tablet computers) and non-mobile touch screen device use (e.g. television viewing, desktop computers, internet browsing). The second was comprised of papers that measured attachment or related constructs and explored *"problematic"* screen technology use. As previously described, "problematic" technology use refers to a person's use a device or application that negatively impacts on aspects of their life and immediate relationships. These papers could be further grouped into "problematic" internet, mobile phone, gaming or social media use. Constructs related to parent-child attachment explored in the surrounding literature included: communication, family conflict, emotional bond, parental conflict, feelings of alienation to parents and time spent with family.

3.4.1 Key findings from surrounding literature

Given the limited evidence from studies meeting the review inclusion criteria, a discussion of the surrounding literature is presented to provide a better understanding of the evidence closely related to the topic: Is time spent using mobile touch screen devices associated with parent-child attachment? However, it should be noted that these studies were not appraised for quality and are provided here to give context to the systematic review.

3.4.1.1 Is time spent using any screen technology associated with parent-child attachment or related constructs?

Several cross-sectional studies measured time spent using screen technology and parent-child attachment or related constructs, but did not provide data specifically on mobile touch screen device use. These papers found that increased time children or adolescents spent using screen technology (including television viewing, computers, mobile phones, video games and internet browsing) was negatively associated with scores of parent-child attachment or related constructs such as communication quality, in early childhood, as well as adolescence (S.J. Lee, 2009; Richards et al., 2010; Santana-Vega et al., 2019).

For example, among young children aged 2 to 5 years, a large cross-sectional study of 19,957 American parents conducted in 2019 found a modest negative association between increased child screen time (television, computers, cell phones, handheld video games and videos) and parent perceived measures of parent-child attachment (Przybylski & Weinstein, 2019). Among older middle-school children, a cross-sectional study of 222 Korean children aged 10 to 12 years found that total time children spent using the internet was positively and moderately related to their perceived reduction in family time (S.J. Lee & Chae, 2007). An interesting finding of this study was that the influence of internet time on family time was dependent on the type of activity the child was using the internet for. For example, playing online games reduced time spent with family as well as perceived family communication, whereas using the internet for homework did not (Brennan, 1998). Purpose of use was also found to be an important factor in a cross-sectional study of 1,000 Israeli households with adolescents aged 13 to 18 years, which found that more frequent internet use for learning purposes was significantly associated with higher levels of perceived parent-child relationships (Mesch, 2003).

The opposite direction of causality was explored in a couple of studies. For example, a longitudinal study of 1,591 Canadian adolescents assessed across two time periods, 21 months apart, found that less positive parent-child relationships in early high school predicted higher frequency of internet use by adolescents in late high school (Willoughby, 2008). The authors suggested that more time on the internet may result from adolescents turning to the internet due to less positive interactions with their parents. A cross-sectional study of 1,727 American children and adolescents aged 8-18 years found that higher quality parent-child relationships were associated with less time spent using recreational media by children (including watching television, going to the cinema, listening to music or browsing the internet), but this association was only significant for children aged 11-13

years (Jake-Schoffman, Turner-McGrievy, & Walsemann, 2017). The authors suggested that reducing excessive media use in children via improving parent-child relationship quality is especially important during the pre-teen years.

Looking at specific contexts of mobile touch screen device use, one study of 2,616 American parents examined the use of electronic devices (computers, cell phones, Game Boys and e-readers) during family meals and found a strong negative association between the use of these devices by anyone in the family and parental feelings of closeness to their children (J. J. Nelson, 2019). Every one unit increase in the use of digital devices at the table (on a Likert scale from 1=never to 6=daily) decreased parental reports of being close to their children by 12%.

Interestingly, one small study of 36 parent and child (aged 3-4 years) dyads found an inverse relationship where parents' weekend screen use was positively associated with responsiveness to their child's behaviour (Attai, Szabat, Anzman-Frasca, & Kong, 2020). The authors suggest this could be due to co-viewing, or due to parents with higher responsitivity scores using screens when children are asleep or not in their direct care. Results of this study should be interpreted with caution due to the small sample size.

Together these findings provide some evidence to indicate that in general, increased time spent using any screen-based internet technology by children or adolescents may be associated with decreased quality of parent-child attachment or related constructs such as communication and family time, although a key limitation of this evidence is the lack of screen device specificity.

3.4.1.2 Is "problematic" internet use associated with parent-child attachment or related constructs?

Numerous cross-sectional papers did not measure time spent using mobile touch screen devices, but instead explored "problematic" internet use (typically assessed via internet addiction scales) and parent-child attachment or related constructs. These papers explored adolescent internet use, and found that "problematic" internet use was negatively associated with positive parent-child attachment relationships (Bolat, Yavuz, Eliacık, & Zorlu, 2018; Hsieh et al., 2018; Lan & Wang, 2020) and perceived parental warmth, interest and supportive behaviour (Faltýnková, Blinka, Ševčíková, & Husarova, 2020).

For example, a cross-sectional study of 1,105 Italian adolescents found that higher adolescent attachment to parents significantly predicted less "problematic" internet use, which the authors suggested may relate to adolescents using the internet to avoid or reduce

distress caused by poor attachment experiences (Ballarotto, Volpi, Marzilli, & Tambelli, 2018). A cross-sectional study of 97 American teenagers aged 13-18 years found that those with a strong attachment to parents are less likely to have "problematic" internet use, with teens less attached to parents significantly more willing to "sext" ("i.e. send nude or nearly nude images of oneself to others, or exchange sexually explicit verbal messages via mobile devices") than strongly attached teens (Atwood, Beckert, & Rhodes, 2017).

Literature was also found which reported a negative association between parent-child attachment or related constructs and adolescent "problematic" internet use. For example, "problematic" internet use was found to be negatively associated with: scores of parent-child communication among 1,000 Israeli high-school aged students (Boniel-Nissim & Sasson, 2018); scores of perception of care from parents among a large sample of 37,486 Spanish adolescents (Casaló & Escario, 2019); perceived parental emotional availability among 176 Turkish adolescents (Karaer & Akdemir, 2019); and perceived parental connectedness among 27,455 Malaysian adolescents (Awaluddin et al., 2019). "Problematic" internet use was also found to be negatively associated with scores of perceived parent-child relationships among 300 Chinese students aged 13-18 years (Huang, Hu, Ni, Qin, & Lü, 2019). The association was partially mediated by self-concept, and the authors suggested that better parent-child relationships enable adolescents to establish positive self-concept which then leads to less "problematic" behaviours such as internet use.

In summary, some evidence exists that "problematic" internet use by adolescents may be negatively associated with adolescent perceptions of attachment to parents and related constructs such as perceptions of care received and communication, although a key limitation of this cross-sectional evidence is the intertwining of exposure and outcome constructs.

3.4.1.3 Is "problematic" mobile phone use associated with parent-child attachment or related constructs?

Several cross-sectional studies examined "problematic" mobile phone use (largely measured via smartphone addiction and dependence scales) and parent-child attachment or related constructs. Findings indicate that child or adolescent "problematic" mobile phone use was negatively associated with secure parent-child attachment (X. Li & Hao, 2019; Roser, Schoeni, Foerster, & Röösli, 2015; Sun et al., 2020).

For example, a cross-sectional study of 500 children aged 8 to 14 years in Germany found that secure parent-child attachment was associated with lower scores of children's

"problematic" mobile phone involvement (Hefner et al., 2019). This study also found that co-use of mobile phones by parents and children was positively associated with secure attachment, which the authors suggest indicates that using the phone together adds a dimension to the parent-child relationship.

Several papers explored potential mediators in the relationship between parent-child attachment and "problematic" mobile phone use. In one cross-sectional study of 246 Korean students aged 12 to 16 years, self-esteem was found to fully mediate the association between parental attachment and "problematic" mobile phone, with secure parent-child attachment having a positive association with self-esteem, and self-esteem having a negative association with adolescent "problematic" mobile phone use (Kim Y., 2017). In another study, quality of life was found to play a partial mediator role in the negative association between the parent-child relationship and smartphone use disorder among Chinese adolescents (Q. Gao, Sun, Fu, Jia, & Xiang, 2020). Furthermore, the construct loneliness was also found to exert a mediation effect between parent-child relationship and mobile phone dependence in a cross-sectional study of 4,509 Chinese adolescents (Zhen, Liu, Hong, & Zhou, 2019).

Among 493 American college students aged 18-29 years, "problematic" mobile phone use was related to poorer scores of attachment to parents for both males and females, which the authors suggest may be due to mobile phone use displacing other methods of more beneficial social interactions such as face-to-face communication (Lepp et al., 2016).). This research indicates the importance of secure parent-child attachment relationships extends beyond childhood and into adulthood.

There was also literature on constructs related to attachment and adolescent "problematic" mobile phone use that found negative associations between the two. For example, among 485 Korean fourth graders (mean age of 11), perceived parental negligence was found to have an indirect association with mobile phone dependency via peer attachment (Lim & You, 2019). The authors suggest that children who experience parental neglect are less likely to develop close peer relationships, which in turn leads to greater dependence on smartphones to combat feelings of loneliness. Parental neglect was also found to be significantly associated with smartphone addiction among an older sample of 1,170 Korean middle school students (Kwak et al., 2018). In terms of parent-child communication, an important factor in the development of secure parent-child attachments, more positive communication between parents and children has been found to be associated with reduced "problematic" smartphone use among 334 students aged 11 to 13 years (E. J. Lee & Kim, 2018).

Together these findings indicate that there is some evidence "problematic" mobile phone use by children, adolescents or young adults may be associated with decreased quality of parent-child attachment and related constructs such as communication and perceived parental neglect, although again key limitations of this evidence are the intertwining of exposure and outcome constructs and the potential bi-directionality of the associations reported.

3.4.1.4 Is "problematic" gaming using screen technology associated with parent-child attachment or related constructs?

A few cross-sectional studies and one longitudinal study explored child or adolescent "problematic" internet gaming (typically measured via internet gaming addiction scales) and parent-child attachment or related constructs. These papers found that "problematic" internet gaming by children or adolescents was associated with poorer child perceptions of parent-child attachment or related constructs (Grajewski & Dragan, 2020; Malik, Nanda, & Kumra, 2020). In addition, positive affect between parents and children was found to be a possible predictor of future child exposure to violent video gaming (A. Y. Li, Lo, & Cheng, 2018).

For example, cross-sectional studies of high school students have found that those at lower risk of "problematic" internet gaming had better family cohesion, decreased family conflict and stronger family relationships among 434 French adolescents (Bonnaire & Phan, 2017); higher scores of perceived parental emotional warmth among 357 Chinese high school students (I. H. Chen, Lee, Dong, Gamble, & Feng, 2020); and more secure parent-child attachments among 624 South Korean adolescents (Kim & Kim, 2015).

A longitudinal study of 241 child-parent dyads in Hong Kong (child age 8 to 15 years), observed parent-child interactions in a laboratory setting in addition to questionnaires completed by both parents and children on "problematic" internet gaming and exposure to violent video games at baseline, and questionnaires again 12 months later (A. Y. Li et al., 2018). The study found that at baseline, positive affect and cohesiveness were inversely associated with child "problematic" internet gaming. In addition, positive affect was negatively associated with child exposure to violent video games 12 months later, suggesting that affectivity of parent-child interactions is a possible predictor of exposure to violent video games, i.e. problematic gaming is an outcome rather than a cause.

Together the findings from these studies indicate that there is some evidence child or adolescent "problematic" internet gaming may be associated with poorer parent-child

attachment and increased family conflict, and poor quality parent-child relationship may predict future child "problematic" internet gaming. Again, this evidence is limited by the intertwining of exposure and outcome constructs.

3.4.1.5 Is "problematic" social media use associated with parent-child attachment or related constructs?

A few cross-sectional studies explored "problematic" social media use (generally measured via Facebook addiction scales) and parent-child attachment or related constructs. Findings indicated that poor parent-child attachment was associated with adolescent Facebook addiction or problematic Facebook use (Assunção, Costa, Tagliabue, & Mena Matos, 2017; Assunção & Matos, 2017; Badenes-Ribera et al., 2019; Sampasa-Kanyinga, Goldfield, Kingsbury, Clayborne, & Colman, 2020).

For example, a cross-sectional study of 598 Italian adolescents aged 11 to 17 years found that poorer attachment to parents was associated with increased levels of "problematic" Facebook use, with associations being stronger for early adolescents than late adolescents (Badenes-Ribera et al., 2019).

There was also literature on constructs related to attachment and adolescent "problematic" social media use that found negative associations between the two. For example, a cross-sectional study of 761 Portuguese adolescents aged 14-18 years found that those with more "problematic" Facebook use had significantly lower scores of emotional bond to the mother (Assunção & Matos, 2017). A study examining "problematic" Facebook use among 369 Italian adolescents aged 14-20 years found child "problematic" Facebook use was positively associated with scores of alienation towards parents (Marino, Marci, Ferrante, AltoÈ, & Vieno, 2019). One study on 761 Portuguese adolescents found a gender difference, with quality of emotional bond to parents being negatively associated with scores of "problematic" Facebook use for boys, but not for girls (Assunção et al., 2017). In a Canadian cross-sectional study, heavy use of social media by (more than 2 hours a day) by secondary school students was associated with greater odds of negative parent-child relationships, however no significant associations were found between regular social media use (less than 2 hours a day) and parent-child relationships (Sampasa-Kanyinga et al., 2020).

In summary, these findings indicate that there is some evidence that "problematic" social media use by adolescents may be associated with decreased quality of parent-child attachment and related constructs such as emotional bond and feelings of alienation with

parents, and there may be age and gender differences, although the evidence is limited due to the intertwining of exposure and outcome constructs from cross-sectional studies.

3.5 Implications of the findings

The major implication of the findings is that there is minimal evidence to support guidelines limiting the time of use of mobile touch screen devices by parents or children in terms of potential impact on parent-child attachment. This limited evidence from the three studies that met the inclusion criteria suggests that there may be an association between length of time spent using smartphones by parents and children, and parent-child attachment.

The authors of the included studies noted the importance of considering other contextual factors such as the setting and type of device use (e.g. phone calls vs social media use) and the importance of avoiding generalised narratives when discussing screen time risks. The potential for associations between screen technology use and parent-child attachment to be multi-faceted is supported by other research (Coyne, Padilla-Walker, Fraser, Fellows, & Day, 2014). For example, child use of mobile phones for relation-centric purposes such as expressing support and handling conflict has been found to be predictive of perceived closeness to parents, whereas functional uses such as coordinating schedules and sharing content did not predict closeness (Warren & Aloia, 2018).

However, whilst having substantial limitations, the surrounding literature in two areas also suggests use of screen devices in general may be negatively associated with parent-child attachment. Firstly, several studies suggest that increased time spent using screen technology in general (including non-mobile touch screen devices such as televisions and desktop computers) by children may be associated with child and parent perceptions of decreased quality of parent-child attachment and related constructs such as communication and family time. Secondly, a large number of studies have found that "problematic" internet, use, mobile phone use, internet gaming and social media use by children and adolescents may be negatively associated with child perceptions of attachment to parents and related constructs such as communication, family conflict, emotional bond, parental neglect and feelings of alienation to parents. There were no studies exploring "problematic" technology use and parent perspectives of attachment.

These findings indicated a potential bi-directional relationship. In one direction, the presence of secure relationships between children and their parents may have a protective effect to reduce overall time children spend using screen technology and their

"problematic" use of the internet, mobile phones, gaming and social media. Alternatively, in the other direction, increased time spent by children using screen technology and "problematic" use of the internet, mobile phones, gaming and social media may lead to poorer parent-child attachment relationships.

There are several proposed mechanisms which may explain any association between increased time spent using mobile touch screen device by children or parents and poorer parent-child attachment. Poor parent-child relationships may lead to undesirable social anxiety, which then leads to increased use of internet-connected devices (Q. Li, Guo, Bai, & Xu, 2018). Another possible mechanism is that children with poorer family relationships may use the internet-connected devices as a way to avoid family conflict, to avoid emotional distress, or to replace social support (Bernardi & Pallanti, 2009). Similarly, security of attachment may predict future device use, as supported by the finding that higher scores of mother-child interaction quality at 18 months of age were positively associated with less child screen time at 2 and 3 years of age (Detnakarintra et al., 2020). However, the same study found screen time at 2 and 3 years to have a negative relationship with nurturing parenting at 3 and 4 years, respectively. Thus, mechanisms may be bi-directional, with "problematic" use of screen technology potentially displacing interactions such as face-to-face communication, leading to poorer parent-child attachment (Lepp et al., 2016). Further longitudinal studies are required to investigate the temporal nature of the relationship between mobile touch screen device use and parent-child attachment.

3.6 Strengths and limitations

This paper was the first to systematically review associations between time spent using mobile touch screen devices and parent-child attachment, with strengths including a focus on the exposure widely used in guidelines (time), and being specific about the type of device and the outcome. Strengths also include pre-registering the protocol and using a standardised quality assessment approach. A further strength is that this topic is of current relevance to families and is important to explore for advancing knowledge and informing evidence-based guidelines on positive family mobile touch screen device use practices.

A limitation of this review is that the context of use was not explored. As noted in the Introduction, aspects of the context of use such as content and purpose may be critical. For example, the association between screen technology use and parent-child attachment may vary depending on the type of activity being used (e.g. communication purposes versus entertainment purposes). A further limitation of this review is that there may be

confounding factors that have not been considered in the relationship between time spent using mobile touch screen devices and parent-child attachment. For example, there may be underlying factors such as personality traits and mental health issues (e.g. anxiety and depression) that influence both time spent using devices as well as security of attachment.

In the broader literature, there was a scarcity of research examining early childhood. Almost all papers focussed on adolescent cohorts, and only two explored technology use among younger children aged under 5 years. There were no studies exploring prenatal attachment and mobile touch screen device use. Most papers were cross-sectional in design, which does not enable inferences to be made relating to the direction of the associations.

A further limitation of surrounding papers was that data reported on related to associations between child or adolescent screen technology use and attachment related constructs, and there were limited data on parent screen technology use. Also, most studies reported associations between child perceptions of attachment to parents and screen technology use, and there were limited data exploring parent perceptions of attachment to children.

There was limited evidence on the association of parent-child attachment related constructs with device use that is not defined as "problematic". Further, all studies examining "problematic" social media use focused on Facebook use. However, there are a number of other social media platforms that children are increasingly using such as Snapchat, Tik Tok, and Instagram.

Lastly, studies in the wider literature that measured time spent using screen technology grouped together older technologies (e.g. desktop computers and televisions) and newer technologies (e.g. smartphones and handheld gaming devices), despite potentially important differences.

3.7 Future research

Future research in this area could include investigations of associations between nature of device use (not just time) by parents and children and parent-child attachment; parental perspectives on how the use of mobile touch screen devices influences perceptions of parent-child attachment; and longitudinal studies to explore the direction of associations between mobile touch screen device use and parent-child attachment and later child development.

The benefits of mobile touch screen device use and ways with which technology can strengthen or enhance parent-child attachment could also be explored. This would be useful for informing parents how they can best incorporate mobile touch screen device use rather than avoiding devices altogether.

3.8 Conclusions

This systematic review demonstrates that there is currently limited good quality direct evidence on associations between time spent using mobile touch screen devices and parent-child attachment. The minimal evidence from studies that met the inclusion criteria was mainly congruous in demonstrating that duration of device use may be negatively associated with measures of parent-child attachment. However, there were potential methodological biases with these studies, limiting confidence in the findings.

Current national and international guidelines thus rely on evidence for associations with other outcomes, as well as related literature with substantial limitations which suggests increased child time using screen technology may be associated with poorer quality of parent-child attachment and related constructs (e.g. communication and family time); and child "problematic" internet, mobile phone, gaming and social media use may be associated with poorer parent-child attachment and related constructs (e.g. communication, family conflict, parental neglect and feelings of alienation to parents).

Given the known importance of parent-child attachment for a broad range of child developmental and wellbeing outcomes, better evidence to support guidelines for families and professionals is urgently needed.

Chapter Four

4

Study 2A:

Prenatal Qualitative Study

Ergonomics

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'There's good and bad': parent perspectives on the influence of mobile touch screen device use on prenatal attachment

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Abstract

The potential for human-computer interaction to have a substantial impact on adults is well documented. However, its potential importance prior to birth has rarely been reported. Paren©tal use of smartphones and tablet computers could influence the relationship between parent and baby during pregnancy (prenatal attachment) and thus child development. Twenty-seven families were interviewed to explore how parents used these devices during pregnancy, and how device use influenced parents' thoughts, feelings and behaviours towards their baby while in utero. All used devices for a variety of purposes, and all described good levels of prenatal attachment. Parents described both disrupted and enhanced connectedness as a result of device use, and increased parental stress. The findings highlight a new opportunity for how device design and use guidelines could support families to maximise benefits and reduce detriments of device use to optimise prenatal attachment, and thus future parent-child attachment and child development.

Practitioner summary

Many parents regularly use smartphones and tablet computers while pregnant. This qualitative study found that how devices were used either enhanced or disrupted feelings of prenatal attachment. Practitioners should be aware of potential beneficial and detrimental impacts of device use during pregnancy given implications for future attachment and child development.

Keywords: human-computer interaction; mobile touch screen device use; prenatal attachment; screen time; technology use; The ORIGINS Project; thematic analysis; qualitative research

4.1 Introduction

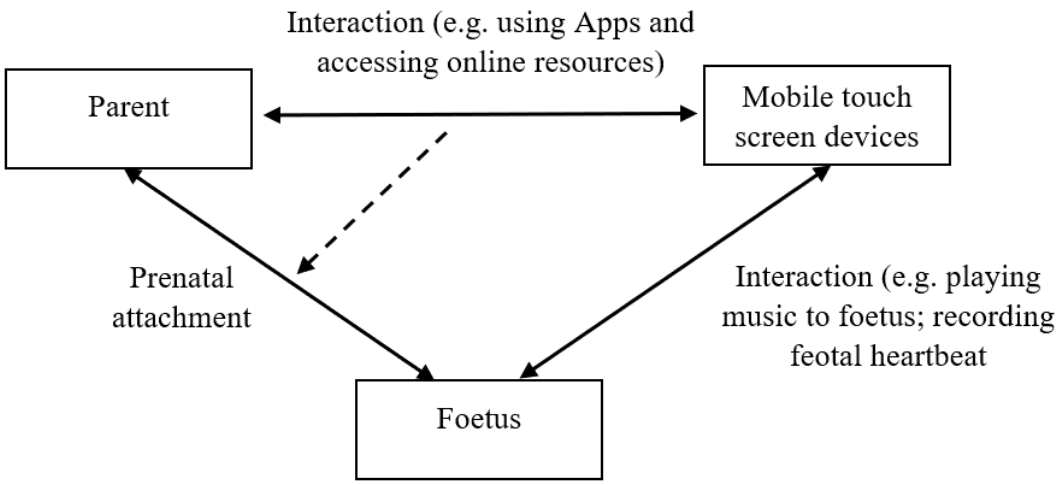
Over the past decades, considerable evidence has been accumulated in ergonomics research demonstrating that human-computer interaction can have a substantial impact on human factors such as performance efficiency, education, health, cognitive science and culture (Coenen et al., 2019; Gurcan, Cagiltay, & Cagiltay, 2021; Kyriakoullis & Zaphiris, 2015). Whilst the majority of this evidence has focused on human-computer interaction among adults (Tan, Chen, & Hao, 2021; Toh, Coenen, Howie, & Straker, 2017; Xie, Zhou, & Wang, 2017), some research has examined child use and outcomes (Howie et al., 2017; Lovato & Piper, 2019; Toh et al., 2020; Yuill & Martin, 2016). However, very little research has explored human-computer interactions prior to birth (Fleming, Vandermause, & Shaw, 2014; Lu et al., 2017), or the potential for human-computer interactions to influence parent-foetal relationships during the prenatal stage.

The use of digital technology within many families has increased considerably in recent years. With the rise in technology use, particularly portable devices such as smartphones and tablet computers, it is important to consider human-computer interactions to ensure humans and devices work together in an effective, safe and efficient manner (Kantowitz & Sorkin, 1983). The concept of the family system (White & Klein, 2008) provides a suitable framework for understanding human-computer interactions within a family context, whereby members interact to influence each other's behaviours and actions. Family systems theory characterizes the family unit as a whole rather than as individual elements, in which members interconnect to influence each other's experiences and actions (Kerr & Bowen, 1988).

At the core of the family system is the parent-child (or parent-foetal) dyad. The theoretical concept of prenatal attachment proposes that the development of an emotional bond between a parent and child begins prior to birth, and can be described as the parents' emotions, perspectives and behaviours that demonstrate affection and commitment toward the foetus (Bowlby, 1980; Brandon et al., 2009; Pisoni et al., 2014). Characteristics that demonstrate an emotional bond between the parent and foetus include: interaction with the foetus (e.g. I talk to my unborn baby), attributing characteristics and intentions (e.g. I have chosen a name), giving of self (e.g. I do things to improve my well-being and baby), differentiation of self (e.g. I dream about what my baby thinks and feels) and role taking (e.g. I picture myself taking care of my baby after birth) (Cranley, 1981).

In conjunction with the theory of prenatal attachment, family systems theory suggests that how one member of the family (i.e. the mother) interacts with technology may influence other aspects of the family, such as the development of an emotional bond between mother and child prior to birth. Therefore, it is reasonable to consider human-computer interactions in a family systems context prior to birth within an ergonomics framework, as the interactions between a parent and their devices may influence prenatal attachment between the parent and foetus. Prior models of human-computer interaction provide a framework for exploring influences of technology use within the family system (Straker et al., 2014; Straker & Pollock, 2005). Figure 4.1 shows a proposed model of human computer interaction within a prenatal context, with solid line arrows depicting the interaction and flow of information. The double headed arrow between parent or foetus and mobile touch screen device represents the parent/foetus sending information to the device and the device sending information to the parent/foetus. The dashed line arrow represents the potential influence of parent-device interaction on prenatal attachment.

Figure 4.1
Human-computer interaction in a prenatal family system



The model expands on the theories of prenatal attachment and family systems by illustrating proposed mechanisms by which parent use of mobile touch screen devices may influence their interaction and attachment with their foetus. For example, measuring foetal movements via devices may lead to enhanced prenatal attachment (Mikhail et al., 1991). Alternatively, increased frequency and duration of device use for general purposes may lead to poorer attachment quality (Gutierrez & Ventura, 2021).

Although there is very little research on prenatal human-computer interactions, understanding prenatal attachment is of critical importance as attachment in the third trimester of pregnancy has been found to remain stable in early childhood (J. Condon, Corkindale, Boyce, & Gamble, 2013; de Cock et al., 2016; Trombetta et al., 2021) and is an important determinant for more positive parenting and attachment relationships after birth (Benoit, Parker, & Zeanah, 1997; Theran, Levendosky, Anne Bogat, & Huth-Bocks, 2005). For example, a study of 100 Swedish mothers found that those with higher scores on the Prenatal Attachment Inventory had significantly higher scores of observed maternal involvement, sensitivity and stimulation during interactions with their infants 12 weeks following birth (Anver Siddiqui & Hägglöf, 2000).

The relationship between parents and their children prior to birth and in the early years is of critical importance, as evidence suggests that it provides the foundation for children's future development. There is considerable research on the positive influence of higher levels of parent-child attachment on various aspects of children's development, including: cognitive development such as IQ scores (McCormick et al., 2016), literacy and numeracy (West et al., 2013); socio-emotional development such as behaviour (Ding et al., 2014) and coping skills (Zimmer-Gembeck et al., 2017); and physical development such as obesity risk (Powell et al., 2017) and physical activity (R. Li et al., 2016).

Many potential influences on prenatal attachment have previously been explored. For example, in a recent systematic review of 41 cross-sectional studies that used a range of measures to assess prenatal attachment and prenatal depressive symptoms, 31 found a significant negative association between the two constructs (Rollè, Giordano, Santoniccolo, & Trombetta, 2020). Ultrasound scans (Milne & Rich, 1981), parental warmth in expectant mothers' own upbringings (A. Siddiqui, Hagglof, & Eisemann, 2000), foetal movements, income, and planning of pregnancy (Lerum & LoBiondo-Wood, 1989) have also been shown to be associated with prenatal attachment quality. However, another possible influence on prenatal attachment is the use of screen-based technology.

The use of technology by families can be a potential mechanism for influencing family interactions and parent-child attachment positively. For example, viewing television and co-playing video games have been linked to higher perceived levels of family connectedness through access to shared experiences (Padilla-Walker et al., 2012). However, there are also potential mechanisms for technology use to influence attachment negatively including: displacement of parent-child engagement time such as interrupting unstructured playtime together (McDaniel & Coyne, 2016) and distraction leading to

decreased sensitivity and responsiveness to the child's expressed needs (Radesky et al., 2014). A recent systematic review (Hood, Zabatiero, Zubrick, et al., 2021) found a very limited number of studies investigating associations between time spent using mobile touch screen devices by parents and/or children and parent-child attachment, highlighting the need for more research to better inform families and health and education professionals. Quality evidence in this area, including from qualitative research, is imperative to better understand potential impacts of device use on parent-child attachment relationships.

There has been a major social change over the last decade in the use of technology, with mobile touch screen devices increasingly becoming an integral part of the lives of most parents and children, particularly since the release of the first iPhone in 2007 and iPad in 2010. Ownership of smartphones has increased dramatically in recent years, with available reports showing that in 2019, 81% of adult Americans owned smartphones and 52% owned internet-connected tablets (up from just 35% and 8%, respectively in 2011) (Pew Research Centre, 2019a). The majority of Australian families have mobile touch screen devices in their homes, with statistics showing that 91% had mobile or smartphones in the household and 66% had internet-connected tablets in 2016-17 (Australian Bureau of Statistics, 2017). In a recent study of Australian adults, the average duration of touch screen device use was 153 minutes per day, with participants engaging with their device on average 52 times per day (ranging from 4 to 195 times per day) (Alzhrani, Johnstone, Winkler, Healy, & Cook, 2022).

There is already some evidence that prolonged parental mobile touch screen device use during pregnancy is related to poorer pregnancy outcomes including lower birth weights, with increased anxiety and depression and poorer sleep posited as possible mechanisms (Lu et al., 2017). Compared to prior information technologies such as televisions and desktop computers, the portability, functionality and ease of use of mobile touch screen devices create many more opportunities for their use, and thus potential influences on parent-child attachment both positively and negatively.

Mobile touch screen devices are often used extensively by expectant mothers. For example, a large cross-sectional study of 2,345 pregnant Chinese women found that 63% reported viewing content on their mobile phone for more than one hour per day (Xu et al., 2018). Mobile touch screen devices play an important role in seeking information to help in the transition to parenthood. It has been reported that there is a greater number of pregnancy-related Apps than for any other medical topic (Tripp et al., 2014), illustrating

how commonly expectant mothers engage with Apps on their devices as a routine part of their pregnancy experience.

Although there is some evidence on time spent using devices and ownerships of Apps by expectant families, little is known about their in-depth mobile touch screen devices use practices. As devices are likely to provide both beneficial and deleterious mechanisms in the formation of parent-child attachment, and given the importance of prenatal attachment, it is crucial to better understand how the use of mobile touch screen devices during pregnancy influences a parent's thoughts, feelings and behaviours towards their baby.

As expectant families are navigating the transition to parenthood in an increasingly digital environment, and mobile touch screen technology use is having an increasingly pervasive impact on how they communicate, acquire knowledge and seek entertainment, it is important to investigate the implications of this on the quality of prenatal attachment. Given prenatal attachment is critical for future parent-child attachment and child development, it is imperative to explore the role of mobile touch screen devices in order to advance knowledge and to better inform education and guidelines directed at families on how they use mobile touch screen device use.

This study aimed to explore: how and why expectant families used touch screen devices; what influence they perceived this use had on their prenatal attachment; and the mechanisms by which device use influenced attachment.

4.2 Materials and methods

4.2.1 Study design

A qualitative design using convenience sampling was employed to gain an understanding of expectant parents' practices of mobile touch screen device use and their perspectives on influences of device use on prenatal attachment.

Participants were part of a larger prospective longitudinal birth cohort study titled the ORIGINS Project (https://originsproject.telethonkids.org.au). The ORIGINS Project was designed to collect detailed information about how the early environment influences the risk of a range of non-communicable diseases including allergies, asthma, diabetes, obesity and mental health disorders. This study is a sub-project of the ORIGINS Project. This unique long-term study, a collaboration between Telethon Kids Institute and Joondalup Health Campus, is one of the most comprehensive studies of pregnant women

and their families in Australia to date, recruiting 10,000 families over a decade from the Joondalup and Wanneroo communities of Western Australia.

4.2.2 Participants

Participants were recruited from the larger pool of participants in the ORIGINS Project. All families who had consented to be part of the broader ORIGINS Project and were in their third trimester of pregnancy at the end of July 2019 were initially contacted by mobile phone message with information about a study on mobile touch screen device use and prenatal attachment. Potential participants were provided with an opportunity to opt-out from further contact within five days of receiving the message. Those who did not opt-out received an email with detailed information, followed by a phone call a few days later to invite them to participate and schedule an interview. Participants were remunerated with an AUD$50 voucher for their participation in the study.

ORIGINS Project participants were eligible to participate in this study if they were available for a qualitative interview either face-to-face at the health service centre or by phone, and were in the third trimester of pregnancy or within 8 weeks post birth at the time of the interview. Participants were excluded if they had insufficient English proficiency to understand the information provided and engage in the interview, or if they ceased participation in the ORIGINS Project (e.g. they had a stillbirth or they gave birth in a different hospital). Informed consent was obtained from all participants included in the study. Ethics approval for the current study was provided by Joondalup Health Campus Human Research Ethics Committee (approval # 1804) and Curtin University Human Research Ethics Committee (approval # AHRE2018-0065).

4.2.3 Data collection/instrument

An Interpretive Description framework (Thorne, Kirkham, & MacDonaldEmes, 1997) was chosen as a suitable approach for generating knowledge with practical outcomes regarding family mobile touch screen device use practices and potential influences on parent-child attachment. For this approach, a schedule of questions for the semi-structured interviews was developed based on findings from previous research on young children's screen technology use, as well as in consultation with experts in the field (Appendix F). The interview schedule was also reviewed by the ORIGINS Project community reference group.

The interview schedule included open-ended questions relating to: 1) family structure, 2) typical mobile touch screen device use practices, 3) perspectives on prenatal attachment in general, and 4) perspectives on perceived influences of mobile touch screen devices on prenatal attachment. Interview questions used to evaluate prenatal attachment were adapted from the Maternal Antenatal Attachment Scale (J. Condon, 1993) and the Maternal Fetal Attachment Scale (Cranley, 1981). These questions covered the same constructs of prenatal attachment as the aforementioned quantitative scales, but in a qualitative approach using open-ended questions relating to the parent's experiences of pregnancy and their thoughts, feelings and behaviours towards their foetus.

The use of a semi-structured interview format, with open-ended questions and reflective listening was used to enable a rich in-depth understanding of the experiences and perspectives of the participants, and to enable the researcher the opportunity to request additional information or clarification when required (O'Cathain & Thomas, 2004). The interviews were audio-recorded and transcribed verbatim.

4.2.4 Data analysis

The interview transcriptions were entered into NVivo11 (QSR International Pty Ltd, version 11, 2016) to facilitate data management and analysis. Data analysis was completed concurrently with data collection to monitor the emergence of new themes. Data were analysed by RH using thematic analysis to code and identify emerging themes in an inductive manner, including familiarising with the data via transcribing, reading and re-reading the data, generating codes, searching for themes, reviewing and defining themes (Braun & Clarke, 2006).

Peer debriefing was used as an approach to enhance the trustworthiness of the analysis process (Lincoln & Guba, 1985). A second researcher (JZ) familiar with the thematic analysis process independently reviewed the primary analyst's interpretation of the data, and codes and themes were decided on after discussions between the two reviewers. A third reviewer (LS) was consulted prior to final agreement of themes and sub-themes.

Once all interviews were completed, a summary of the themes that emerged was presented to 20 participants by phone for member checking purposes. These participants were asked if they perceived the summary to be an accurate reflection of their own experience and of those around them. All agreed that it was a reasonable summary and provided no new information, except for one participant who reinforced that from her perspective, device use did not have an influence on relationships within her family.

4.3 Results

4.3.1 Sample and interview details

At the end of July 2019, 1,498 women had agreed to participate in the ORIGINS Project, 116 of these were in their last trimester of pregnancy and were therefore eligible for this sub-project. Eighty-five potential participants who did not opt-out to further contact received an email and phone call. Twenty-seven of these were willing and able to participate in the interview, providing a response rate of 32%.

Of the 27 participants, 24 interviews had only the mother present, one interview had only the father present, and two interviews had both mother and father present. The characteristics of mothers who took part are shown in Table 4.1. Interviews were conducted by RH and/or JZ between July 2019 and September 2019, with six conducted face-to-face and 21 by phone. On average, the length of the interviews was 35 minutes, ranging from 19 to 65 minutes.

Table 4.1
Characteristics of mothers

Characteristics of mothers	N	%
Age in years (n=27)		
18-25 years	1	3.7
26-34 years	17	63.0
≥ 35 years	9	33.3
Employment (n=26)		
Employed full-time	17	65.4
Employed part-time	5	19.2
Home duties	4	15.4
Highest level of education (n=20)		
Postgraduate degree	8	40.0
Bachelor degree	4	20.0
Year 12 secondary school	4	20.0
Year 10 secondary school	0	0
Other	4	20.0
Occupation (n=20)		
Professional	11	55.0
Technical or trades worker	1	5.0
Clerical or administrative	2	10.0
Sales worker	2	10.0
Home duties	4	20.0
Marital status (n=27)		
Married	21	77.8
Living with partner	6	22.2
Single	0	0
Family structure (n=27)		
Pregnant with first child	6	22.2
Pregnant with second and/or third child	4	14.8
Recently gave birth to first child	9	33.3
Recently gave birth to second and/or third child	8	29.6
Household income (n=20)		
Up to $50,000 a year	1	5.0
$50,001 to $100,000 a year	5	25.0
$100,001 to $150,000 a year	9	45.0
More than $150,000 a year	5	25.0

[1] Characteristics were obtained from the ORIGINS Project questionnaires, supplemented with information provided from the interviews. Some data is missing due to incomplete responses to the ORIGINS Project questionnaires.

The mean (range) age of participants was 33 years (25-40 years). Seventeen of the participants had given birth at the time of being interviewed, either due to the time required for the administrative process of scheduling an interview, or due to the participant requesting a post-birth interview. Of those who were still pregnant at the time of interview, the mean (range) gestational age was 36 weeks (31 to 40 weeks). Of those who had recently given birth, the mean (range) age of the baby was 3 weeks (1 to 7 weeks).

All participants had a partner and were currently living with the partner of the due to be born/recently born child. All participants were on parental leave at the time of the interview. Prior to commencing leave, the majority of participants were employed full-time (65%), and most worked in a professional role (55%).

4.3.2 Prenatal attachment

Overall, participants described emotions, perspectives and behaviours that demonstrate affection and commitment toward the foetus. All mothers interviewed described feelings of connection, love and excitement. Representative quotes supporting the themes related to prenatal attachment are presented in Table 4.2. Unless otherwise stated as being a quote from the father, quotes are from interviewed mothers. No participants described ambivalent or affectless thoughts and feelings towards their babies while pregnant.

Although a couple of participants mentioned feeling a strong connection early on in their pregnancy, a common theme among most participants was that feelings of attachment increased as pregnancies progressed. Participants particularly mentioned higher levels of prenatal attachment after becoming aware of foetal movements, viewing ultrasound scans, and as their baby increased in size.

Several participants discussed feeling reluctant to become too attached early in pregnancy due to concerns about the viability of their baby's development. For one participant, increased maternal anxiety was associated with prior perinatal loss. However despite this, the participant still described feelings of connection with her baby during pregnancy.

Table 4.2
Descriptions of prenatal attachment

Theme	Representative Quotes
Descriptions of affection and commitment toward the foetus	– PPT X [35yo, pregnant, no other children]: *"There's a lot of love there. I've waited a long time to be pregnant, so there was a lot of joy associated with being pregnant."* – PPT U [35yo, pregnant, no other children]: *"I just felt that it was the best thing that happened to me."* – PPT S [32yo, pregnant, 1yo and 10yo siblings]: *"We couldn't wait for him to be here and we were so excited to be having a boy."*
Increase in feelings of attachment as pregnancies progressed	– PPT G [28yo, pregnant, no other children]: *"In the beginning I didn't really feel much. But when she started to move then I felt more connected and it was more real."* – PPT J [29yo, newborn, no other children]: *"I think it took a while to actually feel any excitement until the baby started moving. And you started seeing the belly. I didn't feel pregnant until maybe halfway through my pregnancy an d that's when I felt my connection grow. As things progressed and I started getting bigger, I obviously started feeling more love and excitement towards the whole process."* – PPT I [36yo, pregnant, no other children]: *"The further along I got, the more connected I felt and the more devastated I would be if anything were to go wrong or if we would lose him at any point."*
Reluctancy to become too attached early in pregnancy	– PPT Y [30yo, newborn, 4yo sibling]: *"In the earlier stages of the pregnancy I was a bit (because I was worried that something would go wrong), a bit reluctant to get too attached. But then as I progressed in it and things were okay, I felt much more confident and happier that things were going to work out okay."* – PPT L [32yo, newborn, no other children]: *"For the first 20 weeks or so, I was probably very fearful because I was obviously worried that something might go wrong and that the pregnancy might not keep going. But particularly after that point, once you can feel it moving, that's when all the excitement kicks in and you start to want to talk to it a bit more and feel it."*

4.3.3 Typical mobile touch screen device use practices among expectant parents

4.3.3.1 Mobile touch screen device use practices

Unless otherwise stated, the term 'devices' refers to mobile touch screen devices. All households owned at least two smartphones and a range of screen devices including tablet computers, laptop computers, desktop computers, smartwatches, and gaming consoles (e.g. Sony PlayStation, Microsoft Xbox, Nintendo Wii, Nintendo Switch). All participants described using screen devices routinely throughout their typical day, for up to several hours a day. Several mentioned that they often multi-task with more than one screen device, such as watching TV while playing a game on their phone. Smartphones in particular were described by participants as being an integral component of everyday life. For example, one participant described: *"You do everything with your phone. It's like your partner in crime. It's like your best friend. It's the key to the rest of the world. We take our phones everywhere."* (Participant H, 37yo, pregnant, no other children).

Participants also commonly described using their smartphone throughout the day, from the moment they wake up. For example: "I have my alarm set through my phone, so that will wake me up in the morning. I'll normally scroll through Facebook and Instagram, and read my emails before I get out of bed." (Participant X, 35yo, pregnant, no other children).

Several participants identified positive and negative aspects of mobile touch screen device use. For example, one father described: *"I recognise there's a huge value with devices. It's obvious. But I also feel there's enormous disadvantages, particularly because it atrophies your abilities in other ways…Social media has made it a whole new nightmare. It can be extremely useful or it can be incredibly dangerous and toxic." (*Participant Q, father, newborn, no other children). Another participant described: *"Technology at the moment is incredibly easy to be a distraction for everyone, especially parents. As long as it's productive I find that okay."* (Participant B, 32yo, pregnant, 3yo siblings).

4.3.3.2 Role of mobile touch screen device use among expectant parents

Participants described using screen devices for a range of purposes while on parental leave. In terms of non-mobile touch screen devices (e.g. televisions, laptop and desktop computers), these were regularly used for entertainment and studying purposes, and as a means to entertain older siblings while the parent was attending to household chores. Mobile touch screen devices were commonly described as being used for a wider range of

purposes, including maintaining connections, assisting daily life tasks, aiding relaxation and enabling a better understanding of pregnancy. Table 4.3 provides sub-themes and representative quotes related to these themes.

A couple of participants mentioned the importance of technology in maintaining connections, by keeping in contact with partners who worked away from home for extended periods of time, and many mentioned communicating with family and friends via their devices.

Many parents described using their devices as a functional tool to assist with their daily lives, such as a calendar, alarm clock, torch, camera, navigator, language translator and as a means to access online resources. Information was sought through online search engines as well as Apps such as Pinterest and YouTube.

Devices were frequently described as being used for relaxation purposes such as playing puzzle games, streaming shows, watching videos, reading books and listening to music. A couple of participants mentioned using devices to entertain older children, particularly while waiting for appointments or at a restaurant.

Almost all participants described using their devices to access information to better understand pregnancy. This included the use of devices to research pregnancy information online and use of Apps to track baby's development.

Table 4.3
Role of mobile touch screen device use among expectant parents

Theme	Sub-Theme	Representative Quotes
Maintained connections	Communicating with family and friends	– PPT C [31yo, pregnant, no other children]: *"We use it a lot to keep in touch with each other, family and friends."*
		– PPT J [29yo, newborn, no other children]: *"I use WhatsApp to talk to my partner, and Facebook Messenger to talk together when he's working because he's only on Wi-Fi. And then I use email and then obviously text messages and phone calls."*
	Connecting with other expectant parents	– PPT W [33yo, newborn, no other children]: *"There were a couple of Apps with support groups of people who are having babies in the same month. It's like little chat rooms where you can speak to other people who are going through the same thing as well."*
		– PPT J [29yo, newborn, no other children]: *"[Device use is] positive I guess in some way, like obviously researching and being part of like mother's groups and having people to talk to about, like your experience [and] being able to connect with other mums"*
Assisted daily life tasks	Performing functional tasks	– PPT X [35yo, pregnant, no other children]: *"I have my alarm set through my phone, so that will wake me up in the morning."*
		– PPT Q [40yo, newborn, no other children]: *"[I use my devices for] photos, videos, and the iPhone as a torch."*
		– PPT H [37yo, pregnant, no other children]: *"With one particular friend, I'll message her in English and then she'll message back in Indonesian. And so she translates my English to Indonesian and I translate her Indonesian to English. And so then we understand what each other's writing, but it's faster for us to write in our own language."*
	Accessing general online resources	– PPT H [37yo, pregnant, no other children]: *"On Pinterest I get lots of different ideas for renovating the house. And often when I'm using YouTube I'll be looking up how to do things, like how to make a desk or how to concrete a floor or something like that."*
		– Participant K [25yo, newborn, 2yo and 5yo siblings]: *"I [use devices to] read the news, I do that every day. And a lot of banking."*

Theme	Sub-Theme	Representative Quotes
Aided relaxation	Parent's own relaxation	– PPT S [32yo, pregnant, 1yo and 10yo siblings]: *"I use it to read. I download books on my phone."*
		– PPT Z [35yo, newborn, no other children]: *"I just normally play the really basic games like Sudoku or Bubbles or something like that."*
		– PPT I [36yo, pregnant, no other children]: *"Every night I use, it's called Relax Melodies is the name of the App, and it plays white noise. So that helps me sleep."*
	Older child's relaxation	– PPT A [30yo, newborn twins, 1yo sibling]: *"Sometimes when we're at a restaurant and she's (1 year old daughter) had something to eat and she's getting a bit restless and there's nowhere for her to play, that's when we'll play some Peppa Pig on my phone."*
		– PPT Y [30yo, newborn, 4yo sibling]: *"If it's somewhere that you're waiting around, like at the doctor's or whatever, for an appointment, I guess it (the iPad) is something for her to do just to stop her having a tantrum."*
Enabled a better understanding of pregnancy	Accessing pregnancy-specific online resources	– PPT D [34yo, newborn, no other children]: *"I used to watch a lot of YouTube videos on pregnancy."*
		– PPT J [29yo, newborn, no other children]: *"I found technology useful because you could research things and be like: "Oh this is what's happening now. This is what the baby's doing now."*
	Using Apps for pregnancy purposes	– PPT K [25yo, newborn, 2yo and 5yo siblings]: *"I used my phone to take photos of my belly with her in it and I'd use Apps for kick counting."*
		– PPT E [38yo, newborn, 3yo sibling]: *"While I was pregnant, I downloaded a couple of the pregnancy Apps."*

4.3.4 Perceived influences of mobile touch screen device use on prenatal attachment

4.3.4.1 Initial responses

Participants were asked to describe their thoughts on how the use of mobile touch screen devices influenced, in any way, the relationship between them and their baby during pregnancy. Many participants responded that they had not previously considered this. More than half said they perceived there to be no influence, and several responded that they did not know.

4.3.4.2 Responses after further reflection

When given further time for reflection of how mobile touch screen devices may influence their relationship with their baby, almost a quarter of participants overall responded that they did not perceive devices as having any influence on their prenatal attachment relationship. These participants described their device use in relation to their baby as being for information purposes only, with no implications for their feelings of connectedness with their baby.

Overall, perceived negative influences of their mobile touch screen device use on prenatal attachment were reported by a quarter of participants including: disrupted connectedness and increased parental stress. Several participants described their devices as distracting them from thinking about their baby during pregnancy, while using the device to scroll through social media, or continuing to use their device for a multitude of other purposes after completing their initial primary task such as checking the weather forecast. Mobile touch screen devices were commonly described as being used out of habit rather than for a specific purpose. Several participants mentioned that reading pregnancy related material via their devices had a negative influence on their relationship with their baby, by causing them to experience increased levels of anxiety and fear. For these women, viewing information through their devices led to an adverse effect of increased worrying about negative outcomes such as stillbirth.

Overall, perceived positive influences of their mobile touch screen device use on prenatal attachment were reported by half of the participants including: enhanced connectedness. Many participants stated that they used their devices to access pregnancy related Apps and online information, enabling enhanced feelings of closeness and connection. The Apps most frequently mentioned were ‘What to Expect’ and ‘Baby

Centre'. Participants stated that Apps and online information enabled them to visualise their baby in utero and understand what to expect at different time points of pregnancy. Several participants described playing music for their baby during pregnancy via their mobile touch screen devices, which led to increased feelings of connectedness. For example, one participant mentioned playing meditation music for her baby, and another mentioned playing fast songs to her baby to encourage more foetal movements. Table 4.4 presents sub-themes and representative quotes related to the emergent themes on the perceived influence of mobile touch screen device use on prenatal attachment.

Table 4.4
Influence of mobile touch screen device use on prenatal attachment

Theme	Sub-Theme	Representative Quotes
Discrupted connectedness	Distracted parent	– PPT G [28yo, pregnant, no other children]: *"If start to research something about the baby and something else will take my attention it will probably go away and I will forget what I was doing, and lose stuff, like I lost what I was doing before. So this probably is negative in a way because I get distracted from something else."*
		– PPT J [29yo, newborn, no other children]: *"It's very easy to be on there for a lot longer. You check the news, you check the weather, and then all of a sudden you're doing about 10 other things you hadn't planned on doing."*
		– PPT M [28yo, newborn, no other children]: *"Sometimes you can get a little bit too caught up in being on the phone and obviously social media...You lose touch with reality sometimes just sitting on the device"*
		– PPT B [32yo, pregnant, 3yo sibling]: *"I find myself scrolling through Facebook and my brain going: "What are you doing? You're not even paying attention to it."*
	Created a physical barrier	– PPT B [32yo, pregnant, 3yo sibling]: *"If I'm using my mobile or tablet, especially my tablet if I'm lying in bed or sitting on the couch, I might even rest it on my lovely bump. So I think that does stop me from rubbing my belly so much. But then every now and then she'll give a big kick and my iPad might go a little bit to the right or the left, depending on where she kicked. I think that it takes your mind away from the fact that you've got a bump. So being on your device is so much of a distraction that even your own body goes a bit numb."*
Increased parental stress	Parental stress	– PPT Y [30yo, newborn, 4yo sibling]: *"You have such easy access to all these different people's lives and all these different illnesses and things that can go wrong, that I wouldn't have even known about if I hadn't been able to get online. There's good and bad with it. It's good to be able to track what baby's doing and what's normal and stuff like that. But then the downside is if you're an anxious person you can just see the negative side of things and that can make it worse."*

Theme	Sub-Theme	Representative Quotes
Enhanced connectedness	Accessing Apps and pregnancy-specific online resources	– PPT Y [30yo, newborn, 4yo sibling]: *"I had the baby Apps on my phone so I'd be able to track what size she was and developmentally what stage she was at in my stomach. So that made me feel a bit closer."*
		– PPT B [32yo, pregnant, 3yo sibling]: *"I do use my phone quite a bit for using an app called 'What to Expect'. So it's while I'm reading that there is that very strong connection with what's happening with the baby and with my body."*
		– PPT J [29yo, newborn, no other children]: *"I feel I used technology a lot throughout my pregnancy to help me connect…It made things more exciting knowing where the baby was at development-wise."*
		– PPT I [36yo, pregnant, no other children]: *"Some of the Apps that I'm using that are pregnancy related, like the Baby Centre App, I think that actually helps me really understand and appreciate what's going on at any given point in time, and makes me feel a lot more excited and connected to him."*
	Playing music for the baby	– PPT G [28yo, pregnant, no other children]: *"I connected putting music all the time. I always try to hear the kind of music I thought will be good for her after as well. So she could recognise when she came outside."*
		– PPT U [35yo, pregnant, no other children]: *"I like to play music for the baby because the baby moves a lot when I put music...I use my phone to play music for the baby, because I noticed that the baby started moving whenever I play music."*
		– PPT Z [35yo, newborn, no other children]: *"I would play meditation tunes and stuff like that. That's mainly for him because for me, I don't even listen to music very often on my mobile phone, so that's mainly for him."*

4.4 Discussion

The 27 participant families described good levels of attachment with their babies during pregnancy (characterised by emotions, perspectives and actions that demonstrate affection and commitment to their baby), which grew stronger as pregnancies progressed. The in-depth interviews found high levels of use of mobile touch screen devices for a vast range of general and pregnancy-related purposes. When asked for their thoughts on how the use of these devices influenced their prenatal attachment, many parents indicated that they had not previously considered this. However, on further reflection, there were mixed perspectives about the influence of mobile touch screen device use on their attachment to their baby.

In terms of prenatal attachment in general, all expectant parents in the current study expressed feelings of connectedness to their babies during pregnancy, which grew stronger as their pregnancies developed. This is similar to other studies of expectant mothers, where prenatal attachment has been found to develop as early as 10 weeks gestation (Caccia, Johnson, Robinson, & Barna, 1991), and typically increases as pregnancy progresses (Hjelmstedt, Widstrom, & Collins, 2006; Laxton-Kane & Slade, 2002) and is associated with feeling foetal movements during late pregnancy (Malm, Hildingsson, Rubertsson, Rådestad, & Lindgren, 2016).

The results of this study indicate that mobile touch screen devices play an important role for expectant families. All participants described owning a range of devices, including smartphones and tablet computers. All participants described using devices (particularly their smartphones) regularly throughout their typical day, for up to several hours a day, and often from first thing in the morning.

A broad range of purposes of device use were described by participants including maintaining connections, assisting daily life tasks, aiding relaxation and enabling a better understanding of pregnancy, which is comparable to findings from prior research. For example, a small qualitative study of pregnant American women found that almost all used social networking sites at least once per day (Kraschnewski et al., 2014). The current study found that the majority of participants use their devices specifically for pregnancy purposes such as seeking information and tracking foetal development. This is in line with previous research (Lupton & Pedersen, 2016) suggesting that Apps are increasingly being used by pregnant women as an important source of information. It is important to

understand the context of device use in order to ensure technology hardware and software designs and use guidelines directed at expectant families are appropriate.

Several participants described mobile touch screen device use in general as having the potential to be beneficial or harmful, depending on how it is used. This supports previous research findings where mobile touch screen devices have been perceived as both 'good' and 'bad', depending on how the devices are used. For example, devices have been perceived as having the potential to both enhance levels of family connectedness (Padilla-Walker et al., 2012), as well as negatively influence interactions (McDaniel et al., 2018).

Despite all participants using mobile touch screen devices regularly throughout their typical day, the potential for device use to have an influence on prenatal attachment was something many participants had not previously considered, with more than half stating they perceived no influence or that they did not know. However, on further reflection, there were mixed perspectives about the influence of mobile touch screen device use on their attachment to their baby. The potential for both negative and positive influences is consistent with prior qualitative studies of expectant mothers which reported that that although using the internet and mobile phone technology enabled some to have peace of mind by becoming more informed about pregnancy, for others reading worst case scenarios and extreme cases increased their levels of anxiety and fear (Fleming et al., 2014; Prescott & MacKie, 2017).

The potential for a negative influence of device use was reported in a cross-sectional study of 461 mothers in Japan finding that those who used their mobile phones excessively (defined by higher scores of text-message dependency) during pregnancy, had babies with lower birth weights, and higher frequencies of infant emergency transport (Lu et al., 2017). The authors of this study proposed a possible mechansim whereby excessive mobile phone use leads to increased anxiety and depression, and poorer sleep quality, which then leads to adverse outcomes. This is similar to previous research reporting that pregnancy Apps can lead to reports of increased anxiety by pregnant women (N. Wang, Deng, Wen, Ding, & He, 2019), as reported by participants in the current study. Although parents may have traditionally accessed pregnancy and birth related information via other means (e.g. a hard copy book), there are some potential differences with mobile touch screen devices. The portability and ease with which parents can access information via a device may lead to increased opportunities for distraction or exposure to more varied material (including undedited content, descriptions of personal experiences and opinions from a range of authors with or without professional expertise).

The finding that half of this study's participants described positive influences of accessing pregnancy and birth related information online through their devices is comparable with other research findings that pregnant women commonly use the internet to seek pregnancy information (Grimes, Forster, & Newton, 2014; Rodger et al., 2013) and are increasingly relying on pregnancy Apps to access information related to pregnancy health and foetal development (Hughson, Oliver Daly, Woodward-Kron, Hajek, & Story, 2018; Y. Lee & Moon, 2016). A couple of participants from the current study described accessing support groups via Apps to connect with other parents with a similar due date, which is similar to other research indicating that forums are a useful way for women to find support networks and avoid isolation (Fredriksen, Harris, & Moland, 2016).

4.5 Implications of the findings

This study provides unique information on human-computer interactions within a family systems context prior to birth, and what influences parents perceive this interaction has on their thoughts, feelings and behaviours towards their baby in the prenatal period.

The proposed model of human-computer interaction in a prenatal family system that is based on concepts of human-computer interaction (Straker & Pollock, 2005; Straker, Pollock, & Burgess-Limerick, 2006), family systems (White & Klein, 2008) and prenatal attachment (Bowlby, 1980; Brandon et al., 2009) provides a useful framework for exploring these perceived influences. The model illustrates that human-computer interactions by a mother during pregnancy has flow-on effects to other aspects of the family system such as the mother-foetus relationship, and should not be viewed in isolation but considered within the context of the family unit, as per the family systems framework. The findings add evidence to potential pathways proposed in the model by which device use may influence prenatal attachment. The perspectives of the mothers interviewed are in line with the proposed mechanisms of the model, whereby device use for the specific intention of accessing pregnancy resources and playing music for the foetus led to enhanced connectedness, and device use without specific intentions such as scrolling through social media disrupted connectedness.

The mixed perspectives on the influence of mobile touch screen device use on prenatal attachment indicate that although devices are an important information-seeking tool for expectant parents and can enhance connectedness with their baby prior to birth, there is the potential for device use to be a distraction and lead to feelings of anxiety and concern, which could negatively influence prenatal attachment. This information will be

useful for informing technology development which can guide and encourage consumers to interact with their mobile touch screen devices in a manner that enhances the benefits and minimises downsides of device use during pregnancy.

The findings add further evidence to attachment theory, by suggesting there are multiple mechanisms in the link between device use during pregnancy and attachment outcomes. Device use can enhance prenatal attachment through enabling parents to accurately visualise their baby while in utero, and enabling co-listening of music and meditation content with their baby. However, device use can detract from prenatal attachment by displacing and interrupting parents' thoughts and feelings towards their baby, and increasing fear and uncertainty. Expanding on these potential mechanisms is the theoretical consideration of reflective functioning, which refers to the pregnant woman's ability to differentiate herself from her foetus and think of her foetus as a separate individual with their own features and needs (Pajulo et al., 2015). Recent research has found parental reflective functioning to be positively correlated with scores of prenatal attachment (Røhder et al., 2020), suggesting that the role of device use in parental reflective functioning may also be important to consider.

As prenatal attachment has been found to be significantly associated with the quality of later parent-child attachment (Petri et al., 2018), and higher levels of parent-child attachment has been found to predict future child development (Ding et al., 2014; R. Li et al., 2016; McCormick et al., 2016) there is a unique opportunity for families, health professionals providing services to families and technology designers to be informed about the role of mobile touch screen devices in prenatal attachment before the baby has been born, in order to optimise the child's future development.

4.6 Strengths and limitations

To the authors' knowledge this paper is the first to focus on parental perspectives of mobile touch screen device use and its influence on prenatal attachment, and highlights the importance of being cognizant of how mobile touch screen devices have the potential to enhance or detract from prenatal attachment.

A limitation of this study is that the convenience sample drawn from a community population did not include families with the full range of characteristics and practices that could influence mobile touch screen device use and how it relates to prenatal attachment. Therefore the findings may not be generalizable to families of single parents, fathers, parents with lower levels of education, parents with lower levels of prenatal attachment,

and parents with very limited mobile touch screen device use. In addition, this study did not explore the role of different devices on prenatal attachment or how other variables can impact the effect of mobile touch screen device use on prenatal attachment.

4.7 Future research

As mobile touch screen devices continue to be increasingly used by families, including expectant parents, it is important to extend theories of attachment by exploring potential mechanisms by which device use is associated with attachment. Further research in this field is required in order to ensure guidelines for the design and use of devices within families are as appropriate and comprehensive as possible.

Further research to extend knowledge in this field could include investigation of associations between mobile touch screen device use and prenatal attachment with a more diverse sample; investigation of other potential factors influencing prenatal attachment in conjunction to devices; exploration of other activities related to parent-child relationships that are being replaced by parental mobile touch screen device use; and exploration of which Apps and online resources best support prenatal attachment.

Future research could also explore post-birth attachment, such as: associations between mobile touch screen device use and parent-child attachment among families with infants/toddlers; and influences of device use and parent-child attachment on child development. Parental perspectives on how mobile touch screen device use influences attachment among families with infants/toddlers, could also be explored.

It is important to note that this study was conducted prior to the COVID-19 pandemic. Future research could explore the effects of the pandemic on mobile touch screen device use and parent-child attachment, as there is the potential for social changes associated with the pandemic to have an influence on both the use of devices and family dynamics.

4.8 Conclusions

The findings indicated that:

1. All participants described good levels of attachment with their babies during pregnancy, which grew stronger as pregnancies progressed.
2. All expectant parents regularly used mobile touch screen devices for a variety of purposes.
3. Several participants described mobile touch screen device use as having the potential to be both beneficial and harmful in general, depending on how it is used.
4. Most expectant parents described using their mobile touch screen devices to access information to better understand pregnancy.
5. Many parents had not considered the potential for their use of mobile touch screen devices to influence prenatal attachment.
6. On reflection, many perceived their use of mobile touch screen devices to have positive and/or negative influences on prenatal attachment.
7. Together these findings highlight a new opportunity for how guidelines on the technological design and use of mobile touch screen devices could support families to maximise the positives and reduce the negatives of mobile touch screen device use in order to optimise prenatal attachment, and thus future parent-child attachment and child development. The findings indicate that using devices as a tool for specific pregnancy purposes may serve to enhance prenatal attachment, whereas general device use may disrupt connectedness to the foetus.

Chapter Five

5

Study 2B:

Infant Qualitative Study

Submitted paper:

Hood, R., Zabatiero, J., Zubrick, S.R., Silva, D. & Straker, L. (2022). "It helps with our bonding together". Parent perspectives on how the use of smartphones and tablet computers influences parent-infant attachment. Submitted to *International Journal of Child-Computer Interaction*

Abstract

As families increase their use of digital technologies (smartphones and tablet computers), there is potential for this use to influence parent-child interactions that are required to form a secure attachment during infancy. Evidence suggests that attachment security is predictive of future child developmental outcomes. Parents and professionals are uncertain about these impacts and extending research in this area is developmentally useful to inform evidence-based guidance to families around wise technology use. Thirty families of infants (aged 9-15 months) were interviewed to explore how parents and infants use these devices, and how device use influenced parents' thoughts, feelings and behaviours towards their infant and other family interactions. All parents used devices for a variety of purposes, and all described good levels of perceived attachment. Two-thirds of infants were routinely involved in family video calls via mobile touch screen devices, and one-third of infants used devices for other purposes. Parent and/or child device use served to both enhance connection and increase distraction between parents and infants and between other family members. Mechanisms for these influences are discussed. The findings highlight an opportunity for how device design and use guidelines could support families to maximise benefits and reduce detriments of device use in order to optimise parent-child attachment and child development.

Keywords: human-computer interaction; mobile touch screen device use; parent-child attachment; screen time; technology use; qualitative research

5.1 Introduction

Over the past few decades, human-computer interaction has been found to have considerable effects on humans including their performance, communication and health (Gurcan et al., 2021). As newer technologies have emerged, such as mobile touch screen devices, research has also evolved to explore implications of their use. Much of this evidence has centred on human-computer interaction among adults (Coenen et al., 2019; Han, Lee, & Shin, 2019); however some research has explored child use and outcomes (Harris & Straker, 2000; Straker et al., 2014) and even human-computer interactions prior to birth (Fleming et al., 2014; Hood et al., 2022).

Many families now regularly use newer digital technologies such as smartphones and tablet computers with ownership of these devices increasing dramatically in recent years. For example in 2021, 85% of U.S. adults reported owning a smartphone and 53% a tablet computer (up from 35% and 8% respectively in 2011) (Pew Research Centre, 2021). A recent field study of Australian adults found the average duration of touch screen device use to be 2.5 hours per day, with participants engaging with their device on average 52 times a day (Alzhrani et al., 2022). Among young children, one-third (36%) of Australian pre-schoolers have been reported to own their own tablet or smartphone (Rhodes, 2017). A study of Irish children aged 12 months to 3 years found that 71% had access to touchscreen devices, with a median usage time of 15 minutes per day (Ahearne et al., 2016).

With the rapid uptake in mobile touchscreen technology among adults and children, it is important to consider human-computer interactions within families to both understand their consequences on behaviour and development – particularly for growing children – and to ensure they are used in a positive manner. Family systems theory (White & Klein, 2008) and the bioecological model (Bronfenbrenner, 2006) provide a framework for exploring human-computer interactions in a family setting, where the whole family unit is considered, along with their mutual influence on each other's behaviours and experiences.

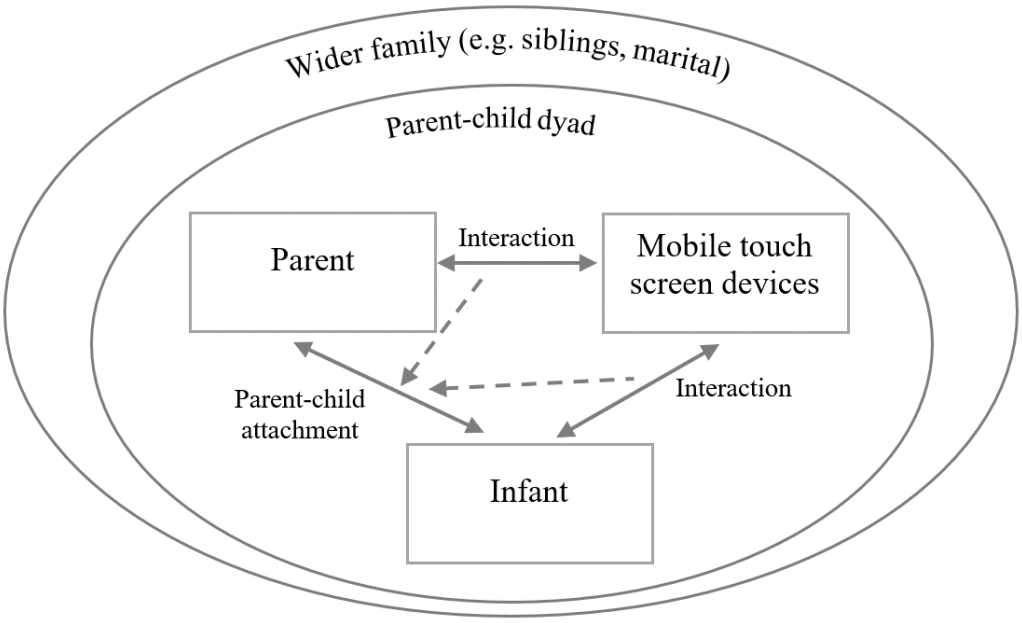
At the core of the family system is the parent-child dyad. The theory of parent-child attachment proposes that infants develop an emotional bond with their primary caregiver during their first years of life (Bowlby, 1980). In the presence of a secure attachment relationship, the parent is sensitive and responsive to their child's needs and signals for attention, and the child is able to use the caregiver as a secure base from which to explore their environment (M. Ainsworth et al., 1978; Rees, 2005).

The establishment of a secure attachment between the parent and child in infancy is critical with evidence to suggest that it is predictive of aspects of child development such

as cognitive performance (Schore, 2001; West et al., 2013), emotion regulation (Brumariu, 2015; Zimmer-Gembeck et al., 2017), social competence with peers (Bohlin, Hagekull, & Rydell, 2000; Groh et al., 2014) and duration of sleep (Bordeleau, Bernier, & Carrier, 2012; Cheung et al., 2017). The use of mobile touch screen devices requires investments of both time and attention by the user. There is a potential for the interactions between a parent and infant that are necessary for the formation of a secure attachment to be influenced by the use of mobile touch screen devices (Beamish et al., 2019). Parents and professionals alike express concern and seek guidance about potential developmental impacts from use of mobile touch screen devices and evidence informing these concerns remains scant but would be useful in guiding advice.

Previous models of human-computer interaction provide a framework for considering influences of device use within the family system (Straker et al., 2014; Straker & Pollock, 2005). Figure 5.1 depicts a new proposed integrated model of human-computer interaction within a family context, with solid line arrows showing the interaction and flow of information. The double headed arrows between parent or infant and mobile touch screen device represent the parent/infant sending information to the device (e.g. launching an App) and the device sending information to the parent/infant (e.g. music playing through the device's speakers). The dashed line arrows depict the potential influence of parent-device or infant-device interaction on parent-infant attachment.

Figure 5.1
Model of potential influence of mobile touch screen device use on parent-child attachment in an integrated family system



The proposed model expands on the theories of parent-child attachment, family systems and the bioecological model by exemplifying possible mechanisms by which parent and/or child use of mobile touch screen devices may influence parent-child interactions and attachment.

Possible mechanisms for device use to have a positive influence on attachment are by enhancing connectedness through: using devices collaboratively such as playing games together (Padilla-Walker et al., 2012); and maintaining relationships when physically apart (Graham & Sahlberg, 2021; Leung & Wei, 2000). Possible mechanisms for device use to have a negative influence on attachment are by increasing distractedness through: disrupting maternal sensitivity and responsiveness to the child's cues and signals for attention (Gutierrez & Ventura, 2021; Kildare & Middlemiss, 2017; Wolfers et al., 2020), displacing interactions such as face-to-face communication (Lepp et al., 2016), lowering conversation quality (Przybylski & Weinstein, 2013) and being a source of family conflict (Rhodes, 2017). These mechanisms may be bi-directional, as indicated by the finding that higher scores of mother-child interaction quality at 18 months were positively associated with less child screen time at 2 and 3 years of age (Detnakarintra et al., 2020).

Much of the related research on mobile touch device screen use has focused on adults with a recent systematic review finding only very limited evidence concerning associations between time spent using devices by parents and/or children and parent-child attachment (Hood, Zabatiero, Zubrick, et al., 2021). This calls for more quality evidence in this area, including from qualitative research to explore the nature of use, to better understand potential impacts of device use on parent-child attachment.

This study aimed to explore: how and why families with infants aged 9 to 15 months use mobile touch screen devices; what influence they perceived this use had on their parent-child attachment; and the mechanisms by which device use may have influenced attachment.

5.2 Materials and methods

5.2.1 Study design

A qualitative design was used to gain an understanding of parent practices of mobile touch screen device use and their perspectives on influences of device use on parent-child attachment and family interactions.

Participants were recruited using convenience sampling from a larger longitudinal birth cohort study titled The ORIGINS Project (Silva et al., 2020). This unique long-term

study, a collaboration between Telethon Kids Institute and Joondalup Health Campus, is one of the most comprehensive studies of pregnant women and their families in Australia to date, recruiting 10,000 families over a decade from the Joondalup and Wanneroo communities of Western Australia. Recruitment of families who were 18 weeks pregnant and attended private and public health services at a general hospital in Perth, Western Australia commenced in 2017.

It is important to note that this study was conducted several months after the start of the COVID-19 pandemic, which may have implications for the study outcomes. In addition, Perth in Western Australia is one of the most isolated major cities in the world, and there are more people employed in positions that require them to work at remote job sites than in the general Australian population which may have influenced findings e.g. these families may be more familiar with communicating with family and friends via mobile touch screen devices.

5.2.2 Recruitment

Participants were eligible if they were available for a qualitative interview either by audio call or video call (due to COVID-19 restrictions), had an infant aged 9 to 15 months of age at the time of the interview, had sufficient English proficiency and had not previously participated in the prenatal qualitative study and were therefore all new to the research aims and interview questions.

All families who had consented to be part of the ORIGINS Project and had an infant aged 9 to 15 months at the beginning of July 2020 were contacted by mobile phone message. They received brief information about a study on mobile touch screen device use and attachment and were provided with an opportunity to opt-out from further contact within five days of receiving the message. Participants who did not opt-out were grouped into child age in months (from nine to 15 months at the time of being interviewed) and equal numbers of parents for each age group were contacted via email with detailed information. This was followed by a phone call a few days later to invite them to participate and schedule an interview. Interviews were conducted between July and September 2020. Participants were remunerated with an AUD$50 voucher for participation.

Verbal informed consent was obtained from participants included in the study. Ethics approval was provided by Joondalup Health Campus Human Research Ethics Committee (approval # 1804) and Curtin University Human Research Ethics Committee (approval # AHRE2018-0065).

5.2.3 Data collection/instrument

An interpretive description approach (Thorne et al., 1997) was used with the aim of generating knowledge with practical outcomes for family mobile touch screen device use practices and family interactions. Using this approach, an interview schedule of questions was designed based on findings from prior research on young children's screen technology use and in consultation with experts in the field (Appendix G). This schedule of interview questions was also reviewed by the ORIGINS Project community reference group.

The interview schedule included open-ended questions pertaining to: 1) family structure, 2) typical mobile touch screen device use practices, 3) perspectives on family device use practices, 4) perspectives on parent-infant attachment in general, and 5) perspectives on perceived influences of device use on parent-infant attachment and other family interactions. Questions related to parent-infant attachment were adapted from the Maternal Postnatal Attachment Scale (J. Condon, 2015) and covered the same constructs of attachment as the quantitative scale, but in a qualitative approach using open-ended questions on the parent's thoughts, feelings and behaviours towards their infant.

The format of semi-structured interviews was chosen to enable reflective listening and the ability to prompt for further information or clarification to gain an in-depth understanding of participant perspectives and experiences. The interviews were audio-recorded and transcribed verbatim.

5.2.4 Data analysis

Interview transcriptions were entered into the qualitative data analysis software NVivo (QSR International Pty Ltd, 2020) to facilitate organisation and analysis of data. Data were analysed alongside completion of interviews, to monitor whether data saturation was being reached.

Data were analysed by RH using thematic analysis to code and identify emerging themes in an inductive manner, including familiarising with the data via transcribing, reading and re-reading the data, generating codes, searching for themes, reviewing and defining themes (Braun & Clarke, 2006). To enhance the trustworthiness and credibility of data interpretation, the approach of peer debriefing was used (Lincoln & Guba, 1985). A second researcher (JZ) independently reviewed the primary analyst's interpretation of the data. Before themes and sub-themes were finalised, a third reviewer (LS) was consulted.

Data are reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) Checklist (Tong, Sainsbury, & Craig, 2007). Once all

interviews were completed, participants were contacted by phone for member checking purposes. Fourteen participants were presented with a summary of key themes and asked if they perceived it to be a reasonable summary; no new information was provided by the participants.

5.3 Results

5.3.1 Sample and interview details

There were 282 participants of the ORIGINS Project who were parents of infants aged 9 to 15 months at the commencement of interview recruitment and were therefore eligible for this sub-project. One hundred potential participants who did not opt-out to further contact received an email and phone call. Thirty of these were willing and able to participate in the interview, providing a response rate of 30%.

For all 30 interviews, the interview was conducted with the mother. Although interviews were available to either/both parent(s), no interviews with fathers were completed. The characteristics of parents who took part are shown in Table 5.1. Interviews were conducted by RH with sixteen conducted by audio-call and fourteen by video-call, according to the preference of the interviewee. On average, the length of the interviews was 56 minutes, ranging from 30 to 76 minutes.

The mean (range) age of mothers was 34 years (21-42 years) and the mean (range) age of infants was 12.5 months (9 to 15 months). Most participants were married, and all were currently living with the father of the infant. Half of the participants had one child only, and the other half had between two and five children. The ages of the older children ranged from 3 years to 9 years of age.

Just over half of the participants were currently working in a full-time, part-time or casual position, and three of these were also studying concurrently. Six participants were employed but on maternity leave. Most husbands/partners (n=28) were employed in a full-time position. One was employed in a part-time role and one in a casual role. Five husbands/partners had Fly-In-Fly-Out (FIFO) work positions, a term used to describe someone with a work roster that entails flying to a remote job site for a period of time before flying home.

Due to the interviews taking place during the COVID-19 pandemic, questions related to the influence of the pandemic on family interactions and technology use were included and are reported elsewhere (Hood, Zabatiero, Silva, et al., 2021).

Table 5.1
Characteristics of mothers

Characteristics of mothers	N	%
Age in years (n=30)		
18-25 years	1	3.3
26-34 years	12	10.0
≥ 35 years	17	56.7
Employment (n=30)		
Full-time	5	16.7
Part-time	8	26.7
Casual	3	10.0
Maternity Leave	6	20.0
Home duties	8	26.7
Marital status (n=30)		
Married	28	93.3
Living with partner	2	6.7
Single	0	0.0
Family structure (n=30)		
One child	15	50.0
Two children	12	40.0
Three children	2	6.7
≥ Four children	1	3.3
Highest level of education (n=27)		
Postgraduate degree	5	18.5
Bachelor degree	12	44.4
Year 12 secondary school	5	18.5
Year 10 secondary school	1	3.7
Other	4	14.8
Household income (n=26)		
Up to $50,000 a year	2	7.7
$50,001 to $100,000 a year	5	19.2
$100,001 to $150,000 a year	10	38.5
More than $150,000 a year	9	34.6

Note: Characteristics were obtained from the ORIGINS Project questionnaires, supplemented with information provided from the interviews. Some data is missing due to incomplete responses to the ORIGINS Project questionnaires.

5.3.2 Parent-infant attachment

All participants described emotions, perspectives and behaviours that demonstrated affection and commitment toward the infant such as feelings of connection, love and happiness. For example, one participant described: P1 [21yo, 9mo, no other children]: *"I love him [infant] to bits. He makes me so happy. I can be having a really bad day and then he just smiles at me and then I'm all good."*

Although no participants described ambivalent or affectless thoughts and feelings towards their infants, several parents described challenges they faced while adjusting to parenthood. This included postnatal anxiety and depression, breastfeeding issues, and not being able to go to work due to caring for their infant. For example, one mother described: P27 [41yo, 13mo, no other children]: *"I had problems breastfeeding at the start and then she was braced [for hips dysplasia] at 10 weeks. So, you know, you kind of lose your newborn cuddles in a way. She was premmie [premature]. There's like a lot along the way and recently I've kind of imploded from just one too many challenges I think. But hopefully we're coming through the other side…But my attachment with her is very strong."*

When asked about ways in which they connect with their infant, parents most frequently described: spending time together, playing, talking, singing songs, reading books, breastfeeding, physical contact, bath time, eye contact and observing their development. The most frequently described hindrances to connecting with their infants included: attending work, having older children to care for, lack of sleep, household chores and infant teething issues.

5.3.3 Typical device use practices by infants and parents

5.3.3.1 Infant use of devices

Televisions were the most commonly used screen device for this age group. Almost all infants routinely viewed television, particularly while parents were preparing for the day and during mealtimes. For example, one participant described: P12 [29yo, 13mo, no other children]: *"At night-time when [infant] comes home from daycare, we probably put the TV on between when he has his dinner and when he has his bath. So, because he sort of sits in his high chair and watches TV while he eats his dinner."*

For some households, a television was regularly on throughout the day in the background. For example: P4 [38yo, 11mo, no other children]: "I'll turn it [television] on generally in the morning and it will just be on all day until we go out." In contrast, three

mothers stated that their infants had never viewed television and they purposely did not turn the television on while their infants were awake. For example: P6 [38yo, 13mo, no other children]: We actually haven't put on the TV at all yet. We're trying to hold off as much as we can. So the TV is never on when she's awake."

In terms of mobile touch screen devices, two-thirds of infants (n=19) were regularly included in family video calls, including calls to extended family in the Eastern States of Australia and overseas, and calls to their mother or father while at their workplace (including parents in FIFO positions). For example: P10 [39yo, 14mo, no other children]: *"My son uses a lot the mobile because all the family is abroad. So what we usually do during the afternoon, we do video calls with the grannies, auntie, uncles…This is on a daily basis."* Another described: P26 [33yo, 12mo, 3yo, 5yo, FIFO husband]: *"That's the only kind of interaction with my phone that she [infant] has. And it's obviously, you know, she gets so excited and happy…My mum will play like the piano to her and she'll, you know…She'll make happy noises and offer things to the people on my phone. It's very sweet."*

Around a third of infants (n=11) had experienced other uses of mobile touch screen devices including watching nursery rhymes and children's cartoons, using a colouring-in or flashcard app, taking or viewing photos. For example: P12 [29yo, 13mo, no other children]: *"She [infant] just takes my phone and walks around with it. Like a lot. She can access the camera which she likes to play with…There's all these like little videos of me doing things…We have like couple of little game apps on my phone, which she likes to sometimes play with…She likes to play flashcards, which we will do for like half an hour every day because I couldn't find any of the good ones, like the physical ones. So I got them on my phone…She watches music videos on YouTube for about an hour."*

For many of the infants who used mobile touch screen devices for purposes other than video calls, device use was rare and constrained to specific situations such as taking medicine, having their nails cut, or on long car journeys. For example: P25 [31yo, 12mo, 8yo]: *"I think the longest we've ever kind of had her in front of it is maybe 15 minutes watching an episode of Bluey if we're, you know, trying to get her to take medicine or something equally awful.* Another described: P4 [38yo, 11mo, no other children]: *"Sometimes the iPad is used when we drive and we put it where the mirror is for her, so that she can watch nursery rhymes or listen to music."*

A couple of families described placing a mobile touch screen device in their infant's bedroom overnight to play white noise to aid their infant's sleep.

5.3.3.2 Parent use of devices

There was a broad range of mobile touch screen device use practices among the parents interviewed including limited, moderate and frequent use. For example, one mother explained: P3 [31yo, 10mo, no other children]: *"I won't be on my phone unless I've got a call or message or something to attend to."* In contrast, another parent described: P5 [26yo, 14mo, no other children]: *"I'm on it pretty much all the time, whether it's Facebook or emails, or just in general."*

When asked how they felt about their family use of devices, around half described feeling satisfied with their current level of device use. The remaining half stated that they would prefer less use of devices within their family. For example: P13 [37yo, 11mo, no other children]: *"I definitely feel like my usage is over the top and I would love to cut back…The barrier is my own self discipline."*

A common theme that emerged was parents being mindful of their own device use in front of their child. For example: P24 [34yo, 12mo, 3yo, 5yo]: "I'm very conscious that I don't use my phone a lot when I'm around the children. That's one of my things. I don't like him [infant] seeing me be on the phone all the time." Several parents described feelings of guilt, regardless of duration of use: P27 [41yo, 13mo, no other children]: "I really hate it when I'm on it [smartphone], because I feel like she's just sitting there and doesn't know what I'm doing and it takes me away from her. So I feel really guilty about that." A few parents mentioned being conscious of role modelling their own use of devices to their infants: P22 [41yo, 12mo, 4yo]: "I need to be a healthy role model to them. So both in the sense that I don't want them looking, I don't want to miss moments with them. I don't want them looking back or feeling that the phone is more important than them."

Several parents described routinely using devices while infant feeding. For example: P30 [35yo, 12mo, 3yo]: "When I'm breastfeeding, I use a Kindle. Like at the moment she's only down to feeding at night. But I'd always use it when I'm feeding her at night before bed time…I probably used the phone more when she was first born. And then the Kindle I've been using for six to eight months." However, a few other parents mentioned not using devices while infant feeding due to the light from their phone distracting their infant, wanting to make eye contact with their infant while feeding, or it being too difficult to hold the device while feeding: P29 [35yo, 12mo, 3yo]: "It's hard to hold the bottle and him [infant]. I need two hands. I think too, like I did try to use, to not look at my phone as

much while feeding, because I'd read that it was really important to make eye contact with them when you're feeding."

5.3.4 Perceived influences of device use on parent-infant attachment and family relationships

5.3.4.1 Influences of device use on parent-infant attachment

Several participants initially described devices as having no influence on their relationship with their infant. However when given further time for reflection, all described some influence of device use on their interactions and relationship with their infant.

Analysis of the data yielded three key themes in relation to the influence of device use on parent-infant attachment. These themes (which are not mutually exclusive) are displayed in Table 5.2 along with example quotes:

1. **Enabled a better understanding of infancy** by accessing information about child development online and accessing ideas for infant activities online;
2. **Enhanced interactions** by playing music for the infant, capturing and viewing photos together, and connecting to parent at work; and
3. **Disrupted interactions** by taking the parents' attention away from their infant, disrupting the flow of interactions, and affecting mood/behaviour.

Almost all participants (n=28) contributed data to the first two themes which represent perceived benefits, and two-thirds (n=21) contributed data to the third theme of perceived downsides of device use in parent-infant attachment.

Devices were also described by a couple of parents as a useful means to view infant images at any time and place, which enhanced the parent experience of connectedness when apart: For example: P5 [26yo, 14mo, no other children]: *"You take photos and they're always stored on your phone. So, you have them as your backdrop or your background, you know, so you're always looking at her [infant]."*

One mother expressed that as a result of being mindful of her own device use, her relationships with her friends had been impacted: P17 [35yo, 15mo, 3yo]: *"With the time difference on top of the fact that I'm not really on my phone, by the time the kids are in bed it's too late for me to call friends. So I think I've probably done the reverse, rather than my relationship with the kids suffering, it's more that my personal relationships suffer.*

Table 5.2
Influences of device use on parent-infant attachment

Theme	Sub-theme	Participants	Representative Quotes
Enabled a better understanding of infancy	Accessing information about child development and parenting online	1, 2, 6, 7, 10, 13, 21, 25, 26, 27, 28, 29, 30	– P25 [31yo, 12mo, 8yo]: *"In using the Better Beginnings [App] with her, it just gives a bunch of different ideas and I guess, tools in some ways to help her develop and grow which just makes me as the parent, I suppose, feel like I'm doing the right thing by her and again, building that kind of relationship and connection with her in that respect."* – P27 [41yo, 13mo, no other children]: *"Things like researching good food for her and different recipes and that sort of stuff makes me proud and happy to be a mum. So if I'm feeling a bit happier, that enhances our relationship. So being able to organize myself like that and get ideas and research and stuff, I like doing that and yeah, it makes me feel like I'm doing a good job."* – P1 [21yo, 9mo, no other children]: *"I read a fair amount of articles on development and different ways of strengthening the fine motor skills and stuff like that… It's definitely influenced my relationship with him and made it better over the last nine months when I've looked at why he's behaving in certain ways."*
	Accessing ideas for infant activities online	2, 13, 21, 22, 24, 28	– P24 [34yo, 12mo, 3yo, 5yo]: *"Finding the classes and signing up for them…Like our baby sensory class…That brings me a lot of happiness knowing how much he's enjoying it and that strengthens our bond."* – P13 [37yo, 11mo, no other children]: *"It [device use] is more with some of the Facebook groups around parenthood and getting various sort of ideas of toys or activities from there to then help influence the bond which is good…Just being able to come up with different ideas for activities or outings or yeah, just different ideas of how to spend time with him. And I think that just spending time with them essentially is what helps create the bond.* – P21 [35yo, 15mo, no other children]: *"I picked up a few [ideas] off Instagram actually. What is it? 'Play At Home Mummy' has some fantastic sensory things to do. So whether it's like the corn flour and water just mixed on a tray and letting him splash that…Instagram has definitely given me some really good tips of non-screen activities to do with him."*

Theme	Sub-theme	Participants	Representative Quotes
Enhanced interactions	Playing music for infant	2, 4, 7, 9, 12, 14, 15, 17, 19, 21, 22, 23	– P15 [42yo, 14mo, no other children]: *"We've been using YouTube a bit, looking up different songs and that to sing to [infant]…Definitely it helps with our bonding together, but also learning the actions and everything to go along with the songs…I think it's helping her and it's also helping us bond as well."*
			– P4 [38yo, 11mo, no other children]: *"It makes me feel more connected in that if I sing the songs we've seen without the screen being there or whatever, like she remembers and we do the actions together and have a laugh or a smile and I guess it makes me feel like we're really learning from each other and really, I guess, connected in that we remember that moment or these moments that we share. It's like building memories."*
			– *P19 [32yo, 11mo, no other children]: "When we watch the YouTube channel it actually gives us more time of bonding because I didn't know any kiddie songs before. Now that I watched the videos with him [infant], they helped me to know the songs as well…We use it as our bonding time …For me to get his attention I will sing a song and then I'll start feeding him and then he'll start eating because I'm singing. He's watching me singing while I'm feeding him. It does help."*
	Capturing and viewing photos together	1, 2, 5, 14, 24, 25, 28, 29	– P29 [35yo, 12mo, 3yo]: *"Looking at photos and videos together brings us yeah, that's a positive experience and kind of brings us closer together."*
			– P12 [29yo, 13mo, no other children]: *"She [infant] likes to watch the videos of herself that were taken during that day. And she sort of has a baby discussion about what's going on in the video. She likes me recording her. She smiles for photos and stuff. And then like at the end of the day, we'll sit and we'll watch what we did that day and talk about it. So that's nice. It's very positive. She likes to just cuddle up under my wing and look at videos of herself. It's very nice."*
			– P25 [31yo, 12mo, 8yo]: *"In taking selfies and videos and whatnot, when she's able to look back on them, it's watching her react to herself and laugh at herself and start to make the connection that, "Hey, that thing in the picture is me!" Again, watching her grow and watching her develop is that kind of connection builder. That, you know, relationship builder."*

Theme	Sub-theme	Participants	Representative Quotes
	Connecting to parent at work	6, 9, 17, 18, 26	– P26 [33yo, 12mo, 3yo, 5yo, FIFO husband]: *"It helps her connection with my husband. So that's nice. I mean, yeah, I'm cuddling her, so she knows that I'm there. We get that bonding and she also gets to see her daddy. So that bonds us all. We're all snuggled together. It's all happy…We can kind of share with him and involve him in daily life. Even though he's not physically here, we can see and talk and interact with us on the phone. And so it makes it a little bit easier."* – P6 [38yo, 13mo, no other children]: *"When [husband] is on night shift (he does night shift one night a week or one week a month), at lunchtime usually then I will (or dinner time) I would get him on the WhatsApp video chat and she [infant] knows it's him…She can understand that it's him and she would be laughing and smiling and enjoying it. So in that way, actually it does, it is a good thing. She doesn't do it with grandparents because she doesn't know who they are. It's nothing familiar. Whereas when we ring her Daddy, it's very familiar and she knows who it is. So actually that's one positive thing."* – P17 [35yo, 15mo, 3yo, FIFO husband]: *"When my husband's at work, we generally FaceTime once a day. Sometimes twice if he has the time. I think for him it's easier if we just do it once a day, usually when the boys are eating dinner. They both sit in a high chair (just because my three year old has regressed to wanting to do whatever my one year old does). So I usually just set up the phone in front of them, and they talk."*
Disrupted interactions	Taking parents' attention away from infant	3, 4, 5, 6, 8, 9, 10, 14, 20, 23, 24, 27, 29, 30	– P3 [31yo, 10mo, no other children]: *"The mobile is the biggest distraction because you just find yourself grabbing it and checking an app if there's a notification or something, so my attention is away from him [infant]."* – P6: *He [husband] has got more of a tendency to check his phone in front of her [infant] and to be holding it in front of her, which is a bit of a gripe with us. And he's more like, if we're playing with her in the kitchen here, you know, he'd go off and check his phone and then she'll be looking at him trying to make eye contact and he's looking at his phone."* – P30 [35yo, 12mo, 3yo]: *"I get distracted with it [smartphone]. So I might have seen something and then I pick it up and then I get engrossed at looking at something and then all of a sudden just realize like, Oh, she's actually, you know, pottered over to my knee or something. She's trying to get me to get up or something. I'm like, Oh. So yeah, it's making me less present and yeah. So it is a negative impact."*

Theme	Sub-theme	Participants	Representative Quotes
	Disrupting the flow of interactions	6, 10, 13, 19, 22, 25, 28, 30	– P10 [39yo, 14mo, no other children]: *"There is distraction of course, when you use your mobile…Maybe you are playing with him and you receive a message and you want to answer it straight back and this interrupts the flow of the playing with him. With the interaction with him. Or if he's eating and you are helping him out eating, or you are interacting with him eating and you receive a message, it interrupts the flow."* – P13 [37yo, 11mo, no other children]: *"I'll be playing with him and then I might grab my phone and check my phone. And so I do feel like that is taking away attention and focus that I could be putting on him or even just getting stuff done around the house, which would then make me feel better and feel like a better mum."* – P28 [38yo, 13mo, 3yo]: *"If it [smartphone] is either in my pocket or if it's on the couch in the lounge room and if I'm playing on the floor with her [infant] and then the screen pops up or it beeps. And I'll just look at it and then think, "Oh, what's this?" and I'll keep scrolling. And then she's not getting my attention. Which I know is good for her to have independent play also. But I just think that's stopping me from interacting with her, even if it's only for a few minutes, it's stopping something. It's potentially making me miss something."*
	Affecting behaviour/ mood	1, 9, 11, 23	– P1 [21yo, 9mo, no other children]: *"It [device use] definitely has a negative impact because you know, if you're busy texting somebody or calling somebody or busy watching something and they interrupt you, you get very frustrated. It's obviously not his fault, He's still a baby."* – P11 [35yo, 14mo, 4yo]: *"He's like very, very clingy towards me. He hates me being on my phone. So generally he'll be grizzly when I'm on my phone and not paying him attention. When I'm around him, obviously, because it's not a lot, he wants my full attention…Why would that be? Because it takes the attention away from him. That's what it is. When he's got me, he wants me to be his. I can't blame him really."* – P9 [32yo, 13mo, no other children]: *"Occasionally he [infant] likes to play and likes to just come in the phone [call] and then try to grab it or try to press the buttons and that sort of thing. And then I try, and then I, I, I wasn't, I'm not angry. I wasn't angry or anything, but I probably just sort of raised my voice and that sort of thing."*

5.3.4.2 Influences of device use on other family relationships

Analysis of the data yielded two key themes in relation to the influence of device use on other family relationships. These two themes (which are not mutually exclusive), displayed in Table 5.3 along with representative quotes, were:

1. **Enhanced interactions** between parents, between the parent and older child, and between siblings; and
2. **Disrupted interactions** between parents, between the parent and older child, and between siblings.

For parent relationships, several participants described benefits in maintaining connections during the day especially for families with a FIFO father. However, almost half of the participants described poorer communication with their partner due to device use. For example: P4 [38yo, 11mo, no other children]: *"They [devices] help in that when he's away, we can actually still see each other face to face by video calling each other. So we can feel connected in that way. But I think when he's around, we probably feel disconnected when we're in the same room and we're both just looking at our phones or the TV and not really communicating with each other. So it helps and it doesn't help, if that makes sense."*

Between parents and their older children, the co-use of a device was described as a benefit by one participant. However, disrupted interactions were described by a few participants, particularly due to the parent attending to their phone while the child was trying to get their attention.

Between siblings, a couple of participants mentioned enhanced interactions between siblings due to shared experiences while using devices. However, several families mentioned that the use of a device by their older child hampered communication and interactions between the older child and their infant sibling by leading them to be less responsive or frustrated when interrupted.

Table 5.3
Influences of device use on other family relationships

Theme	Sub-theme	Participants	Representative Quotes
Enhanced interactions	Between parents	1, 4, 9, 21, 26, 27	– P1 [21yo, 9mo, no other children]: *"During the day I get to talk to him [husband] which is fantastic. Like sending him messages or updates of our son, sending him pictures and videos which is great. Like the first time my son crawled my husband was at work and I got it on video. So I was able to send it to him. Being able to contact him when he leaves work and find out how his day was [and] keep him company while he's on his way home because he's got a long commute."* – P27 [41yo, 13mo, no other children, FIFO husband]: *"We stay connected during the week when he's at work, in a way that would be very difficult without devices. And it's very nice to send him photos and videos of [infant]…It's really nice. And it is one of the reasons, like I said, that I keep the devices on me during the day. It's to stay connected with him."* – P26 [33yo, 12mo, 3yo, 5yo, FIFO husband]: *"He [husband] has been FIFO since we met…you feel like you're not fully alone [by using devices]. Even though you're physically alone with the baby you're not emotionally alone. And just letting the other one know that you are always there and, you know, not necessarily physically always there, but emotionally and mentally and all that. Yeah. That's really good and helpful for us."*
	Between parent and older child	20	– P20 [32yo, 11mo, 3yo]: *At first with the iPad, sometimes when he [3yo] is playing some of the educational games that I've got on there, he needed help with those, so I did sit with him through those and we went through it together. I think he enjoyed that just because I was there too, and he likes me to watch shows with him…I think he likes to talk about stuff that's happening, so if I'm there, he can talk to me about what he's watching, and same with what he's playing. He talks to me about what he's playing, because he's likes to show me stuff. If I'm there too, so if both of us are doing the same thing, then I find that he seems a lot better with that than if I was to just put the screen on and leave him…It helps us get connected if we're both using the same device and talking about it."*
	Between siblings	2, 23	– P23 [29yo, 12mo, 3yo]: *"If we play music [via a touch screen device] probably like once or twice a week, we'll just have a bit of a dance and a boogie and then they [children] will probably interact a bit together as well then."* – P2 [29yo, 10mo, 6yo]: *"She tends to, if there's something on there [tablet computer] that she thinks is funny or great, she tries to show it to the baby or she's got a good relationship with her, so she tries to share a lot of things. She'll put some Wiggles on sometimes and she'll pop it down and she'll dance with her. So yeah, she's good in that way with trying to share what she's watching with her."*

Theme	Sub-theme	Participants	Representative Quotes
Disrupted interactions	Between parents	2, 3, 4, 6, 10, 13, 14, 19, 20, 21, 23, 29, 30	– P10 [39yo, 14mo, no other children]: *"Since we have the internet on our mobiles, I feel like the relationship changed because we spend more time watching, like, especially when [infant] goes to bed, we spend a lot of time with the mobile rather than interacting between us. This, I think this effects a little bit the relationship. In a bad way…I feel like when like myself or my husband looks over the phone, I feel like the person is not present in that moment. So I think, yeah, in this sense, it's in a very negative sense. Sometimes you feel like the person is with you in the room or with your son, but you have the feeling that that person is not there. Because you get so disconnected from the reality that it's like your mind is not there. Only your body is there.*
			– P4 [38yo, 11mo, no other children]: *"I feel like we might, we use the phones too much, like after she's gone to bed or something like that. If we're not watching TV together, then we kind of are both on our phones and we don't get to really interact with the other person. And yeah, so I think I would really like that to be less. And for us to be more focused on each other than on the phone and internet."*
			– P6 [38yo, 13mo, no other children]: *"Rather than talk to each other we, you know, we're on our phones a bit too much. I think it would definitely negatively impact our relationship because we're not chatting to each other as much and we don't communicate together as much."*
	Between parent and older child	20, 23, 29, 30	– P20 [32yo, 11mo, 3yo]: *With my husband, he's always on his phone. I just find that the oldest always wants his attention. He's asking him questions and stuff, but then he won't answer because he's on his phone and I'm just like, "Your child's talking to you. Can you answer him please?"... He's just being ignored because his Dad's too distracted by whatever he's doing on his phone. I don't know. I just feel like the eldest just feels a bit neglected sometimes because if we're busy on our phones or something, then he just feels a bit ignored, I suppose. I find that a lot with my husband and the phone. I get really annoyed with him especially when our oldest is trying to have a conversation with him, and he's not really there because he's on his phone."*
			– P30 [35yo, 12mo, 3yo]: *"I think that him [partner] and the kids, it can be the same as myself. I see it happen as well, where he gets distracted and, you know, engrossed in the phone and they might be trying to get his attention and it will take a minute, same as myself, to get him."*
			– P23 [29yo, 12mo, 3yo]: *"The three-year-old, if he's on like the tablet or yeah, if he's on the tablet or playing a game, he won't be interacting with anyone. Like he'll just be focused on that. He won't have any interactions with anyone unless you sit down and play it with him. Like if it's a game and you sit down with him."*

Theme	Sub-theme	Participants	Representative Quotes
	Between siblings	17, 20, 22, 24, 29, 30	– P30 [35yo, 12mo, 3yo]: *"When my three-year-old is using something like she's just zoned into it. So there is no communication around it at all. So trying to get her attention away from it, especially the tablet…And I try to tell my three-year-old like, "Just answer your sister [infant]" or "Your sister's calling you"*
			– P22 [41yo, 12mo, 4yo]: *"Say he [4yo] was on the iPad watching or doing Reading Eggs while I was making dinner (which is not common, but has happened in the past) and she [infant] is happy to be in the playpen. But I see her getting, not necessarily distressed, but her attention is going to him or she's trying to get his attention and he's not giving her that attention at all because he's so focused on what he's doing."*
			– P29 [35yo, 12mo, 3yo]: *Maybe like [3-year-old] being on my iPad or watching TV, it can be hard to get his attention... If [3-year-old]'s watching something and [infant] gets in the way, he gets upset. [Infant] tries to grab the iPad or then he gets upset."*

5.4 Discussion

Overall, the 30 participant families described secure attachment relationships with their infants, characterised by emotions, perspectives and actions that demonstrate affection and commitment to their infant. When asked about influences on parent-child attachment, device use was found to both enhance connection and increase distraction between parents and infants, and between other family members.

Two-thirds of infants were routinely involved in family video calls via mobile touch screen devices, which may in part be influenced by the COVID-19 pandemic and related travel restrictions that were ongoing at the time of the study. A third of infants had experienced other uses of mobile touch screen devices and were able to actively engage with the device, supporting other findings where children as young as 12 months old were found to be able to unlock, swipe, and actively look at touch screen devices (Ahearne et al., 2016). Overall, the use of devices by infants in this study was for education or maintaining communication and relationships, was constrained to certain situations and was in the company of a parent. Infant device use was typically infrequent and during specific circumstances such as distracting the child while giving them medicine, cutting their nails or taking them on long car journeys. This supports other research of families with some screen exposure by 6 months of age, where almost half of parents (44%) used devices with their infant while trying to calm them, and a third (30%) used devices while in the company of an adult caregiver during infant mealtimes, when putting infants to sleep, and when waiting (Wiltshire, Troller-Renfree, Giebler, & Noble, 2021).

Among parents, all used devices for a multitude of purposes and there was a broad range of device use practices from minimal to frequent use. Around half of parents were satisfied with their current level of device use, and half stated they would prefer to use their devices less. Similar to other findings (Hiniker et al., 2015) many described being mindful, concerned or guilty about their use of devices, regardless of their duration of use.

When looking at the influence of device use on parent-child interactions, the findings provide support for the proposed integrated model of human-computer interaction within a family context, whereby parent and/or child use of mobile touch screen devices may influence parent-child interactions and attachment through a series of potential mechanisms. These mechanisms served to either enhance connection or lead to distraction.

The mechanisms that enhanced connection included accessing information about child development and accessing ideas of infant activities online, playing music for the

infant, capturing and viewing photos together, and connecting to parents while at work. These findings support other qualitative research findings where a main reason for parents using digital devices with their young children was for the purposes of bonding with them (W. Chen, Teo, & Nguyen, 2019). In particular, devices were found in the current study to be a useful tool for refreshing memories of nursery rhyme lyrics and actions, which is a known way of facilitating emotional communication between a mother and child (Creighton, 2011). For example, an empirical study with 96 mother-infant dyads exploring the effect of music and movement on mother-infant attachment found that mothers in the experimental group who learnt a variety of songs and lullabies and physical actions had a greater perception of the attachment bond than those in the control group (Vlismas, Malloch, & Burnham, 2013).

Parental viewing of infant photos on a device in tandem with their child or alone also emerged as a key mechanism for enhancing connection in this study. This indicates that viewing images may be an important dimension of parent-to-infant attachment, as supported by the findings of a small laboratory study of 6 mothers where mothers who viewed images of their own infants had increased activation of their orbitofrontal cortex (which correlates to pleasant mood ratings) during functional magnetic resonance imaging compared with mothers who viewed photographs of other infants (Nitschke et al., 2004). The ability to view infant photographs on a portable device may be particularly important for parents who are separated from their children while at work or in FIFO positions.

The findings indicate that devices may facilitate parents' abilities to develop the necessary characteristics for establishing attachment security (J. T. Condon & Corkindale, 1998) by providing a means to seek: pleasure in proximity (by interacting with the infant via viewing photos and videos together), needs gratification and protection (by accessing information online on how to meet the infant's needs appropriate to their developmental stage); and knowledge acquisition (by enabling the parent to better understand their infant and feel a sense of competency as a result).

The mechanisms that increased distraction included taking the parents' attention away from their infant, disrupting the flow of interactions, and affecting mood or behaviour. These results support a recent experimental study of Israeli mothers and their 24- to 36-month-old toddlers, where mothers were found to be less responsive to child bids for attention and exchanged in fewer conversational turns when engaged with a smartphone than during uninterrupted free-play (Lederer, Artzi, & Borodkin, 2022). The finding that parents in the current study were less attentive and less present with their infants while

engaged with their device and experienced altered child mood and behaviour adds further evidence to the theory of the "Still Face Paradigm" which posits that initiating and responding to child social cues is important for connection (Braungart-Rieker, Murphy Garwood, Powers, & Notaro, 1998), and a lack of these parent reactions is associated with increased negative affect such as infant distress and confusion (Myruski et al., 2018). The use of smartphones by parents while in the company of their infant may disrupt parent-infant engagement and lead to a still face, as evidenced by a recent scoping review where the use of smartphones by parents of 0-5-year-olds was found to be associated with decreased parental sensitivity and responsiveness (Braune-Krickau et al., 2021), which are key elements in the formation of a secure attachment (M. D. S. Ainsworth, Bell, & Stayton, 1974). This decreased parent responsiveness and subsequent infant distress have been exemplified in a TED Talk demonstrating the impact of parent device use during parent-infant interactions (Mindaroo Foundation, 2021).

When asked about the influence of device use on other family relationships, similar mechanisms of enhanced connection when devices were used collaboratively and increased distraction when used independently while in the presence of each other were found. For example, devices appeared to enhance parents' relationships when used as a tool for communicating when physically apart but served to disrupt relationships when used independently in each other's company. This supports findings of other qualitative research on 66 married couple dyads which found that interactive technologies (mobile phones, internet and social networking sites) facilitated communication and connection, yet also led to distraction and challenged marital boundaries (Vaterlaus & Tulane, 2019).

The findings indicate that influences on the wider layer of other family relationships should also be considered when investigating influences of device use on the inner parent-child dyad layer of the proposed model of device use in an integrated family system. This is because there may be links between wider family relationships and the security of parent-child attachment. For example, marital relationship dissatisfaction is associated with increased risk of depression and anxiety (Pilkington, Milne, Cairns, Lewis, & Whelan, 2015), which in turn is associated with lower levels of parent-child attachment security (Badovinac et al., 2018; Teti, Gelfand, Messinger, & Isabella, 1995). In addition, higher scores of sibling attachment are associated with fewer depressive symptoms and greater self-worth (Noel, Francis, & Tilley, 2017), and child depression symptoms have been found to be associated with insecure attachment to primary caregivers (although this association is likely to be bi-directional) (Spruit et al., 2020).

Overall, the findings of this study indicate that how families interact with mobile touch screen devices is important in whether device use is beneficial or detrimental to parent-child and other family relationships. In particular, the nature of how parents interacted with screens was important rather than simply the amount of screen use. The intentional use of devices for the purposes of accessing infant-related information, playing music for the infant and capturing and viewing photos together appeared to enhance connectedness between parents and their infants, whereas general use of devices for checking notifications and scrolling through social media while in the company of their infant served to disrupt interactions.

Although parents may have traditionally acquired child development knowledge or been less engaged with their child due to other means (e.g. reading a hard copy book), there are some key differences with mobile touch screen devices. The portability and ease of access to devices may lead to increased opportunities for both enhanced connection and distraction.

The mechanisms may be the same for wider family relationships, however other factors such as autonomy and access to devices for older family members (e.g. between marital partners) may play an important role. In addition, relationships between device use and family connectedness are likely to be bi-directional in nature (Detnakarintra et al., 2020), and there is evidence to suggest that families with inherently strong bonds are more likely to be enriched by the use of devices in terms of social interaction whereas families with inherently vulnerable bonds are more likely to be weakened by the use of devices (Dubrov, 2020).

5.5 Implications of the findings

The implication for theoretical work in this area is that the proposed model of human-computer interaction in a family system that is based on concepts of human-computer interaction (Straker & Pollock, 2005), family systems theory (White & Klein, 2008), the bio-ecological model (Bronfenbrenner, 2006) and parent-child attachment (Bowlby, 1980) is a useful framework for investigating potential mechanisms and demonstrates that the nature of screen use is important to consider rather than simply the amount of screen use.

In terms of practical implications, this study provides unique information on human-computer interactions within a family systems context among families of infants, and what influences parents perceive this interaction has on their thoughts, feelings and behaviours towards their infant and on wider family relationships.

The findings suggest that some engagement with technology can improve forming a bond between the parent and infant, particularly when devices are used specifically for: accessing information about child development and parenting online using well-known and trusted sources of information, accessing ideas for infant activities online, playing music for the infant, learning lyrics and actions to nursery rhymes, capturing and viewing photos together, and connecting with parents virtually while they are at work. The results also indicate that while there are some potential benefits to using devices during among families with infants, parents should also be mindful of what they are using devices for as they can be distracting, especially when used without a specific purpose. Given the importance of parent-infant attachment to future child outcomes (including cognitive, physical and socio-emotional outcomes), this knowledge is useful in guiding families and professionals who provide services to families in order to optimise future child development.

In terms of wider family relationships (e.g. siblings and the marital relationship), the practical implications are that using devices collaboratively while together or to communicate while apart can enhance interactions and perceptions of connectedness, while using devices independently while in each other's presence can diminish interactions and lead to feelings of disconnectedness.

5.6 Strengths and limitations

This paper advances research on the influence of device use on parent-infant attachment, an area in need of research due to the rapid advancement in technology use among families of young children, and highlights the importance of using technology wisely.

The qualitative interview approach enabled reflective listening and further prompting when required, which provided rich and detailed information of family perspectives and experiences. Parents were asked to reflect on their current family experiences which may have led to reduced memory bias while participating in the interviews. Further strengths include the involvement of a consumer group in refining interview questions to ensure the relevance of the content, and member checking to enhance trustworthiness of the data.

In addition, the study proposed a model of family human-computer interaction that acknowledges the importance of considering an additional layer of the wider family on parent-child attachment and device use which recognises that influences do not occur in isolation but as part of a family system.

A limitation was that a convenience sample was used which did not include families with some characteristics that could influence device use and parent-child attachment e.g. single parents, fathers, and parents with perceived insecure attachments. The study participants had high levels of education, occupation and income which may be associated with higher levels of attachment and lower levels of technology use. In addition, the participation rate of the convenience sample was relatively low which may have introduced selection bias where those who participated may have differed to those who did not.

Interviews were conducted during the COVID-19 pandemic, and there is a potential for social changes associated with the pandemic to influence device use and family interactions, which may affect generalisability of findings. For example, infants may have been involved in family video calls via touch screen devices to a greater extent than usual due to pandemic-related restrictions.

5.7 Future research

Our work here suggests several lines of future research. To better inform tailored technology use advice to families, studies of attachment and mobile touch screen device use entailing large, more representative samples of families differentiated by diverse family structures and stratified by developmental ages (e.g. toddlers, pre-schoolers and grade-schoolers) are needed. In addition, the use of time diaries, touch technology time-stamps or observational studies in situ would be useful to address to address potential biases in self-reports of mobile device use.

Further areas of research could include longitudinal studies of parent-child attachment, mobile touch screen device use and child developmental outcomes to inform directions of associations, investigation of other potential factors that influence parent-infant attachment, and randomised control trials to explore the use of technology to support attachment security.

The effects of the COVID-19 pandemic on mobile touch screen device use and parent-child attachment is also important to explore, as there is the potential for pandemic-related restrictions to have an influence on both the use of devices and family dynamics.

5.8 Conclusions

The findings shed light as to how parent and/or infant mobile touch screen device use may affect the parent's perceived relationship with their infant. Reasons for which devices were used appeared to be important, rather than simply the amount of screen time. When

used for the for the purposes of accessing infant-related information, virtual communication, playing music for the infant and capturing and viewing photos together, devices were perceived to enhance feelings of connectedness between parents and their infants.

However, general use of devices for checking notifications and scrolling through social media while in the company of their infant served to disrupt interactions and led to parents feeling a sense of disconnection to them. Among other family members such as siblings and the marital relationship, device use enhanced feelings of connectedness when used collaboratively together or for communication purposes while apart, and led to feelings of distractedness and disconnectedness when used independently in the presence of each other.

The findings will be useful for providing information for families with infants on how they can take advantage of devices for the purposes of enhancing interactions and relationships while being aware of potential downsides.

Chapter Six

6

Study 2C:

COVID-19 Qualitative Study

Hood, R., Zabatiero, J., Zubrick, S.R., Silva, D. & Straker, L. (2021). "Coronavirus changed the rules on everything": parent perspectives on how the COVID-19 pandemic influenced family routines, relationships and technology use in families with infants. *International Journal of Environmental Research and Public Health,* 18(23), 12865.
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Abstract

This study explored how the first wave of the COVID-19 pandemic influenced family routines, relationships and technology use (smartphones and tablet computers) among families with infants. Infancy is known to be an important period for attachment security and future child development, and a time of being susceptible to changes within and outside of the family unit. A qualitative design using convenience sampling was employed. Thirty mothers in Perth, Western Australia participated in semi-structured interviews by audio or video call. All mothers were parents of infants aged nine to 15 months old. Interviews were audio-recorded and transcribed, and data were analysed using thematic analysis to code and identify themes in an inductive manner. Families described staying home and stopping all external activities. Three themes relating to family interactions and wellbeing were found: enhanced family relationships; prompted reflection on family schedules; and increased parental stress. Two themes related to family device use were found: enabled connections to be maintained; and source of disrupted interactions within the family unit. Overall, participants described more advantages than downsides of device use during COVID-19. Findings will be of value in providing useful information for families, health professionals and government advisors for use during future pandemic-related restrictions.

Keywords: children; COVID-19; family relationships; mobile touch screen device use; screen time; technology use; thematic analysis; qualitative research; The ORIGINS Project

6.1 Introduction

The novel coronavirus disease (COVID-19) was declared a global pandemic on March 12, 2020 by the World Health Organisation (World Health Organization, 2020). Globally, countries have experienced varying degrees of infections and deaths that have occurred across multiple 'waves'. A variety of responses have been adopted to these waves aimed at minimising public health and economic impacts, including social distancing, travel limitations and periods of restrictions ('lockdown') which typically require people to stay at home with exceptions for purchasing essential supplies, attending medical appointments, exercise, and essential work.

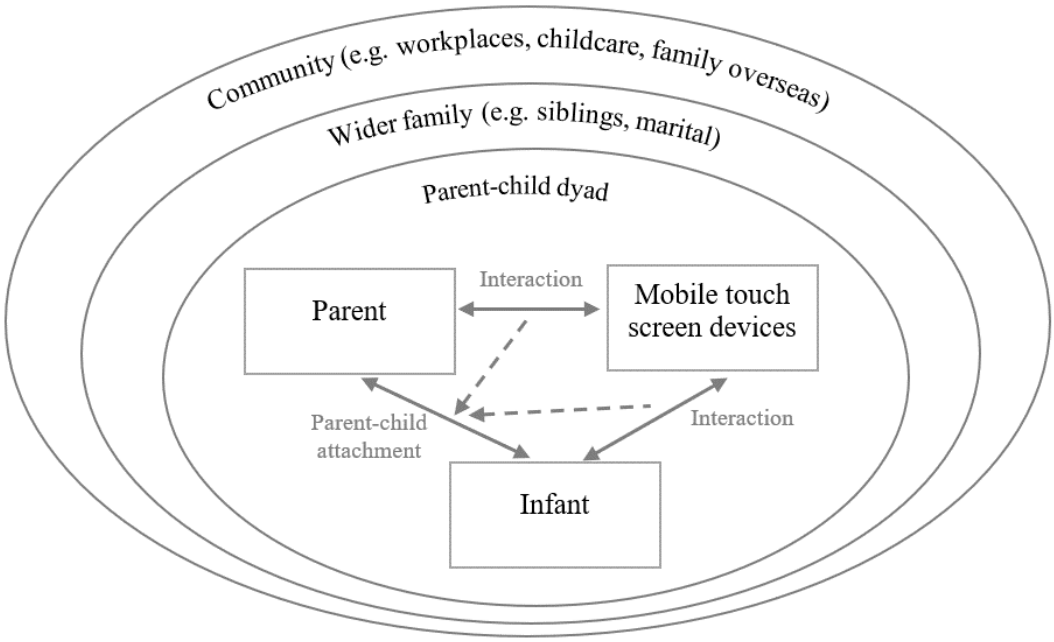
Around the world, the pandemic and its associated restrictions have been linked with social isolation, psychological distress and post-traumatic stress symptoms (Ando, Takeda, & Kumagai, 2021; Brooks et al., 2020; McGinty, Presskreischer, Han, & Barry, 2020; Ostacoli et al., 2020; Sampaio, Sequeira, & Teixeira, 2020). For example, a US national study of parents with children aged under 18 years found that almost a third of parents reported a decline in mental health for themselves, and 14% reported a decline in behavioural health for their children since the pandemic began (Patrick et al., 2020). A negative impact of the pandemic on physical activity (Shalash et al., 2020; Srivastav, Sharma, & Samuel, 2021), sleep quality (Bates et al., 2020) and eating behaviours (Robinson et al., 2021) has also been described. For example, a longitudinal study of Croatian adolescents found a significant decrease in physical activity levels during COVID-19 pandemic related restrictions compared to pre-pandemic levels (Sekulic, Blazevic, Gilic, Kvesic, & Zenic, 2020).

Although the literature has focused primarily on effects of the pandemic on individual health, theories of family systems suggest that how the COVID-19 pandemic affects one individual may impact the functioning of all family members (Prime, Wade, & Browne, 2020) including parent-child, sibling and marital relationships, and connections with extended family and friends. Key frameworks relevant for exploring influences on the family system include attachment theory (M. Ainsworth et al., 1978; Bowlby, 1980), family systems theory (White & Klein, 2008), the bioecological model (Bronfenbrenner, 2006) and the human-computer interaction model (Straker et al., 2014; Straker & Pollock, 2005).

Figure 6.1 shows an integrated family systems model of mobile touch screen device use, with solid line arrows depicting the interaction and flow of information. The double headed arrow between parent or infant and mobile touch screen device represents the

parent/infant sending information to the device (e.g. opening an App) and the device sending information to the parent/infant (e.g. the device playing music or a guided meditation). The dashed line arrows represent the potential influence of parent-device interaction or infant-device interaction on parent-child attachment.

Figure 6.1
Mobile touch screen device use in an integrated family system



The integration of these theories acknowledges the likely intertwining of experiences and actions in the parent-child context (e.g. poorer parental mental health due to isolation, fear of infection or financial insecurity), wider family contexts (e.g. disruptions to work and childcare routines) and community contexts (e.g. family living overseas or witnessing the unfolding of the pandemic globally on news outlets). An important assumption is that links within the integrated model are not one-directional, but rather changes to any domain may result in effects to other parts of the model. The disruptions caused by COVID-19 present a unique opportunity to explore the flow-on effects of disturbing typical family routines on how the different parts of the integrated model relate to each other.

The emerging research on the influence of the COVID-19 pandemic on family systems has generally demonstrated more adverse than beneficial effects. For example, a cross-sectional Singaporean study of 258 parents of children aged 12 years and under reported a negative association between parental perceived impact of COVID-19 and parent-child closeness, which was mediated by parental stress (Chung, Lanier, & Wong,

2020). Participants were surveyed during the 'circuit-breaker' lockdown period during the first wave of the pandemic in Singapore, when schools and workplaces were closed. In a large cross-sectional study of 4,891 Chinese adults in Hong Kong, perceived harms to family well-being due to the COVID-19 outbreak, including increased family negative emotion and decreased family happiness, outweighed the perceived benefits of improved family hygiene, physical health and ability to cope with difficulties (Wong, Lam, Lai, Wang, & Ho, 2021). The study was conducted after the second wave in China was under control. A qualitative analysis exploring experiences among families with children aged below 4 years during the initial COVID-19 lockdown in both Australia and the UK found both positive impacts (including relaxed routines, quality time with family, and positive impact on child development) and negative impacts (including financial insecurity, mental health and not seeing friends and family) (Gibson et al., 2021). It is important to note that COVID-19 case numbers and government responses (e.g. mandatory mask wearing and enforced lockdown periods) have varied across countries and regions which may influence the impact on families.

It is imperative to extend research in this field given the continued duration of the pandemic with subsequent waves occurring worldwide, and due to the potential for short-term changes in the family system as a consequence of the pandemic leading to longer-term changes. Infancy is known to be a sensitive period for the shaping of future brain function and behaviour based on early experiences (C. A. Nelson, Zeanah, & Fox, 2019). In particular, it is critical to investigate implications of the pandemic on the parent-child relationship among families with infants, given the known importance of developing attachment security in the first years of life for future attachment security (Theran et al., 2005) and future child development (R. Li et al., 2016; McCormick et al., 2016; Zimmer-Gembeck et al., 2017). Initial research into the role of the parent-child relationship during the COVID-19 pandemic has found attachment security to be a protective factor for adolescent depression and anxiety symptoms during the March 2020 outbreak of COVID-19 in China (Cao et al., 2021), which is an early indication of the importance of secure parent-child relationships in pandemic conditions.

One of many potential key factors that may be influenced by the COVID-19 restrictions and may affect parent-child relationships and the family system is technology use (in particular mobile touch screen devices such as smartphones and tablet computers) by parents and children. Prior research demonstrates that how parents and children interact with technology is important in whether it enhances child development such as improving

literacy skills (Neumann, 2018) or leads to reduced academic achievement (Kates et al., 2018); and whether it enhances family connectedness (Padilla-Walker et al., 2012) or leads to poorer quality parent-child interactions (Kildare & Middlemiss, 2017). A recent systematic review found a very limited number of studies exploring associations between time spent using devices by parents and/or children and parent-child attachment (Hood, Zabatiero, Zubrick, et al., 2021) highlighting a need for more quality evidence in this area, including from qualitative research, to better understand potential impacts of device use on parent-child attachment. It is important to explore the potential for COVID-19 to influence both family device use and attachment relationships is important to explore in order to better understand ramifications of the pandemic and inform appropriate responses.

For many parents and children, the use of devices is a regular part of their lives. For example, 3-year-old Canadian children have been found to spend an average of 1.5 hours a day using screens (including TV viewing, gaming and mobile devices) (Tamana et al., 2019), and one-third (36%) of Australian pre-schoolers are reported to own their own tablet or smartphone (Rhodes, 2017). Many parents often use their devices while supervising children, as evidenced by an observational study which found the majority (76%) used their mobile device while caring for young children in a playground (Mangan et al., 2018). During the first wave of the global pandemic, both parent and adolescent technology use has been reported to increase for the purposes of communication and distance learning (Drouin, McDaniel, Pater, & Toscos, 2020; Kovacs et al., 2022). However, little research has explored the influence of COVID-19 on the use of technology by very young children. Given the high level of technology engagement by parents and young children and the importance of parent-child relationships in non-pandemic situations, exploring how technology use and relationships within families of young children have been influenced by the COVID-19 pandemic will provide valuable information.

Prior research indicates a potential bi-directional relationship, whereby higher parent-child interaction scores have been found to predict less future child device use, as well as less child time spent using device use predicting more nurturing future parenting (Detnakarintra et al., 2020). This bi-directional relationship is likely to apply to pandemic conditions due to increased time together and increased technology use during periods of restrictions.

This study aimed to extend research into how the COVID-19 pandemic has resulted in changes to the family system, specifically family routines, relationships and technology use by parents and infants. The findings will be of value in providing useful information

for families, health, education and social welfare professionals and government advisors for use during future pandemic-related restrictions.

6.2 Materials and methods

6.2.1 Study design

A qualitative design involving semi-structured interviews with a convenience sample of Western Australian parents was used. Participants were from the larger longitudinal birth cohort study titled the ORIGINS Project (https://originsproject.telethonkids.org.au) which invited participation by families who were 18 weeks pregnant, when attending private and public health services at a tertiary hospital in Perth, Western Australia.

This study is a sub-project of The ORIGINS Project. This unique long-term study, a collaboration between Telethon Kids Institute and Joondalup Health Campus, is one of the most comprehensive studies of pregnant women and their families in Australia to date, recruiting 10,000 families over a decade from the Joondalup and Wanneroo communities of Western Australia.

6.2.2 Recruitment

Potential participants for the current study were provided with information about a study on mobile touch screen device use and attachment and with the opportunity to opt-out from any further contact. Those who did not opt-out were recruited via email and phone call if they had an infant aged 9 to 15 months at the time of the interview, had sufficient English proficiency, and were available for a qualitative interview either by audio call or video call (due to COVID-19 restrictions). The target age of the infants of interviewed families was 12 months. However, to enable flexibility with booking and scheduling interviews with participants, the age bracket was extended to three months either side of this age.

Participants were remunerated with an AUD$50 voucher for participation in the study. Ethics approval was provided by Joondalup Health Campus Human Research Ethics Committee (approval # 1804) and Curtin University Human Research Ethics Committee (approval # AHRE2018-0065).

6.2.3 COVID-19 context

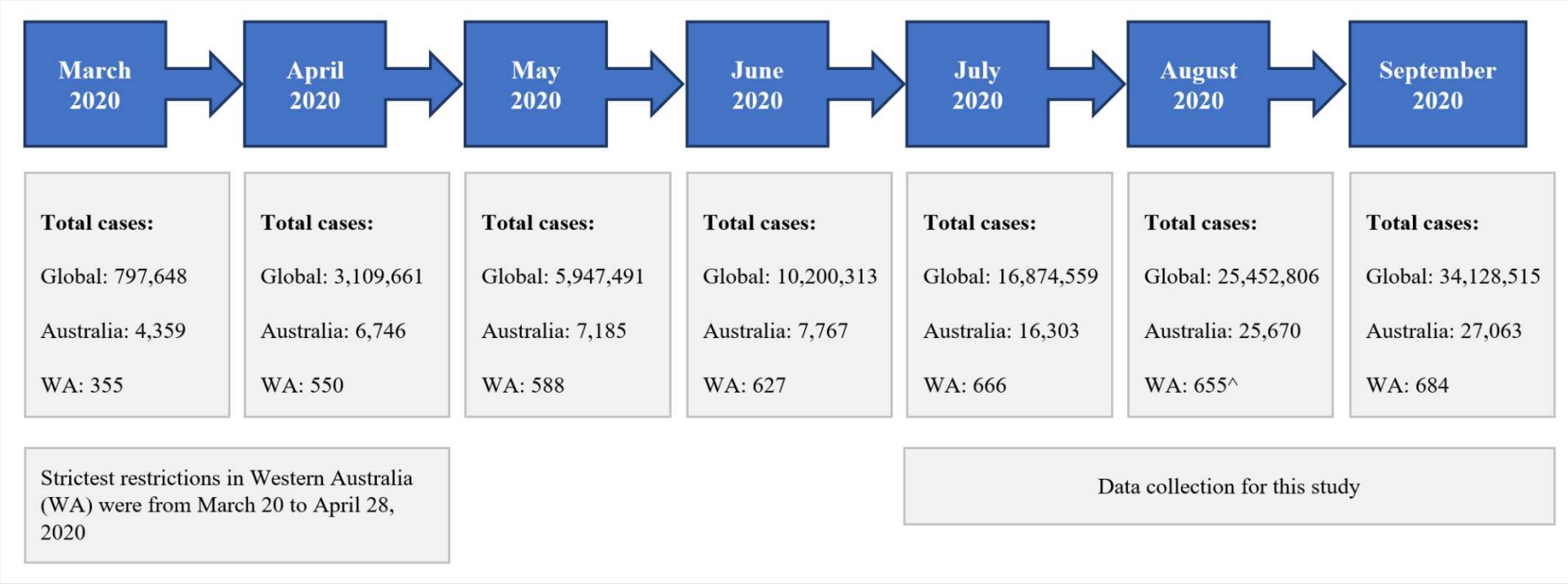
When recruitment commenced for this study at the end of July 2020, there were close to 17 million total COVID-19 cases and over 700,000 deaths globally, and around 17,000

total cases and 200 deaths in Australia (World Health Organisation, 2020) (see Figure 6.2). In Western Australia, the setting for the current study, there were low case numbers and deaths (665 cases and 9 deaths).

The strictest restrictions for Western Australia were in place between 20 March and 28 April 2020. This included closure of Australian borders to non-residents, closure of schools and non-essential venues and activities, and prohibition of regional travel (Government of Western Australia, 2020; Prime Minister of Australia, 2020a). Residents were required to stay at home with exemptions for purchasing essential supplies, attending medical appointments, one-hour daily exercise, commuting to work if unable to work from home, and compassionate reasons (Prime Minister of Australia, 2020b).

It is important to note that this study was conducted at a time of uncertainty (with vaccines in early stages of development) and prior to subsequent waves of the pandemic for many countries, including subsequent waves in the Eastern States of Australia. Western Australia was well placed to deal with the repercussions of the pandemic due to a well-equipped and equitably accessible healthcare system, a strong economy supported by resource production, capacity for strong border control due to Australia being an island, and government financial supplements provided to business and employees affected by the pandemic. Despite low case numbers at the time of the study, there was a great deal of uncertainty about the progression of the pandemic and whether case numbers would escalate rapidly, and if an effective vaccine would become available in the future. Therefore strict restrictions were enforced.

Figure 6.2
Total COVID-19 case numbers at the end of each month, key time-points and study design



Source: WHO, 2021; Government of Western Australia, 2020
^ Total WA case count reduced due to change in reporting procedure

6.2.4 Data collection/instrument

An interpretive description framework (Thorne et al., 1997) was used to generate data with practical outcomes. A semi-structured interview schedule was used, with questions based on findings from previous research on young children's screen technology use. The schedule was developed in consultation with experts in the field and reviewed by the ORIGINS Project community reference group.

A semi-structured interview format was chosen to enable open-ended questions and the ability to prompt for further information. Reflective listening also enabled an in-depth understanding of participants' perspectives. Interviews were audio-recorded and transcribed verbatim.

The interview schedule included open-ended questions relating to how COVID-19 influenced family:

1. Routines including work and childcare;
2. Interactions and relationships; and
3. Device use by parents and infants.

Interview questions used to evaluate parent-to-infant attachment were adapted from the Maternal Postnatal Attachment Scale (J. Condon, 2015). These questions covered the same constructs of postnatal attachment as the quantitative scale, but in a qualitative approach using open-ended questions relating to the parent's thoughts, feelings and behaviours towards their infant.

6.2.5 Data analysis

Interview transcriptions were entered into NVivo11 (QSR International Pty Ltd, version 11, 2016) to facilitate organisation and analysis of data. Data were analysed by RH using thematic analysis to code and identify emerging themes in an inductive manner (Braun & Clarke, 2006). A second researcher (JZ) independently reviewed RH's interpretation of the data, to improve trustworthiness of data analysis. Data are reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) Checklist (Tong et al., 2007).

Once interviews were completed, participants were contacted by phone for member checking purposes. Contact was made with fourteen participants, who were presented with key themes and asked if they perceived it to be a reasonable summary. All agreed that it was a reasonable summary and provided no new information.

6.3 Results

6.3.1 Sample and data collection

At the end of July 2020, there were 282 ORIGINS Project participants who were mothers of infants aged 9 to 15 months and were therefore eligible for this sub-project. One hundred potential participants who did not opt-out to further contact received an email invitation and phone call. Thirty of these were willing and able to participate in the interview, providing a response rate of 30%.

For all 30 interviews, the interview was conducted with the mother. Although interviews were available to either/both parent(s), no fathers participated in the interviews. Interviews were conducted by RH between July 2020 and September 2020, with sixteen conducted by phone and fourteen by video-call, according to the preference of the interviewee. On average, the length of the interviews was 56 minutes, ranging from 30 to 76 minutes.

The mean (range) age of mothers was 34 years (21 to 42 years). The mean (range) age of infants was 12.5 months (9 to 15 months). Most participants (n=28) were married, and all were currently living with the father of the infant. Half of the participants had one child only, and the other half had between two and five children. The older children were aged 3 to 9 years.

Sixteen participants were currently working in a full-time, part-time or casual position, and three of these were also studying concurrently. Six participants were employed but on maternity leave. Of the eight participants not currently employed, two had recently been made redundant as a result of the COVID-19 pandemic and were seeking employment. Most husbands/partners (n=28) were employed in a full-time position. One was employed in a part-time role and one in a casual role. Five husbands/partners had Fly-In-Fly-Out work positions where they were rostered to work away from the home for periods of time.

6.3.2 Influence of COVID-19 on family routines

The pandemic had a varied effect on family work routines (Table 6.1). While several participants described no changes to their family's working arrangements, most stated that they experienced an increase or decrease in working hours, and many described either themselves or their partner working from home for a few weeks to a few months.

For several families, there were no changes to childcare arrangements. However, others described taking their child out of childcare either due to the parent(s) staying home or due to wanting to avoid potential exposure to COVID-19. Most described staying home and stopping all activities. For some, this continued once restrictions eased.

Table 6.1
Influence of COVID-19 on family routines

Theme	Sub-theme	Participants	Representative Quotes
Changes to parent(s) work hours	Parent(s) had increased hours	1, 11, 12, 21, 28	– P11 [35yo (owns a sales business), 14mo, 4yo]: *"When the pandemic hit, I now have to work more because I've got less staff hours. I'm working a lot more than I was planning on unfortunately. It's the only way to do it."* – P28 [38yo (works in retail), 13mo, 3yo]: *"Our routine was completely out the window and I was just working extra when needed and I would be kind of on call, a bit of relief work."*
	Parent(s) had reduced hours	9, 16, 18, 19, 23, 29	– P29 [35yo, 12mo, 3yo]: *"My husband went down to three days. His whole office did to try and save money but not have to let anyone go"* – P16 [39yo, 14mo, 4yo]: *"For a few months there was a disruption. My husband was working only three days a week."*
	Parent(s) worked from home	3, 12, 14, 18, 21, 22, 25, 27, 30	– P3 [31yo, 10mo, no other children]: *"My husband did three months working from home"* – P21 [35yo, 15mo, no other children]: *"Corona threw everything out…We couldn't go on campus for the first half…I would just hole myself off in the [home] study and pretend I wasn't there"*
	Parent(s) made redundant	5, 13	– P5 [26yo (worked in hospitality), 14mo, no other children]: *"I'm just a blubbering mess…I got stood down from work…My partner luckily still had an income. Like he was still working. He didn't get stood down either. So I'm lucky compared to some people. But it doesn't make it any easier"* – P13 [37yo (worked in Human Resources), 11mo, no other children]: *"I literally worked up until the week before having bubs and the intention was to go back in September three days a week. It's what I was hoping, but I was made redundant last month"*

Theme	Sub-theme	Participants	Representative Quotes
Changes to childcare	No changes	2, 7, 8, 10, 26	– P10 [39yo, 14mo, no other children]: *"I felt it was a safe thing to do"* – P26 [33yo, 12mo, 3yo, 5yo]: *"It was family daycare so we just kept going through Corona. We weren't interrupted at all which was good"*
	Commenced daycare	1	– P1 [21yo, 9mo, no other children]: *"The boys went into daycare for the first time while it was free" (note: Child care services were fee-free for families between 6 April and 28 June 2020 in Western Australia)*
	Abstained from daycare	9, 11, 16, 20, 30	– P9 [32yo, 13mo, no other children]: *"When it was quite bad in Western Australia around March/April, we just had to take him out of daycare for that two months and we would just stay at home"* – P16 [39yo, 14mo, 4yo]: *"We didn't send our son to daycare because my parents came over from abroad and they are 70 years old, so we didn't want to take a risk."*
Changes to other activities	Stopped usual activities and stayed home during lockdown	1, 3, 4, 13, 15, 24, 28	– P1 [21yo, 9mo, no other children]: *"We basically didn't leave the house for two months"* – P4 [38yo, 11mo, no other children]: *"We didn't go to the library or rhyme time or catch up as much with other mums."* – P13 [37yo, 11mo, no other children]: *"Because of the isolation restrictions it meant that we weren't able to go and do the activities that we were doing such as baby sensory and Gymbaroo…which meant being stuck at home which became very much a bit of a ground hog day"*
	Continued to reduce activities after lockdown restrictions eased	3, 15, 28	– P3 [31yo, 10mo, no other children]: *"We haven't re-joined any of our classes that we did before. So it's still a bit, we're still a bit wary when we go out."* – P15 [42yo, 14mo, no other children]: *"Even before they started asking people to stay at home, I decided that's one thing that we could do for the community is to stay home as much as possible. So we probably, we did stay home more and we are still staying home more."* – P28 [38yo, 13mo, 3yo]: *Before Covid happened we had a busier week where we had swimming lessons and we would go to a dance class. But once that all stopped we just haven't got back into it."*

6.3.3 Influence of COVID-19 on family relationships

Analysis of the data yielded three key themes in relation to the influence of COVID-19 on family relationships. These themes, displayed in Table 6.2, were: enhanced family relationships; prompted a reflection on family schedules; and increased parental stress.

Almost a third of mothers described an enhanced relationship with their infant as a result of COVID-19 restrictions due to spending more time at home together. A couple of participants mentioned noticing their child displaying signs of separation anxiety due to the increased time at home. For example, one participant stated: *"I don't think I noticed as much until after the restrictions started to ease. But his separation anxiety, even the first time we had someone over to the house after all the home isolation type stuff, he completely freaked out. So I think he was clinging to me more than I'd actually realized during that time."* (P17, 35yo, 15mo, 3yo).

No mothers described poorer attachment with their infants due to COVID-19 restrictions. However, one mentioned her child was less dependent on her since having to swap roles with her husband and increase her hours of work while he stayed at home caring for the children: *"She just wasn't so dependent on me anymore…It's been nice for him [husband] and most of the time I think it's nice, but there's still part of me that goes, well, she's my little baby. I liked being her favourite. But you've got to do what you've got to do."* (P28, 38yo, 13mo, 3yo].

Several participants reflected on the benefits that COVID-19 restrictions had on their typical schedules or routines and described enjoying spending additional time together. Some participants described changes to their family interactions including more time engaging in home-based family activities such as playing board games, art and craft and riding bikes.

In terms of parental mental health, several participants spoke of the lockdown situation as being overwhelming and stressful due to uncertainty about the future, having the children home for an extended period of time with no break, and not being able to leave the house. However, one participant noted less worry for her and her husband, explaining that: *"We actually found it great…because of the postnatal depression he [husband] was happier because he wasn't as worried about me and how I was coping and things like that, because he could be here. COVID made that time easier for us"* (P30, 35yo, 12mo, 3yo).

Many of the mothers interviewed talked of feeling isolated and alone due to decreased opportunities to connect socially with other parents, and less face-to-face interactions and support from family members either residing locally or interstate/overseas. The repercussions of the restrictions on sustaining early friendships were also described.

Table 6.2
Influence of COVID-19 on family interactions and wellbeing

Theme	Sub-theme	Participants	Representative Quotes
Enhanced family relationships	Enhancing relationship between mother and infant	4, 9, 16, 17, 18, 22, 23, 26	– P4 [38yo, 11mo, no other children]: *"We've become more attached because we've had to stay at home together"* – P17 [35yo, 15mo, 3yo]: *"It did affect our relationship. In a good way. We were quite close"* – P18 [36yo, 12mo, no other children]: *"It actually made me more connected to him because I worked from home so I had time and he could see me throughout the day."*
	Enhancing relationship between father and infant	19, 28	– P19 [32yo, 11mo, no other children]: *"Since this COVID-19 started my husband is at home more, so that's when I see that he's getting more closer to his dad"* – P28 [38yo, 13mo, 3yo]: *"She [1 year old] was with him [father] twenty-four seven. So they did become more attached, which was quite nice."*
	Enhanced relationship within family unit	2, 13, 16, 22, 23, 30	– P23 [29yo, 12mo, 3yo]: "I'd probably say it brought us all [mother, father and two children] closer to be honest *because we had to entertain them as opposed to going out and entertaining them, like at the aquarium or the zoo. Like I had to entertain them at home. So yeah, I guess it brings that bond closer"* – P13 [37yo, 11mo, no other children]: *"With my husband, he had to work from home for about six weeks. And because of that, it allowed us to go for a walk together in the morning and we were able to have lunch together. And that was actually really really nice. And that was definitely nice for the [marital] relationship."* – P30 [35yo, 12mo, 3yo]: "*It actually was a blessing in lots of ways as well. It was good family time and actually being able to properly interact with each other at home…There was more free time to actually do things and activities. So probably in that way, it was probably better for our [family] relationship."* – P16 [39yo, 14mo, 4yo]: *"I think the Corona, talking to other people and feeling it for myself, it actually deepens the family bond because you realize that, either spending more time at home or just listening to other stories, it feels like: 'This is important. I don't need to go anywhere really'"*

Theme	Sub-theme	Participants	Representative Quotes
Prompted a reflection on family schedules	Reflection on family schedules	6, 16, 22, 30	– P6 [38yo, 13mo, no other children]: *"It was nearly a welcome change because it gave us an excuse to stay at home…You kind of had more time to yourself that you could concentrate on their development rather than rushing around trying to do these classes. And now I kind of realize after the fact that we probably do a little bit too much. It was probably nice to actually get to take the break, and less is more with babies. I think I've just learned that."* – P16 [39yo, 14mo, 4yo]: *Before I used to go shopping because I didn't know what to do with myself and I needed to get out of the house, and now I don't have that need anymore and I feel like this is good, we can just be us…I think it brought us closer. The value of spending time together and that's the time we've got, we should be spending together and enjoying it…It actually teaches you things, teaches you to embrace your family."* – P22 [41yo, 12mo, 4yo]: *"Coronavirus kind of reaffirmed the need for healthy habits and finding a nice balance. You know, finding, trying to find a balance between the benefits of using screen time, using screens to promote how you live rather than letting screen times dictate how you live."*
	Changes to family interactions	2, 13, 21, 22, 23	– P22 [41yo, 12mo, 4yo]: *"We did a lot more…We were throwing balls, riding bikes, playing board games, my little one would help me with sewing"* – P21 [35yo, 15mo, no other children]: *"I bought some art supplies and things like that so we could do more activities together"* – P23 [29yo, 12mo, 3yo]: *"We would go for walks every day, and yeah, generally we try and do different activities"*

Theme	Sub-theme	Participants	Representative Quotes
Increased parental stress	Parental stress	1, 5, 13, 20, 29	– P29 [35yo, 12mo, 3yo]: *"I did feel a bit crazy maybe…Starts to get full on looking after the two kids, without them being at daycare and getting that break. It gets overwhelming and stressful."*
			– P5 [26yo, 14mo, no other children]: *"For me to not be able to get out of the house and do something it really *** with me. Sorry for my language. My mental health side of it went down because it's not like I could just go out and do what I wanted"*
			– P1 [21yo, 9mo, no other children]: *"It did become very stressful because we were worried. Obviously through all the media with everything going on which was all coming through the devices that we were going to, he was going to lose his job and it was going to be the end of the world. So it became very stressful for all of us, finding articles and sending it to him, you know, and him, us wanting to protect our son, make sure that we will have food, you know?"*
	Social isolation	13, 15, 18, 20, 21, 24, 27	– P27 [41yo, 13mo, no other children]: *"I felt very alone and very isolated... It triggers all those feelings of isolation and just endless hours at home by myself or with [child]."*
			– P13 [37yo, 11mo, no other children]: *"The mother's group had only met a couple of times. And so to then just not meet, like our mother's group essentially is kind of diminished because there wasn't long enough, strong enough connections to keep it going. And I feel sorry for the people who didn't get to join the mother's group at all, because I desperately needed that support at the beginning."*
			– P24 [34yo, 12mo, 3yo, 5yo]: *"I felt a bit sorry for him (1 year old) because it was going to be the time that he started doing his little groups and things at the beginning of Covid. And then they were all cancelled so he didn't"*
			– P20 [32yo, 11mo, 3yo]: *"It was so hard because I see my parents quite a lot, and they refused to see me. My husband was at work and it was pretty much just me and the kids all day, every day."*
			– P21 [35yo, 15mo, no other children]: *"My family's all on the East coast [of Australia] so they haven't been able to come over and visit for our birthday. And my mum is, this is her first grandchild, so she's really missing seeing everything. She would have been over here at least once, maybe twice if it wasn't Corona."*

6.3.4 Role of mobile touch screen device use during COVID-19

6.3.4.1 Time using devices

Around a third of participants described no changes to their family device use during the COVID-19 pandemic. Almost two-thirds described an increase in the use of devices, typically in relation to their own use of them. For example, one mother described: *"I've gotten a lot worse since COVID. Before, I didn't really use to spend a lot of time on my phone, but now I'm finding that am on it way more than usual." (P20, 32yo, 11mo, 3yo)).* Another participant stated: *"Coronavirus changed the rules on everything. So I probably wouldn't have expected us to be using the devices as much, but then no one expected a pandemic either…The rule book went out the window"* (P15, 42yo, 14mo, no other children).

A couple of participants described less time using devices. For example: *"While we were all at home, we kind of made more of an effort to spend more time with the family. So we did a lot of board games and colouring in and activities and stuff rather than, we didn't have much time on the tablets or TV or anything at all."* (P2, 29yo, 10mo, 6yo).

6.3.4.2 Reasons for using devices

Most important reasons for using devices more during COVID-19 restrictions were:

- Communication with family and friends, especially family interstate and overseas;
- Keeping children entertained while at home;
- Home-schooling and educational apps;
- Exercise such as yoga classes on YouTube;
- Online shopping;
- Working from home such as meetings via Zoom;
- Appointments such as physiotherapy;
- Reading news about the pandemic; and
- Searching for ideas for home activities to do with children.

Boredom was also a common reason for using devices more frequently or for longer periods. For1 example, one mother described: *"Because we're stuck in the house a bit more, I guess I get more bored and just pick up the phone and start looking through it rather than being out doing other stuff." (P4, 38yo, 11mo, no other children).* Another stated: *"I was never an online shopper before [COVID] and I didn't actually need most of*

the things I bought, but you just, a lot of was out of boredom or just having not gone out." (P28, 38yo, 13mo, 3yo).

Several participants described continuing with increased device use once restrictions had eased. For example: *"I probably am still using it a little bit more because it became a bit more of a habit. So yeah, there's times where I pick up my phone to check it and I realize that I've only just really put it down. I don't know. It's probably become a bit of a mindless kind of thing. It's out of habit. I'll finish what I'm doing and pick up my phone and it may have only been a couple of minutes." (P15, 42yo, 14mo, no other children).* Another participant reflected: *"That's the downside. I developed this habit of being on my phone and it hasn't really gone away."* (P20, 32yo, 11mo, 3yo).

6.3.5 Influence of device use

A couple of participants stated that the increased use of devices during COVID-19 had no effect on other aspects of their lives. For participants who did describe an impact, analysis of the data yielded two key themes in relation to the influence of COVID-19 on family device use: maintained connections, and disrupted interactions within the family unit (Table 6.3).

Around half of the participants spoke of the importance of devices in maintaining communication with family and friends around Australia and overseas. This was particularly important for families with relatives residing in countries with higher rates of COVID-19 cases and deaths. In contrast to the benefits participants described of device use during COVID-19, one participant stated that she felt *"very frustrated and overwhelmed with all the messaging from friends…it stressed me out"* (P29, 35yo, 12mo, 3yo).

The ability to continue with activities was described as a beneficial aspect of device use, with participants using devices to maintain a sense of normalcy and continue with activities during the lockdown period such as baby sensory classes, martial arts, exercise classes and church mass. A couple of participants described this ability to connect with the outside world and continue activities as stress relieving.

A few participants mentioned their devices being a source of distraction within the family unit during the pandemic, due to spending more time on them during the period of restrictions.

Table 6.3
Role of mobile touch screen device use during COVID-19

Theme	Sub-theme	Participants	Representative Quotes
Maintained connections	Enabling communication with family	3, 7, 10, 13, 15, 16, 17, 18, 21, 22, 25, 26, 27	– P10 [39yo, 14mo, no other children]: *"It was very bad in Italy and it was a bit overwhelming for our family back there. So we tried to call them a little bit more because they had the lockdown. So they had to stay home and we tried to be more close to them and call them more often. So maybe we called even more than once a day"*
			– P15 [42yo, 14mo, no other children]: *"We had a number of family birthdays over Zoom"*
			– P16 [39yo, 14mo, 4yo]: *"Using devices actually helped us to get in touch. We probably got in touch more often than we normally do, just to check on them [family in Italy] and [ask] "is everything all right and how are you coping being under lockdown?" I think with the rest of the family, actually devices and all the Skype messages and the emails helped, and sending photos of grandchildren to keep the spirits up and things like that. That was actually a good thing. I think it came handy and we used it in a positive way."*
			– P22 [41yo, 12mo, 4yo]: *"We do more video calls now because we can't go and visit family in the Eastern States (of Australia)"*
			– P27 [41yo, 13mo, no other children]: *"All our family is in England which aren't dealing with the pandemic very well. So it's been really nice to check in with them"*
	Enabling activities to continue	7, 13, 15, 17, 21, 22, 24, 25	– P13 [37yo, 11mo, no other children]: *"So in particular with Corona, because we had been doing baby sensory classes we're doing some online videos through the restrictions. So I did a little bit of that with him, which helped with the bonding at the time."*
			– P15 [42yo, 14mo, no other children]: *"Even our physio exercise classes were on Zoom. We had our church mass on Zoom… They [devices] probably helped both of our mental states…For me to be able to do some exercise and everything and just see that there was other people out there, that life was going on."*
			– P21 [35yo, 15mo, no other children]: *"It helped alleviate a bit of our anxiety, just living through a pandemic…By having something to still be connected to the rest of the world I think it was stress relieving"*
			– P25 [31yo, 12mo, 8yo]: *"Martial arts went online. So we actually did that from home for a while there, which was pretty cool."*
			– P7 [39yo, 13mo, 4yo, 9yo, 9yo, 9yo]: *"They [9 year old daughters and their friends] do bingo online with each other and that (you know, even just talking online), that was a whole new thing. And that's a positive thing."*

Theme	Sub-theme	Participants	Representative Quotes
Disrupted interactions within family unit	Increasing distraction from family	4, 11, 20, 23	– P4 [38yo, 11mo, no other children]: *"Instead of going out to catch up with friends or stuff like that, we have to do it on the phone, which means increased phone use and more distractions from each other."* – P20 [32yo, 11mo, 3yo]: *"I was maybe spending more time on my phone than with him, I suppose. If he was happy exploring a room, then I would just be there, but then I'd be on my phone just keeping an eye on him. I suppose I wasn't really interacting with him."* – P23 [29yo, 12mo, 3yo]: *"With the pandemic we probably gave them [children] like more screen time. So then they wouldn't be interacting I guess with each other."* – P11 [35yo, 14mo, 4yo]: *"I guess the only thing is most probably again, the distraction. More time equals more screen time. Like more time at home equals more screen time."*

6.4 Discussion and implications

In-depth interviews with 30 mothers of infants aged 9 to 15 months found that COVID-19 restrictions had substantial and varied effects on family routines, relationships and technology use. The proposed model of family human-computer interaction in a COVID-19 context that was based on concepts of family systems theory (White & Klein, 2008), the bioecological model (Bronfenbrenner, 2006) and human-computer interaction (Straker et al., 2014; Straker & Pollock, 2005) provides a useful framework for investigating perceived influences and reveals a potential cascading effect. The 'circuit breaker' lockdown approach, which has been found to be an advantageous response for reducing public health and economic impacts in relation to COVID-19 outbreaks for high income countries such as Australia (Kompas, Grafton, Che, Chu, & Camac, 2021), had flow-on effects to the community, wider family, and parent-child levels of the integrated model. The role of technology use varied at each level.

At a community level, a varied effect of COVID-19 on parents' workplace and childcare arrangements was described, demonstrating that family systems were uniquely and heterogeneously influenced by the pandemic at this level. Interviewed parents reported disruptions to forming early connections with other local mothers, which led to feelings of isolation and loneliness. However, feelings of isolation were mitigated to a degree by the ability to maintain connection with extended family and friends and continue activities via the use of mobile touch screen devices. This highlights the positive role of device use during COVID-19 at the community level in alleviating feelings of isolation and loneliness. These findings indicate that devices have played a vital role within the proposed model by enabling continued communication and engagement in activities in a virtual capacity, which has been found to be important for reducing the risk of mental health problems due to pandemic-related restrictions (Gabbiadini et al., 2020). This is similar to other findings that keeping in touch with family and friends via a virtual setting is a useful strategy for parents to manage parenting difficulties during COVID-19 (Adams, Smith, Caccavale, & Bean, 2021).

At the wider family and parent-child levels, positive and negative effects on relationships were described. This supports findings of a qualitative study of family functioning during the COVID-19 lockdown period in Spain, which revealed themes related to both improvement (including family (re)connection, better communication and emotional expressiveness) as well as deterioration themes (including loneliness, family distance and conflict atmosphere) (Günther-Bel, Vilaregut, Carratala, Torras-Garat, &

Pérez-Testor, 2020). In addition, a cross-sectional study of 4,342 Chinese school students found that around half (52%) perceived the experience of home quarantine as positive for reasons including increased time at home and with parents, and negative impacts including not being able to meet friends and classmates, disturbance in hobbies and interests, and disturbance to their regular routine (Tang, Xiang, Cheung, & Xiang, 2021). In the current study, many parents described an enhanced relationship with their infant as a result of the COVID-19 pandemic, which is in line with an Australian survey of 2,018 parents of children 18 years and under where almost half (42%) stated they were more connected to their child since the pandemic (The Royal Children's Hospital National Child Health Poll, 2020).

In terms of technology use, most families described increased time spent using devices which continued once restrictions eased. This is similar to a study of 2,426 Chinese children and adolescents, which found a significant increase of approximately 30 hours a week of screen time during the pandemic compared to before the pandemic (Xiang, Zhang, & Kuwahara, 2020). Additionally, in a cross-sectional study of 1,836 American mothers of pre-schoolers, most (74%) reported an increased in child screen-time due to the COVID-19 outbreak, with screen-time higher in homes that had greater scores of 'household chaos' (Kracht, Katzmarzyk, & Staiano, 2021). Although most parents surveyed (76%) felt screen time had an overall positive effect on their child during this time, 'excessive screen time' was reported as the top-rated child health problem (Kracht et al., 2021).

The findings of the current study provide further evidence that family relationships and technology use have been affected by the pandemic, and that using devices in a way that reinforces benefits and reduces downsides is important, especially in a pandemic context.

At the individual level, some mothers interviewed in this study described increased stress due to the COVID-19 pandemic and government-imposed restrictions, including concerns about the future and being overwhelmed with the length of time spent with their children at home without practical support or a break. This is consistent with other studies that have explored psychological effects of lockdown, such as a cross-sectional study of Cypriot adults which found higher perceived stress and lower social support during lockdown (Gabbiadini et al., 2020). In a U.S. longitudinal study, parental stress (most commonly related to changes in children's routines and worry about COVID-19) increased from before COVID-19 to during the peak of stay-at-home mandates, and

remained elevated once restrictions eased (Adams et al., 2021). These findings demonstrate the substantial effect the pandemic had, and is continuing to have, on many parents and families.

These findings suggest that the COVID-19 pandemic influenced the family system in a myriad of ways, and highlights the complexities of disruptions to everyday family life. The influence of device use on family interactions showed differential effects, where benefits and disadvantages were related to the nature of screen use rather than simply the amount of screen use. The use of device for the specific purposes of communication and continuation of activities appeared to enhance connectedness within families, whereas increased general device use led to more opportunities for disrupted interactions within the family unit.

It is important to note that the Western Australian wave-one lockdown was of a relatively short duration, and longer periods of pandemic-related restrictions have been associated with poorer mental health (Hawryluck et al., 2004) as well as poorer economic growth (Coccia, 2021). Although the same government restrictions applied to all families, the ways with which these restrictions impacted on everyday life and family routines differed, which supports prior suggestions that people have heterogeneous responses to pandemic situations due to reasons such as pre-existing psychopathology (Fiorillo & Gorwood, 2020).

It is also critical to consider long-term implications of the pandemic on family interactions and technology use beyond the easing of restrictions. Detrimental health consequences of COVID-19 lockdown have been found to persist after the lifting of restrictions in longitudinal studies in England (Chandola, Kumari, Booker, & Benzeval, 2020) and Austria (Pieh, Budimir, Humer, & Probst, 2021). Therefore there is the potential for short-term changes in family relationships and technology use due to the COVID-19 pandemic to lead to longer-term changes, and policy should be directed at promoting positive family interactions and screen use behaviours beyond the easing of restrictions.

Although the focus of most research relating to COVID-19 has been on implications to the individual, these findings demonstrate that government-imposed restrictions and lockdown periods are influential to parent-child, wider family and community contexts. Overall, the findings indicate that access to devices has played a positive role in alleviating the effects of the COVID-19 pandemic on families. However, being aware of the potential downsides of technology use in creating new habits and disrupting family interactions is likely to be of value for families in making wise technology use decisions during pandemic

related restrictions. Useful information (e.g. recommendations or guidelines) for families should be prepared for use during future pandemic-related restrictions.

6.5 Strengths and limitations

This study adds information to the COVID-19 literature by emphasizing implications for family routines and highlighting complexities surrounding the benefits and downsides related to family relationships and device use. The qualitative interview approach provided rich and detailed information of family experiences during the first wave of the pandemic. The study was well timed in terms of capturing parent reflections within weeks of lockdown restrictions occurring, which may have led to reduced memory bias and also enabled participants to have had time to reflect on their experiences prior to being interviewed.

A further strength of this study was in proposing a model of family human-computer interaction in a COVID-19 context that recognises the importance of considering multiple layers of influences on relationships and device use, and acknowledging that these influences do not occur in isolation but as part of a system.

A limitation of this study was that a convenience sample was used which did not include families with a full range of characteristics that could influence device use and attachment e.g. single parents, infants with insecure attachments, families with poor marital relationships. This study was conducted in Perth, Western Australia where the lockdown period was relatively short and case numbers/deaths were relatively low. In addition, Western Australia fared better than most other advanced national economies. In addition, government approaches differ interstate as well as internationally which may limit generalizability of the findings.

It is important to consider that there are potentially other influences that may not have been captured by this cohort of Western Australian mothers, and their reflections may not apply to the experiences of all people in all situations across all times. For example, the findings suggest families without digital access may have fared worse during the pandemic given the positive effects of technology use in alleviating feelings of isolation and enabling activities to continue; however, this could not be studied in this cohort as all families interviewed had access to mobile devices and the internet. In addition, the study captured a snapshot in time, and does not explore long-term effects of the pandemic and related restrictions.

6.6 Future research

Given the dynamic nature of the COVID-19 pandemic, continued research into the impacts on family routines, relationships and technology use is essential in appropriately addressing the needs of children and parents throughout ongoing waves of the pandemic.

Future research could explore the impact of device use on child and parent outcomes within different family structures and age groups (toddlers, preschoolers and grade-schoolers) to better inform appropriate technology use decisions during pandemic-related restrictions. Future research could also explore other potential influences of COVID-19 on families such as mental health, family income and education. Extending research in this field would be of benefit in better understanding the implications of the pandemic, and for informing the trialing of interventions to support parents in mitigating the effects of the pandemic on their families, enhancing any potential benefits and being cognisant of potential detriments of device use.

Further research could investigate associations between mobile touch screen device use, parent-infant attachment and child development in general (unrelated to COVID-19) in order to ensure guidelines for the use of devices within families are as appropriate and comprehensive as possible.

6.7 Conclusions

In summary, the findings indicated that:

1. Families described staying at home and stopping all external activities during the strictest pandemic-related restrictions in Western Australia.
2. Three themes relating to family interactions and wellbeing were found due to the pandemic and associated restrictions: enhanced family relationships; prompted reflection on family schedules; and increased parental stress.
3. Two themes related to family device use were found: enabled connections to be maintained; and source of disrupted interactions within the family unit.
4. Overall, participants described more advantages than downsides of device use during COVID-19.
5. Findings will be of value in providing useful information for families, health professionals and government advisors for use during future pandemic-related restrictions.

Chapter Seven

7

Discussion

7.1 Summary of findings from the thesis

This thesis found some evidence that increased time spent using mobile touch screen devices is associated with poorer parent-child attachment outcomes, and that parents perceive devices to both enhance and detract from their relationship with their child (including prior to birth, during infancy and in the context of the COVID-19 pandemic) depending on the nature and purpose of use.

To explore the evidence that was available at the commencement of this thesis regarding time using mobile touch screen devices and associations with attachment, the literature was systematically reviewed. Some mixed quality evidence was found on negative associations between duration of parent/child device use and attachment outcomes. A narrative synthesis on related literature from the systematic review found some evidence that child time using any screen technology (including television viewing) and child 'problematic' internet, mobile phone, gaming and social media use were negatively associated with attachment.

To explore parent perspectives of device use during pregnancy and infancy, 57 families were interviewed. All described secure attachment relationships characterised by emotions, perspectives and actions that demonstrate affection and commitment to their

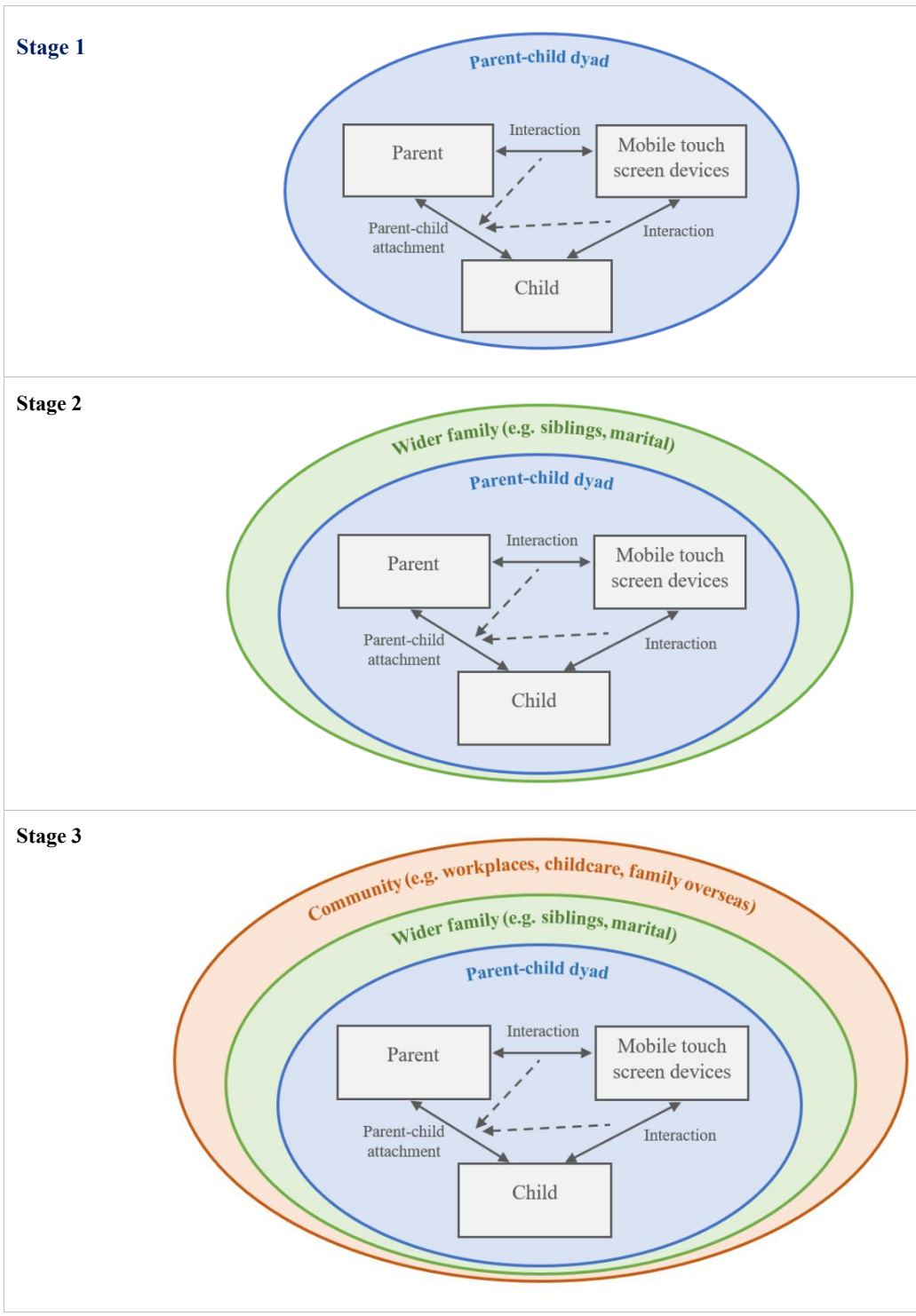
child. When asked about influences on prenatal and infant parent-child attachment, device use was found to both enhance connection (when used for child specific purposes) and increase distraction (when used without a specific purpose or for non-child purposes) between the parent and child. When asked about the wider family and community, devices served to both enhance connection (when used to connect with each other while physically apart) and increase distraction and conflict (when used independently while in each other's company).

The findings indicate that there is some limited direct evidence on negative associations between time parents or children spend using devices and parent-child attachment, and there is some evidence to suggest that how, why and when devices are used is important in whether it is perceived to enhance attachment or not.

The findings also informed the staged development of a model of parent/child device use within the context of the wider family and community which makes an important contribution to theoretical development (Figure 7.1). There are also practical implications that can be drawn from this model that may be useful to support future research and guidelines on technology use within families with young children.

The findings of this thesis' systematic review showed that at the time of commencing this thesis, there was some mixed quality evidence that time spent using mobile touch screen devices by children was negatively associated with parent-child attachment outcomes. Potential pathways for this association are that increased time spent by children on devices may displace interactions required for the formation of a secure attachment, or that children with poorer family relationships may use devices more frequently to compensate for a lack of parental warmth. However, only three papers met the inclusion criteria, and these studies had some potential methodological biases which limited confidence in the findings.

Figure 7.1
Stages of development of a model for human-computer interaction in an integrated family system: Stage 1: the parent-child dyad; stage 2: the wider family; and stage 3: the community.



7.2 Evidence that time using devices is negatively associated with parent-child attachment outcomes

Since the completion of the systematic review, further research has been reported which has demonstrated an association between 'problematic use' of devices and parent-child attachment outcomes (Cheng, Yang, & Lee, 2021; Gong et al., 2022; Jimeno et al., 2022; Özaslan, Yıldırım, Güney, Güzel, & İşeri, 2021). For example, a longitudinal study of 527 Chinese adolescents found the parent-child relationship to be negatively associated with subsequent smartphone addiction, indicating a potential causal pathway between the two constructs (Qiu, Li, Luo, Li, & Nie, 2022). The study demonstrated that hope and life satisfaction were potential mechanisms in the link between parent-child relationship and adolescent smartphone addiction.

However, no new studies explicitly examining duration of time using devices and associations with parent-child attachment have been identified. Thus, there is still a scarcity of studies in this research area and conclusions on duration of device use and parent-child attachment are still preliminary.

7.3 Parent use of devices was perceived to be associated with attachment within the parent-child dyad, depending on nature of use

The findings from the qualitative studies of this thesis demonstrated that for the parent-child dyad, there were perceived pros and cons of device use for prenatal and parent-child attachment, depending on the nature and purpose of device use.

In terms of the pros of device use, potential mechanisms for enhancing attachment included purposeful use of devices and child/parenting focused use of devices (e.g. using the device as a tool to visualise the baby while in utero); accessing information about child development to better understand their child and feel more confident in the parenting role; seeking ideas of infant activities and playing music to the child to interact with them; learning nursery rhyme lyrics and actions to sing to the child; parent and child viewing photos together; and the child connecting with a parent at work. These findings indicated that device use may facilitate a parent's ability to form the characteristics that are deemed necessary for establishing attachment security, which include 'pleasure in proximity' (e.g. by interacting with the infant via viewing photos together), 'needs gratification and protection' (e.g. by accessing information online on how to meet the infant's needs appropriate to their developmental stage), and 'knowledge acquisition' (e.g. by enabling

the parent to better understand their infant and feel a sense of competency as a result) (Condon & Corkindale, 1998). This supports other recent qualitative research of 11 Singaporean parents of children aged 1-5 years, where parents described that one of their main reasons for using devices with their child was to bond with them (W. Chen et al., 2019). All parents were well educated in this study which may have influenced the findings, with all participants having attained a university degree and half also completing a postgraduate degree.

In addition, a recent American longitudinal study found that media use during infant feeding was related to lower levels of parent child dysfunction one year later (Coyne et al., 2022). The authors speculated that parents who perceive poorer attachment with their infant may use their phone while feeding to access child-related information and as a coping mechanism to alleviate stress, loneliness, frustration, pain or boredom, which then leads to improved parent-child relationships outside of the feeding context. The purpose of device use has been found by other researchers to be important in whether it enhances parent-child relationships or not, with a recent cross-sectional study finding that screen use for the purpose of maintaining social connections was related to positive parenting outcomes, whereas screen use for general relaxation purposes was not (Zhang, Madigan, & Browne, 2022). However, it is important to note that the Zhang et al (2022) study defined screen use as smartphone, tablet, computer and television use.

In terms of the cons of device use, potential mechanisms for decreased quality of interactions included general or non-purposeful use of devices (e.g. taking the parents' attention away from the infant); disrupting the flow of interactions and playtime; and affecting the parent and child's mood or behaviour. These findings showed that in some instances, parent use of devices while in the company of their children may lead to distracted parenting and less engagement with their child. This supports observational research where caregivers who used devices while in the company of children aged 12 years and under in Australian malls joined in play, initiated conversations and responded to bids for attention less often than non-device using caregivers (Ewin, Reupert, & McLean, 2021). Although a strength of this study was the observation of parent device use behaviours and parent-child interactions in a naturalistic setting, interactions were described by researchers and not measured using a standardised validated measure of parent-child interaction.

Similarly, a recent American study found that caregiver device use was negatively associated with responsiveness and sensitivity to child cues when caregiver-child dyads

were anonymously observed in public settings (e.g. parks and food courts) during real-time and naturally occurring interactions (Ochoa, Reich, & Farkas, 2021). The type of activity on the device was related to interaction quality, with typing and swiping being associated with fewer components of quality interactions than simply looking at the screen or taking a photo of the child, suggesting that it is important to consider the nature of parent device use. A limitation of this study was that, due to the observational nature of the study, researchers estimated how caregivers were using their device and specific content and activities were not known.

The reverse pathway of poor attachment security influencing greater device use was not found in this thesis. However, this may reflect the participant sample as all parents interviewed described secure attachment relationships. Other recent research indicates that this reverse pathway is possible, with young adults with insecure attachments being more likely to have technology addiction, through the pathway of the temperament characteristics of self-esteem and persistence (Remondi et al., 2022).

Overall, the findings of this thesis and related research demonstrate that how, why and when devices are used is important in whether it is perceived to enhance or detract from parent-child attachment. Purposeful use of devices and child/parenting use of devices was described as beneficial to the parent-child relationship, whereas general or non-purposeful use of devices was described as detrimental.

7.4 Use of devices with the wider family was perceived to be associated with quality of interactions, depending on nature of use

When asked about the influence of device use on other interactions and relationships within the wider family (sibling and marital relationships), similar mechanisms were found of enhanced connection and shared experiences when used collaboratively and increased distraction when used independently while in the presence of each other.

Other research has found that children's relationships with their siblings can influence how and why they use digital technologies, with younger children learning digital skills through modelling their older siblings actions which influences how they perceive, make sense of and interact with technology themselves (Chaudron, 2015). For example, a European study of 2,694 children and their siblings aged 2 to 18 years found that child screen time duration (including TV viewing and computer/game console use) was associated with the respective screen time duration of their siblings (Bogl et al., 2020). Near-aged siblings (≤2.7 years) had more similarity in device use behaviours than siblings

with a larger age difference (>2.7 years) (Bogl et al., 2020), which could be influenced by family rules on technology use. As well as being a source of expertise, older siblings are also often a source of 'hand-me-down' digital technologies such as out-dated mobile phones and game consoles (Plowman, McPake, & Stephen, 2008). If the sibling interactions and relationship can influence an infant's use of digital devices in terms of how and why they use them, then this may also have an influence on parent-child interactions and attachment, demonstrating a link between the layers of the proposed model.

In addition to influencing younger sibling access and use of devices, there may be other pathways by which the sibling relationship may affect the parent-child dyad. For example, higher scores of sibling attachment are associated with fewer depressive symptoms and greater self-worth in children (Noel et al., 2017), and child depression symptoms have been found to be associated with insecure attachment to primary caregivers (although this association is likely to be bi-directional) (Spruit et al., 2020).

In terms of the marital relationship, the findings from this thesis support other research, where use of devices has been associated with both improved communication and connection while physically apart (Coyne et al, 2011; Jiang & Hancock, 2013) as well as lower relationship satisfaction, less positive face-to-face interactions and more conflict over technology use in romantic relationships when together (McDaniel & Drouin, 2019; Roberts & David, 2016). For example, a recent Chinese cross-sectional study of 470 married adults found that being distracted by a smartphone while in the presence of their partners was negatively associated with marital satisfaction (X. Wang & Zhao, 2022). As this study was cross-sectional in design, the direction of the association cannot be inferred, and it could be possible that adults with poorer marital satisfaction are more likely to be distracted by their smartphone while in the company of each other.

As well as device use having an influence on the marital relationship layer, there may also be links between this layer and the parent-child dyad in the proposed model. For example, marital relationship dissatisfaction is associated with increased risk of adult/parent depression and anxiety (Pilkington et al., 2019), which in turn is associated with lower levels of parent-child attachment security (Teti et al., 1995; Badovinac et al., 2018).

These findings and the related research imply that the influence of device use on parent-child relationships and the wider family is likely to be multifaceted. Also, the nature of how families engage with technology is important in whether it enhances connection or

not, with collaborative use being described as beneficial and independent use in the company of other family members being described as a source of distraction and frustration.

7.5 Use of devices with the community was perceived to be associated with quality of interactions during the context of the COVID-19 pandemic

During the context of the COVID-19 pandemic, many participants of this thesis described their family use of devices as being increased compared to pre-pandemic conditions. This is similar to other findings of significant increases in screen media use among children aged 2-13 years during the first wave of the COVID-19 pandemic (Eales, Gillespie, Alstat, Ferguson, & Carlson, 2021). However, an increase in time using devices does not necessarily mean an increase in negative outcomes. For many families interviewed, the increased device use was for the specific purposes of communicating with family and friends and for replacing face-to-face activities. When asked about the influence of device use on the interactions and relationships within the wider family and community, only perceived benefits were described. In particular, the use of video calls with extended family members was described as positive, and enabled social interactions to take place between parents, infants and their extended family members. Recent research has emphasised that being able to communicate with family via video calls is important as it supports skills such as turn taking, enabling word learning and maintaining family bonds (Glick, Saiyed, Kutlesa, Onishi, & Nadig, 2022).

Prior to the COVID-19 pandemic, studies found that connecting with others through devices was important in reducing feelings of isolation. For example, a cross-sectional South Korean study of 2,708 adults found that use of smartphone Apps for communication and social media led to reduced perceptions of social isolation by helping to build social capital (Cho, 2015). The benefit of devices may be even greater in pandemic situations when people's capacity to engage with their extended family members is drastically reduced due to lock-down restrictions and border closures. Maintaining social connections to family and friends via devices during the challenges of the COVID-19 pandemic may also have an indirect effect on the parent-child relationship. For example, a multinational cross-sectional study with respondents from Britain, North America and Australia found that parent use of devices during COVID-19 to connect with people on social media or video chat was related to positive parenting outcomes (e.g. enjoyment with their child, providing care and attention, and listening to their child's ideas and opinions) (Zhang et

al., 2022). This study did not measure attachment per se, but parenting outcomes could be considered as a proxy measure of the parent-child relationship.

Connecting to the community via attending online gatherings (e.g. baby sensory classes, physiotherapy classes and church mass) during the COVID-19 pandemic was also found to be a key use of devices in this thesis. Participants described the ability to virtually attend baby-related community classes as being directly beneficial to their parent-child bond. In addition, the virtual attendance of community classes and events may have indirectly influenced the parent-child attachment relationship through the potential pathway of alleviating loneliness and stress. This thesis found that some participants perceived a reduction in stress levels and feelings of isolation due to connecting in a virtual capacity with both their wider family and the community during the COVID-19 pandemic. This is important for parent-child attachment, as decreased maternal depressive scores are known to be associated with increased quality of interactions with their infant (persistence in play and experience of joy with the child) (Edhborg, Lundh, Seimyr, & Widström, 2003).

Although the findings from this thesis demonstrated benefits of device use during the COVID-19 pandemic for parents and infants, the wider family members are also likely to have benefited from access to devices during this time as well. For example, a study of adults aged 65 years and older in Canada found that while they indicated significantly more feelings of isolation in 2020 compared to previous years due to pandemic restrictions, many felt positively towards the benefits of technology and the majority increased their use of devices for health, wellness and communication purposes (and intended to continue these uses after the pandemic). These older adults agreed that technology can be used to combat social isolation (Sixsmith, Horst, Simeonov, & Mihailidis, 2022).

The findings of the current study and related research demonstrate that in the context of the wider family and community, device use during the COVID-19 pandemic was predominantly positive. In addition, being able to communicate and connect with wider family and community members via devices may have had a flow on positive effect to the parent-child relationship through the pathway of improving parent mental health. This provides further evidence that using devices in a way that reinforces the benefits and reduces downsides is important for all layers of the family, from the parent-child dyad to the wider family and community, especially in a pandemic context.

7.6 Implications

7.6.1 Theoretical implications

The findings of this thesis have theoretical implications by informing the development of a new model expanding on the theories of parent-child attachment, family systems theory, the bioecological model, and human-computer interaction models. This thesis proposes a model of human-computer interaction in an integrated family system to demonstrate that there are likely to be multiple mechanisms or pathways by which the use of devices can influence parent-child attachment in either a beneficial or detrimental way. Although not explored in this thesis's qualitative studies it is acknowledged that the reverse relationship may also be possible, whereby attachment security may influence how devices are used.

7.6.2 Practical implications

The proposed model indicates that when planning future research or developing guidelines and advice for child screen use, the context of the broader family system and community should be taken into consideration. Although there is some evidence that time spent using devices may be an important factor in parent-child relationships, the studies from this thesis indicate that nature of use is also likely to be important.

Thus, the findings from this thesis and the literature review suggest that the guidelines should be expanded to include practical advice on the nature of use rather than simply a focus on time. In addition, the findings indicate that the scope of technology use guidelines should be expanded to focus not just on the child, but on the child's family and social environment e.g. the use of devices by parents, siblings, grandparents, workplaces and childcare settings. This is because these broader layers are likely to have a direct influence on the child's own use of devices (e.g. by role modelling 'healthy' technology use) as well as having an indirect effect on their relationship with their parent (e.g. a positive use of technology by parents is linked to better mental health, which then may lead to improved parent-child attachment).

Practical implications for families and professionals working with families based on the results of this thesis and the other literature reviewed are listed below.

- Devices can be used in a positive way and as a tool to improve parent-child attachment during pregnancy and infancy:

- Using Apps to help visualise what the baby currently looks like while pregnant.
- Seeking information about child development from evidence-based online sources.
- Seeking fun and creative ideas for playing with the child appropriate to the child's developmental stage from trusted and reliable online sources.
- Viewing photos and videos together with the child.
- Playing music to the child to listen and dance to together, and for the parent to learn/remember nursery rhymes and actions.
- Connecting with family members via video calls (including the child being a participant of the call).
- Child co-viewing quality and educational content with parents.
- Participating in online activities such as baby sensory classes, when in-person classes are not an option (e.g. due to pandemic situations).

- To reduce the downsides of device use on parent-child attachment, devices use for the following purposes should be minimised:
  - Parent non-specific internet browsing and scrolling through social media when in the company of the child.
  - Use of devices independently by family members while in the company of each other.
  - Replacing other means of traditional play with the child, such as outdoor play and imaginative free play.

7.7 Strengths

This thesis advances research in an area in need of evidence due to the rapid uptake of technology among families with young children. The systematic review was the first to systematically review evidence of association between time spent using devices and parent-child attachment, with strengths including pre-registration of the research protocol, the use of a standardised quality assessment approach, and a focus on the exposure of time which is widely used in screen use guidelines.

The interview approach in the qualitative studies enabled reflective listening and prompting for further information when required, which provided rich and detailed information on the nature of use and parent perspectives of family device use. Further strengths include involving a consumer group to refine the interview questions, member

checking of the data analysis to enhance trustworthiness of the findings, and consideration of the potential influence of maternal device use prior to birth.

In addition, this thesis integrated several models from different disciplines to develop a staged model of family human-computer interaction. This model provides a more complete conceptualisation of family device use and acknowledges multiple potential (and possibly bi-directional) pathways for device use to be associated with parent-child attachment and child development. The proposed model is of current relevance to families with young children, and can be used to advance knowledge, provide practical implications, and inform guidelines on positive family device use practices.

7.8 Limitations

A limitation of the thesis was that the convenience samples included in the qualitative studies comprised families from relatively high socioeconomic status backgrounds, which may have influenced parent-child attachment and types of technology use. There was a limited range in participant characteristics e.g. a lack of representation from families with single parents, low-income, and varied geographical location, which may limit generalisability of the findings.

There was also the potential for recall bias, particularly among families who were interviewed about their perspectives of device use during pregnancy after they had given birth. Lastly, social desirability bias may be present, where participants are inclined to provide what they perceive to be socially desirable responses instead of expressing true device use practices and perspectives.

7.9 Future research

As mobile touch screen devices continue to be increasingly used by families with young children, including expectant parents, it is important to explore potential mechanisms by which device use is associated with attachment. Further research in this field is needed to ensure the evidence base for technology use guidelines are as appropriate and comprehensive as possible.

Further research to extend knowledge in this area could include studies of device use and attachment using large, more representative samples of families differentiated by diverse family structures and stratified by child age (e.g. toddlers, pre-schoolers and grade-schoolers). This would enable advice that can be tailored to family structure and child

developmental age. More robust sampling methods, including random sampling, would enable greater generalisability to the wider community,

The use of objective measures of technology use such as screen time reports recorded by the device and observational studies to capture time and type of content or activity (e.g. phone calls, camera use, social media, internet browsing) would be useful to help address potential biases in self-reported device use behaviours. In addition, more objective measures of attachment such as observing parent-child interactions would reduce possible biases in self-reported attachment.

Other research could include longitudinal studies of parent-child attachment, device use and child developmental outcomes and behaviour to inform directions of associations, and randomised controlled trials to explore the use of technology to support attachment security which would help inform parents on how to best incorporate family device use rather than avoiding devices altogether.

Another potentially relevant area of research could include the influence of parent and child device use on safety and independence among older children. For example, an exploration of potential benefits such as increased child independence due to device ownership and location sharing, and potential downsides such as increased accidents due to distractedness while using mobile touch screen devices.

Chapter Eight

8

Conclusion

This thesis demonstrates that how, why, and when technology is used is important in whether it is perceived by parents to enhance attachment or not, and the context of the wider family and community is also important to consider when providing guidance to families with young children.

There were perceived pros and cons to the use of technology by parents. Although the systematic review suggested that parent screen time may have negative outcomes in terms of parent-child attachment, the qualitative findings suggested the nature and context of device use was important in whether it enhanced or detracted from attachment. While parent device use can lead to perceived poorer interactions when used in a non-specific way in the company of the child (e.g. by disrupting the flow of interactions and taking the parents' attention away from the child) there were also perceived positives when used in a purposeful way and for child/parenting purposes (e.g. by viewing photos together and seeking ideas of infant activities). Current screen use guidelines typically do not provide advice on parent device use, therefore this information is useful in extending the evidence base used to guide and support parents of young children.

The qualitative research studies in this thesis showed that there were also perceived pros and cons to device use within the context of wider family and the community. Among siblings, devices were perceived as both positive when used together collaboratively (e.g.

by enabling shared experiences) or negative when used independently in the company of each other (e.g. by disrupting interactions and leading to conflict). Among marital relationships, devices were perceived as positive when used for specific relationship purposes (e.g. by enabling communication with their partner while apart) or negative when used independently while in the company of each other (e.g. disrupting communication when using separate devices while together).

Among the community, device use was perceived as generally positive as it enabled families to maintain social communication with relatives, friends and community members while apart, including infants to become familiar with grandparents who did not live nearby. The use of devices also enabled parents to work from home and continue social and exercise activities when necessary during the COVID-19 pandemic.

The studies in this thesis provided evidence that there were perceived benefits to use of devices by infants in certain circumstances. While most screen guidelines typically do not recommend any form of screen time for infants aged 1 year and under, and no sedentary screen time for children aged 2 years and under, the qualitative findings suggested there may be some gains from infants using devices in specific circumstances. For example, devices were perceived as positive when used for the purposes of bonding with the parent when looking at photos/videos together, connecting with parents who work away, providing ideas and opportunities for families to engage with each other, and connecting with relatives during the pandemic. No perceived downsides of infant device use were described by the cohort of parents. However, the sample was relatively small, and infants of families interviewed had limited device use for purposes other than video calls.

Overall, the thesis findings indicate that the context of the parent-child dyad, the wider family and the community are important to consider when providing technology use advice. The findings from this thesis extend research to look at parent-child attachment relationships (including prenatal attachment) and mechanisms for how and why device use influences relationships. This is useful as current guidelines are typically based on developmental outcomes such as language development, attention span, and school readiness. The current research program demonstrates that conceptualising parent and infant device use within a family systems framework is likely to be useful as there is the potential for the quality of interactions between others in the wider family and the community to be associated with device use, and in turn this may affect parent-child attachment security. Therefore, family and community factors are likely to be important when exploring associations between device use and parent-child attachment.

References

Adams, E. L., Smith, D., Caccavale, L. J., & Bean, M. K. (2021). Parents are stressed! Patterns of parent stress across COVID-19. *Frontiers in Psychiatry, 12*, 626456-626456. doi:10.3389/fpsyt.2021.626456

Ahearne, C., Dilworth, S., Rollings, R., Livingstone, V., & Murray, D. (2016). Touch-screen technology usage in toddlers. *Archives of Disease in Childhood, 101*(2), 181-183. doi:10.1136/archdischild-2015-309278

Ahn, D., & Shin, D.-H. (2013). Is the social use of media for seeking connectedness or for avoiding social isolation? Mechanisms underlying media use and subjective well-being. *Computers in Human Behavior, 29*(6), 2453-2462. doi:10.1016/j.chb.2012.12.022

Ainsworth, M., Blehar, M., Waters, E., & Wall, S. (1978). *Patterns of attachment: a pscyhological study of the strange situation*. New York: Lawrence Erlbaum Associates.

Ainsworth, M. D. S., Bell, S. M., & Stayton, D. F. (1974). Infant-mother attachment and social development: Socialization as a product of reciprocal responsiveness to signals. In *The integration of a child into a social world.* (pp. 99-135). New York, NY, US: Cambridge University Press.

Alzhrani, A. M., Johnstone, K. R., Winkler, E. A. H., Healy, G. N., & Cook, M. M. (2022). Using touchscreen mobile devices-when, where and how: a one-week field study. *Ergonomics, 65*(4), 561-572. doi:10.1080/00140139.2021.1973577

American Academy of Pediatrics Council on Communications and Media. (2016). Media and young minds. *Pediatrics, 138*(5), e20162591.

Ando, M., Takeda, T., & Kumagai, K. (2021). A qualitative study of impacts of the COVID-19 pandemic on lives in adults with attention deficit hyperactive disorder in Japan. *International Journal of Environmental Research and Public Health, 18*(4), 1-10. doi:10.3390/ijerph18042090

Ansari, A., & Crosnoe, R. (2016). Children's hyperactivity, television viewing, and the potential for child effects. *Children and Youth Services Review, 61*, 135-140. doi:10.1016/j.childyouth.2015.12.018

Assunção, R. S., Costa, P., Tagliabue, S., & Mena Matos, P. (2017). Problematic Facebook use in adolescents: Associations with parental attachment and alienation to peers. *Journal of Child and Family Studies, 26*(11), 2990-2998. doi:10.1007/s10826-017-0817-2

Assunção, R. S., & Matos, P. M. (2017). Adolescents' profiles of problematic Facebook use and associations with developmental variables. *Computers in Human Behavior, 75*, 396-403. doi:10.1016/j.chb.2017.05.034

Attai, P., Szabat, J., Anzman-Frasca, S., & Kong, K. L. (2020). Associations between parental and child screen time and quality of the home environment: A preliminary investigation. *International Journal of Environmental Research and Public Health, 17*(17), 1-11. doi:10.3390/ijerph17176207

Atwood, R. M., Beckert, T. E., & Rhodes, M. R. (2017). Adolescent problematic digital behaviors associated with mobile devices. *North American Journal of Psychology, 19*(3), 659-683. https://www.proquest.com/docview/1967813291?pq-origsite=gscholar&fromopenview=true

Australian Bureau of Statistics. (2017). Household Use of Information Technology, Australia, 2016-17. (No. 8146.0). Retrieved from https://www.abs.gov.au/ausstats/abs@.nsf/mf/8146.0

Australian Department of Health. (2017). Australian 24-hour movement guidelines for the early years (birth to 5 years): An integration of physical activity, sedentary behaviour, and sleep. Retrieved from https://www1.health.gov.au/internet/main/publishing.nsf/content/npra-0-5yrs-brochure

Awaluddin, S. M. B., Ying Ying, C., Yoep, N., Paiwai, F., Lodz, N. A., Muhammad, E. N., . . . Nik Abd Rashid, N. R. (2019). The association of internet addiction and perceived parental protective factors among Malaysian adolescents. *Asia-Pacific Journal of Public Health, 31*(8_suppl), 57S-64S. doi:10.1177/1010539519872642

Badenes-Ribera, L., Fabris, M. A., Gastaldi, F. G. M., Prino, L. E., & Longobardi, C. (2019). Parent and peer attachment as predictors of facebook addiction symptoms in different developmental stages (early adolescents and adolescents). *Addictive Behaviors, 95*, 226-232. doi:10.1016/j.addbeh.2019.05.009

Badovinac, S., Martin, J., Guerin-Marione, C., O'Neill, M., Riddell, R. P., Bureau, J.-F., & Spiegel, R. (2018). Associations between mother-preschooler attachment and maternal depression symptoms: A systematic review and meta-analysis. *PLoS One, 13*(10), e0204374-e0204374. doi:10.1371/journal.pone.0204374

Ballarotto, G., Volpi, B., Marzilli, E., & Tambelli, R. (2018). Adolescent internet abuse: A study on the role of attachment to parents and peers in a large community sample. *BioMed Research International, 2018*, 5769250-5769210. doi:10.1155/2018/5769250

Bank, A. M., Barr, R., Calvert, S. L., Parrott, W. G., McDonough, S. C., & Rosenblum, K. (2011). Maternal depression and family media use: a questionnaire and diary analysis. *Journal of Child and Family Studies, 21*(2), 208-216. doi:10.1007/s10826-011-9464-1

Bar Lev, Y., Elias, N. (2020). Digital parenting: media uses in parenting routines during the first two years of life. *Studies in Media and Communication, 8*(2), 41-48. doi:10.11114/smc.v8i2.5050

Bates, L. C., Zieff, G., Stanford, K., Moore, J. B., Kerr, Z. Y., Hanson, E. D., . . . Stoner, L. (2020). Covid-19 impact on behaviors across the 24-hour day in children and adolescents: Physical activity, sedentary behavior, and sleep. *Children, 7*(9), 138. doi:10.3390/children7090138

Beamish, N., Fisher, J., & Rowe, H. (2019). Parents' use of mobile computing devices, caregiving and the social and emotional development of children: a systematic review of the evidence. *Australasian Psychiatry, 27*(2), 132-143. doi:10.1177/1039856218789764

Bedford, R., Saez de Urabain, I. R., Cheung, C. H. M., Karmiloff-Smith, A., & Smith, T. J. (2016). Toddlers' fine motor milestone achievement is associated with early touchscreen scrolling. *Frontiers in Psychology, 7*, 1108-1108. doi:10.3389/fpsyg.2016.01108

Benoit, D., Parker, K. C. H., & Zeanah, C. H. (1997). Mothers' representations of their infants assessed prenatally: Stability and association with infants' attachment classifications. *Journal of Child Psychology and Psychiatry, 38*(3), 307-313. doi:10.1111/j.1469-7610.1997.tb01515.x

Bentley, G. F., Turner, K. M., & Jago, R. (2016). Mothers' views of their preschool child's screen-viewing behaviour: A qualitative study. *BMC Public Health, 16*(1), 718-718. doi:10.1186/s12889-016-3440-z

Bernardi, S., & Pallanti, S. (2009). Internet addiction: a descriptive clinical study focusing on comorbidities and dissociative symptoms. *Comprehensive Psychiatry, 50*(6), 510-516. doi:10.1016/j.comppsych.2008.11.011

Bogl, L. H., Mehlig, K., Ahrens, W., Gwozdz, W., De Henauw, S., Molnár, D., . . . Hebestreit, A. (2020). Like me, like you-relative importance of peers and siblings on children's fast food consumption and screen time but not sports club participation depends on age. *The International Journal of Behavioral Nutrition and Physical Activity, 17*(1), 50-50. doi:10.1186/s12966-020-00953-4

Bohlin, G., Hagekull, B., & Rydell, A.-M. (2000). Attachment and social functioning: A longitudinal study from infancy to middle childhood. *Social Development, 9*(1), 24-39. doi:10.1111/1467-9507.00109

Bolat, N., Yavuz, M., Eliacık, K., & Zorlu, A. (2018). The relationships between problematic internet use, alexithymia levels and attachment characteristics in a sample of adolescents in a high school, Turkey. *Psychology, Health & Medicine, 23*(5), 604-611. doi:10.1080/13548506.2017.1394474

Boniel-Nissim, M., & Sasson, H. (2018). Bullying victimization and poor relationships with parents as risk factors of problematic internet use in adolescence. *Computers in Human Behavior, 88*, 176-183. doi:10.1016/j.chb.2018.05.041

Bonnaire, C., & Phan, O. (2017). Relationships between parental attitudes, family functioning and Internet gaming disorder in adolescents attending school. *Psychiatry Research, 255*, 104-110. doi:10.1016/j.psychres.2017.05.030

Bordeleau, S., Bernier, A., & Carrier, J. (2012). Longitudinal associations between the quality of parent-child interactions and children's sleep at preschool age. *Journal of Family Psychology, 26*(2), 254-262. doi:10.1037/a0027366

Bowlby, J. (1980). *Attachment and loss. Loss, sadness and depression* (Vol. 3). New York: Basic Books.

Brandon, A. R., Pitts, S., Denton, W. H., Stringer, C. A., & Evans, H. M. (2009). A history of the theory of prenatal attachment. *Journal of Prenatal & Perinatal Psychology & Health, 23*(4), 201-222. https://pubmed.ncbi.nlm.nih.gov/21533008/

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. doi:10.1191/1478088706qp063oa

Braune-Krickau, K., Schneebeli, L., Pehlke-Milde, J., Gemperle, M., Koch, R., & Wyl, A. (2021). Smartphones in the nursery: Parental smartphone use and parental sensitivity and responsiveness within parent–child interaction in early childhood (0–5 years): A scoping review. *Infant Mental Health Journal, 42*(2), 161-175. doi:10.1002/imhj.21908

Braungart-Rieker, J., Murphy Garwood, M., Powers, B. P., & Notaro, P. C. (1998). Infant affect and affect regulation during the still-face paradigm with mothers and fathers: The role of infant characteristics and parental sensitivity. *Developmental Psychology, 34*(6), 1428-1437. doi:10.1037/0012-1649.34.6.1428

Brennan, K. A., Clark, C.L., & Shaver, P.R. . (1998). *Self-report measurement of adult attachment: An integrative overview.* New York: Guildford.

Bronfenbrenner, U., Morris, P. (2006). *The bioecological model of human development* (Vol. 6th Edition). Hoboken NJ: Wiley.

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The Lancet (British edition), 395*(10227), 912-920. doi:10.1016/S0140-6736(20)30460-8

Brumariu, L. E. (2015). Parent-child attachment and emotion regulation. *New Directions for Child and Adolescent Development, 2015*(148), 31-45. doi:10.1002/cad.20098

Byrne, R., Terranova, C. O., & Trost, S. G. (2021). Measurement of screen time among young children aged 0–6 years: A systematic review. *Obesity Reviews, 22*(8), e13260-n/a. doi:10.1111/obr.13260

Caccia, N., Johnson, J. M., Robinson, G. E., & Barna, T. (1991). Impact of prenatal testing on maternal-fetal bonding: chorionic villus sampling versus amniocentesis. *American Journal of Obstetrics and Gynecology, 165*(4), 1122-1125. doi:10.1016/0002-9378(91)90484-9

Cao, Y., Huang, L., Si, T., Wang, N. Q., Qu, M., & Zhang, X. Y. (2021). The role of only-child status in the psychological impact of COVID-19 on mental health of Chinese adolescents. *Journal of Affective Disorders, 282*, 316-321. doi:10.1016/j.jad.2020.12.113

Casaló, L. V., & Escario, J.-J. (2019). Predictors of excessive internet use among adolescents in Spain: The relevance of the relationship between parents and their children. *Computers in Human Behavior, 92*, 344-351. doi:10.1016/j.chb.2018.11.042

Chandola, T., Kumari, M., Booker, C. L., & Benzeval, M. J. (2020). The mental health impact of COVID-19 and lockdown related stressors among adults in the UK. *Psychological Medicine*, 1-10. doi:10.1017/S0033291720005048

Chaudron, S., Beutel, M.E., Donoso Navarrete, V., Dreier, M., Fletcher-Watson, B., Heikkila, A.S. (2015). Young children (0-8) and digital technology: A qualitative exploratory study across seven countries. Retrieved from https://www.researchgate.net/publication/283398879_Young_Children_0-8_and_digital_technology_A_qualitative_exploratory_study_across_seven_countries/link/56377b4508aed65d3c42c5f0/download

Chen, I. H., Lee, Z.-H., Dong, X.-Y., Gamble, J. H., & Feng, H.-W. (2020). The influence of parenting style and time management tendency on internet gaming disorder among adolescents. *International Journal of Environmental Research and Public Health, 17*(23), 1-16. doi:10.3390/ijerph17239120

Chen, S., Weng, L., Su, Y., Wu, H., & Yang, P. (2003). Development of a Chinese internet addiction scale and its psychmetric study. *Chinese Journal of Psychology, 45*, 279-294. https://psycnet.apa.org/record/2004-10292-005

Chen, W., Teo, M. H., & Nguyen, D. (2019). Singapore parents' use of digital devices with young children: motivations and uses. *The Asia-Pacific Education Researcher, 28*(3), 239-250. doi:10.1007/s40299-019-00432-w

Cheng, Y.-C., Yang, T.-A., & Lee, J.-C. (2021). The relationship between smartphone addiction, parent-child relationship, loneliness and self-efficacy among senior high school students in Taiwan. *Sustainability, 13*(16), 9475. doi:10.3390/su13169475

Cheung, C. H. M., Bedford, R., Saez De Urabain, I. R., Karmiloff-Smith, A., & Smith, T. J. (2017). Daily touchscreen use in infants and toddlers is associated with reduced sleep and delayed sleep onset. *Scientific Reports, 7*(1), 46104-46104. doi:10.1038/srep46104

Cho, J. (2015). Roles of smartphone app use in improving social capital and reducing social isolation. *Cyberpsychology, Behavior, and Social Networking, 18*(6), 35-355. doi:10.1089/cyber.2014.0657

Chung, G., Lanier, P., & Wong, P. Y. J. (2020). Mediating effects of parental stress on harsh parenting and parent-child relationship during Coronavirus (COVID-19) pandemic in Singapore. *Journal of Family Violence, 37*(5), 801-812. doi:10.1007/s10896-020-00200-1

Coccia, M. (2021). The relation between length of lockdown, numbers of infected people and deaths of Covid-19, and economic growth of countries: Lessons learned to cope with future pandemics similar to Covid-19 and to constrain the deterioration of economic system. *The Science of the Total Environment, 775*, 145801. doi:10.1016/j.scitotenv.2021.145801

Coenen, P., van der Molen, H. F., Burdorf, A., Huysmans, M. A., Straker, L., Frings-Dresen, M. H. W., & van der Beek, A. J. (2019). Associations of screen work with neck and upper extremity symptoms: a systematic review with meta-analysis. *Occupational and Environmental Medicine, 76*(7), 502-509. doi:10.1136/oemed-2018-105553

Condon, J. (1993). The assessment of antenatal emotional attachment: development of a questionnaire instrument. *British Journal of Medical Psychology, 66*(2), 167-183. doi:10.1111/j.2044-8341.1993.tb01739.x

Condon, J. (2015). Maternal Postnatal Attachment Scale [Measurement instrument]. Retrieved from https://doi.org/10.25957/5dc0f28d14338

Condon, J., Corkindale, C., Boyce, P., & Gamble, E. (2013). A longitudinal study of father-to-infant attachment: antecedents and correlates. *Journal of Reproductive and Infant Psychology, 31*(1), 15-30. doi:10.1080/02646838.2012.757694

Condon, J. T., & Corkindale, C. J. (1998). The assessment of parent-to-infant attachment: Development of a self-report questionnaire instrument. *Journal of Reproductive and Infant Psychology, 16*(1), 57-76. doi:10.1080/02646839808404558

Coyne, S. M., Padilla-Walker, L. M., Fraser, A. M., Fellows, K., & Day, R. D. (2014). Media time = family time: Positive media use in families with adolescents. *Journal of Adolescent Research, 29*(5), 663-688. doi:10.1177/0743558414538316

Coyne, S. M., Shawcroft, J., Gale, M., Reich, S. M., Linder, L., McDaniel, B., . . . Booth, M. (2022). Digital distraction or accessible aid? Parental media use during feedings and parent-infant attachment, dysfunction, and relationship quality. *Computers in Human Behavior, 127*, 107051. doi:10.1016/j.chb.2021.107051

Cranley, M. S. (1981). Development of a tool for the measurement of maternal attachment during pregnancy. *Nursing Research, 30*(5), 281-284. doi:10.1097/00006199-198109000-00008

Creighton, A. (2011). Mother-infant musical interaction and emotional communication: A literature review. *Australian Journal of Music Therapy, 22*, 37-58. doi:10.3316/informit.686676185202331

D'Arienzo, M. C., Boursier, V., & Griffiths, M. D. (2019). Addiction to social media and attachment styles: a systematic literature review. *International Journal of Mental Health and Addiction, 17*(4), 1094-1118. doi:10.1007/s11469-019-00082-5

de Cock, E. S. A., Henrichs, J., Vreeswijk, C. M. J. M., Maas, A. J. B. M., Rijk, C. H. A. M., & van Bakel, H. J. A. (2016). Continuous feelings of love? The parental bond from pregnancy to toddlerhood. *Journal of Family Psychology, 30*(1), 125-134. doi:10.1037/fam0000138

Detnakarintra, K., Trairatvorakul, P., Pruksananonda, C., & Chonchaiya, W. (2020). Positive mother-child interactions and parenting styles were associated with lower screen time in early childhood. *Acta Paediatrica, 109*(4), 817-826. doi:10.1111/apa.15007

Dijkers, M. (2013). Introducing GRADE: A systematic approach to rating evidence in systematic reviews and to guideline development. . Retrieved from https://ktdrr.org/products/update/v1n5/dijkers_grade_ktupdatev1n5.pdf

Ding, Y.-h., Xu, X., Wang, Z.-y., Li, H.-r., & Wang, W.-p. (2014). The relation of infant attachment to attachment and cognitive and behavioural outcomes in early childhood. *Early Human Development, 90*(9), 459-464. doi:10.1016/j.earlhumdev.2014.06.004

Domoff, S. E., Harrison, K., Gearhardt, A. N., Gentile, D. A., Lumeng, J. C., & Miller, A. L. (2019). Development and validation of the problematic media use measure: a parent report measure of screen media "addiction" in children. *Psychology of Popular Media Culture, 8*(1), 2-11. doi:10.1037/ppm0000163

Dong, G. S., Yujeong, P., Min Kyung, K., & Jaekook, P. (2016). Mobile phone dependency and its impacts on adolescents' social and academic behaviors. *Computers in Human Behavior, 63*, 282-292. doi:10.1016/j.chb.2016.05.026

Drouin, M., McDaniel, B. T., Pater, J., & Toscos, T. (2020). How parents and their children used social media and technology at the beginning of the COVID-19 pandemic and associations with anxiety. *Cyberpsychology, Behavior and Social Networking, 23*(11), 727-736. doi:10.1089/cyber.2020.0284

Dubrov, D. I. (2020). Information and communication technologies and family relations: Harm or benefit? *Social Psychology and Society, 11*(1), 72-91. doi:10.17759/sps.2020110105

Dutra, G. F., Kaufmann, C. C., Pretto, A. D. B., & Albernaz, E. P. (2015). Television viewing habits and their influence on physical activity and childhood overweight. *Jornal de Pediatria, 91*(4), 346-351. doi:10.1016/j.jped.2014.11.002

Eales, L., Gillespie, S., Alstat, R. A., Ferguson, G. M., & Carlson, S. M. (2021). Children's screen and problematic media use in the United States before and during the COVID-19 pandemic. *Child Development, 92*(5), e866-e882. doi:10.1111/cdev.13652

Early Childhood Australia. (2015). Screen time and children. Retrieved from https://earlychildhood.qld.gov.au/earlyYears/Documents/pts-screen-time-and-children.pdf

Early Childhood Australia. (2018). Statement on young children and digital technologies. Retrieved from http://dx.doi.org/10.23965/ECA.001

Edhborg, M., Lundh, W., Seimyr, L., & Widström, A. M. (2003). The parent-child relationship in the context of maternal depressive mood. *Archives of Women's Mental Health, 6*(3), 211-216. doi:10.1007/s00737-003-0020-x

Ewin, C. A., Reupert, A., & McLean, L. A. (2021). Naturalistic observations of caregiver – Child dyad mobile device use. *Journal of Child and Family Studies, 30*(8), 2042-2054. doi:10.1007/s10826-021-01993-5

Faltýnková, A., Blinka, L., Ševčíková, A., & Husarova, D. (2020). The associations between family-related factors and excessive internet use in adolescents. *International Journal of Environmental Research and Public Health, 17*(5), 1754. doi:10.3390/ijerph17051754

Fang, K., Mu, M., Liu, K., & He, Y. (2019). Screen time and childhood overweight/obesity: a systematic review and meta-analysis. *Child Care Health and Development, 45*(5), 744-753. doi:10.1111/cch.12701

Fiorillo, A., & Gorwood, P. (2020). The consequences of the COVID-19 pandemic on mental health and implications for clinical practice. *European Psychiatry, 63*(1), e32-e32. doi:10.1192/j.eurpsy.2020.35

Fleming, S. E., Vandermause, R., & Shaw, M. (2014). First-time mothers preparing for birthing in an electronic world: internet and mobile phone technology. *Journal of Reproductive and Infant Psychology, 32*(3), 240-253. doi:10.1080/02646838.2014.886104

Floros, G., & Siomos, K. (2013). The relationship between optimal parenting,internet addiction and motives for social networking in adolescence. *Psychiatry Research, 209*(3), 529-534. doi:10.1016/j.psychres.2013.01.010

Frankel, L. A., Umemura, T., Jacobvitz, D., & Hazen, N. (2015). Marital conflict and parental responses to infant negative emotions: Relations with toddler emotional regulation. *Infant Behavior & Development, 40*, 73-83. doi:10.1016/j.infbeh.2015.03.004

Fredriksen, E. H., Harris, J., & Moland, K. M. (2016). Web-based discussion forums on pregnancy complaints and maternal health literacy in Norway: A qualitative study. *Journal of Medical Internet Research, 18*(5), e113-e113. doi:10.2196/jmir.5270

Frosch, C. A., Mangelsdorf, S. C., & McHale, J. L. (2000). Marital behavior and the security of preschooler-parent attachment relationships. *Journal of Family Psychology, 14*(1), 144-161. doi:10.1037/0893-3200.14.1.144

Gabbiadini, A., Baldissarri, C., Durante, F., Valtorta, R. R., De Rosa, M., & Gallucci, M. (2020). Together apart: The mitigating role of digital communication technologies on negative affect during the COVID-19 outbreak in Italy. *Frontiers in Psychology, 11*, 554678-554678. doi:10.3389/fpsyg.2020.554678

Gao, Q., Sun, R., Fu, E., Jia, G., & Xiang, Y. (2020). Parent–child relationship and smartphone use disorder among Chinese adolescents: The mediating role of quality of life and the moderating role of educational level. *Addictive Behaviors, 101*, 106065-106065. doi:10.1016/j.addbeh.2019.106065

Gao, T., Meng, X., Qin, Z., Zhang, H., Gao, J., Kong, Y., . . . Mei, S. (2018). Association between parental marital conflict and Internet addiction: a moderated mediation analysis. *Journal of Affective Disorders, 240*, 27-32. doi:10.1016/j.jad.2018.07.005

Gibson, L. Y., Lockyer, B., Dickerson, J., Endacott, C., Bridges, S., McEachan, R. R. C., . . . Davis, J. A. (2021). Comparison of experiences in two birth cohorts comprising young families with children under four years during the initial covid-19 lockdown in australia and the uk: A qualitative study. *International Journal of Environmental Research and Public Health, 18*(17), 9119. doi:10.3390/ijerph18179119

Glick, A. R., Saiyed, F. S., Kutlesa, K., Onishi, K. H., & Nadig, A. S. (2022). Implications of video chat use for young children's learning and social-emotional development: Learning words, taking turns, and fostering familial relationships. *Wiley Interdisciplinary Reviews. Cognitive science*, e1599-e1599. doi:10.1002/wcs.1599

Gong, J., Zhou, Y., Wang, Y., Liang, Z., Hao, J., Su, L., . . . Wang, Y. (2022). How parental smartphone addiction affects adolescent smartphone addiction: The effect of the parent-child relationship and parental bonding. *Journal of Affective Disorders, 307*, 271-277. doi:10.1016/j.jad.2022.04.014

Government of Western Australia. (2020). Changes to government school learning from Monday. Media Statements: March 26, 2020. Retrieved from https://www.mediastatements.wa.gov.au/Pages/McGowan/2020/03/Changes-to-government-school-learning-from-Monday.aspx

Graham, A., & Sahlberg, P. (2021). Growing up digital Australia: Phase 2 technical report. Retrieved from https://www.gie.unsw.edu.au/growing-digital-australia-phase-2-results

Grajewski, P., & Dragan, M. (2020). Adverse childhood experiences, dissociation, and anxious attachment style as risk factors of gaming disorder. *Addictive Behaviors Reports, 11*, 100269-100269. doi:10.1016/j.abrep.2020.100269

Grant, J. E., Lust, K., & Chamberlain, S. R. (2019). Problematic smartphone use associated with greater alcohol consumption, mental health issues, poorer academic performance, and impulsivity. *Journal of Behavioral Addictions, 8*(2), 335-342. doi:10.1556/2006.8.2019.32

Grimes, H. A., Forster, D. A., & Newton, M. S. (2014). Sources of information used by women during pregnancy to meet their information needs. *Midwifery, 30*(1), e26-e33. doi:10.1016/j.midw.2013.10.007

Groh, A. M., Fearon, R. P., Bakermans-Kranenburg, M. J., van Ijzendoorn, M. H., Steele, R. D., & Roisman, G. I. (2014). The significance of attachment security for children's social competence with peers: a meta-analytic study. *Attachment & Human Development, 16*(2), 103-136. doi:10.1080/14616734.2014.883636

Günther-Bel, C., Vilaregut, A., Carratala, E., Torras-Garat, S., & Pérez-Testor, C. (2020). A mixed-method study of individual, couple, and parental functioning during the state-regulated COVID-19 lockdown in Spain. *Family Process, 59*(3), 1060-1079. doi:10.1111/famp.12585

Gurcan, F., Cagiltay, N. E., & Cagiltay, K. (2021). Mapping human-computer interaction research themes and trends from its existence to today: A topic modeling-based review of past 60 years. *International Journal of Human-Computer Interaction, 37*(3), 267-280. doi:10.1080/10447318.2020.1819668

Gutierrez, S., & Ventura, A. (2021). Associations between maternal technology use, perceptions of infant temperament, and indicators of mother-to-infant attachment quality. *Early Human Development, 154*, 105305-105305. doi:10.1016/j.earlhumdev.2021.105305

Han, H., Lee, S., & Shin, G. (2019). Naturalistic data collection of head posture during smartphone use. *Ergonomics, 62*(3), 444-448. doi:10.1080/00140139.2018.1544379

Harris, C., & Straker, L. (2000). Survey of physical ergonomics issues associated with school childrens' use of laptop computers. *International Journal of Industrial Ergonomics, 26*(3), 337-346. doi:10.1016/S0169-8141(00)00009-3

Hawryluck, L., Gold, W. L., Robinson, S., Pogorski, S., Galea, S., & Styra, R. (2004). SARS control and psychological effects of quarantine, Toronto, Canada. *Emerging Infectious Diseases, 10*(7), 1206-1212. doi:10.3201/eid1007.030703

Hefner, D., Knop, K., Schmitt, S., & Vorderer, P. (2019). Rules? Role model? Relationship? The impact of parents on their children's problematic mobile phone involvement. *Media Psychology, 22*(1), 82-108. doi:10.1080/15213269.2018.1433544

Hiniker, A., Sobel, K., Suh, H., Sung, Y.-C., Lee, C., & Kientz, J. (2015, 2015). *Texting while parenting: how adults use mobile phones while caring for children at the playground.* Paper presented at the Conference on Human Factors in Computing Systems.

Hinkley, T., Brown, H., Carson, V., & Teychenne, M. (2018). Cross sectional associations of screen time and outdoor play with social skills in preschool children. *PLoS One, 13*(4), e0193700-e0193700. doi:10.1371/journal.pone.0193700

Hjelmstedt, A., Widstrom, A.-M., & Collins, A. (2006). Psychological correlates of prenatal attachment in women who conceived after In vitro fertilization and women who conceived naturally. *Birth, 33*(4), 303-310. doi:10.1111/j.1523-536X.2006.00123.x

Hood, R., Zabatiero, J., Silva, D., R Zubrick, S., & Straker, L. (2022). 'There's good and bad': parent perspectives on the influence of mobile touch screen device use on prenatal attachment. *Ergonomics*, 1-16. doi:10.1080/00140139.2022.2041734

Hood, R., Zabatiero, J., Silva, D., Zubrick, S. R., & Straker, L. (2021). “Coronavirus changed the rules on everything”: Parent perspectives on how the COVID-19 pandemic influenced family routines, relationships and technology use in families with infants. *International Journal of Environmental Research and Public Health, 18*(23), 12865. doi:10.3390/ijerph182312865

Hood, R., Zabatiero, J., Zubrick, S. R., Silva, D., & Straker, L. (2021). The association of mobile touch screen device use with parent-child attachment: a systematic review. *Ergonomics, 64*(12), 1606-1622. doi:10.1080/00140139.2021.1948617

Hormes, J. M. (2016). Under the influence of Facebook? Excess use of social networking sites and drinking motives, consequences, and attitudes in college students. *Journal of Behavioral Addictions, 5*(1), 122-129. doi:10.1556/2006.5.2016.007

Houghton, S., Hunter, S. C., Rosenberg, M., Wood, L., Zadow, C., Martin, K., & Shilton, T. (2015). Virtually impossible: Limiting Australian children and adolescents daily screen based media use. *BMC Public Health, 15*(1), 5-5. doi:10.1186/1471-2458-15-5

Howe, A. S., Health, A. M., Lawrence, J., Galland, B. C., & Gray, A. R. (2017). Parenting style and family type, but not child temperament, are associated with television viewing time in children at two years of age. *PLoS One, 12*(12), e0188558-e0188558. doi:10.1371/journal.pone.0188558

Howie, E. K., Coenen, P., Campbell, A. C., Ranelli, S., & Straker, L. M. (2017). Head, trunk and arm posture amplitude and variation, muscle activity, sedentariness and physical activity of 3 to 5 year-old children during tablet computer use compared to television watching and toy play. *Applied Ergonomics, 65*, 41-50. doi:10.1016/j.apergo.2017.05.011

Hsieh, Y.-P., Shen, A. C.-T., Wei, H.-S., Feng, J.-Y., Huang, S. C.-Y., & Hwa, H.-L. (2018). Internet addiction: A closer look at multidimensional parenting practices and child mental health. *Cyberpsychology, Behavior and Social Networking, 21*(12), 768-773. doi:10.1089/cyber.2018.0435

Huang, S., Hu, Y., Ni, Q., Qin, Y., & Lü, W. (2019). Parent-children relationship and internet addiction of adolescents: The mediating role of self-concept. *Current Psychology, 40*(5), 2510-2517. doi:10.1007/s12144-019-00199-9

Hughson, J.-A. P., Oliver Daly, J., Woodward-Kron, R., Hajek, J., & Story, D. (2018). The rise of pregnancy apps and the implications for culturally and linguistically diverse women: Narrative review. *JMIR mHealth and uHealth, 6*(11), e189-e189. doi:10.2196/mhealth.9119

Jake-Schoffman, D. E., Turner-McGrievy, G., & Walsemann, K. M. (2017). Wired: parent-child relationship quality and recreational media use in a diverse sample of US children and adolescents. *Journal of Children and Media, 11*(3), 347-357. doi:10.1080/17482798.2017.1303523

Jimeno, M. V., Ricarte, J. J., Toledano, A., Mangialavori, S., Cacioppo, M., & Ros, L. (2022). Role of attachment and family functioning in problematic smartphone use in young adults. *Journal of Family Issues, 43*(2), 375-391. doi:10.1177/0192513X21993881

Kabali, H. K., Irigoyen, M. M., Nunez-Davis, R., Budacki, J. G., Mohanty, S. H., Leister, K. P., & Bonner, J. R. L. (2015). Exposure and use of mobile media devices by young children. *Pediatrics, 136*(6), 1044-1050. doi:10.1542/peds.2015-2151

Kantowitz, B. H., & Sorkin, R. D. (1983). *Human factors: understanding people-system relationships*: Wiley, New York.

Karaer, Y., & Akdemir, D. (2019). Parenting styles, perceived social support and emotion regulation in adolescents with internet addiction. *Comprehensive Psychiatry, 92*, 22-27. doi:10.1016/j.comppsych.2019.03.003

Kates, A. W., Wu, H., & Coryn, C. L. S. (2018). The effects of mobile phone use on academic performance: a meta-analysis. *Computers and Education, 127*, 107-112. doi:10.1016/j.compedu.2018.08.012

Kaye, L. K., Orben, A., Ellis, D. A., Hunter, S. C., & Houghton, S. (2020). The conceptual and methodological mayhem of "screen time". *International Journal of Environmental Research and Public Health, 17*(10), 3661. doi:10.3390/ijerph17103661

Kerr, M. E., & Bowen, M. (1988). *Family Evaluation: An Approach Based on Bowen Theory.*: New York: W. W. Norton.

Kildare, C. A., & Middlemiss, W. (2017). Impact of parents mobile device use on parent-child interaction: A literature review. *Computers in Human Behavior, 75*, 579-593. doi:10.1016/j.chb.2017.06.003

Kim, K., & Kim, K. (2015). Internet game addiction, parental attachment, and parenting of adolescents in South Korea. *Journal of Child & Adolescent Substance Abuse, 24*(6), 366-371. doi:10.1080/1067828X.2013.872063

Kim Y., C. H., Lee H. (2017). The effect of parental attachment of teenagers on cell-phone dependence: Focusing on mediator effect of self-esteem. *Journal of Engineering and Applied Sciences, 12*(1), 5699-5703. doi:10.3923/jeasci.2017.5699.5703

King, D. L., & Delfabbro, P. H. (2016). Features of parent-child relationships in adolescents with internet gaming disorder. *International Journal of Mental Health and Addiction, 15*(6), 1270-1283. doi:10.1007/s11469-016-9699-6

Kompas, T., Grafton, R. Q., Che, T. N., Chu, L., & Camac, J. (2021). Health and economic costs of early and delayed suppression and the unmitigated spread of COVID-19: The case of Australia. *PLoS One, 16*(6), e0252400-e0252400. doi:10.1371/journal.pone.0252400

Kostyrka-Allchorne, K., Cooper, N. R., & Simpson, A. (2017). The relationship between television exposure and children's cognition and behaviour: A systematic review. *Developmental Review, 44*, 19-58. doi:10.1016/j.dr.2016.12.002

Kovacs, V. A., Starc, G., Brandes, M., Kaj, M., Blagus, R., Leskošek, B., . . . Okely, A. D. (2022). Physical activity, screen time and the COVID-19 school closures in Europe - An observational study in 10 countries. *European Journal of Sport Science, 22*(7), 1094-1103. doi:10.1080/17461391.2021.1897166

Kracht, C. L., Katzmarzyk, P. T., & Staiano, A. E. (2021). Household chaos, family routines, and young child movement behaviors in the U.S. during the COVID-19 outbreak: a cross-sectional study. *BMC Public Health, 21*(1), 860-860. doi:10.1186/s12889-021-10909-3

Kraschnewski, J. L., Chuang, C. H., Poole, E. S., Peyton, T., Blubaugh, I., Pauli, J., . . . Reddy, M. (2014). Paging Dr. Google: Does technology fill the gap created by the prenatal care visit structure qualitative focus group study with pregnant women. *Journal of Medical Internet Research, 16*(6), e147-e147. doi:10.2196/jmir.3385

Kucirkova, N., Messer, D., Sheehy, K., & Flewitt, R. (2013). Sharing personalised stories on iPads: a close look at one parent-child interaction. *Literacy, 47*(3), 115-122. doi:10.1111/lit.12003

Kwak, J. Y., Kim, J. Y., & Yoon, Y. W. (2018). Effect of parental neglect on smartphone addiction in adolescents in South Korea. *Child Abuse & Neglect, 77*, 75-84. doi:10.1016/j.chiabu.2017.12.008

Kwok, S. W. H., Lee, P. H., & Lee, R. L. T. (2017). Smart device use and perceived physical and psychosocial outcomes among Hong Kong adolescents. *International Journal of Environmental Research and Public Health, 14*(2), 205. doi:10.3390/ijerph14020205

Kyriakoullis, L., & Zaphiris, P. (2015). Culture and HCI: a review of recent cultural studies in HCI and social networks. *Universal Aaccess in the Information Society, 15*(4), 629-642. doi:10.1007/s10209-015-0445-9

Lan, X., & Wang, W. (2020). Parental attachment and problematic internet use among chinese adolescents: The moderating role of gender and grit. *International Journal of Environmental Research and Public Health, 17*(23), 1-13. doi:10.3390/ijerph17238933

Lauricella, A. R., Wartella, E., & Rideout, V. J. (2015). Young children's screen time: The complex role of parent and child factors. *Journal of Applied Developmental Psychology, 36*, 11-17. doi:10.1016/j.appdev.2014.12.001

Laxton-Kane, M., & Slade, P. (2002). The role of maternal prenatal attachment in a woman's experience of pregnancy and implications for the process of care. *Journal of Reproductive and Infant Psychology, 20*(4), 253-266. doi:10.1080/0264683021000033174

Lederer, Y., Artzi, H., & Borodkin, K. (2022). The effects of maternal smartphone use on mother–child interaction. *Child Development, 93*(2), 556-570. doi:10.1111/cdev.13715

Lee, E., & Carson, V. (2018). Physical activity, sedentary behaviour, and psychosocial well-being among young South Korean children. *Child Care Health and Development, 44*(1), 108-116. doi:10.1111/cch.12491

Lee, E. J., & Kim, H. S. (2018). Gender differences in smartphone addiction behaviors associated with parent-child bonding, parent-child communication, and parental mediation among Korean elementary school students. *Journal of Addictions Nursing, 29*(4), 244-254. doi:10.1097/JAN.0000000000000254

Lee, S. J. (2009). Online communication and adolescent social ties: Who benefits more from internet use? *Journal of Computer-Mediated Communication, 14*(3), 509-531. doi:10.1111/j.1083-6101.2009.01451.x

Lee, S. J., & Chae, Y. G. (2007). Children's Internet use in a family context: influence on family relationships and parental mediation. *Cyberpsychology, Behavior, and Social Networking, 10*(5), 640-644. doi:10.1089/cpb.2007.9975

Lee, Y., & Moon, M. (2016). Utilization and content evaluation of mobile applications for pregnancy, birth, and child care. *Healthcare Informatics Research, 22*(2), 73-80. doi:10.4258/hir.2016.22.2.73

Lemmens, J. S., Valkenburg, P. M., & Peter, J. (2009). Development and validation of a game addiction scale for adolescents. *Media Psychology, 12*(1), 77-95. doi:10.1080/15213260802669458

Lepp, A., Li, J., & Barkley, J. E. (2016). College students' cell phone use and attachment to parents and peers. *Computers in Human Behavior, 64*, 401-408. doi:10.1016/j.chb.2016.07.021

Lerum, C. W., & LoBiondo-Wood, G. (1989). The relationship of maternal age, quickening, and physical symptoms of pregnancy to the development of maternal-fetal attachment. *Birth, 16*(1), 13-17. doi:10.1111/j.1523-536X.1989.tb00848.x

Leung, L. (2008). Linking psychological attributes to addiction and improper use of the mobile phone among adolescents in Hong Kong. *Journal of Children and Media, 2*(2), 93-113. doi:10.1080/17482790802078565

Leung, L., & Wei, R. (2000). More than just talk on the move: Uses and gratifications of the cellular phone. *Journalism & Mass Communication Quarterly, 77*(2), 308-320. doi:10.1177/107769900007700206

Li, A. Y., Lo, B. C.-y., & Cheng, C. (2018). It is the family context that matters: Concurrent and predictive effects of aspects of parent-child interaction on video gaming-related problems. *Cyberpsychology, Behavior and Social Networking, 21*(6), 374-380. doi:10.1089/cyber.2017.0566

Li, Q., Guo, X., Bai, X., & Xu, W. (2018). Investigating microblogging addiction tendency through the lens of uses and gratifications theory. *Internet Research, 28*(5), 1228-1252. doi:10.1108/IntR-03-2017-0092

Li, R., Bunke, S., & Psouni, E. (2016). Attachment relationships and physical activity in adolescents: The mediation role of physical self-concept. *Psychology of Sport and Exercise, 22*, 160-169. doi:10.1016/j.psychsport.2015.07.003

Li, X., & Hao, C. (2019). The relationship between parental attachment and mobile phone dependence among Chinese rural adolescents: The role of alexithymia and mindfulness. *Frontiers in Psychology, 10*, 598-598. doi:10.3389/fpsyg.2019.00598

Lim, S. A., & You, S. (2019). Effect of parental negligence on mobile phone dependency among vulnerable social groups: Mediating effect of peer attachment. *Psychological Reports, 122*(6), 2050-2062. doi:10.1177/0033294118799339

Lincoln, Y., & Guba, E. G. (1985). *Naturalistic Inquiry*. Newbury Park, CA: Sage.

Lovato, S. B., & Piper, A. M. (2019). Young children and voice search: What we know from human-computer interaction research. *Frontiers in Psychology, 10*, 8-8. doi:10.3389/fpsyg.2019.00008

Lu, X., Oda, M., Ohba, T., Mitsubuchi, H., Masuda, S., & Katoh, T. (2017). Association of excessive mobile phone use during pregnancy with birth weight: An adjunct study in Kumamoto of Japan Environment and Children's Study. *Environmental Health and Preventive Medicine, 22*(1), 52-52. doi:10.1186/s12199-017-0656-1

Lundqvist, J., & Sandström, M. (2019). A bioecological content analysis: an analysis technique rooted in the bioecological model for human development. *International Journal of Early Childhood Special Education, 11*(2), 194-206. doi:10.20489/intjecse.670478

Lupton, D., & Pedersen, S. (2016). An Australian survey of women's use of pregnancy and parenting apps. *Women and Birth: Journal of the Australian College of Midwives, 29*(4), 368-375. doi:10.1016/j.wombi.2016.01.008

Malik, A., Nanda, A. P., & Kumra, R. (2020). Children in the digital world: exploring the role of parental–child attachment features in excessive online gaming. *Young Consumers, 21*(3), 335-350. doi:10.1108/YC-01-2020-1090

Malm, M.-C., Hildingsson, I., Rubertsson, C., Rådestad, I., & Lindgren, H. (2016). Prenatal attachment and its association with foetal movement during pregnancy – A population based survey. *Women and Birth: Journal of the Australian College of Midwives, 29*(6), 482-486. doi:10.1016/j.wombi.2016.04.005

Mangan, E., Leavy, J. E., & Jancey, J. (2018). Mobile device use when caring for children 0-5 years: A naturalistic playground study. *Health Promotion Journal of Australia, 29*(3), 337-343. doi:10.1002/hpja.38

Marino, C., Marci, T., Ferrante, L., AltoÈ, G., & Vieno, A. (2019). Attachment and problematic Facebook use in adolescents: The mediating role of metacognitions. *Journal of Behavioral Addictions, 8*(1), 63-78. doi:10.1556/2006.8.2019.07

McCormick, M. P., O'Connor, E. E., & Barnes, S. P. (2016). Mother–child attachment styles and math and reading skills in middle childhood: The mediating role of children's exploration and engagement. *Early Childhood Research Quarterly, 36*, 295-306. doi:10.1016/j.ecresq.2016.01.011

McDaniel, B. T., & Coyne, S. M. (2016). Technology interference in the parenting of young children: Implications for mothers' perceptions of coparenting. *The Social Science Journal, 53*(4), 435-443. doi:10.1016/j.soscij.2016.04.010

McDaniel, B. T., & Drouin, M. (2019). Daily technology interruptions and emotional and relational well-being. *Computers in Human Behavior, 99*, 1-8. doi:10.1016/j.chb.2019.04.027

McDaniel, B. T., Galovan, A. M., Cravens, J. D., & Drouin, M. (2018). "Technoference" and implications for mothers' and fathers' couple and coparenting relationship quality. *Computers in Human Behavior, 80*, 303-313. doi:10.1016/j.chb.2017.11.019

McGinty, E. E., Presskreischer, R., Han, H., & Barry, C. L. (2020). Psychological distress and loneliness reported by US adults in 2018 and April 2020. *The Journal of the American Medical Association, 324*(1), 93-94. doi:10.1001/jama.2020.9740

MedlinePlus. (2021). Screen time and children. Retrieved from https://medlineplus.gov/ency/patientinstructions/000355.htm

Mesch, G. S. (2003). The family and the internet: The Israeli case. *Social Science Quarterly, 84*(4), 1038-1050. doi:10.1046/j.0038-4941.2003.08404016.x

Mikhail, M. S., Freda, M. C., Merkatz, R. B., Polizzotto, R., Mazloom, E., & R., M. I. (1991). The effect of fetal movement counting on maternal attachment to fetus. *American Journal of Obstetrics and Gynecology 165*(4), 988-991.

Milne, L. S., & Rich, O. J. (1981). Cognitive and affective aspects of the response of pregnant women to sonography. *Maternal Child Nursing, 110*, 5-39.

Mindaroo Foundation. (2021). Molly Wright: How every child can thrive by five, TED Talk.

[Video file]. Retrieved from https://www.youtube.com/watch?v=aISXCw0Pi94

Mo, Y., Gong, W., Wang, J., Sheng, X., & Xu, D. R. (2018). The association between the use of antenatal care smartphone apps in pregnant women and antenatal depression: Cross-sectional study. *Journal of Medical Internet Research, 6*(11), e11508-e11508. doi:10.2196/11508

Moawad, G. E. L. N. A., & Ebrahem, G. G. S. (2016). The relationship between use of technology and parent-adolescents social relationship. *Journal of Education and Practice, 7*(14), 168.

Modecki, K. L., Low-Choy, S., Uink, B. N., Vernon, L., Correia, H., & Andrews, K. (2020). Tuning into the real effect of smartphone use on parenting: a multiverse analysis. *Journal of Child Psychology and Psychiatry, 61*(8), 855-865. doi:10.1111/jcpp.13282

Moran, K. (2009). Parent/caregiver perceptions and practice of child water safety at the beach. *International Journal of Injury Control and Safety Promotion, 16*(4), 215-221. doi:10.1080/17457300903307045

Moyer-Packenham, P. S., Bullock, E. K., Shumway, J. F., Tucker, S. I., Watts, C. M., Westenskow, A., . . . Jordan, K. (2015). The role of affordances in children's learning performance and efficiency when using virtual manipulative mathematics touch-screen apps. *Mathematics Education Research Journal, 28*(1), 79-105. doi:10.1007/s13394-015-0161-z

Myruski, S., Gulyayeva, O., Birk, S., Pérez-Edgar, K., Buss, K. A., & Dennis-Tiwary, T. A. (2018). Digital disruption? Maternal mobile device use is related to infant social-emotional functioning. *Developmental Science, 21*(4), e12610-n/a. doi:10.1111/desc.12610

Nelson, C. A., Zeanah, C. H., & Fox, N. A. (2019). How early experience shapes human development: The case of psychosocial deprivation. *Neural Plasticity, 2019*, 1676285-1676212. doi:10.1155/2019/1676285

Nelson, J. J. (2019). Pass the iPad: Assessing the relationship between tech use during family meals and parental reports of closeness to their children. *Sociological Quarterly, 60*(4), 696-715. doi:10.1080/00380253.2019.1580548

Neumann, M. M. (2018). Using tablets and apps to enhance emergent literacy skills in young children. *Early Childhood Research Quarterly, 42*, 239-246. doi:10.1016/j.ecresq.2017.10.006

Nitschke, J. B., Nelson, E. E., Rusch, B. D., Fox, A. S., Oakes, T. R., & Davidson, R. J. (2004). Orbitofrontal cortex tracks positive mood in mothers viewing pictures of their newborn infants. *NeuroImage, 21*(2), 583-592. doi:10.1016/j.neuroimage.2003.10.005

Noel, V. A., Francis, S. E., & Tilley, M. A. (2017). An adapted measure of sibling attachment: Factor structure and internal consistency of the sibling attachment inventory in youth. *Child Psychiatry and Human Development, 49*(2), 217-224. doi:10.1007/s10578-017-0742-z

O'Cathain, A., & Thomas, K. J. (2004). "Any other comments?" Open questions on questionnaires - A bane or a bonus to research? *BMC Medical Research methodology, 4*(1), 25-25. doi:10.1186/1471-2288-4-25

O'Connor, T. M., Chen, T.-A., Baranowski, J., Thompson, D., & Baranowski, T. (2013). Physical activity and screen-media–related parenting practices have different associations with children's objectively measured physical activity. *Child Obesity, 9*(5), 446-453. doi:10.1089/chi.2012.0131

Ochoa, W., Reich, S. M., & Farkas, G. (2021). The observed quality of caregiver-child interactions with and without a mobile screen device. *Academic Pediatrics, 21*(4), 620-628. doi:10.1016/j.acap.2020.07.012

Orben, A., & Przybylski, A. K. (2019). The association between adolescent well-being and digital technology use. *Nature Human Behaviour, 3*(2), 173-182. doi:10.1038/s41562-018-0506-1

Ostacoli, L., Cosma, S., Bevilacqua, F., Berchialla, P., Bovetti, M., Carosso, A. R., . . . Benedetto, C. (2020). Psychosocial factors associated with postpartum psychological distress during the Covid-19 pandemic: a cross-sectional study. *BMC Pregnancy and Childbirth, 20*(1), 703-703. doi:10.1186/s12884-020-03399-5

Özaslan, A., Yıldırım, M., Güney, E., Güzel, H. Ş., & İşeri, E. (2021). Association between problematic internet use, quality of parent-adolescents relationship, conflicts, and mental health problems. *International Journal of Mental Health and Addiction*. doi:10.1007/s11469-021-00529-8

Padilla-Walker, L. M., Coyne, S. M., & Fraser, A. M. (2012). Getting a high-speed family connection: Associations between family media use and family connection. *Family Relations, 61*(3), 426-440. doi:10.1111/j.1741-3729.2012.00710.x

Pagani, L. S., Fitzpatrick, C., & Barnett, T. A. (2013). Early childhood television viewing and kindergarten entry readiness. *Pediatric Research, 74*(3), 350-355. doi:10.1038/pr.2013.105

Pajulo, M., Tolvanen, M., Karlsson, L., Halme-Chowdhury, E., Öst, C., Luyten, P., . . . Karlsson, H. (2015). The prenatal parental reflective functioning questionnaire: Exploring factor structure and construct validity of a new measure in the Finn brain birth cohort Pilot Study. *Infant Mental Health Journal, 36*(4), 399-414. doi:10.1002/imhj.21523

Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2018). The effectiveness of computer and tablet assisted intervention in early childhood students' understanding of numbers. An empirical study conducted in Greece. *Education and Information Technologies, 23*(5), 1849-1871. doi:10.1007/s10639-018-9693-7

Patrick, S. W., Henkhaus, L. E., Zickafoose, J. S., Lovell, K., Halvorson, A., Loch, S., . . . Davis, M. M. (2020). Well-being of parents and children during the COVID-19 pandemic: A national survey. *Pediatrics, 146*(4), e2020016824. doi:10.1542/peds.2020-016824

Petri, E., Palagini, L., Bacci, O., Borri, C., Teristi, V., Corezzi, C., . . . Mauri, M. (2018). Maternal-foetal attachment independently predicts the quality of maternal-infant bonding and post-partum psychopathology. *The Journal of Maternal-Fetal & Neonatal Medicine, 31*(23), 3153-3159. doi:10.1080/14767058.2017.1365130

Pew Research Centre. (2019a). Internet and Technology: Mobile Fact Sheet. Retrieved from https://www.pewresearch.org/internet/fact-sheet/mobile/

Pew Research Centre. (2019b). Spring 2018 Global Attitudes Survey. Retrieved from https://www.pewresearch.org/global/wp-content/uploads/sites/2/2019/02/Pew-Research-Center_Global-Technology-Use-2018_2019-02-05.pdf

Pew Research Centre. (2021). Internet and Technology: Mobile Fact Sheet. Retrieved from https://www.pewresearch.org/internet/fact-sheet/mobile/

Pieh, C., Budimir, S., Humer, E., & Probst, T. (2021). Comparing mental health during the COVID-19 lockdown and 6 months after the lockdown in Austria: A longitudinal study. *Frontiers in Psychiatry, 12*, 625973-625973. doi:10.3389/fpsyt.2021.625973

Pilkington, P. D., Milne, L. C., Cairns, K. E., Lewis, J., & Whelan, T. A. (2015). Modifiable partner factors associated with perinatal depression and anxiety: A systematic review and meta-analysis. *Journal of Affective Disorders, 178*, 165-180. doi:10.1016/j.jad.2015.02.023

Pisoni, C., Garofoli, F., Tzialla, C., Orcesi, S., Spinillo, A., Politi, P., . . . Stronati, M. (2014). Risk and protective factors in maternal–fetal attachment development. *Early Human Development, 90*, S45-S46. doi:10.1016/S0378-3782(14)50012-6

Plowman, L., McPake, J., & Stephen, C. (2008). Just picking it up? Young children learning with technology at home. *Journal of Education, 38*(3), 303-319. doi:10.1080/03057640802287564

Poulain, T., Ludwig, J., Hiemisch, A., Hilbert, A., & Kiess, W. (2019). Media use of mothers, media use of children, and parent-child interaction are related to behavioral difficulties and strengths of children. *International Journal of Environmental Research and Public Health, 16*(23), 4651. doi:10.3390/ijerph16234651

Powell, E. M., Frankel, L. A., Umemura, T., & Hazen, N. (2017). The relationship between adult attachment orientation and child self-regulation in eating: The mediating role of persuasive-controlling feeding practices. *Eating Behaviors, 26*, 121-128. doi:10.1016/j.eatbeh.2017.02.006

Prescott, J., & MacKie, L. (2017). You sort of go down a rabbit hole..you're just going to keep on searching: A qualitative study of searching online for pregnancy-related information during pregnancy. *Journal of Medical Internet Research, 19*(6), e194-e194. doi:10.2196/jmir.6302

Price, S., Jewitt, C., & Crescenzi, L. (2015). The role of iPads in pre-school children's mark making development. *Computers and Education, 87*, 131-141. doi:10.1016/j.compedu.2015.04.003

Prime, H., Wade, M., & Browne, D. T. (2020). Risk and resilience in family well-being during the COVID-19 pandemic. *The American Psychologist, 75*(5), 631-643. doi:10.1037/amp0000660

Prime Minister of Australia. (2020a). Border restrictions. Prime Minister of Australia: March 19 2020. Retrieved from https://www.pm.gov.au/media/border-restrictions

Prime Minister of Australia. (2020b). Update on coronavirus measures. Prime Minister of Australia: March 26 2020. Retrieved from https://www.pm.gov.au/media/update-coronavirus-measures-24-March-2020

Przybylski, A. K., & Weinstein, N. (2013). Can you connect with me now? How the presence of mobile communication technology influences face-to-face conversation quality. *Journal of Social and Personal Relationships, 30*(3), 237-246. doi:10.1177/0265407512453827

Przybylski, A. K., & Weinstein, N. (2017). A large-scale test of the Goldilocks Hypothesis: Quantifying the relations between digital-screen use and the mental well-being of adolescents. *Psychological Science, 28*(2), 204-215. doi:10.1177/0956797616678438

Przybylski, A. K., & Weinstein, N. (2019). Digital screen time limits and young children's psychological well-being: Evidence from a population-based study. *Child Development, 90*(1), e56-e65. doi:10.1111/cdev.13007

Qiu, C., Li, R., Luo, H., Li, S., & Nie, Y. (2022). Parent-child relationship and smartphone addiction among Chinese adolescents: A longitudinal moderated mediation model. *Addictive Behaviors, 130*, 107304-107304. doi:10.1016/j.addbeh.2022.107304

Radesky, J. S., Kistin, C. J., Zuckerman, B., Nitzberg, K., Gross, J., Kaplan-Sanoff, M., . . . Silverstein, M. (2014). Patterns of mobile device use by caregivers and children during meals in fast food restaurants. *Pediatrics, 133*(4), e843-e849. doi:10.1542/peds.2013-3703

Raman, S., Guerrero-Duby, S., McCullough, J. L., Brown, M., Ostrowski-Delahanty, S., Langkamp, D., & Duby, J. C. (2017). Screen exposure during daily routines and a young child's risk for having social-emotional delay. *Clinical Pediatrics, 56*(13), 1244-1253. doi:10.1177/0009922816684600

Rees, C. A. (2005). Thinking about children's attachments. *Archives of Disease in Childhood, 90*(10), 1058-1065. doi:10.1136/adc.2004.068650

Remondi, C., Compare, A., Tasca, G. A., Lo Coco, G., Chiozza, V., Favini, A., . . . Brugnera, A. (2022). The effects of attachment, temperament, and self-esteem on technology addiction: A mediation model among young adults. *Cyberpsychology, Behavior, and Social Networking, 25*(4), 258-263. doi:10.1089/cyber.2021.0237

Rhodes, A. (2017). Screen time: What's happening in our homes? Retrieved from https://www.rchpoll.org.au/wp-content/uploads/2017/06/ACHP-Poll7_Detailed-Report-June21.pdf

Richards, R., McGee, R., Williams, S. M., Welch, D., & Hancox, R. J. (2010). Adolescent screen time and attachment to parents and peers. *Archives of Pediatrics and Adolescent Medicine, 164*(3), 258-262. doi:10.1001/archpediatrics.2009.280

Rideout, V., & Robb, M. B. (2019). The Common Sense Census: Media Use by Tweens and Teens, 2019. Retrieved from https://www.commonsensemedia.org/sites/default/files/uploads/research/2019-census-8-to-18-full-report-updated.pdf

Robb, M. B., Bay, W., Vennegaard, T.,. (2017). The new normal: parents, teens and digital devices in Japan. Retrieved from https://www.commonsensemedia.org/sites/default/files/research/report/2019_thenewnormalmexico-final-release_eng-092519_web.pdf

Roberts, J. A., & David, M. E. (2016). My life has become a major distraction from my cell phone: Partner phubbing and relationship satisfaction among romantic partners. *Computers in Human Behavior, 54*, 134-141. doi:10.1016/j.chb.2015.07.058

Robinson, E., Boyland, E., Chisholm, A., Harrold, J., Maloney, N. G., Marty, L., . . . Hardman, C. A. (2021). Obesity, eating behavior and physical activity during COVID-19 lockdown: A study of UK adults. *Appetite, 156*, 104853-104853. doi:10.1016/j.appet.2020.104853

Rodger, D., Skuse, A., Wilmore, M., Humphreys, S., Dalton, J., Flabouris, M., & Clifton, V. L. (2013). Pregnant women's use of information and communications technologies to access pregnancy-related health information in South Australia. *Australian Journal of Primary Health, 19*(4), 308-312. doi:10.1071/PY13029

Røhder, K., Væver, M. S., Aarestrup, A. K., Jacobsen, R. K., Smith-Nielsen, J., & Schiøtz, M. L. (2020). Maternal-fetal bonding among pregnant women at psychosocial risk: The roles of adult attachment style, prenatal parental reflective functioning, and depressive symptoms. *PLoS One, 15*(9), e0239208-e0239208. doi:10.1371/journal.pone.0239208

Rollè, L., Giordano, M., Santoniccolo, F., & Trombetta, T. (2020). Prenatal attachment and perinatal depression: A systematic review. *International Journal of Environmental Research and Public Health, 17*(8), 2644. doi:10.3390/ijerph17082644

Roser, K., Schoeni, A., Foerster, M., & Röösli, M. (2015). Problematic mobile phone use of Swiss adolescents: is it linked with mental health or behaviour? *International Journal of Public Health, 61*(3), 307-315. doi:10.1007/s00038-015-0751-2

Roskos, K., Burstein, K., Shang, Y., & Gray, E. (2014). Young children's engagement with e-books at school: Does device matter? *SAGE Open, 4*(1), 215824401351724. doi:10.1177/2158244013517244

Royal College of Paediatrics and Child Health. (2019). The health impacts of screen time: a guide for clinicians and parents Retrieved from https://www.rcpch.ac.uk/sites/default/files/2018-12/rcpch_screen_time_guide_-_final.pdf

Sampaio, F., Sequeira, C., & Teixeira, L. (2020). Nurses' mental health during the Covid-19 outbreak: A cross-sectional study. *Journal of Occupational and Environmental Medicine, 62*(10), 783-787. doi:10.1097/JOM.0000000000001987

Sampasa-Kanyinga, H., Goldfield, G. S., Kingsbury, M., Clayborne, Z., & Colman, I. (2020). Social media use and parent–child relationship: A cross-sectional study of adolescents. *Journal of Community Psychology, 48*(3), 793-803. doi:10.1002/jcop.22293

Santana-Vega, L.-E., Gómez-Muñoz, A.-M., & Feliciano-García, L. (2019). Adolescents problematic mobile phone use, fear of missing out and family communication. *Comunicar Journal, 27*(59), 39-47. doi:10.3916/C59-2019-04

Schore, A. N. (2001). Effects of a secure attachment relationship on right brain development, affect regulation, and infant mental health. *Infant Mental Health Journal, 22*(1-2), 7-66. doi:10.1002/1097-0355(200101/04)22:1<7::AID-IMHJ2>3.0.CO;2-N

Sekulic, D., Blazevic, M., Gilic, B., Kvesic, I., & Zenic, N. (2020). Prospective analysis of levels and correlates of physical activity during COVID-19 pandemic and imposed rules of social distancing; gender specific study among adolescents from Southern Croatia. *Sustainability, 12*(10), 4072. doi:10.3390/SU12104072

Shalash, A., Roushdy, T., Essam, M., Fathy, M., Dawood, N. L., Abushady, E. M., . . . Hamid, E. (2020). Mental health, physical activity, and quality of life in Parkinson's disease during COVID-19 pandemic. *Movement Disorders, 35*(7), 1097-1099. doi:10.1002/mds.28134

Siddiqui, A., & Hägglöf, B. (2000). Does maternal prenatal attachment predict postnatal mother–infant interaction? *Early Human Development, 59*(1), 13-25. doi:10.1016/S0378-3782(00)00076-1

Siddiqui, A., Hagglof, B., & Eisemann, M. (2000). Own memories of upbringing as a determinant of prenatal attachment in expectant women. *Journal of Reproductive and Infant Psychology, 18*(1), 67-74. doi:10.1080/02646830050001690

Silva, D. T., Hagemann, E., Davis, J. A., Gibson, L. Y., Srinivasjois, R., Palmer, D. J., . . . Prescott, S. L. (2020). Introducing the ORIGINS project: a community-based interventional birth cohort. *Reviews on Environmental Health, 35*(3), 281-293. doi:10.1515/reveh-2020-0057

Sixsmith, A., Horst, B. R., Simeonov, D., & Mihailidis, A. (2022). Older people's use of digital technology during the COVID-19 pandemic. *Bulletin of Science, Technology & Society, 42*(1-2), 19-24. doi:10.1177/02704676221094731

Smahel, D., Machackova, H., Mascheroni, G., Dedkova, L., Staksrud, E., Olafsson, K., Livingstone, S. & Hasebrink, U. (2020). EU Kids Online 2020: Survey results from 19 countries. Retrieved from https://www.eukidsonline.ch/files/Eu-kids-online-2020-international-report.pdf

Souto, P. H. S., Santos, J. N., Leite, H. R., Hadders-Algra, M., Guedes, S. C., Nobre, J. N. P., . . . Morais, R. L. d. S. (2019). Tablet use in young children is associated with advanced fine motor skills. *Journal of Motor Behavior, 52*(2), 196-203. doi:10.1080/00222895.2019.1602505

Spruit, A., Goos, L., Weenink, N., Rodenburg, R., Niemeyer, H., Stams, G. J., & Colonnesi, C. (2020). The relation between attachment and depression in children and adolescents: A multilevel meta-analysis. *Clinical Child and Family Psychology Review, 23*(1), 54-69. doi:10.1007/s10567-019-00299-9

Srivastav, A. K., Sharma, N., & Samuel, A. J. (2021). Impact of Coronavirus disease-19 (COVID-19) lockdown on physical activity and energy expenditure among physiotherapy professionals and students using web-based open E-survey sent through WhatsApp, Facebook and Instagram messengers. *Clinical epidemiology and global health, 9*, 78-84. doi:10.1016/j.cegh.2020.07.003

Statistica. (2022). Consumer electronics ownership in Australia in 2022. Retrieved from https://www.statista.com/forecasts/1004184/consumer-electronics-ownership-in-australia

Straker, L., Abbott, R., Collins, R., & Campbell, A. (2014). Evidence-based guidelines for wise use of electronic games by children. *Ergonomics, 57*(4), 471-489. doi:10.1080/00140139.2014.895856

Straker, L., Maslen, B., Burgess-Limerick, R., Johnson, P., & Dennerlein, J. (2010). Evidence-based guidelines for the wise use of computers by children: Physical development guidelines. *Ergonomics, 53*(4), 458-477. doi:10.1080/00140130903556344

Straker, L., & Pollock, C. (2005). Optimizing the interaction of children with information and communication technologies. *Ergonomics, 48*(5), 506-521. doi:10.1080/00140130400029233

Straker, L., Pollock, C., & Burgess-Limerick, R. (2006). Towards evidence-based guidelines for wise use of computers by children. *International Journal of Industrial Ergonomics, 36*(12), 1045-1053. doi:10.1016/j.ergon.2006.09.006

Straker, L., Zabatiero, J., Danby, S., Thorpe, K., & Edwards, S. (2018). Conflicting guidelines on young children's screen time and use of digital technology create policy and practice dilemmas. *Journal of Pediatrics, 202*, 300-303. doi:10.1016/j.jpeds.2018.07.019

Suchert, V., Hanewinkel, R., & Isensee, B. (2016). Screen time, weight status and the self-concept of physical attractiveness in adolescents. *Journal of Adolescence, 48*(1), 11-17. doi:10.1016/j.adolescence.2016.01.005

Sun, R., Gao, Q., Xiang, Y., Chen, T., Liu, T., & Chen, Q. (2020). Parent–child relationships and mobile phone addiction tendency among Chinese adolescents: The mediating role of psychological needs satisfaction and the moderating role of peer relationships. *Children and Youth Services Review, 116*, 105113. doi:10.1016/j.childyouth.2020.105113

Tamana, S. K., Ezeugwu, V., Chikuma, J., Lefebvre, D. L., Azad, M. B., Moraes, T. J., . . . Mandhane, P. J. (2019). Screen-time is associated with inattention problems in preschoolers: Results from the CHILD birth cohort study. *PLoS One, 14*(4), e0213995-e0213995. doi:10.1371/journal.pone.0213995

Tan, H., Chen, C., & Hao, Y. (2021). How people perceive and expect safety in autonomous vehicles: An empirical study for risk sensitivity and risk-related feelings. *International Journal of Human-Computer Interaction, 37*(4), 340-351. doi:10.1080/10447318.2020.1860515

Tang, S., Xiang, M., Cheung, T., & Xiang, Y.-T. (2021). Mental health and its correlates among children and adolescents during COVID-19 school closure: The importance of parent-child discussion. *Journal of Affective Disorders, 279*, 353-360. doi:10.1016/j.jad.2020.10.016

Teti, D. M., Gelfand, D. M., Messinger, D. S., & Isabella, R. (1995). Maternal depression and the quality of early attachment: An examination of infants, preschoolers, and their mothers. *Developmental Psychology, 31*(3), 364-376. doi:10.1037/0012-1649.31.3.364

The Nielson Company. (2018). The Nielson Total Audience Report Q1 2018. Retrieved from https://www.nielsen.com/wp-content/uploads/sites/3/2019/04/q1-2018-total-audience-report.pdf

The Royal Children's Hospital National Child Health Poll. (2020). COVID-19 pandemic: Effects on the lives of Australian children and families. Poll Number 18. Retrieved from https://www.rchfoundation.org.au/2020/08/child-health-poll-on-effects-of-covid-19-pandemic-on-families/

Theran, S. A., Levendosky, A. A., Anne Bogat, G., & Huth-Bocks, A. C. (2005). Stability and change in mothers' internal representations of their infants over time. *Attachment & Human Development, 7*(3), 253-268. doi:10.1080/14616730500245609

Thorne, S., Kirkham, & MacDonaldEmes, J. (1997). Interpretive description: A noncategorical qualitative alternative for developing nursing knowledge. *Research in Nursing & Health, 20*(2), 169-177. https://doi.org/10.1002/(SICI)1098-240X(199704)20:2<169::AID-NUR9>3.0.CO;2-I

Toh, S. H., Coenen, P., Howie, E. K., Mukherjee, S., Mackey, D. A., & Straker, L. M. (2019). Mobile touch screen device use and associations with musculoskeletal symptoms and visual health in a nationally representative sample of Singaporean adolescents. *Ergonomics, 62*(6), 778-793. doi:10.1080/00140139.2018.1562107

Toh, S. H., Coenen, P., Howie, E. K., Smith, A. J., Mukherjee, S., Mackey, D. A., & Straker, L. M. (2020). A prospective longitudinal study of mobile touch screen device use and musculoskeletal symptoms and visual health in adolescents. *Applied Ergonomics, 85*, 103028-103028. doi:10.1016/j.apergo.2019.103028

Toh, S. H., Coenen, P., Howie, E. K., & Straker, L. M. (2017). The associations of mobile touch screen device use with musculoskeletal symptoms and exposures: A systematic review. *PLoS One, 12*(8), e0181220-e0181220. doi:10.1371/journal.pone.0181220

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care, 19*(6), 349-357. doi:10.1093/intqhc/mzm042

Tran, P., & Subrahmanyam, K. (2013). Evidence-based guidelines for the informal use of computers by children to promote the development of academic, cognitive and social skills. *Ergonomics, 56*(9), 1349-1362. doi:10.1080/00140139.2013.820843

Tremblay, M. S., Chaput, J.-P., Adamo, K. B., Aubert, S., Barnes, J. D., Choquette, L., . . . Carson, V. (2017). Canadian 24-Hour movement guidelines for the early years (0-4 years): An integration of physical activity, sedentary behaviour, and sleep. *BMC Public Health, 17*(Suppl 5), 874-874. doi:10.1186/s12889-017-4859-6

Tripp, N., Hainey, K., Liu, A., Poulton, A., Peek, M., Kim, J., & Nanan, R. (2014). An emerging model of maternity care: Smartphone, midwife, doctor? *Women and Birth: Journal of the Australian College of Midwives, 27*(1), 64-67. doi:10.1016/j.wombi.2013.11.001

Trombetta, T., Giordano, M., Santoniccolo, F., Vismara, L., Della Vedova, A. M., & Rollè, L. (2021). Pre-natal attachment and parent-to-infant attachment: A systematic review. *Frontiers in Psychology, 12*, 620942-620942. doi:10.3389/fpsyg.2021.620942

Twenge, J. M., & Campbell, W. K. (2018). Associations between screen time and lower psychological well-being among children and adolescents: Evidence from a population-based study. *Preventive Medicine Reports, 12*, 271-283. doi:10.1016/j.pmedr.2018.10.003

UK Department of Health. (2019). UK Chief Medical Officers' Physical Activity Guidelines. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/832868/uk-chief-medical-officers-physical-activity-guidelines.pdf

Vatalaro, A., Culp, A. M., Hahs-Vaughn, D. L., & Barnes, A. C. (2017). A quasi-experiment examining expressive and receptive vocabulary knowledge of preschool head start children using mobile media apps. *Early Childhood Education Journal, 46*(4), 451-466. doi:10.1007/s10643-017-0877-3

Vaterlaus, J. M., & Tulane, S. (2019). The perceived influence of interactive technology on marital relationships. *Contemporary Family Therapy, 41*(3), 247-257. doi:10.1007/s10591-019-09494-w

Velicu, A., Chaudron, S., Dias, P., Brito, R., & Lobe, B. (2019). Parental concerns regarding young children and digital technology: An exploratory qualitative investigation in three european countries. *Revista Română de Sociologie, 30*(3/4), 1-18. https://www.proquest.com/docview/2330576170?accountid=10382&forcedol=true&pq-origsite=primo

Vlismas, W., Malloch, S., & Burnham, D. (2013). The effects of music and movement on mother-infant interactions. *Early Child Development and Care, 183*(11), 1669-1688. doi:10.1080/03004430.2012.746968

von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2007). The strengthening the reporting of observational studies in epidemiology (STROBE) statement: Guidelines for reporting observational studies. *Preventive Medicine, 45*(4), 247-251. doi:10.1016/j.ypmed.2007.08.012

Walsh, J. J., Barnes, J. D., Tremblay, M. S., & Chaput, J.-P. (2020). Associations between duration and type of electronic screen use and cognition in US children. *Computers in Human Behavior, 108*, 106312. doi:10.1016/j.chb.2020.106312

Wang, N., Deng, Z., Wen, L. M., Ding, Y., & He, G. (2019). Understanding the use of smartphone apps for health information among pregnant chinese women: Mixed methods study. *JMIR mHealth and uHealth, 7*(6), e12631-e12631. doi:10.2196/12631

Wang, X., & Zhao, K. (2022). Partner phubbing and marital satisfaction: The mediating roles of marital interaction and marital conflict. *Social Science Computer Review*, 89443932110722. doi:10.1177/08944393211072231

Warren, R., & Aloia, L. (2018). Parent-adolescent communication via mobile devices: Influences on relational closeness. *Journal of Family Issues, 39*(15), 3778-3803. doi.org/10.1177/0192513X18793924

West, K. K., Mathews, B. L., & Kerns, K. A. (2013). Mother–child attachment and cognitive performance in middle childhood: An examination of mediating mechanisms. *Early Childhood Research Quarterly, 28*(2), 259-270. doi:10.1016/j.ecresq.2012.07.005

White, J., & Klein, D. (2008). *The Systems Framework. Family Theories.* (Vol. 3rd Edition). Thousand Oaks, CA: Sage Publications.

Willoughby, T. (2008). A short-term longitudinal study of internet and computer game use by adolescent boys and girls: Prevalence, frequency of use, and psychosocial predictors. *Developmental Psychology, 44*(1), 195-204. doi:10.1037/0012-1649.44.1.195

Wiltshire, C. A., Troller-Renfree, S. V., Giebler, M. A., & Noble, K. G. (2021). Associations among average parental educational attainment, maternal stress, and infant screen exposure at 6 months of age. *Infant Behavior & Development, 65*, 101644. doi:10.1016/j.infbeh.2021.101644

Wolfers, L. N., Kitzmann, S., Sauer, S., & Sommer, N. (2020). Phone use while parenting: An observational study to assess the association of maternal sensitivity and smartphone use in a playground setting. *Computers in Human Behavior, 102*, 31-38. doi:10.1016/j.chb.2019.08.013

Wong, B. Y.-M., Lam, T.-H., Lai, A. Y.-K., Wang, M. P., & Ho, S.-Y. (2021). Perceived benefits and harms of the Covid-19 pandemic on family well-being and their sociodemographic disparities in Hong Kong: A cross-sectional study. *International Journal of Environmental Research and Public Health, 18*(3), 1-14. doi:10.3390/ijerph18031217

Wooldridge, M. B., & Shapka, J. (2012). Playing with technology: Mother–toddler interaction scores lower during play with electronic toys. *Journal of Applied Developmental Psychology, 33*(5), 211-218. doi:10.1016/j.appdev.2012.05.005

World Health Organisation. (2020). WHO Coronavirus (Covid-19) Dashboard. Coronavirus pandemic. Retrieved from https://covid19.who.int/

World Health Organization. (2019). Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age. Retrieved from https://apps.who.int/iris/handle/10665/311664

World Health Organization. (2020). WHO announces COVID-19 outbreak a pandemic. Retrieved from https://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/3/who-announces-covid-19-outbreak-a-pandemic

Xiang, M., Zhang, Z., & Kuwahara, K. (2020). Impact of COVID-19 pandemic on children and adolescents' lifestyle behavior larger than expected. *Progress in Cardiovascular Diseases, 63*(4), 531-532. doi:10.1016/j.pcad.2020.04.013

Xie, B., Zhou, J., & Wang, H. (2017). How influential are mental models on interaction performance? Exploring the gap between users' and designers' mental models through a new quantitative method. *Advances in Human-Computer Interaction, 2017*, 1-14. doi:10.1155/2017/3683546

Xu, X., Liu, D., Rao, Y., Zeng, H., Zhang, F., Wang, L., . . . Zhao, Y. (2018). Prolonged screen viewing times and sociodemographic factors among pregnant women: A cross-sectional survey in China. *Internatinal Journal of Environmental Research and Public Health, 15*(3), 403. doi:10.3390/ijerph15030403

Young, K. S. (1998). Internet addiction: The emergence of a new clinical disorder. *Cyberpsychology and Behavior, 1*, 237-244. doi.org/10.1089/cpb.1998.1.237

Yuill, N., & Martin, A. F. (2016). Curling up with a good e-book: Mother-child shared story reading on screen or paper affects embodied interaction and warmth. *Frontiers in Psychology, 7*, 1951-1951. doi:10.3389/fpsyg.2016.01951

Zabatiero, J., Straker, L., , Mantilla, A., Edwards, S., , & Danby, S. (2018). Young children and digital technology: Australian early childhood education and care sector adults' perspectives. *Australasian Journal of Early Childhood, 43*(2), 14-22. doi:10.23965/AJEC.43.2.02

Zhang, J., Madigan, S., & Browne, D. (2022). Caregivers' psychological distress, technology use, and parenting: The importance of a multidimensional perspective. *Computers in Human Behavior, 134*, 107324. doi:10.1016/j.chb.2022.107324

Zhao, J., Zhang, Y., Jiang, F., Ip, P., Ho, F. K. W., Zhang, Y., & Huang, H. (2018). Excessive screen time and psychosocial well-being: The mediating role of body mass index, sleep duration, and parent-child interaction. *Journal of Pediatrics, 202*, 157-162.e151. doi:10.1016/j.jpeds.2018.06.029

Zhen, R., Liu, R.-D., Hong, W., & Zhou, X. (2019). How do interpersonal relationships relieve adolescents' problematic mobile phone use? The roles of loneliness and motivation to use mobile phones. *International Journal of Environmental Research and Public Health, 16*(13), 2286. doi:10.3390/ijerph16132286

Zimmer-Gembeck, M. J., Webb, H. J., Pepping, C. A., Swan, K., Merlo, O., Skinner, E. A., . . . Dunbar, M. (2017). Review: Is parent–child attachment a correlate of children's emotion regulation and coping? *International Journal of Behavioral Development, 41*(1), 74-93. doi:10.1177/0165025415618276

Zimmerman, F. J., & Christakis, D. A. (2005). Children's television viewing and cognitive outcomes: A longitudinal analysis of national data. *Archives of Pediatrics and Adolescent Medicine, 159*(7), 619-625. doi:10.1001/archpedi.159.7.619

Zimmerman, F. J., Christakis, D. A., & Meltzoff, A. N. (2007). Associations between media viewing and language development in children under age 2 years. *Journal of Pediatrics, 151*(4), 364-368. doi:10.1016/j.jpeds.2007.04.071

APPENDICES

Appendix A
Joondalup Health Campus Ethics Approval

Joondalup
Health Campus
Part of Ramsay Health Care
Joondalup Hospital Pty Ltd trading as
Joondalup Health Campus
ABN 61 106 723 193
Cnr Grand Blvd & Shenton Ave
Joondalup WA 6027
PO Box 242
Joondalup WA 6919
Telephone: 08 9400 9400
Facsimile: 08 9400 9054
Web: www.ramsayhealth.com.au

14 September 2018

Dr Julia Zabatiero
School of Physiotherapy and Exercise Science
Curtin University
GPO Box U1987
PERTH WA 6845

juliana.zabatiero@curtin.edu.au

Dear Dr Zabatiero

RE: Screen ORIGINS: First longitudinal study of multidimensional influences and impacts of contemporary screen technology use over the first five years of life (1728)

At its meeting on 13 September 2018, the Human Research Ethics Committee of Joondalup Health Campus (JHC HREC) approved following document/s:

DOCUMENT TITLE	VERSION	DATE
Screen ORIGINS: Qualitative investigation of parental views and practices regarding screen technology use by young children – Interview Questions	2	31/08/18

Best wishes for your research.

Yours sincerely

Joanna Brisbane
Ethics Officer, JHC HREC
JHC-Ethics@ramsayhealth.com.au

ec

Appendix B
Curtin Reciprocal Ethics Approval

Curtin University

Office of Research and Development

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Facsimile +61 8 9266 3793
Web research.curtin.edu.au

21-Feb-2018

Name: Juliana Gomes Zabatiero
Department/School: School of Physiotherapy and Exercise Science
Email: Juliana.Zabatiero@curtin.edu.au

Dear Juliana Gomes Zabatiero

RE: Reciprocal ethics approval
Approval number: HRE2018-0065

Thank you for your application submitted to the Human Research Ethics Office for the project Screen ORIGINS: Qualitative investigation of parental views and practices regarding screen technology use by young children.

Your application has been approved by the Curtin University Human Research Ethics Committee (HREC) through a reciprocal approval process with the lead HREC.

The lead HREC for this project has been identified as Joondalup Health Campus Human Research Ethics Committee.

Approval number from the lead HREC is noted as 1804.

The Curtin University Human Research Ethics Office approval number for this project is **HRE2018-0065**. Please use this number in all correspondence with the Curtin University Ethics Office regarding this project.

Approval is granted for a period of one year from **21-Feb-2018** to **19-Feb-2022**. Continuation of approval will be granted on an annual basis following submission of an annual report.

Personnel authorised to work on this project:

Name	Role
Gomes Zabatiero, Juliana	CI
Straker, Leon	Co-Inv

You must comply with the lead HREC's reporting requirements and conditions of approval. You must also:

- Keep the Curtin University Ethics Office informed of submissions to the lead HREC, and of the review outcomes for those submissions
- Conduct your research according to the approved proposal
- Report to the lead HREC anything that might warrant review of the ethics approval for the project
- Submit an annual progress report to the Curtin University Ethics Office on or before the anniversary of approval, and a completion report on

Appendix C
Study 1 PROSPERO Registration

The associations of mobile touch screen device use with parent-child attachment: a systematic review

Rebecca Hood, Leon Straker, Juliana Zabatiero

Citation

Rebecca Hood, Leon Straker, Juliana Zabatiero. The associations of mobile touch screen device use with parent-child attachment: a systematic review. PROSPERO 2019 CRD42019136746
Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42019136746

Review question

To systematically review available literature on parent-child attachment and exposures associated with family mobile touch screen device use.

Searches

Systematic searches of the literature will be conducted in relevant electronic databases (EMBASE, ScienceDirect, PsycINFO, PubMed, MEDLINE, Cochrane Library, Cochrane Central Register of Controlled Trials (CENTRAL) and Proquest) for articles published from database inception to the time of the review, using keywords relating to mobile touch screen devices and parent-child attachment. Studies eligible for inclusion will be limited to those reported following peer review and written in the English language. Case reports, reviews, editorials and conference proceedings will be excluded. A search of the reference lists of included studies will also be completed.

Types of study to be included

Cross-sectional and longitudinal studies will be included.

Condition or domain being studied

The area being studied is the use of mobile touch screen devices, such as smartphones and tablet computers, and their associations with parent-child attachment e.g. secure or insecure attachment styles.

Participants/population

Inclusion:

(1) Children up to and including age 18 who have completed a scale measuring attachment to their parents;

(2) Parents of children up to and including age 18 who have completed a scale measuring attachment to their children; and

(3) Parents in the prenatal period, who have completed a scale measuring prenatal attachment to their foetus.

Exclusion:

(1) Older children (over 18 years of age) who have completed a scale measuring attachment to their parents; and

(2) Parents of older children (over 18 years of age) who have completed a scale measuring attachment to their children.

Intervention(s), exposure(s)

Articles that describe studies that have examined both the use of mobile touch screen devices (MTSD) and

associations with parent-child attachment outcomes, e.g. secure or insecure attachment styles, will be included. Studies that examined MTSD use and prenatal attachment will be included. Studies that do not relate attachment specifically to MTSD, or when outcomes from the use of MTSD are unable to be differentiated from non touch screen devices, will be excluded. Studies that examine attachment relationships that do not include parent-child attachment, e.g. marital or peer attachments, will be excluded.

Comparator(s)/control

Not applicable

Context

No limits on the context of study settings will be imposed.

Main outcome(s)

This systematic review will explore associations between mobile touch screen device use and parent-child attachment in either direction. There are two primary outcomes: mobile touch screen device use and parent-child attachment.

(1) Mobile touch screen device use will be measured using quantitative scores of time spent using specific types of devices (e.g. smartphones or tablet computers)

(2) Parent-child attachment will be measured using scales of attachment including (but not limited to): the Inventory of Parent and Peer Attachment, Parental Bonding Index, Experiences in Close Relationships Scale, Parental Bonding Instrument, Closeness to Parents Scale, Father and Mother Attachment Questionnaire, and the Prenatal Attachment Inventory.

Timing and effect measures

Not applicable

Additional outcome(s)

None

Timing and effect measures

Not applicable

Data extraction (selection and coding)

Relevant data will be extracted from eligible studies, including study purpose, study design, study population, parent-child attachment and mobile touch screen device use measures, statistical analyses and results. Titles and abstracts of articles identified in the search process will be assessed for inclusion by two researchers. In the event of any disagreement, consensus will be reached during a meeting between the two reviewers. If agreement could not be reached, discussion will be held with a third reviewer to decide on the matter.

Risk of bias (quality) assessment

Methodological quality and risk of bias of included studies will be assessed using the Grading of Recommendations Assessment Development and Evaluation (GRADE) approach, a formal process to rate the quality of scientific evidence in systematic reviews. Two review authors will independently assess the quality of the included studies using the GRADE approach. Consensus between the two reviewers will be reached through discussion, and if agreement cound not be reached discussion will be held with a third reviewer.

Strategy for data synthesis

Systematic searches of the literature will be conducted in relevant electronic databases. Search findings will be managed on EndNote and duplicate papers will be removed. Following this, search findings will be uploaded to Covidence to be independently reviewed for selection by two reviewers. Consensus between the two reviewers will be reached through discussion, and if agreement cannot be reached, discussion will be held with a third reviewer.

Once consensus has been reached regarding the papers to be included, one researcher will extract data, assess quality of included studies using the GRADE approach, and synthesise findings. Data extraction, quality assessment and synthesis of findings will be closely reviewed by an additional two researchers. In the event of any disagreement, consensus will be reached during a meeting between all researchers.

The following data will be extracted: author, year, country, sample size and characteristics, purpose, measure of mobile touch screen device use, measure of parent-child attachment, statistical analyses and key findings, and assessment of methodological quality. A critical interpretive approach will be used to collate study findings into a text narrative, with descriptions of the study characteristics (including context and quality of methodology) and key findings. Depending on the number of studies included, findings may be separated into subgroups by type of device (e.g. smartphone and tablet computer) or type of attachment (e.g. prenatal, child attachment score and parent attachment score).

Aggregate participant data will be used. If homogeneous studies are found, a meta-analysis for primary outcomes (i.e. associations between mobile touch screen device use and parent-child attachment) will be conducted using Review Manager (RevMan version 5.3 Copenhagen: the Nordic Cochrane Centre, The Cochrane Collaboration 2014). If this is not possible due to expected heterogeneity among included studies, a structured narrative synthesis of the findings will be undertaken.

Analysis of subgroups or subsets

If there are sufficient data, a sub-group analysis or narrative synthesis will be conducted. For example, possible sub-groups may include type of device (smartphone, Ipad), prenatal attachment, child age groups.

Contact details for further information

Rebecca Hood
rebecca.hood@postgrad.curtin.edu.au

Organisational affiliation of the review

Curtin University
www.curtin.edu.au

Review team members and their organisational affiliations

Ms Rebecca Hood. Curtin University
Professor Leon Straker. Curtin University
Dr Juliana Zabatiero. Curtin University

Type and method of review

Meta-analysis, Narrative synthesis, Systematic review

Anticipated or actual start date

24 May 2019

Anticipated completion date

01 November 2019

Funding sources/sponsors

Curtin University

Conflicts of interest

None known

Language

English

Country

Australia

NIHR | National Institute for Health Research

PROSPERO
International prospective register of systematic reviews

Stage of review
Review Ongoing

Subject index terms status
Subject indexing assigned by CRD

Subject index terms
Child; Humans; Parent-Child Relations; Parents

Date of registration in PROSPERO
18 October 2019

Date of publication of this version
18 October 2019

Details of any existing review of the same topic by the same authors

Stage of review at time of this submission

Stage	Started	Completed
Preliminary searches	Yes	No
Piloting of the study selection process	Yes	No
Formal screening of search results against eligibility criteria	No	No
Data extraction	No	No
Risk of bias (quality) assessment	No	No
Data analysis	No	No

Versions
18 October 2019

Appendix D
Study 1 Quality Assessment Tool

1. Study purpose
Did the study clearly state the research objectives, including any pre-specified hypotheses?
1 = Yes
0 = No
2. Study design
Was the study design well described and appropriate? This includes the setting, locations, periods of recruitment, and data collection.
1 = Yes
0 = No
3. Study population
Were participants randomly selected (or representative of the study population)?
1 = Yes
0 = No
4. Mobile Touch Screen Device Use (MTSD) Outcome
Was the mobile touch screen device use measure reliable and valid?
1 = Yes
0 = No
5. Parent-Child Attachment Outcome
Was the parent-child attachment measure reliable and valid?
1 = Yes
0 = No
6. Statistical analyses
Are statistical methods well described and appropriate?
1 = Yes
0 = No
7. Results
Are results well described and appropriately reported in sufficient details?
1 = Yes
0 = No

Note: Methodological quality assessment tool adapted from STROBE statement (Von Elm, E., Altman, D., Egger M., Pocock, S., Gotzsche, P. & Vandenbroucke, J. (2008). The Strengthening the Reporting of Observational Studies in Epidimiology (STROBE) statement: Guidelines for reporting observational bias. *Journal of Clinical Epidemiology, 61,* 344-349.)

Appendix E
Study 1 Quality Assessment Scores

Study	Study purpose	Study design	Study population	MTSD Outcome	Attachment Outcome	Analyses	Results	Overall /7
Moawad et al, 2016	0 - Aim and hypothesis not well described e.g. is more adolescent tech use hypothesised to be associated with more or less interaction with parents?	1 + Details of data collection were clearly described.	1 + Participants were randomly selected.	0 - No standardised reliable and valid measure used.	0 - No standardised reliable and valid measure used.	0 - The study described a correlation design, but instead reported results of a t-test.	0 - No indication of whether hours per day or per week were measured. - Only the response category 3-5 hours was reported on, and no data for <3hours or >5hours.	2
Modecki et al, 2020	1 + Clear indication of study purpose.	1 + Details of data collection were clearly described.	0 - Participants were not described as being randomly selected and may not be representative of all Australian parents.	0 - No standardised reliable and valid measure used.	0 - Although the item was taken from a reliable and valid scale, the reliability and validity of using a single item in isolation was not described.	1 + Multiverse analysis was well described and appropriate.	1 + Results were well described and reported in sufficient detail.	4

Study	Study purpose	Study design	Study population	MTSD Outcome	Attachment Outcome	Analyses	Results	Overall /7
Wolfers et al, 2020	1 + Clear indication of study purpose.	1 + Details of data collection were clearly described. - Observational design may have introduced bias.	0 - Mothers attending playground may not be representative of all mothers.	1 + A suitable approach was used to record duration and frequency of smartphone use. High consensus between observers was reported.	1 + A valid and reliable measure of maternal sensitivity was used.	1 + Multivariate linear regression was well described and appropriate.	1 + Results were well described and reported in sufficient detail.	6

Appendix F
Study 2A Interview Schedule

Prior to initiating the interview: Researcher introduces themselves, gives a summary of the project aim and procedures (including audio recording), clarifies any queries participant may have about the study, provides definitions for terms used (e.g. screen devices) and obtains participant consent to be interviewed and for the information we collect as part of this study to be shared with the ORIGINS Databank.

---

1. Can you tell me about your family?
    a) Where do you live?
    b) Who lives with you? (e.g. adults and marital status, children (gender, age))
    c) Working status for yourself and your partner (if applicable), school/kindy status for children (if applicable), typical weekly routines (work/school/kindy) (pre-pandemic)
2. Can you tell me about the type of screen devices you and your family have in the home?
    a) How many screen devices and what type?
    b) Where these screen devices are located in the home?
    c) Who has access to the screen devices and when?
    d) Are any of these screen devices used outside of the home (e.g. car trips, shops, work/school, parks, family and friends' houses)
3. Can you tell me what a typical week of screen device use would look like for you and each of your family (partner and child(ren) if applicable)?
    a) Let's start with your week – on Mondays what devices do you use in the morning….are the other week days similar? Is your use of screens different on Saturday? on Sunday?
        i. Home vs outside of the home (work/school)?
        ii. What types of programmes or activities/apps are watched/done with each screen device and by whom?
        iii. How are the screen devices used (individually/collaboratively)?
        iv. How do you feel about your family's current screen use practices?
        v. What do you expect your family's technology use will look like once the baby is born?

4. Can you tell me about the reasons why you and your family use screen devices?
    a) What do you and your family use the screen devices for?
        i. You, partner, each child (if applicable)
        ii. What do you and your family expect from the use of screen devices?
5. Can you tell me more about how you and your family manage the use of screen devices?
    a) Have you considered or discussed any strategies you and your family use to decide how or when to use screen devices?
        i. If so, can you tell me more about it (who developed them? How are they used?)
    b) What else has influenced your decisions around screen use?
6. We would like to better understand what your relationship is like with your child.
    a) What can you tell me about your experience of your baby right now in your pregnancy? (or reflecting back if baby has already been born)
    b) How do you think or feel towards your baby?
    c) How have your feelings about your baby changed over the course of your pregnancy?
    d) What kinds of things do you do (during pregnancy) that help you connect with your baby, or that distract you from being connected with your baby?
7. We would like to know your thoughts on how the use of screen devices, particularly mobile touchscreen devices, by you and/or other members of your family may influence, in any way…
    a) The relationship between you and your child? e.g. how often you think about your baby, how you feel towards baby (emotionally distant or close, happy, sad, loving, irritated), your desire to read about or get information about baby, picturing in your mind what your baby looks like, how often you talk to baby, expectations of meeting baby, how often you feel or rub your stomach
    b) The interactions between the family members?
        i. e.g. <u>You and your partner/family members other than children</u>: how you think/feel/behave towards each other; how much time you spend together
        ii. e.g. <u>Your partner and your child(ren)(if applicable)</u>: how he/she thinks / feels / behaves towards the child; how much time he/she spends with the child

iii. e.g. Your children (if applicable): how they think/feel/behave towards each other; how much time they spend together

c) How do you think device use may influence future relationships once the baby is born?

8. We would like to know your thoughts on how the use of screen devices, particularly mobile touchscreen devices, by you and/or other members of your family may influence, in any way…

   a) How your child(ren) will learn (e.g. how they will explore the environment, learn to solve problems, copy/mimic your actions)
   b) How your child(ren) will communicate with other people (e.g. play games, learn how to say words) and learn how to deal with emotions
   c) How your child(ren) will develop physically (e.g. how they learn to hold different objects, throw a ball, to sit/crawl/walk/run/jump)

9. What kind of information would you find useful to help guide your family's use of mobile touch screen devices?

   a) How would you like to receive that information? (e.g. online seminar, brochure, through your playgroup)

Researcher concludes interview, thanks participant for their time and thoughts, and arranges the delivery of the voucher to participant. Researcher also mentions that a summary of the results will be put on the ORIGINS website, probably around the end of the year.

Appendix G
Study 2B and 2C Interview Schedule

Prior to initiating the interview: Researcher introduces themselves, gives a summary of the project aim and procedures (including audio recording), clarifies any queries participant may have about the study, provides definitions for terms used (e.g. screen devices) and obtains participant consent to be interviewed and for the information we collect as part of this study to be shared with the ORIGINS Databank.

---

1. Can you tell me about your family?
    a) Where do you live?
    b) Who lives with you? (e.g. adults and marital status, children (gender, age))
    c) Working status for yourself and your partner (if applicable), school/kindy status for children (if applicable), typical weekly routines (work/school/kindy) (pre-pandemic)
    d) Have your family's work/child care arrangements changed as a result of the COVID-19 pandemic?
2. Can you tell me about the type of screen devices you and your family have in the home?
    a) How many screen devices and what type?
    b) Where these screen devices are located in the home?
    c) Who has access to the screen devices and when?
    d) Are any of these screen devices used outside of the home (e.g. car trips, shops, work/school, parks, family and friends' houses)
3. Can you tell me what a typical week of screen device use would look like for you and each of your family (partner and child(ren) if applicable)?
    a) Let's start with your week – on Mondays what devices do you use in the morning….are the other week days similar? Is your use of screens different on Saturday? on Sunday?
        i. Home vs outside of the home (work/school)?
        ii. What types of programmes or activities/apps are watched/done with each screen device and by whom?
        iii. How are the screen devices used (individually/collaboratively)?

iv. How do you feel about your family's current screen use practices?

v. What do you expect your family's technology use will look like once the baby is born?

vi. Has your family's use of screen devices changed as a result of the COVID-19 pandemic?

4. Can you tell me about the reasons why you and your family use screen devices?

   a) What do you and your family use the screen devices for?

      i. You, partner, each child (if applicable)

      ii. What do you and your family expect from the use of screen devices?

5. Can you tell me more about how you and your family manage the use of screen devices?

   a) Have you considered or discussed any strategies you and your family use to decide how or when to use screen devices?

      i. If so, can you tell me more about it (who developed them? How are they used?)

   b) What else has influenced your decisions around screen use?

6. We would like to better understand what your relationship is like with your child.

   a) What can you tell me about your experience of your baby right now in your pregnancy? (or reflecting back if baby has already been born)
   b) How do you think or feel towards your baby?
   c) How have your feelings about your baby changed over the course of your pregnancy?
   d) What kinds of things do you do (during pregnancy) that help you connect with your baby, or that distract you from being connected with your baby?
   e) Has your relationship with your child changed as a result of the COVID-19 pandemic?

7. We would like to know your thoughts on how the use of screen devices, particularly mobile touchscreen devices, by you and/or other members of your family may influence, in any way…

   a) The relationship between you and your child? e.g. how often you think about your baby, how you feel towards baby (emotionally distant or close, happy, sad, loving, irritated), your desire to read about or get information about baby,

picturing in your mind what your baby looks like, how often you talk to baby, expectations of meeting baby, how often you feel or rub your stomach

b) The interactions between the family members?

i. e.g. <u>You and your partner/family members other than children</u>: how you think/feel/behave towards each other; how much time you spend together

ii. e.g. <u>Your partner and your child(ren)(if applicable)</u>: how he/she thinks / feels / behaves towards the child; how much time he/she spends with the child

iii. e.g. <u>Your children (if applicable)</u>: how they think/feel/behave towards each other; how much time they spend together

c) How do you think device use may influence future relationships once the baby is born?

d) How do you think the influence of device use on the relationship between you and your child (and other relationships within your family) has changed as a result of the COVID-19 pandemic?

8. We would like to know your thoughts on how the use of screen devices, particularly mobile touchscreen devices, by you and/or other members of your family may influence, in any way…

   a) How your child(ren) will learn (e.g. how they will explore the environment, learn to solve problems, copy/mimic your actions)

   b) How your child(ren) will communicate with other people (e.g. play games, learn how to say words) and learn how to deal with emotions

   c) How your child(ren) will develop physically (e.g. how they learn to hold different objects, throw a ball, to sit/crawl/walk/run/jump)

9. What kind of information would you find useful to help guide your family's use of mobile touch screen devices?

   a) How would you like to receive that information? (e.g. online seminar, brochure, through your playgroup)

Researcher concludes interview, thanks participant for their time and thoughts, and arranges the delivery of the voucher to participant. Researcher also mentions that a summary of the results will be put on the ORIGINS website, probably around the end of the year.