

https://dspace.org/

The Impact of Maternal Mental Health on Synchrony in Mother-Infant Interactions

Cantrell, Sarah Jane

2025
University of the Witwatersrand, Johannesburg
https://hdl.handle.net/10539/50023
Cantrell, Sarah Jane. (2025). The Impact of Maternal Mental Health on Synchrony in Mother-Infant Interactions [PhD thesis, University of the Witwatersrand, Johannesburg]. WIRDSpace. https://hdl.handle.net/10539/50023

Downloaded from a DSpace repository. https://dspace.org/

THE IMPACT OF MATERNAL MENTAL HEALTH ON SYNCHRONY IN MOTHER-INFANT INTERACTIONS

Sarah Jane Cantrell

Student number: 0712062A

Supervisors

Doctor Alessandra Prioreschi

Professor Rebecca Pearson

A THESIS

Submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfillment of the requirements for the degree of Doctor of Philosophy

JOHANNESBURG, SOUTH AFRICA

2025

Declaration

I, Sarah Jane Cantrell, declare that this thesis is my own original, unaided work. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg, South Africa. It has not been submitted before for any degree or examination at any other University or institution.



Signed by Sarah Jane Cantrell

This 8th day of July 2025 in Stellenbosch

Dedication

To every unseen mother and her baby

Acknowledgements

I dedicate this thesis to the inspirational individuals who have played various roles in my doctoral journey.

First and foremost, I express my deepest gratitude to my supervisors, Alessandra Prioreschi and Rebecca Pearson. Alessandra's consistent and constructive feedback has been instrumental in shaping the direction of my research and refining my analytical skills. I'm grateful for her mentorship and our engagements that challenged me to think critically, ensuring the robustness of this research. Rebecca's knowledge and expertise in the use of technology to investigate relationships has taken the psychologist, such as myself, out of the therapy room and into people's homes. I'm grateful that our collaboration will open the door to support thousands of people who have never had the opportunity to be assisted with their mental health.

Professor Peter Kamerman and his solid approach to problem solving and teaching has been invaluable. Thank you, Pete for your patience and guidance. I have learned so much from you. To Fiona Bennin, Helene Theunissen, Dumsile Maduna, Zama Cebekhulu, Ngomeni Mchunu and Duduzile Khumalo. Our shared experiences, interesting discussions and collaborative efforts created a supportive academic community that inspired me to persevere through the last three years. Our laughs in the car driving through Soweto kept us in good spirits even when we were off to do somewhat triggering emotional work in the field.

I must acknowledge the courageous participants who consented to be part of this research. Mothers of Soweto were willing to share their experiences into their sometimes-harsh environments and their own mental health struggles. This couldn't have been easy to disclose. I am truly humbled by the stories and appreciate the release of delicate emotions that you have held close. Thank you for the trust that you placed in me when trust can be precarious.

Not only has Lesley Caplan been my psychology supervisor, but also a transformational mentor in her way of being. Thank you, Lesley, for your gentleness and unconditional love for all living things. Associate Prof Stella Iacovides's guidance on this journey has been unwavering and I would never have started a doctoral process if it were not for my dear friend. Nichi Casati was a parachute during the last few years and brought calm through her love and wisdom. Dankie, liewe Nichs. Mary van Zyl - thank you for your red pen and kindness.

To my mom, Jem. Remember the story when Ouma (my grandmother) was sitting in the sun to relax after chemotherapy, and I sneaked up behind her and hit her hard on the head with a slipper? I was 3. Instead of yelling at me, you coaxed me onto your lap and told me that it must be difficult for me to share my mommy with a sick granny who really needs help. Not many mothers would've been so insightful. Dad- there are also not many fathers who would show so much love, always reminding me at a young age that I was your 'loveable and adorable baby'. My brother John and sister Helen - your commitment to our family is remarkable and I'm in awe of your selfless service to everyone around you. You're the best siblings anyone could wish for. To Natalie, Alissa, Rosie, Rex, Liesl and Keith - your support has been irreplaceable, and I thank you for your love and the interest you show in all spheres of my life.

To my family. I dedicate this work not only as an acknowledgement of your steadfast support but also as a testament to the strength and resilience that a loving family, two poodles, ten chickens and a pet hamster can provide. To my three musketeers. My beloved Tessa, Jemma and Ant - thank you for allowing me the privilege of being your mother. I've consciously tried to get the balance right between this PhD and my devotion to you. Thank you for your patience through the process. As your circles of security widen; know that you always have space on my lap.

Lastly, to my skat, Marc. Your own work ethic and the bubbles of ideas that burst from your brain and keep you up at night are an inspiration. I love that we take life seriously and that we embody curiosity and drive but also fun and adventure in this playground of life. Thank you for your patience throughout the countless hours, the stages of my self-doubt, our chats about analyses and for standing by my side when our world was turned upside down over the past three years. You were there when I landed up in ICU and was trying to submit a paper days later, after complicated surgery, when we moved a thousand kilometers to live down South. You supported us all even through starting your own business and when we lost all the support that had carried us for so long. The most consistent thing was you. Thank you for giving me the freedom to follow this dream of mine when it sometimes came at the expense of the family. I'm delighted that the completion of this academic venture will foster meaning within the family and for our lives together.

Manuscripts in review arising from this research project

Cantrell, S.J., Pearson, R.P. & Prioreschi, A (2024). Maternal perspectives on poor mental health and the impact on mother-infant relationships. Now published in the Journal of Reproductive and Infant Psychology (1).

Cantrell, S.J., Pearson, R.P., Kamerman, P. & Prioreschi, A (2024). Describing the synchrony of visual attention and facial expression between mothers and their infants in a poorly resourced setting.

Cantrell, S.J., Pearson, R.P. Kamerman, P. & Prioreschi, A (2024). Durations and transitions of smiles: A comparative study of non-depressed and sub-clinically depressed mothers while interacting with their infants.

Co-authorship on publications

I co-authored the following papers during my PhD tenure which started in August 2021. I am grateful for the opportunities that I was given in contributing to this meaningful work carried out by fellow researchers in South Africa and the United Kingdom. The references to these are:

Costantini, I., López-López, J.A., Caldwell, D., Campbell, A., Hadjipanayi, V., Cantrell, S.J., Thomas, T., Badmann, N., Paul, E., James, D.M. and Cordero, M. (2023). Early parenting interventions to prevent internalizing problems in children and adolescents: a global systematic review and network meta-analysis. BMJ Mental Health 26(1). Manuscript number: bmjment-2023-300811.

Prioreschi, A., Pearson, R., Richter, L., Bennin, F., Theunissen, H., Cantrell, S.J., Maduna, D., Lawlor, D. and Norris, S.A., 2023. Protocol: Protocol for the PLAY Study: a randomised controlled trial of an intervention to improve infant development by encouraging maternal self-efficacy using behavioural feedback. BMJ Open, 13(3).

Award related to this research project

Postgraduate Merit Award 2021-2024 awarded by the University of the Witwatersrand.

Table of contents

SECTION 1: LITERATURE REVIEW AND METHODOLOGY 19

CHAPTER 1 20

Introduction 20

1.1 The mother-infant relationship 22

1.1.1 Sensitivity 22

1.1.2 Responsive caregiving 24

1.1.3 Bonding and attachment 24

1.1.4 Reflective functioning 26

1.1.5 Bidirectionality 27

1.2 Synchrony 28

1.2.1 Defining synchrony 28

1.2.2 Observing synchrony 29

1.2.3 Measuring and analysing synchrony 32

1.2.4 Effects of synchrony 35

1.3 Mother-infant interaction and synchrony 35

1.3.1 Social bonding 35

1.3.2 Visual attention 37

1.3.3 Facial expressions 40

1.4 Mother-infant interaction and cultural differences 42

1.5 Mothers and infants in South Africa 44

1.5.1 The local environment 45

1.5.2 Living conditions 46

1.5.3 Relationships 47

1.5.4 Childhood experience 47

1.6 Maternal mental health 48

1.6.1 The effect of maternal mental health on mother-infant interactions 49

1.6.2 Relationships between postnatal depression and anxiety and synchrony.....51
1.7 Summary.....53
1.8 The problem.....55
1.9 Aims and objectives.....55
CHAPTER 2.....56
Study sample and methodology.....56
2.1 Research setting.....57
2.2 Research sample.....58
2.2.1 Research sample for objective 1.....58
2.2.2 Research sample for objectives 2 and 3.....59
2.3 Ethical approval.....59
2.4 Methodology.....60
2.4.1 Measurement tools.....60
2.4.2 Specific methodology for each objective.....65
2.5 Analyses.....72
2.6 Ethical considerations.....75
2.7 Researcher reflexivity.....76
SECTION 2: EMPIRICAL CHAPTERS.....78
CHAPTER 3.....79
Maternal perspectives of poor mental health and the impact on mother-infant relationships.....79
3.1 Introduction.....80
3.2 Methods.....82
3.3 Qualitative analysis.....85
3.4 Results.....87
3.5 Discussion.....94
3.6 Limitations.....97
3.7 Conclusion.....98

CHAPTER 4 99

Describing the synchrony of visual attention and facial expression between mothers and their infants in a poorly resourced setting 99

4.1 Introduction 100

4.2 Methods 103

4.3 Results 110

4.4 Discussion 123

4.5 Strengths 128

4.6 Limitations 128

4.7 Conclusion 129

CHAPTER 5 130

Durations and transitions of smiles: A comparative study of non-depressed and sub-clinically depressed mothers while interacting with their infants 130

5.1 Introduction 131

5.2 Methods 134

5.3 Results 141

5.4 Discussion 149

5.5 Limitations 153

5.6 Conclusion 154

SECTION 3: INTEGRATION 155

CHAPTER 6 156

Integrated discussion 156

6.1 Introduction 157

6.2 Study rationale 157

6.3 Key findings 158

6.4 Discussion 162

CHAPTER 7 165

Conclusion 165
7.1 Introduction 166
7.2 Strengths of the research 166
7.3 Limitations of the research and suggestions for future investigation 167
7.4 Recommendations for interventions in South Africa 170
7.4.1. Interventions for supporting mothers 170
7.5 Future research 172
7.5.1 The Model of Observing Mother and Infant (MOMI) 172
7.6 Conclusion 177

Nomenclature

ACE	Adverse Childhood Events
CAG	Community Advisory Group
CHBAH	Chris Hani Baragwanath Academic Hospital
DPHRU	Developmental Pathways for Health Research Unit
DSM-5	Diagnostic and Statistical Manual 5th edition
EPDS	Edinburgh Postnatal Depression Scale
FE	Facial expression
FGDs	Focus Group Discussions
HICs	High income countries
IWM	Internal working model
LA	Lag analysis
LMICs	Low to middle income countries
MD	Mean duration
MHINT	Mental Health Intergenerational Transmission Process Manual
PBQ	Postpartum bonding questionnaire
PCL-5	PTSD Checklist for DSM-5
PLAY	Play, Love and You study
RC	Responsive caregiving
RF	Reflective functioning
SA	South Africa
SDQ	Sociodemographic questionnaire
TD	Total duration
VA	Visual attention
WEIRD	Western, Educated, Industrialised, Rich, and Democratic
WHO	World Health Organisation

List of figures

Figure 1: The spheres of influence that shape the dyadic mother-infant relationship 45

Figure 2: Influence of the mother's mental state on the dyadic relationship (Adapted from John Bowlby's maternal deprivation theory, 1969). 54

Figure 3: Map illustrating the location of Soweto in South Africa..... 58

Figure 4: The spheres of influence that shape the dyadic mother-infant relationship with objectives 60

Figure 5: Example of micro coded data on the behavioural domains of visual attention and facial expressions for mother and infant with timestamps..... 107

Figure 6: The percentage of time spent with visual attention on each focus point for infants and mothers (57 dyads)..... 113

Figure 7: Percentage of time that mothers and infants showed with different facial expressions. Only mothers could engage in "Mock surprise"..... 115

Figure 8: The probability of the infant leading the interaction of looking at the mother and having the mother follow (blue grey), and the probability of the mother leading the interaction of looking at the infant and having the infant follow (orange), within 3 seconds. Sample size = 55 dyads with sufficient data to analyse both mother leading infant and infant leading mother within a dyad 120

Figure 9: The probability of the infant leading the interaction of looking at a distraction and having the mother follow (blue grey), and the probability of the mother leading the interaction of looking at a distraction and having the infant follow (orange), within 3 seconds. Sample size = 37 dyads with sufficient data to analyse both mother leading infant and infant leading mother within a dyad 121

Figure 10: The probability of the infant leading the interaction with smiling and having the mother follow (blue grey), and the probability of the mother leading the interaction with smiling and having the infant follow (orange), within 3 seconds. Sample size = 45 dyads with sufficient data to analyse both mother leading infant and infant leading mother within a dyad 122

Figure 11: The probability of the infant leading the interaction of having a neutral expression and having the mother follow (blue grey), and the probability of the mother leading the interaction of

having a neutral expression and having the infant follow (orange), within 3 seconds. Sample size = 40 dyads with sufficient data to analyse both mother leading infant and infant leading mother within a dyad..... 123

Figure 12: Example of micro-coded data on the behavioural domains of mother-infant facial expressions with timestamps. Only data for maternal neutral, positive and smiling facial expressions were used..... 138

Figure 13: The predicted probability distributions showing differences in transitions from neutral to positive facial expressions between non-depressed and sub-clinically depressed mothers for 1, 2, and 3-second lag periods using Bayesian analysis..... 144

Figure 14: The predicted probability distributions showing differences in transitions from neutral to smile facial expressions between non-depressed and sub-clinically depressed mothers for 1, 2, and 3-second lag periods using Bayesian analysis..... 146

Figure 15: The predicted probability distributions showing differences in transitions from positive to smile facial expressions between non-depressed and sub-clinically depressed mothers for 1,2, and 3-second lag periods using Bayesian analysis..... 148

Figure 16: The observe mother and infant model..... 173

List of tables

Table 1: Details of questionnaires used……... 63

Table 2: Method of coding using "The Observer" and the MHINT manual……... 68

Table 3: Measuring tools used for specific objectives…… 70

Table 4: Summary of methodologies, measuring tools and data collected…….. 71

Table 5: Themes and correlating subthemes……... 87

Table 6 Characteristics of mothers and their infants (n=15)……... 87

Table 7: Analysis of assessments…… 89

Table 8: Exemplar quotes regarding perceived causes of maternal mental health……. 91

Table 9: Exemplar quotes regarding perceptions of the effect of maternal mental health issues on the dyad…….. 94

Table 10: Demographic characteristics for mothers and their infants……..…
110

Table 11: Mean durations, number of occurrences, and total durations for visual attention of infants and mothers (n = 57 dyads)…….. 116

Table 12: Mean durations, number of occurrences, and total durations for facial expressions for infants and mothers (n = 57 dyads)…….. 118

Table 13: Demographic characteristics of the sample……... 141

Table 14: Mean durations, number of occurrences, and total durations for maternal facial expressions 142

Table 15: Number of participants transitioning between different facial expressions…….. 143

Table 16: Ordinal regression analysis for maternal neutral to positive facial expression. Odds ratios indicate the odds of being in a higher quintile of transition probability in sub-clinically depressed mothers compared to non-depressed mothers……..145

Table 17: Ordinal regression analysis for maternal neutral to smile facial expression. Odds ratios indicate the odds of being in a higher quintile of transition probability in sub-clinically depressed mothers compared to non-depressed mothers…….. 147

Table 18: Ordinal regression analysis for maternal positive to smile facial expression. Odds ratios indicate the odds of being in a higher quintile of transition probability in sub-clinically depressed mothers compared to non-depressed mothers……... 149

Table 19: Overview of study findings per objective…….. 160

List of appendices

Appendix A: Theoretical underpinnings of the study
Appendix B: The PLAY study information and consent form
Appendix C: HREC ethical clearance certificate for Community Advisory Group study
Appendix D: HREC ethical clearance certificate for Sarah Cantrell's PHD study
Appendix E: HREC ethical clearance certificate for Play Love And You study
Appendix F: Sociodemographic questionnaire
Appendix G: Adverse Childhood Events (ACES)
Appendix H: Edinburgh Postnatal Depression Scale (EDPS)
Appendix I: Postnatal bonding questionnaire (PBQ)
Appendix J: PTSD Checklist (PCL-5)
Appendix K: Social stress and social support questionnaires
Appendix L: Infographic pamphlet about maternal mental health and bonding
Appendix M Possible topic for video: 'Bonding is about trust'
Appendix N: Possible topic for video: 'Why bonding is important'
Appendix O: Possible topic for video: 'How to form a trusting bond with your baby'
Appendix P: Student's contribution to article(s) and agreement of co-authors
Appendix Q: Turn it in report

Preface

As a teenager I was privileged enough to be allowed to bottle feed abandoned newborns in Johannesburg every week after school. When I began my journey as a community counselling psychologist, I started working with orphans and their 'house mothers' (caregivers at the children's home) at Epworth Children's Village where therapy sessions were filled with feeding, hair brushing, baking and games. Issues of abandonment, over sexualisation and attachment disorders were common themes. We were affiliated to a Place of Safety where infants and young children - who had been removed from their homes due to neglect or abuse - were brought to us to be assessed for placements into foster care. I remember four siblings who arrived with a social worker. The youngest was an 8-month-old infant with purple gentian violet (a topical antiseptic) on her cheeks. Nobody knew what to do with her while we were working with her brothers. I volunteered to hold her and to assess the oldest brother at the same time. Developmentally, an 8-month-old usually displays separation anxiety, but this young infant threw herself into my arms and soon fell asleep. A few hours passed by. I was leaning over her on the couch to wake her up. She opened her eyes and smiled at me. A stranger. No crying. No looking for mom. Only then did I understand how she had never had consistent caregiving from an attachment figure to love her and to teach her about trust in people or trust in the world. She would have clung to me for dear life if she'd had the choice. I'm not sure what happened to her, but she probably bounced from caregiver to caregiver conceptualising herself and the world in such inconsistent ways that she got lost in herself and the system. I finally comprehended 'attachment' and the destruction of deprivation.

What followed for me was private practice and a three-year course of psychoanalytic infant observation, during which I met the parents of an unborn baby and continued to visit and watch the family in their home for an hour a week until the infant's second birthday. What a profound impact an ill mother can have on the infant and the family system. It was clear that my being in the room had an impact on the observation and I always wondered what it might be like to observe the dyadic relationship as the proverbial 'fly on the wall'. My journey has brought me here for this reason, to this topic and to this thesis.

In exploring the impact of maternal mental health on mother-infant interactions, I conducted in-depth interviews, asking mothers about their perceptions of the causes of depression and anxiety as well as their attitudes toward bonding. I then sent home pairs of head mounted cameras for infants and their mothers to video record footage of themselves interacting during free play. Mother-infant interaction involves tactile, auditory and vocal exchange. Much literature reveals that good bonding is related to healthy amounts of eye contact and facial expressions that are mirrored as an indication of shared emotional experience, bringing a feeling of closeness between the pair. The aim was to download recorded footage, to code how many times each mother and each infant looked at the other or at a distraction, focus object or other person in the room and then to see how synchronous they were in their visual attention. I coded facial expressions too and micro-analysed the frequency, duration and synchronicity of these behaviours. The third phase of enquiry was to look at the relationship between maternal mental health and the timing of the transitions of the mother's facial expressions during her interaction with her infant. This would give an indication of the possible effect of maternal mental health on dyadic relationships. As secure bonding is important for the infant's social, emotional and cognitive well-being, good relationship skills, healthy trust formation, better emotional regulation and cognitive ability would result and could assist in forming a more functional individual and society.

This PhD dissertation has been formatted alongside the WITS doctoral programme guidelines and the framework of the thesis is outlined as follows:

SECTION 1 covers the literature review, study sample and methodology.
Chapter 1 provides an orientation to the key literature relating to the essence of the mother-infant relationship. It defines responsive caregiving in terms of bonding and attachment and explains mother-infant interaction as well as the synchrony, or to and fro, of interaction between a mother and her infant that essentially defines their relatedness. It continues to highlight that responsive caregiving is crucial for social, emotional and cognitive development in children. It further explores important cultural issues and caregiving that differ in communities. After contextualising mothers and infants in South Africa, the issue of psychopathology and its negative effect on the dyad is discussed.

Chapter 2 describes in greater detail the study sample, participants, setting, data collection and general methodology used as well as presenting ethical approvals granted for the research objectives. These objectives are to explore maternal perspectives on poor mental health and the impact this has on mother-infant relationships, to describe the synchronisation of face-to-face interactions between mothers and their infants and to compare the transitions of facial affect of mothers with varying degrees of depression in a socially vulnerable population.

SECTION 2 contains the empirical chapters representing the body of the thesis which consist of 3 manuscripts presented in publication format.

Chapter 3 presents the manuscript entitled "Maternal perspectives of poor mental health and the impact on mother-infant relationships."

Chapter 4 presents the manuscript entitled "Describing the synchrony of visual attention and facial expression between mothers and their infants in a poorly resourced setting."

Chapter 5 presents the manuscript entitled "Durations and transitions of smiles: A comparative study of non-depressed and sub-clinically depressed mothers while interacting with their infants."

SECTION 3 brings all the findings together.

Chapter 6 consolidates the results of the three manuscripts, synthesises the main research findings, contextualises these findings within the current literature locally and globally, and outlines the contributions of the work.

Chapter 7 ends the thesis with insights into the strengths of the research, its limitations and considerations for future research.

Abstract

This thesis aims to explore the impact of maternal mental health on mother-infant interactions. Objective one is to explore mothers' perceptions of poor mental health and its influence on their infants. Objective two is to describe the synchrony of visual attention and facial expression between the dyad. Objective three is to analyse durations of maternal facial expressions and to compare facial expression transitions between non-depressed and sub-clinically depressed mothers during these interactions, with the goal of informing context-specific interventions for a vulnerable population in South Africa.

This PhD used mixed methods. A qualitative study with fifteen Sowetan mothers, in two focus groups, explored postpartum mental health experiences and how these experiences affected their bonding with their infants. Thematic analysis identified key contributors to mental health challenges. For the quantitative studies, 57 mother-infant interactions were recorded during free-play with head-mounted cameras. Synchrony in visual attention and facial expressions was analysed using Observer XT 16 ® software focusing on behavioural frequency, duration and lag sequencing. Time-series analyses over 3 second intervals defined synchrony. Facial expression transitions between non-depressed and sub-clinically depressed mothers were compared using 1, 2 and 3-second time lags. A transition was defined as a shift from neutral to an emotional expression within 3 seconds. EPDS scores of 6-13 indicated sub-clinical depression.

Paternal denial, family conflict, financial hardship, and lack of community support were perceived to contribute to poor maternal mental health. A theme of maternal persecution emerged. Behavioural micro-analysis of interactional exchanges revealed that infants looked at their mothers 47% of the time, mothers looked at their infants 92% of the time. Limited behavioural variation complicated synchrony measurement. When focusing on transitions in expressions, sub-clinically depressed mothers were 84% less likely to exhibit a positive facial expression before transitioning to a smile as compared to non-depressed mothers.

A mother's inward-directed anger can erode her self-trust, and when depression affects the relationship, it undermines trust within the dyad. Despite this, mothers showed a strong desire to be 'good enough' and actively sought to connect with their infants. Early intervention is essential, particularly in vulnerable settings with limited research. The study calls for culturally sensitive support for mothers and their infants, with a focus on promoting the virtues of trust and hope.

SECTION 1: LITERATURE REVIEW AND METHODOLOGY

CHAPTER 1

Introduction

"**The child who is not embraced by the village will burn it down to feel its warmth."**

African proverb

Societies around the world have generated wisdoms through the ages which capture truths about human experiences. One of these compelling insights is an African proverb which reads, “The child who is not embraced by the village will burn it down to feel its warmth.” This evocative phrase captures the significance of nurturance and support in the early years. It narrates the importance of the development and growth of the young who become adults in their communities, responsible for shaping the well-being of their people and the generations to come.

Furthermore, it highlights the significance of the mother-infant bond. This deeply intricate and delicate dyadic relationship between a mother and her infant serves as a foundation for childhood growth and is influenced by a multitude of factors. One such factor is the burgeoning topic of maternal mental health during the postpartum period. Anxiety, depression and trauma profoundly impact a mother’s style of attaching to her infant, shaping the child’s trajectory in terms of social, cognitive and emotional development (2). The devastating ripple effect of trauma on mental health issues leads to the mother’s projection of unprocessed feelings (3), psychopathology and dysfunction, which eventually settle into epigenetics and behaviours whereby the cycle is perpetuated (4). Evidence suggests that maternal mental health difficulties can be transmitted across generations through biological, psychological and social mechanisms. These include alterations in stress regulation systems (e.g., HPA axis dysregulation), epigenetic modifications, learned patterns of emotional expression and regulation, and parenting behaviours shaped by the mother's own early attachment experiences (5,6). Such intergenerational patterns emphasize the critical importance of early interventions that support both maternal mental health and caregiving behaviours.

Low-income mothers and infants nested within this proverbial South African ‘village’ are exposed to their poorly resourced physical surroundings, corrupt political environment, social and familial settings and general support systems. When these systems falter, the repercussions on the mother and infant are far reaching. This thesis explores the complex interplay between maternal mental health, the perceived causes of distress, the sources of stress within the ‘village’ and their collective impact on the quality of mother-infant interactions as assessed using video footage from within the homes of Sowetan families.

All South Africans, including researchers such as myself, are part of the village. My aim is to embrace the child and the mother through this doctorate by highlighting the importance of a 'holding environment' (7) or quality time on a mother's lap [(7); L. Caplan, personal communication, March 2021] to encourage warmth between the pair. I aim to share knowledge to advocate for the first 1000 days of life and maternal mental well-being; and to urge policy makers to endorse preventative interventions during this period, emphasising that early childhood development interventions yield greater benefits compared to reactive approaches.

1.1 The mother-infant relationship

> '…wherever one finds an infant one finds maternal care, and without maternal care there would be no infant.'
>
> [D.W. Winnicott, 1965, The Maturational Processes and the Facilitating Environment (8)]

Maternal care is important because a healthy child needs a healthy mother. A mother's sensitivity and responsiveness to her infant's needs, and the quality of the mother-infant relationship, is critical in the social, emotional, motor and cognitive development of a young child (9). The nature of this dyadic relationship also serves as the infant's basis for the development of self-esteem as well as countless psychological capacities such as self-regulation, readiness to learn and social competence (10).

1.1.1 Sensitivity

Within the realm of maternal-infant interactive behaviours, sensitivity (11) is widely acknowledged as a cornerstone of effective or 'good enough' (7) mothering. It encompasses a mother's attentiveness to her infant's cues, the accuracy of her interpretations, and the timeliness and appropriateness of her response (11). Extensive research has underscored maternal sensitivity as a crucial factor in children's social-emotional development. Numerous studies conducted in both healthy and high-risk populations, across various cultures, and supported by several meta-analyses (12,13), have demonstrated that experiencing sensitive caregiving during the first year of life is essential for the development of children's socialisation, emotional competencies, and overall well-being. Longitudinal research further indicates that maternal sensitivity significantly influences the child's broader social skills (14,15); emotion regulation

abilities (16,17), peer interactions, academic performance (15,18) and behavioural adjustment (19,20) from toddlerhood and preschool years through to adolescence (14,15). To elaborate, this includes a child's capacity to interact effectively and appropriately with others, including sharing, cooperation, communication, and conflict resolution. Emotional regulation abilities involve the child's ability to monitor, evaluate, and modify emotional reactions in a socially acceptable and flexible way. Sensitive parenting helps children develop these skills by modeling and reinforcing appropriate ways of handling emotions like frustration, anger, or sadness. Additionally, behavioural adjustment is the extent to which a child displays socially appropriate behavior and self-control and avoids behaviors such as aggression. Supportive maternal responses help children internalise rules and expectations, promoting better behavioral outcomes over time.

This concept of sensitivity is universal across cultures, although the specific manifestations and practices of caregivers may vary considerably (21,22). Existing knowledge regarding infant mental health predominantly stems from research conducted in high-income countries (HICs), raising questions about its applicability to lower and middle-income countries (LMICs) with differing cultural, social and economic contexts and thus different ideas of what a 'good enough' parent may be (23). While the theoretical framework of the infant-caregiver attachment relationship is presumed to be universal, variations in sensitivity and responsiveness have been observed in interactions across different cultures (24,25). This issue is particularly pertinent in the context of South Africa, where familial dynamics often prioritise collective child-rearing practices over individualistic approaches. This is due to an 'ubuntu' mindset which encapsulates a series of interlinked African-origin principles that highlight the unity between individuals and their broader social and physical environments. 'Ubuntu' is occasionally interpreted as 'I am because we are', or as 'humanity towards others' (in Zulu, umuntu ngumuntu ngabantu). In Xhosa, the latter phrase is employed, often carrying a deeper philosophical connotation signifying 'the belief in a universal bond of sharing that connects all humanity.' However, this collective child-rearing practice has also been implemented because of high unemployment rates, economic hardships, and high HIV prevalence rates (26) where caregiving responsibilities are commonly shared among extended family members such as grandmothers or aunts (27) and even young children who run child-headed households (26). These cultural nuances shape caregiver sensitivity, integrating collective child-rearing values into the caregiving process.

1.1.2 Responsive caregiving

Worldwide, more than 200 million children fail to achieve their developmental capabilities within the initial five years of life due to impoverished circumstances, inadequate healthcare, insufficient nutrition, and limited psycho-social support (28). Children who experience these disadvantages struggle academically, leading to lower incomes in adulthood, increased fertility rates, elevated involvement in criminal activities, and inadequate parenting for their own offspring (29). The World Health Organisation has devised The Nurturing Care Framework for Early Childhood Development (28). This model aims to provide a framework for children to reach healthy human potential. It indicates the importance of five interrelated and inseparable factors regarding early childhood development. They are opportunities for learning, adequate nutrition, health, safety and security, and responsive caregiving.

Responsive caregiving is the cornerstone of this thesis. This concept refers to encouragement of caregivers to make eye contact, to smile, cuddle and praise infants. Responsive parenting (30) occurs when caregivers notice their children's cues of hunger, illness, emotional distress and signs of pleasure; and respond sensitively and appropriately using behaviours that encourage bonding.

1.1.3 Bonding and attachment

Bonding refers to a group of reciprocal behaviours and feelings that connect a mother to her infant. The face-to-face context is said to elicit multi-modal non-verbal communication from mothers, reciprocated by the infant and vice versa as the two engage in shared affect and bonding.

It may be said that bonding is a precursor to attachment (31). Attachment theory, which has been proven valid in laboratory settings (10,32,33) delves into a deeper level of connection between an infant to its mother (34) and is concerned with internal working models of individuals. An internal working model [IWM in Bretherton, 1999, (35)] pertains to a cognitive framework or mental construct that individuals formulate as a result of their early attachment experiences with primary caregivers, predominantly established during infancy and early childhood stages. These early experiences provide the foundation for how individuals perceive themselves, others, and

relationships in general. An IWM also includes representations of the self, the caregiver, and the relationship between them. These representations are influenced by the quality of care and responsiveness received from caregivers during infancy. The desired connection is a secure attachment between mother and baby and means that a mother is tuned in to her infant's needs and can sensitively attend to these needs. She offers a secure base upon which a child may circle out and explore the world and be watched over, while being affirmed and celebrated after returning to a caregiver providing safety [Circle of security in: Cassidy et al., 2011, (36)]. She will help her infant to understand his or her own feelings by empathetically reflecting them in her voice or with attuned facial expressions. The infant feels safe and heard and able to make sense of his own world because of his mother's reflections (37). If a child can experience a trusting and secure relationship with a caregiver, s/he is likely to build trusting relationships with others, believing that they will be available and responsive when needed.

Securely (versus insecurely) attached children, have an increased chance to have more lasting friendships, are comfortable to explore, develop appropriate levels of empathy and may be able to feel better about themselves and what they can contribute (38). Beyond these foundational benefits of secure attachment, research consistently demonstrates a broader range of positive socio-emotional and behavioural outcomes. Securely attached children tend to exhibit superior emotional regulation skills, leading to fewer internalising and externalising behavioural problems. Internalising behaviour refers to anxiety and withdrawal, for example. Externalising behaviours in children refer to a broad range of actions and behaviours that are directed outwardly, often involving disruptions in social interactions and conflict (39). In contrast, it is widely acknowledged that infants with insecure attachment patterns exhibit more frequent and unpredictable emotional reactions, face developmental challenges, show less sensitivity in peer interactions, and are at higher risk of cognitive and emotional difficulties during early childhood compared to infants in secure attachment relationships (40). Furthermore, insecure attachments increase the risk for externalising behaviours and may include aggression, defiance, and conduct related disorders.

1.1.4 Reflective functioning

Reflective functioning, as conceptualised by Peter Fonagy (41) refers to the capacity to understand and interpret one's own behaviour and others' behaviours in terms of underlying mental states, such as feelings, thoughts, intentions, and desires. It involves the ability to 'read people's minds' (42,43), reflect on internal experiences and to make sense of the connections between one's own mental states and those of others. Studies indicate that a high level of reflective function is linked to secure attachment between mothers and infants. Slade et al., 2005 (44) reiterates this link and concludes that caregivers with higher reflective function are more likely to view their infants as intentional beings with independent mental states, thus enhancing attunement and sensitivity. High levels of reflective function have been associated with reduced instances of externalising behaviours in various high-risk populations, such as children in foster care, economically disadvantaged families, and adopted children (45–48).

Reflective functioning is thought to develop through early caregiving experiences, particularly in the context of mother-infant interactions. It enables caregivers to attune to their infants' emotional cues, understand their needs, and respond sensitively and effectively. It involves being able to 'mentalise,' or think about mental states, both one's own and the infant's, in order to empathise and provide nurturing care. Mothers who exhibit high levels of reflection possess the ability to manage and contemplate their own thoughts and emotions while connecting them to their child's internal experiences and actions (44). For example, a parent with high reflective functioning might be able to recognise that her infant's crying may be a sign of distress or discomfort rather than simply an annoyance. She might then reflect on possible reasons for the distress and 'tune in' (attune) or respond in a way that addresses the underlying need, such as comforting, feeding, or changing the infant. The capacity for reflective functioning in parents is associated with their ability to tolerate infant distress (49). Parents who demonstrated a greater interest in their child's mental states showed greater persistence in soothing an inconsolable baby simulator during a parenting-related task, compared to a task unrelated to parenting distress tolerance (49). This indicates that parental reflective functioning specifically influences their ability to tolerate distress in their children.

Reflective functioning shares similarities with, yet remains separate from, other concepts such as 'good enough' mothering (7). It is different from parental sensitivity - which refers to a mother's attentiveness to her infant's cues, and the accuracy of her interpretations (11). It differs from parental responsiveness which follows sensitivity and denotes the caregiver's capacity to react promptly, contingently, and suitably to the child's needs (30). It is not the same as attachment as attachment describes the enduring emotional connection that develops between an infant and their primary caregiver. Attachment is a psychological construct reflecting the infant's internal working models of self and others, shaped by cumulative experiences of sensitive and responsive care, leading to a certain degree of security (33). Reflective functioning, as a metacognitive capacity, acts as a crucial internal mental mechanism that underpins effective caregiving behaviours, which then foster the secure relational outcome of attachment. The theoretical underpinning for the distinction of these concepts lies in their hierarchical and facilitative relationship: High levels of reflective functioning are considered a key prerequisite for consistently sensitive and responsive parenting, as it allows the parent to understand the infant's cues from the infant's perspective. Consistently sensitive and responsive parenting, in turn, is empirically linked to the development of secure attachment bonds. Thus, reflective function acts as a crucial internal mental mechanism that underpins effective caregiving behaviours, which then foster the secure relational outcome of attachment. It plays a vital role in the definition of mother-infant interaction as it frames this relationship as bidirectional and relies on the reciprocity and reactions of both individuals in the pair to respond to each other.

1.1.5 Bidirectionality

The quality of the mother-infant relationship is a product of both mother and child characteristics, and the dyad's reciprocity towards each other. Emphasising the involvement of both individuals in influencing the interaction prevents us from solely attributing maternal challenges or issues with the infant and acknowledges that both partners contribute to the dynamics of the exchange. However, it is important to note that this does not imply that each partner contributes in the same or similar ways (50). The mother typically has more capacity, greater flexibility and presents with feelings towards her infant; while the infant plays a significant role in seeking or avoiding engagement and may bring difficulties in self-regulation,

often referred to as temperament challenges (2). In the early months, the mother facilitates the dyadic relationship through her unique levels of regulation and attuned/unattuned behaviour.

Research in bidirectional mother-infant interaction, has discussed affect attunement which is the 'tuning in' of affective quality between the dyad (51,52). Co-regulation is a dynamic process in which mother and infant continuously modulate each other's emotional and physiological states (53). Contingency is the predictability of behavior over time (54,55). Coordination is the temporal alignment of mother and infant behaviors (56). Matching refers to when mother and infant exhibit congruent states (57,58). Mirroring is the reflection back of each one's emotion state (59,60). Mutual influence means that each partner's behavior alters the other's (61). Shared affect is the joint expression of emotions; dyadic rhythm refers to the natural ebb and flow of mutual engagement. Reciprocity showcases give-and-take and turn taking pertains to the structured alternation of vocalisations, or attention, for example [see Leclère et al., 2014 (62) and Provenzi et al., 2018 (63) for systematic reviews].

These terms have been useful in describing the dyadic to-and-fro of relatedness but have not highlighted the concept of reflective function (41) and the idea that the mother-infant interaction has a crucial aspect of adaptation during exchange. In order to explore this aspect of adaption, authors such as Beebe, Jaffe, Lachmann, Feldstein, Crown, Jasnow, Markese, Buck, Chen, Sameroff, Sanders, Tronick and Cohn (56,57,64–66) have video recorded and coded non-verbal interactions between mother and infant, over a multitude of communication modalities to explore the relationship. Their studies have been based on the premise that communication is made up of a sequence of moments; that each individual's behaviour is made up in the process of collaborative coordination and that engagement is viewed as bi-directional, which is supported by the concept of temporal parameters in synchrony (57,63,67,68).

1.2 Synchrony

1.2.1 Defining synchrony

Synchrony is the to-and-fro or 'dance' and rhythm of the cooing voice, facial expression, affective display, proximity and touch between the dyad whereby the infant first experiences social communication (69,70). As an example, an infant's smile can elicit an affective response

of happiness within the mother resulting in a reciprocated smile, and because of her positive facial expression and feeling of warmth, the infant feels loved and smiles back again. This exchange suggests that the mother was attuned to the non-verbal signals of the infant and recognised and adjusted her own behaviour, which in turn had an effect on the infant's behaviour and affect (71). Not only has a social connection been made, but an infant's internal working model also forms as the mother mirrors the infant.

The term 'synchrony' as described by Stern [in Beebe, 2017 (72)], Feldman, 2007 (69) and Bernieri et al., 1988 (73), refers to the 'timed coordination of micro-level relational behaviours into patterned formations that become internalised and serve to mold infant development over time and repeated experience' (69,73). This dynamic will contribute towards the attachment style formed, which may feed back into the relational or interactional style of a mother and her infant. Feldman, 2007 (69) states that the temporal aspect is a defining feature in the synchrony construct, explaining that a mother and her infant communicate with an interactive flow, rhythmic repetitions, continuous affective matching and sequential mirroring which then reveal emerging social behaviour.

1.2.2 Observing synchrony

In research, the widely acknowledged benchmark for assessing mother-infant interactions typically involves an observer recording an interaction between the mother and child in various settings such as clinical, research, or home environments. The most common types of interactions observed in research have been free play, routines (e.g. feeding time), structured tasks (e.g. an instruction to play with a ball) and experimental instruction [e.g. Still face paradigm, (74)].

Often filming has taken place with a third person present. Lee et al., 2017 (75) discuss three inherent limitations to this approach. Firstly, third person observation creates a less accurate picture of genuine dyadic exchange. When behaviour is coded through the lens of an observer, the coding reflects what the observer perceives rather than what the infant and mother actually experience. Secondly, because of the constraints on both participant and researcher schedules, observations are typically brief, offering only a limited glimpse into the dynamics of the mother-child relationship. Lastly, observing subjects from an external, often unfamiliar perspective, such

as that of a researcher, unavoidably introduces an element of intrusion (76). The presence of a videographer can introduce a novel aspect that triggers responses from those being observed which may not be typical. This phenomenon is commonly referred to as 'demand characteristics' or 'reactivity' (75). Observations may elicit behaviours deemed socially desirable or appropriate while suppressing those considered socially undesirable or inappropriate, and so validity of data may also be impeded by social desirability biases (77). For example, adults may demonstrate increased rates of positive interactions with children (78,79). Furthermore, this effect may vary depending on different maternal attributes whereby certain mothers may exhibit more positive behaviours, while others may become self-aware and consequently display fewer positive behaviours (80). This results in a less natural interaction between mother and infant.

In developmental research, the goal is to accurately capture the infant's or mother's subjective experiences. Hence, first-person observation could be the key to investigating the intricacies of the dyadic relationship. Filming mother-infant interactions from a first-person perspective has been achieved using small cameras mounted on headbands. These cameras would typically be worn by both mother and infant to record moments of interaction from both perspectives, and the video footage obtained provides data to observe and code the behaviours. Advantages of this method of first-person observation have been discussed by Lee et al., 2017 (75) and include that this technique can capture varied perspectives by recording the viewpoints of each participant involved in the interaction. Researchers can alleviate participant burden by eliminating the requirement to participate in or organise a research visit. Furthermore, there is a reduced potential of researcher influence on mother and infant behaviour by eliminating the necessity for a researcher's physical presence.

Studies using this method have been conducted in which Bornstein and Arterberry, 2010 (81) compared the world from a mother's viewpoint versus an infant's perspective. Sugden et al., 2014 (82) similarly employed first-person cameras worn by 3-month-old infants over extended periods within their home environments to quantify infants' exposure to adult faces. Yurovsky et al., 2013 (83) also applied this technique using the idea of a 'child's-eye view' to examine how infants coordinate attention with a visual companion, shedding light on the distinct perspectives of infants in contrast to adults.

In recent years, Beatrice Beebe has been the most prolific author investigating mother-infant interaction from a first-person point of view; using the observation of moment-by-moment communication and the micro-analysis of recorded face-to-face encounters. Beebe, 2006 (2) writes that observing interactions in a ‘microscopic’ manner enables the examination of the nuanced and transient aspects of mother-infant exchange. The interactions under scrutiny unfold swiftly, with individual behaviours typically lasting between one-fourth to one-third of a second, and lag times between partners' behaviours generally under half a second (2,84–86).

Consequently, many facets of these interactions occur outside of conscious awareness, often subconsciously, classified as 'non-conscious' rather than dynamically 'unconscious' [see Lyons-Ruth 1998 (87)], although parents may harbour numerous dynamically unconscious motivations (2). Dynamically unconscious motivations refer to emotional patterns and relational schemas formed early in life that remain outside of conscious awareness but influence caregiving behaviours. These unconscious motivations are critically important for the development of interactional synchrony. Synchrony requires a flexible, attuned, and responsive interplay between mother and infant. When a parent is influenced by unrecognised unconscious motivations, their responses may become rigid, misattuned, or driven by their own internal states rather than the infant’s cues. This can manifest as an inability to differentiate their own feelings from the infant's, leading to 'projective identification' where the parent attributes their own unprocessed emotions (e.g., anger, anxiety) onto the infant, believing the infant is deliberately 'difficult' or 'manipulative'.

Such distortions disrupt the smooth, reciprocal flow of synchronous interaction, making it challenging for the dyad to achieve shared meaning-making and emotional coregulation. Until these dynamically unconscious motivations are brought to reflective awareness and processed, they can impede a parent's capacity for genuine attunement and flexibility, thereby undermining the spontaneity and adaptive potential of mother-infant synchrony (3,50). The infant's repertoire during face-to-face exchanges is multi-faceted, encompassing a remarkable array of behaviours to initiate, sustain, disrupt, or evade such encounters (51,86).

1.2.3 Measuring and analysing synchrony

In a systematic review by Leclère et al., 2014 (62), the authors identified research articles released from 1977 to 2013 using the keywords: 'synchrony', 'mother-child' and 'interaction' to examine how dyadic synchrony was defined and operationalised. Three primary categories of evaluation techniques for examining synchrony surfaced. Firstly, overall interaction scales containing dyadic elements were found to be useful in measuring synchrony [e.g. the Qualitative Ratings for Parent-Child Interaction scale (88)]. Secondly, specialised synchrony scales have also been applied [e.g. the Synchrony Global Coding System (89)]. Lastly, micro-analyses, employing coded time-series data have been used [e.g. coding of video footage generally assisted by a software system such as 'Elan' or 'The Observer'; Noldus, 1991 (90)].

In using micro-analyses to describe maternal synchrony, synchrony has been identified by observing a positive time difference between the behaviours of the mother and the infant in their respective time-series data (52,91), or by correlating the affective or behavioural state codes assigned to infants and mothers on a second-by-second basis (58,92,93). 'Positive time difference' means that mother and infant behaviours are coordinated, yet with a slight delay. When the mother behaves in a certain manner (like smiling), the infant responds shortly after, or vice versa. This delay or time difference between the two actions is considered 'synchrony' because it shows that their behaviours are linked, even if not occurring simultaneously. Previous research has used a delay of 3 seconds between the two actions in sequences to determine synchrony (94) . Where video footage has been used to film mother-infant interactions, the standardised duration for micro-analytic coding of videotape has been set at two and a half minutes for statistical purposes (61,95).

Three kinds of relationships are typically explored in micro-analysing recorded behaviours. 'Concurrent relationships', involve matching behavioural states that are often measured in frequency (96,97) of behaviours (such as simultaneous visual attention or neutral facial expressions of both mother and infant). 'Sequential relationships', encompass the connection between one partner's behaviour and the subsequent behaviour of the other partner (e.g. gaze tracking and responsive facial expressions), including the time delays in response or tracking. Thirdly, the 'continuous lagged associations' between the behavioural patterns of two individuals

involves examining the overall extent to which one individual's behaviour anticipates or corresponds with the delayed behaviour of their partner. Leclère et al., 2014 (62) reported that the most commonly used method in micro-analyses for assessing synchrony typically involved tallying the occurrences of infant and maternal behaviours (frequency) where coders utilised a predetermined list of behaviours, segmenting mother-infant interactions into brief time intervals for analysis. The research described quantified maternal and infant behaviours by initially annotating video footage and then cross-referencing two corresponding sets of time-series data to ascertain the level of alignment between them.

Research on synchrony has utilised various methods to quantify and analyse this phenomenon. Studies have measured the tone and timing of vocal exchanges which capture the rhythmic and affective coordination in mother-infant communication (98). Work on coordinated movements which reflect the temporal alignment of physical actions between caregiver and infant has been done (57). Additionally, studies have measured mutual gaze, indicating shared attention (99) and the strength of smiles used to assess affective mirroring (100). More specifically, De Graag et al., 2012 (101) measured synchrony as the percentage of time during which the mother and infant simultaneously gazed at each other's heads. Isabella et al., 1989 (102) examined synchrony frequency by assessing specific maternal, infant, and dyadic behaviours observed in successive 15-second intervals. Gratier, 2003 (103) employed a more detailed and specific approach by analysing acoustic segments of interaction to explore the mean duration of synchrony. This analysis used spectrograms, which visually represent acoustic data, including onset, end time, duration of vocalisations and silences, energy, loudness, and pitch. Vocalisations were grouped into phrase units, defined as sequences separated by pauses longer than 500 milliseconds. Expressive timing, or the deviation from a regular beat, was also considered. Interactions were categorised as 'interactional synchrony' when vocalisations overlapped, mimicked rhythm and pitch, or followed a turn-taking pattern.

There are pragmatic challenges in measuring synchrony (73,104). Firstly, coding behaviour is time consuming and tedious. At a standard rate of 24 frames of footage for each second of real time, vast amounts of time may be needed to code short snippets of behaviour. Secondly, determining what content should be coded is an issue. Any type of behaviour can be coded and combined for use as a behavioural measure (73). Thus, clearly defined research questions are

needed in behavioural investigation. Thirdly, these metrics of synchrony all encompass the organised timing of behaviours between two individuals during an interaction, but they do this in different ways. Previous research has usually assessed just one (or occasionally two) forms of synchrony within a singular study, posing challenges in comparing findings across studies and leaving unanswered queries about the interconnections between these various measures of synchrony (104). Finally, the interpretation of synchrony can be complex and there is ambiguity in defining what constitutes 'low' or 'high' synchrony (105). For instance, it has been reported that depressed mothers spend less time in synchrony with their infants when measured for verbal interaction and gaze synchrony (106,107). Conversely, hypervigilant caretaking behaviours have resulted in anxious mother-infant dyads showing heightened levels of synchrony (108).

Hence, Beebe et al., 2008 (109) have suggested a ‘midrange model’ of synchrony. This model challenges the simplistic notion that ‘more synchrony is always better.’ It posits that optimal dyadic regulation occurs not at extremely high or low levels of synchrony, but within a 'midrange' or moderate level. This conceptualisation highlights the importance of flexibility, fluidity, and the capacity for both 'matching' and 'mismatching' within interactions.

Excessive synchrony may appear seemingly ideal but can reflect a rigid, intrusive or controlling pattern. A mother who is always perfectly 'in sync' might be overly controlling, overly stimulating, or unable to allow her infant space for independent exploration or self-regulation. This can stifle the infant's developing sense of agency and may be experienced as overwhelming or demanding. Conversely, very low levels of synchrony reflect a disengaged, unresponsive, or neglected interactional environment. Here, the dyad struggles to achieve mutual connection, and the infant's bids for interaction may be consistently ignored or misread, potentially leading to feelings of helplessness or withdrawal.

The midrange model emphasises the adaptive utility of 'mismatches' and subsequent 'repairs' in interaction. Rather than perfect attunement, optimal development thrives on moments of miscommunication or slight asynchronous shifts, followed by the caregiver's sensitive efforts to re-establish connection. These moments of rupture and repair teach the infant about the reliability of their caregiver, the possibility of restoring connection, and the process of emotional co-regulation. It is within this dynamic interplay of attunement and gentle re-attunement that

infants learn about emotional resilience, the ability to tolerate frustration, and the capacity for self-regulation. Therefore, the importance of the midrange model for mother-infant synchrony lies in its recognition that adaptability, the capacity to move in and out of synchrony, and the successful resolution of minor interactional disruptions are more critical for healthy development than constant, rigid perfect matching. The limitation of Beebe's, 2008 (110) model is that parameters have not yet been established.

1.2.4 Effects of synchrony

Research has indicated that synchrony has an impact on the infant intelligence quotient (111,112) infant cognitive processing (113), and school adjustment (114). It has been found to correlate with and/or predict better overall adaptation. For instance, high levels of synchrony are linked to the relation between attachment security and mind-related comments of mothers and fathers during interactions with their infants (115) highlighting the role of reflective functioning in parent-infant synchrony. Synchrony is also influenced by parental attributes and/or abilities, such as maternal sensitivity (113,116). Additionally, dyads where mothers displayed greater synchrony when playing with their children, tended to have higher scores in mutual initiation and mutual compliance (compliance to the partner's initiations of play), which is associated with elevated levels of social competence (117). Conversely, a lack of synchrony has been correlated with individuals at risk, or those facing temperamental challenges (118) as well as mother (self-reported) internalising behaviours (119). Internalising behaviours are characterised by processes within the self, such as anxiety, somatisation and depression.

1.3 Mother-infant interaction and synchrony

1.3.1 Social bonding

Developmentally, the period between 3 and 6 months represents a critical 'window of opportunity' for evaluating infant social capacities (54,111,120). Social interactions during this stage are strong predictors of subsequent social and cognitive development (16,56,64,121–125). Neural and psychophysiological factors in the development of social communication in infants have been reported by Cruz et al., 2022 (126) where they describe key developmental milestones between the ages of 3-5 months. They state that during this period, infants show increased

sensitivity to facial interactions, show prolonged attention to their mother's happy facial expressions (127), develop a social smile and laughter, seek eye contact, and attempt to mirror their caregiver's expressions. Additionally, they can distinguish between different intensities of affect in faces and recognise angry, sad, and surprised facial expressions.

Neurologically, preparation for facial discrimination emerges remarkably early in life. This is evident in the ability of the 2-month-old infant being able to discriminate between facial expressions (128). Neuroimaging research suggests that infants as young as 4 months understand eye contact as an intention to communicate, activating neural structures similar to those in adults (129). Mutual gaze activates cortical brain regions in infants that are also activated in adults during social communication, such as the right posterior superior temporal cortex and right fronto-polar cortex. Direct gaze and eyebrow raises activate the same pre-frontal areas in infant brains as in adult brains (129,130). In essence, direct mutual gaze stimulates the same pre-frontal regions in infant brains that are activated in adult brains during social communication (128). Remarkably, adults and infants are able to show neural wave coupling throughout social interactions, enhancing connectivity at a neural level (130). This synchronisation between the dyad strengthens the infant's communicative efforts through contingent social exchanges (130).

Physiologically, social bonding is also associated with the neuropeptide called oxytocin, known to influence attachment and bonding. In a longitudinal study examining plasma oxytocin and mother-infant interaction (131), Feldman et al., 2007 (131), tracked 62 women during the first and last trimesters of pregnancy and the first month postpartum. Women with high oxytocin levels early in pregnancy generally continued to have these higher levels later and postpartum, exhibited more maternal behaviours, and synchronised their actions with their infants' states more than those with lower early oxytocin levels. These mothers also said that they experienced more pleasurable and vivid thoughts about their infants (131). Oxytocin appears to prepare new mothers to engage in maternal behaviour, initiating the maternal-infant bonding process.

Psychologically, social bonding between mother and infant is best described by Trevarthen, 1979 (132) and Winnicott, [1965, reprinted 2018 (133)]. Trevarthen, 1979 (132) introduces the concept of 'primary intersubjectivity', wherein infant and adult are mutually attentive in face-to-face interactions, each becoming the object of the other's attention. This mutual attentiveness

involves perceiving others as intentional agents with feelings. Primary intersubjectivity is particularly evident in the responsive caregiving and emotional attunement between a mother and her 3-4 month-old infant during dyadic interactions (132). Winnicott also speaks of the face-to-face encounter but goes even further to say that in individual emotional development, the 'precursor of the mirror is the mother's face' (133). A mother's eyes, facial expressions, responsiveness, and interactions with her infant serve as a metaphorical mirror, reflecting the infant's emotional experiences, aiding emotional regulation, and contributing to personality development. The key element is the mother's ability to track her infant's actions and emotions, reflecting them back to support the infant's personality development.

1.3.2 Visual attention

In a similar vein to Winicott's theory, Fogel, 1977 (134) and Tronick et al., 1980 (135) reiterate that at three months, the sharing of social gaze between a mother and her infant becomes the primary mode of coordinated engagements.

Developmentally, newborns exhibit a preference for faces with direct gaze over those with averted gaze, indicating an innate desire for mutual eye contact (129). Mutual gaze aids in establishing non-verbal communication between two people (136). In the context of social communication in infants, eye contact, beginning as early as six weeks old, significantly influences the mother's response to the infant due to increased responsiveness from the infant (137). Around three months of age, infants start to follow gaze, even though their visual acuity is not fully developed, and they can perceive low-frequency contrast (138). Variations in visual attention during the first year are important markers, often linked to later cognitive development (138).

Neurologically, identifying specific, structural, cortical and neural contributors to social gaze responses in a laboratory setting is challenging. However, certain anatomical brain regions contribute to the neurobiology of gaze and are commonly involved in infant gaze development and perception (128). These include the anterior superior temporal sulcus, essential for recognising the head and eyes as stimuli, as well as the amygdala, crucial for attaching socio-emotional significance to these stimuli (139). Direct gaze is a clear and significant evolutionary signal that elicits automatic responses in the brain (128). These responses involve neural

pathways that evolve as we grow. Some pathways develop quickly and are responsible for the immediate, reflexive following of another's gaze, while other pathways develop more slowly and support the understanding and interpretation of where and why someone is looking, contributing to cognitive maturity (140). An infant's ability to follow another person's gaze early in life depends on certain cues, such as making eye contact or hearing speech directed at them, which are influenced by the emotional context of the interaction (140). If infants do not respond to these social gaze cues, it can lead to difficulties in their neurological, social and language development (138,141). Even infants with visual impairments can engage in mirroring behaviours and develop language networks, but they may experience delays in social behaviours compared to their peers (142). The absence of gaze in infants without sight impairments may not always indicate dysfunctional social behaviours but could be due to factors such as fear, attention difficulties or motivation challenges (141,142).

Behaviourally, mothers and infants who are in more secure relationships display typical 'dances' which contribute towards the establishment of trust and emotional connection between the pair. 'Eye love' was coined by Beebe, 1974 (143) and further explored by Beebe and Stern in 1977 (144). It can be described as periods of positive emotions where mothers and infants can engage in synchronous, prolonged, mutual gaze, sometimes lasting as long as 100 seconds.

Physiologically, a typical interactional pattern is that a mother is inclined to look at her infant's face most of the time, while the infant tends to look at the mother and then look away, searching for the mother's face for a time, averting a gaze and then looking back (86). In 1981, Field (145) conducted a study that confirmed that infants employ a deliberate pattern of looking and looking away to manage their level of arousal. Field, 1981 (145) observed infants' heart rates while they engaged in face-to-face play and found that when an infant looks away, it is usually preceded by a sudden increase in arousal within the preceding five seconds. Following this gaze aversion, the infant's heart rate returns to its baseline within the next five seconds, and the infant resumes gazing at their mother's face. Consequently, infant gaze aversion emerges as a critical mechanism for infants to self-regulate their arousal levels. Furthermore, Brazelton, Koslowski and Main, 1974 (146) demonstrated that mothers increase stimulation when their infants are actively looking at them and reduce it when infants avert their gaze.

Psychologically, the study of visual attention between mother and infant is extensively researched due to its critical role in fostering sensitivity, responsive caregiving, the formation of internal working models, and the development of reflective functioning. Ayers, 2014 (147) captures this theory well in her writing and says: 'The eyes of the mother serve to hold the infant emotionally together just as the skin holds the infant somatically together…When the child is held in mother's eye, she is contained in mother's mind. By holding her baby in mind, by reflecting her state of reverie, the mother relates directly to the mental life of the infant and helps to transform the anxieties plaguing her baby. Eye contact ensures direct communication, play and reciprocal empathy between the two. This shared space becomes a unique medium that resonates with the sensations, thoughts, emotions, and mental images of the two. When containing, eyes are a vital presence creating a unity for identity of being and existence. The eye's shininess and reflective qualities can also literally be viewed as a mirror.' [In, Mother-Infant Attachment and Psychoanalysis. The Eyes of Shame' (147)].

Synchrony studies between mothers and infants and shared gaze suggest that visual attention is linked to the formation of attachment (99). Gaze synchrony between parent-infant pairs have revealed that synchrony between same gender dyads was more frequently exhibited (91) and lower mother-infant gaze synchrony has been found with triplets (17). An investigation involving 10–16-week-old infants was conducted whereby nursery rhymes were spoken in and out of synchrony to played audio. Dodd, 1979 (148) found that infants spent less time gazing at their mothers when nursery rhymes were spoken out-of-sync, indicating that less synchronous behaviour is paired with less attention between the dyad. Furthermore, a study by de Graag, 2012 (101) concluded that infant sleep could influence the timing of the dynamics between the mother and infant during gaze interaction, but it did not affect how often their actions were synchronised. Additionally, in a controlled trial focusing on synchrony of gaze by Farran and Kasari, 1990 (99) , the length and frequency of mutual gaze between mothers and infants increased over time. Initially, mothers initiated most of the mutual looks, but as time went on, their initiations decreased while infants began initiating more mutual gaze.

1.3.3 Facial expressions

Understanding facial expressions is essential for social interactions as they provide important clues about people's emotions (149,150). Through facial expressions, individuals can collect a wealth of information to evaluate others' emotions and formulate suitable responses (151) while also developing empathy.

Developmentally, the capacity to recognise facial expressions begins in infancy. Field et al., 1982 (152) found that neonates could discriminate between sad, happy and surprised faces. Haviland and Lelwica, 1987 (153) found that 10-week-old infants could discern between sad, happy and angry faces after coding mothers' and infants' faces using the Maximally Discriminative Facial Movement Coding System. At four months, Montague and Walker-Andrews, 2001 (154) used a peek-a-boo paradigm whereby an experimenter uncovered her face, revealing either a sad, happy, angry or fearful face. The differences in how long the infants looked at different expressions showed that they could tell the expressions apart. As individuals develop from infancy to adulthood, they gradually become more discerning when recognising and understanding facial expressions. This includes refining their ability to tell different emotions apart, correctly labelling these emotions with words, and choosing the right emotional response for different situations (155).

Behaviourally, research indicates that infants display more attention (demonstrated by engaging more with transitions that draw their attention rather than those they avoid) when presented with interactive faces compared to still ones (156). They tend to prefer exaggerated facial expressions over neutral ones (157) and infants exhibit more smiling in response to interactive faces; and more grimacing when presented with 'still' faces (158). Added to this, an infant's behaviour typically tends to rely on its mother's interpretation of the moment when evaluating a situation (159). In a visual cliff experiment, one-year-olds were far less likely to crawl over a perceived drop when their mothers displayed fearful expressions compared to when they displayed happy expressions (160). Thus, we can see that reciprocal, affective communication between the pair can help in regulating each one's actions (57).

Socioemotionally, affective communication regulates infants' arousal and emotions (161–163). According to the mutual regulation model of interaction (164), mothers and infants adjust their

emotional behaviours to match one another. Mothers align their emotional responses with their infants' moods and behaviours, while infants react to their mothers' actions. This ongoing adjustment helps infants practise managing their emotions and arousal levels (56,162) and gradually helps infants to increase range, control, and flexibility in their behaviour (164). Additionally, an infant's learning environment is considered an important influence on its socioemotional development. Much research has investigated the infant's capacity to read facial expressions when raised without a primary caregiver. It was hypothesised that these infants would have a delayed ability to read facial expressions and affect compared to infants raised with attachment figures, who would have had more social interaction with adults (165). Contrary to predictions, institutionalised infants performed similarly to non-institutionalised infants in discriminating between different facial expressions (165,166). They exhibited similar neural processing of these facial expressions and similar patterns in visual attention in their preference for novel facial expressions (166). In contrast to these results, Pollak et al., 2000 (167) learnt that compared to infants in a control group, infants raised in environments that were abusive had delayed abilities to recognise and discern sad and neutral emotions, while having heightened perception for threatening expressions of emotion (167). These conflicting results show the need for further research on the socioemotional development of infants with different environmental support.

Synchrony studies of facial expressions, gaze and vocalisation, include research by Tronick and Cohn, 1989 (57) who found that mother-son dyads spent more time in coordinated, timed sequences than did mother-daughter dyads. Abraham et al., 2014 (168) found no fundamental differences in the caregiving context based on the parent's sexual orientation. In a correlational study looking at behavioural synchrony, Ham and Tronick, 2009 (93) investigated the relationship between synchrony, vagal tone and the Still-Face-Paradigm (169). The Still-Face-Paradigm is used as a three step face-to-face observational tool to look at infants' interactions with their mothers. Step 1 requires a playful interaction between the pair. Step 2 involves an episode whereby the mother looks at her infant with a neutral expression and a 'still face' appearing to be unresponsive. Step 3 is the last episode whereby the mother resumes her playful interaction, and a reunion is formed with her infant. The mother's 'still face' usually evokes a marked change in infant behaviour. Typically, infants display gaze aversion, negative affect and less smiling (170) and have increased cortisol levels (171). Ham and Tronick, 2008 (172)

concluded that during the reunion episodes, when mothers comforted their infants, there was a correlation between skin conductance (the physiological activation triggered by the sympathetic nervous system's activity) and behavioural synchrony.

1.4 Mother-infant interaction and cultural differences

Despite mother-infant synchrony being genetically driven and present in all cultures, specific interaction processes differ across cultures (173). Richter, 1995 (21) reminds us that caregiving itself is influenced by attitudes and beliefs that originate from social, cultural and personal experiences, and that these factors need to be considered when researching universality and variations in early infant development.

In a study comparing differing cultural groups of three-months-olds interacting with their caregivers during free play, Keller et al., 2004 (174) found that dyads from West African descent provided less gaze with more bodily interaction (174) as opposed to those from European groups. These differences in gaze and tactile communication were reiterated in a single yet detailed infant observation study by Maiello, 2000 (175) who found that at three months old, an infant and mother in a low-income group in South Africa used less visual exchange and more touch when compared with a mother-infant dyad from Western cultures. The strength of Maiello's, 2000 (175) study is that it was an in-depth observational case study adding to the understanding of caregiving in the South African context. The limitation is that her results may not be generalised to the population as only one dyad was investigated. Feldman, 2007 (176) reports that parents from Western cultures use vocalisation, gaze and object presentation in more coordinated sequences, versus parents from Africa and the Middle East (174,176).

More specifically, Gusii mothers from Western Kenya primarily responded to their infants through physical actions, while Euro-American middle-class mothers mainly used verbal and visual responses (177). Cultural differences in facial responses have been found when comparing Chinese, Japanese and European American infants. Results indicated that Chinese infants were less expressive in smiling and crying than Japanese and European American infants, highlighting cultural variations in emotional expressiveness in infancy (178).

Furthermore, researchers found cross cultural differences for specific facial actions after facial movement was coded using the BabyFACS (178,179). Six-week-old infants from two diverse settings, namely Munster in Germany and Nso in Cameroon, Africa, were compared in their interactions with their mothers. Results indicated that mothers and their infants from both cultural settings were visually attentive towards one another (180) and smiled at one another (181) for the same amount of time - even though short in duration. The difference was that at 12 weeks, German mother-infant pairs engaged in mutual gaze (180) and imitated each other and smiled more often than did the dyads from Cameroon. The authors discussed that these results did not mean that mothers from this Nso community were less sensitive, rather that findings reflected a style of parenting that was different in different communities. Whereas the Cameroonian parenting style attached more value to body contact, the German style included more dialogue and smiling (181).

These studies give us an indication that parents from diverse socio-cultural backgrounds prioritise different socialisation goals and approaches. Approaches are shaped by culture-specific parenting beliefs about appropriate interactions with their infants (182,183). Varying beliefs influence the interactional practices that parents use with their infants (184). As caregivers regulate infants' emotions, newborns develop into toddlers and grow into adults. This includes many female adults who enter motherhood carrying certain beliefs with distinct, culture-specific emotional responses (185) whereby an intergenerational cycle, with its unique style, is established.

Ultimately, there is scarcity of data on the intricacies of caregiving in culturally specific groups. Provenzi et al., 2018 (63) conducted a systematic review of mother-infant interactions. The search string included words like ‘attunement’, ‘contingency’, coordination’, ‘mirroring’, ‘matching’, ‘mutuality’, ‘reciprocity’ and ‘synchrony’. Researchers found 82 relevant studies to be included from the United States, Israel, Italy, Germany, France, the United Kingdom, Canada, Norway, the Netherlands, Greece, Belgium, Sweden, Denmark, Brazil, Finland and Japan. They report that one study was conducted in South Africa, but no reference was given, and no further mention was made in their review. The Provenzi et al., 2018 (63) review is particularly pertinent to the current study as it highlights a critical oversight in much of the existing research on mother-infant interactions. Their findings underscore that what constitutes 'optimal' interactional

synchrony is not universally defined but is profoundly shaped by culture-specific parenting beliefs and practices. For example, the review notes that in many Western contexts, there is a strong emphasis on verbal communication, face-to-face interaction, and the interpretation of infant distress as a signal for verbal soothing. In contrast, certain African cultural settings might prioritise high levels of tactile contact, co-sleeping, and more immediate physical responses to infant cues, with less emphasis on sustained face-to-face gaze or elaborate verbal exchanges in early infancy. Similarly, in some East Asian cultures, a more subdued emotional display might be valued, leading to less pronounced overt affective synchrony compared to Western dyads (63).

These variations are not indicative of 'better' or 'worse' parenting but rather reflect culturally sanctioned ways of fostering development and attachment. The review (63) therefore serves as a crucial reminder that methodologies and interpretations of mother-infant synchrony must be culturally sensitive, acknowledging that different cultural scripts can lead to diverse, yet equally adaptive, interactional patterns that foster healthy development within their specific contexts.

1.5 Mothers and infants in South Africa

Mothers not only parent within a specific cultural context but also within distinct physical and emotional environments. Numerous factors influence a mother's responsiveness in caregiving, thereby affecting the dyadic relationship (28).

The conceptual model in Figure 1 is underpinned by Bronfenbrenner's Ecological Systems Theory, 1979 (186) which posits that child development occurs within nested environmental systems - from the microsystem to the macrosystem. The microsystem represents the immediate environment and includes the mother's individual characteristics (e.g., mental health and any past trauma), the infant's temperament and family relationships. The mesosystem comprises the interconnections between different microsystems. For instance, the relationship between the home environment and the local clinic, or the interaction between the mother's social support system and her mental health. The exosystem refers to the external settings that indirectly affect the mother-infant relationship, even though the dyad may not directly participate in them. For example, availability of community resources, healthcare or cultural norms influencing gender roles or childcare practices. The macrosystem encompasses broader cultural values, laws,

socioeconomic conditions or national policies on health. These systems lie within the chronosystem or dimension of time which implicitly influence all other systems. Factors such as developmental changes in the infant, relational changes in a family and evolving governmental policy may influence the mother-infant relationship (186). This framework acknowledges the interplay between individual, relational, environmental and societal factors, important when studying childcare and synchrony in a South African context (28).

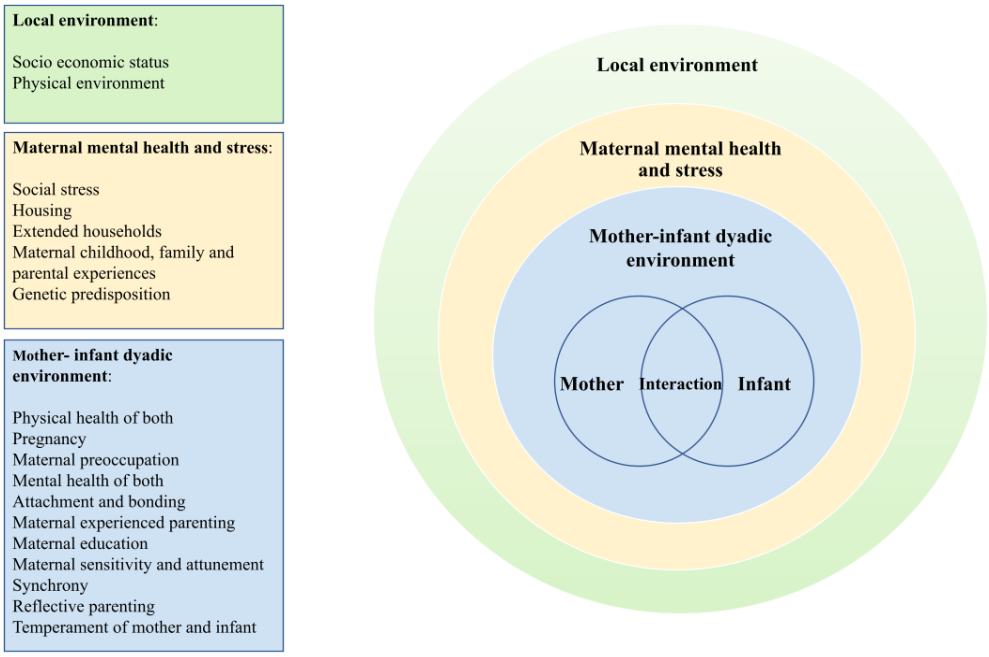


Figure 1: The spheres of influence that shape the dyadic mother-infant relationship

1.5.1 The local environment

Low-income mothers and infants in South African townships face numerous challenges stemming from the country's apartheid legacy, ongoing political instability, corruption, and severe economic issues. These factors contribute to significant income inequality and high unemployment rates. In 2020, 52% of the South Africa population was living in poverty (187). In 2021, the unemployment rate was 36.8% for Black South Africans (188). These socio-economic hardships add to social unrest, an increase in gender-based violence (189), substance abuse, emotional abuse (190), post-traumatic stress, and elevated levels of mental health issues, including depression and suicide (191,192).

The COVID-19 pandemic followed by damaging floods across the country, exacerbated these vulnerabilities when National States of Disaster were declared between 2020 and 2023. Women in Soweto were disproportionately impacted by these disasters, being identified as 'socially vulnerable' due to compounded social, environmental, and economic stressors (193). This social vulnerability results in economic losses and physical and emotional harm, influenced by factors such as socio-economic status, age, gender, race, ethnicity, residential location, and family structure (194).

In these disadvantaged communities, mother-infant units face additional challenges due to limited control over their environments and insufficient institutional support (195). The overburdened healthcare system in South Africa (196) struggles to provide adequate pre- and postnatal care, leaving many mothers and infants without the necessary support for healthy development. This lack of resources and support further strains the caregiving capacity of these mothers, impacting on their ability to provide nurturing and responsive care, which is crucial for the well-being of their children.

1.5.2 Living conditions

Socially vulnerable mothers and their infants in informal settlements face numerous challenges exacerbated by overcrowded living conditions. Families often live in small, poverty-stricken shacks or hostels, sharing space with extended family members (197). The Living Conditions Survey (LCS) is used as part of Statistics South Africa's household evaluation programme and offers household data regarding living circumstances in South Africa. In 2015, out of 35.1 million adults in South Africa, 49.2% lived below the upper bound poverty line, with women experiencing higher levels of poverty than men (198). Nearly 20 million children under 17 lived in poverty, with 60% of those aged 0-4 classified as 'multidimensionally poor,' experiencing multiple deprivations such as inadequate nutrition, housing, education, and sanitation (199).

These conditions contribute to malnutrition, poor physical and mental health, decreased levels of stimulation for infants in home environments, and limited cognitive, motor, and socio-emotional development in children (200). The mothers, anxious about the safety of their inadequate housing, report concerns about indoor space limitations and unfenced yards, which restrict children's outdoor play opportunities (197). They fear that their children may hurt themselves in

the street by getting hit by cars or that they may fall into one of the many communal outdoor toilets. Thus, opportunities for development are limited. High crime rates, including the threat of abduction and sexual violence, further limit safe environments for play and development. Extreme societal stressors, like witnessing crime (201) and relationship difficulties (202) , are strong determinants of postnatal depression among these mothers, further impacting their ability to provide responsive caregiving. Thus, the combination of poverty, unsafe living conditions, and societal stressors severely affects the well-being and development of both mothers and their children in these communities.

1.5.3 Relationships

In urban townships in South Africa, many mothers and their families live in 'extended households' which include multiple generations and often encompass aunts, uncles, siblings, and cousins. Two thirds (66%) of children under 18 years old live in extended households in South Africa while only 21% are said to live in households that may be defined as 'nuclear' (203). Household-centered issues significantly impact levels of chronic anger, stress, depression, and suicidal ideation among women in Soweto, as well as material and relational hardships (204). Furthermore, research by Redinger et al., 2018 (202) identified family relationship issues as key factors associated with postnatal depression and anxiety in a study of 946 pregnant Sowetan women. Women who felt that their significant others made life more difficult were three times more likely to experience depression, and those experiencing stress from family relationships had nearly twice the risk of developing depression and anxiety (202). These relational dynamics can profoundly affect the mother as she navigates parenthood while defining her attachment style with her infant.

1.5.4 Childhood experience

A mother's own childhood experiences of being parented within her unique family system and cultural context significantly influences the way in which she meets her own child's needs and thus impacts the bonding and attachment style between the dyad (3,205). In the seminal paper called 'Ghosts in the Nursery' written by Fraiberg et al., 1975 (3), the authors theorise about the re-enactment of early scenes between the child who is now the parent, and the current child. The ghosts refer to the mother's forgotten feelings that are expressed through behaviour, attitudes and

perceptions towards the child in the here and now. Ghosts are not the thoughts of people of the past. Ghosts refer to the subjective experience of early conflicts in the parent-child relationship. Unresolved conflicts are not the same as trauma, however trauma is an external event that can lead to these unresolved conflicts.

Maternal childhood trauma has been linked to compromised mother-infant bonding (206) poor parenting practices (207) and developmental challenges in infants (208). In South Africa, a direct association between psychological distress and adverse childhood events has also been found (209). This research was conducted using the Adverse Childhood Events (ACEs), which is an assessment that explores various forms of (the mothers') childhood mistreatment, such as physical, emotional and sexual abuse, neglect, and commercial or other exploitation. These experiences can cause actual or potential harm to a child's health, survival, and development, particularly within relationships characterised by power dynamics or trust. A plethora of studies in high income settings have outlined the relationship between ACEs and psychopathology including general poor mental health, adult depression and anxiety disorders. One such study of adverse childhood experiences in 9508 adults in San Diego found that those who had experienced four or more classifications of adverse childhood exposures, versus those who had experienced zero, had a four to 12 times elevated risk for alcoholism, drug abuse, suicide attempts, and depression (210).

1.6 Maternal mental health

Postnatal depression is a global health challenge affecting millions of mothers worldwide. A systematic review of postnatal depression within groups of women from developing countries found an overall prevalence of 27.0% (211). Verkuijl et al., 2014 (212) found that 24% of mothers of 6-month-old infants from Soweto presented with symptoms of postnatal depression. This statistic is similar to the 27% for postnatal depression found in a study conducted by Redinger et al., in 2018 (202).

Anxiety disorders are also prolific and affect children and adults across the world causing them significant difficulty in everyday functioning and extreme feelings of distress (213). They are often hereditary and frequently co-occur with depression, thus there are many cases of misdiagnosis and treatment plans are often incorrect. Research indicates that anxiety disorders

affect 10-15% of women, with higher prevalence among those in low-income groups (202,214). In a meta-analysis and systematic review of the prevalence of postnatal anxiety including 221 974 low risk women over the age of 16 from 34 countries, it was found that the prevalence of symptoms relating to anxiety at 1-24 weeks postpartum was 15.0% (214). In this postnatal group of women assessed for anxiety disorders, the sample size was 28 495 of which 871 women were from low to middle income groups and 27 624 were in the high-income bracket. General results indicated that the prevalence of anxiety disorder was 9.9% and for generalised anxiety disorder was 5.7%. Added to this, the rates were higher in low to middle income countries (215). This statistic is similar to the findings in the Redinger et al., 2018 (202) study in Soweto, South Africa, reporting a 15.2% prevalence rate of state anxiety.

Maternal mental health does not only affect mothers. These psychopathologies have ripple effects on families, which lead to detrimental concerns within systems (216,217). Mental health concerns can hinder a mother's responsiveness to her infant, and this may in turn impede the social, emotional, motor and cognitive development of the child (9).

1.6.1 The effect of maternal mental health on mother-infant interactions

Generally, mentally resilient mothers have sensitive styles of parenting, adapting to their infants' signals and providing appropriate affective, tactile and vocal stimulation in predictable and consistent ways (33). In this context, 'mentally resilient mothers' refers to mothers who, despite facing significant adversity and psychosocial stressors, demonstrate the capacity to maintain adaptive emotional regulation, engage in functionally supportive caregiving behaviours, and recover effectively from stressful experiences. Mental resilience here is defined not as an absence of distress, but as the ability to cope with, adapt to, and even thrive in the face of challenging circumstances, thereby mitigating the negative impact of stress on their own well-being and their interaction with their infants. It does not equate to the absence of mental health conditions; rather, it speaks to an individual's capacity to manage and overcome such challenges, maintaining functionality and relational well-being (218).

This is opposed to depressed mothers. It is acknowledged that while a genetic predisposition to depression exists, the interplay between genetic factors and environmental stressors is complex. For instance, individuals with specific gene variants may exhibit increased susceptibility to

depression when exposed to adverse life events, yet this risk is not deterministic and requires environmental triggers. It has been reported that depressed mothers are less capable of creating environments that promote growth for their infants (4). This may be because depressed mothers find it difficult to regulate their own affect, disrupting their ability to provide a regulatory support structure, and curbing the infant's capability to progress from helpless tactics in infancy to strategies that include forms of coping that are more active (4,164). An infant's 'hopeless tactics' refers to observable behaviours of withdrawal, disengagement, or passive self-soothing (e.g., gaze aversion, turning away, slumping in the caregiver's arms) that emerge when repeated attempts to elicit a contingent, engaging response from a caregiver have been unsuccessful (219). These are often seen in the context of chronic caregiver unresponsiveness or depression, where the infant's active bids for interaction are consistently unmet, leading to a learned helplessness in the dyadic interaction (57). Conversely, 'more active forms of coping' in infants refer to proactive behaviours aimed at re-establishing connection and eliciting caregiver response. These include vocalizations (e.g., cooing, babbling, direct cries for attention), reaching gestures, pointing, and persistent eye contact. These are attempts by the infant to actively regulate the interaction and restore a sense of shared emotional experience with the caregiver (220).

Relationships between depressed mothers and infants are characterised by more inflexible affective expression, low sensitivity and inconsistent levels of engagement with infants (69,221–223). Mothers suffering from depression display more hostility, lower responsivity to infant stress and intrusive behaviour (224–227). They also tend to involve themselves less in joint activity (228) and look towards their offspring less frequently (95).

Infants of depressed mothers engage less in social interaction, engage less frequently with objects and develop less favourable self-regulation capabilities than those of mothers with no depression (229–231). They also have an increased chance of developmental delay in the first 12 months of life (212,232,233). Verkuijl et al., 2014 (212) reported that in South Africa, a significant increase in psychological challenges at two years of age was evident when maternal postnatal depression was present. Infant 'psychological challenges' in this context refers to early manifestations of emotional difficulties that can impact an infant's overall well-being and adaptive functioning. Examples include difficulties in emotion regulation, externalizing (e.g.

aggression, hyperactivity) and internalizing (e.g. depression, anxiety) behaviours in the child (212).

Much less research has focused on anxious mothers and existing studies reveal mixed results (234). Some investigations on maternal anxiety reveal no differences between experimental and control groups while others show that anxious mothers behave in intrusive ways and override their children's signals (4,176,223,235,236). It is also important to note that studies often do not take comorbidity into account and therefore present inconclusive results. One study that has noted co-occurring psychopathology has been written by Murray et al., 2007 (235). They found only slightly significant differences in interactions between healthy and anxious mother-infant pairs. Mothers with social phobia displayed the same amounts of sensitivity as controls, however engaged less and presented as more anxious. During social encounters, socially phobic mothers appeared more fearful, offering less infant engagement. On the other hand, mothers with generalised anxiety disorder were less engaged while playing with their infants but the same as controls while interacting with a stranger. Infants of socially phobic mothers engaged with the stranger less positively, unlike those of general anxiety disordered mothers. The strength of the study was that the authors took comorbidity into account. They reported that excluding mothers with depression did not change these results, meaning that depression was not a confounding factor (237).

In South Africa, Koen et al., 2017 (238) found that within a cohort of trauma-exposed mothers from a low income, peri-urban group in the Western Cape, post-traumatic stress disorder (PTSD) in mothers was significantly associated with poorer infant developmental outcomes in their fine motor and adaptive behaviour. Similarly, Enlow et al., 2011 (239) studied maternal post-traumatic stress symptomology and found a relationship between emotion regulation challenges in infants and an increased risk of mental health problems among the offspring of mothers with PTSD.

1.6.2 Relationships between postnatal depression and anxiety and synchrony

A number of studies using manipulations of the mother's expression have been conducted to investigate the interaction and sequence of behaviour or synchronisation between mother and infant. One such method is the Still-Face-Paradigm (169) as mentioned previously in 1.3.3

whereby the mother interacts with her child, then presents with a 'still face' (a mimic of depressed state) and then reverts back to interacting with her infant in the last phase of the Paradigm. This methodology is used as facial expressions are more negative or flat in women suffering from depression (228). A typical reaction to the mother who has shown a 'still face' would be that the child displays a pattern of becoming positive for a short time, averting gaze and finally showing distress (169). Three-and-a-half-month-old infants tend to gaze at their mothers for longer periods and show more positive emotions when their mothers slow down their own actions during interactions and imitate their infants' behaviours, demonstrating greater attunement (240). In Field's, 1977 (240) study, infants looked at their mothers less and showed more negative affect when their mothers were overly intrusive, displayed anxiety, or sped up their actions during interactions (240).

Mothers' depressive symptoms are often associated with decreased gaze synchrony between mother and infant (241,242) but research findings have been mixed. A study by Feldman et al., 2005 (242), reported that it took 60 seconds longer for a depressed group of mothers to reach mutual gaze with their infants as compared to 12 seconds for the women in the non-depressed group. Additionally, depressed mothers broke their gaze with their infants after infant vocalisation five times more often than in the control group. Contrary to these findings of associated maternal depression with decreased gaze synchrony, two studies found mothers with depression were more synchronised with their infants' facial expressions during interactions (68,109,241,243). Lotzin et al., 2015 (68) showed that this association was mediated by maternal emotion dysregulation, connecting the role of synchrony during interplay as contributing to infants' development of emotion regulation skills. The finding that mothers and infants synchronise their facial expressions more frequently when mothers experience depression could imply that both caregivers and their infants are expressing higher levels of negative or neutral facial expressions (68). This is in keeping with previous research, suggesting that depressed mothers and their two-month-old infants expressed lower levels of positive affect than non-depressed mothers, but all demonstrated similar levels of within-dyad contingent behaviour (244). Similar results have been found in mothers' depressive symptoms and facial affect synchrony with three to five-month-olds (245).

Mild to moderate maternal depression symptoms may have noticeable yet selective impacts on mother-infant interactions (246). In a study by Skotheim et al., 2013 (247), researchers compared patterns of real-life, natural interactions with patterns where the interactions were intentionally set out of phase (unsynchronised) or disrupted. Skotheim et al., 2013 (247) saw that infants of mothers with sub-clinical depression were affected less by these disruptions than infants of non-depressed mothers. A possible explanation for this finding is that infants of sub-clinically depressed mothers might be more accustomed to experiencing non-contingent or inconsistent interaction styles in their daily lives (247). Severe depressive symptoms in mothers (109) and those with more self-criticism (248) as well as mothers with greater distress (241) have also been linked with lower mother-infant synchrony.

There are less data available with regards to anxious mothers interacting with their infants when analysing detailed behaviours between the dyad. Findings from one study conducted by Feldman, et al., 2005 (242), suggested that the behaviours of mothers with increased anxiety were not matched to the states and signals of their infants. A typical finding was that mothers would maintain 'high-pitched, sing-song vocalisations' for a large proportion of time within the engagement, irrespective of whether the infant was responding in appropriate social ways, averting his or her gaze, or displaying signs of fatigue. Added to this, the research found that the interval between episodes of shared gaze was almost three-fold shorter than controls, emphasising the pacey nature of engagement between anxious mothers and their children (249).

It is generally agreed that depressed mothers are more flattened in affect and slow to engage whereas anxious mothers may be quicker in response. To illustrate this, findings from Granat et al., 2017 (108), concluded that gaze and touch synchrony were found to be the lowest in mothers with depression, the highest in mothers with anxiety, and at a moderate level in the control group (108). However, comparing results is challenging due to mixed findings, differences in methodological approaches and measures of synchrony, and the comorbidity of mood disorders that is often not accounted for.

1.7 Summary

Appendix A summarises the theoretical underpinnings of this discussion.

Maternal mental health and a mother's experiences in her own childhood can have a significant effect on her relationship with her infant. These factors, amongst others, shape interactional dynamics which are characterised by varying degrees of maternal sensitivity, responsive caregiving and reflective functioning. At 3-6 months postpartum, social relatedness between the pair is developmentally at its peak and investigation of mother-infant interaction is ideal. Researchers have cast a microscope over the to-and-fro of behaviours between mother and child and explored the timing of exchanges to examine the synchrony between the pair. Patterns of social communication including visual attention and facial expressions for both partners reveal the nature of a dyadic relationship and indicate the emotional experiences shared between them. In response to these patterns between a mother and her infant, the infant may feel loved, rejected, confused or angry, which in turn feeds back into the relational dynamic between the dyad and a certain attachment style is practiced. Nestled within a specific cultural context, the mother-infant relationship is molded by values and norms, influencing the unique ways in which attachment and interaction are expressed and experienced. Figure 2 illustrates how the mother's state may impact the dyadic relationship.

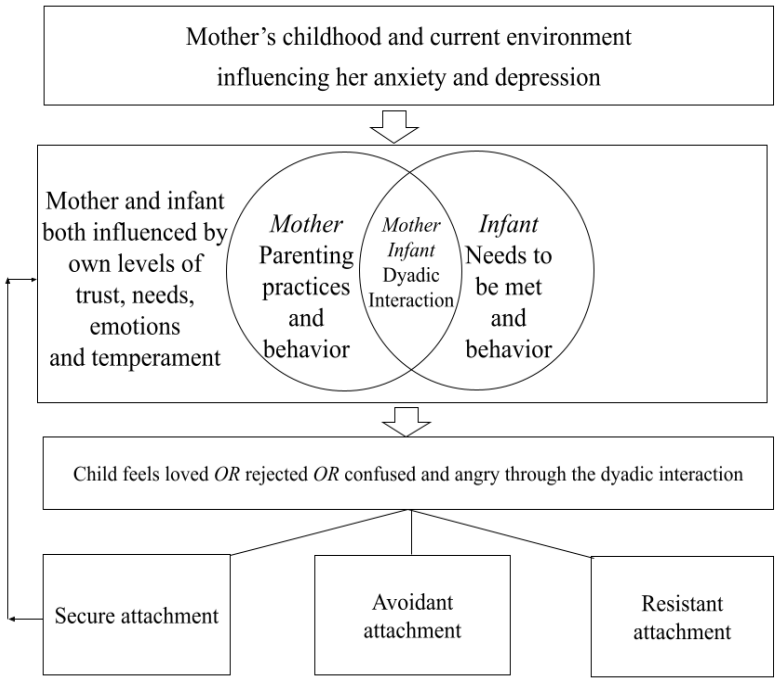


Figure 2: Influence of the mother's mental state on the dyadic relationship [Adapted from John Bowlby's maternal deprivation theory, 1969 (33)]

1.8 The problem

Much research to date has focused on WEIRD (Western, Educated, Industrialised, Rich, and Democratic) countries. These countries often dominate research samples, which can lead to skewed understandings of human behaviour that do not necessarily apply to non-WEIRD populations. This highlights the bias towards studying populations that are not representative of the global population resulting in a lack of studies in low-income settings. Mother-infant relationship dynamics can vary significantly across different cultural contexts; and in South Africa there is limited research on how this socially vulnerable group navigates challenging local environments, living conditions, and relationships. Given compromised social support, and the high prevalence of postpartum depression and anxiety among women with infants; understanding these dynamics is essential for timely and effective interventions that support the social, cognitive and developmental trajectories of mothers and their children.

1.9 Aims and objectives

The aim of this study is to explore the impact of maternal mental health on mother-infant interactions.

The objectives are as follows:

1. To explore maternal perspectives of poor mental health and the impact this has on mother-infant relationships within a community advisory group of Sowetan mothers.

2. To describe the synchrony of visual attention and facial expression between mothers and their infants in a poorly resourced setting in South Africa.

3. To compare durations and transitions of smiles between non-depressed and sub-clinically depressed mothers.

CHAPTER 2

Study sample and methodology

“A mother’s lap is the child’s first school”

Ghanaian proverb

Just as we explore topics in school to deepen our understanding, studying the mother-infant relationship serves as the foundation for our learning in this context. This chapter offers a comprehensive overview of the demographic, economic, and social landscape of the research setting - Soweto, South Africa. It also introduces the overall research methodology and outlines the data analysis approach. In the following chapters (3-5), more specific methods will be detailed, each addressing a distinct research objective.

2.1 Research setting

All data collection for this PhD was conducted in an informal settlement called Soweto, where the vast majority of residents identify as Black Africans (98.5%). Soweto is the acronym for 'The South-Western Townships' as it lies Southwest of Johannesburg in Gauteng, South Africa. It lies within the City of Johannesburg Metropolitan Municipality (see Figure 3). In 2024 the City of Johannesburg released statistics on the population density of surrounding areas and reported that there were approximately 6400 people per square kilometer in Soweto while Johannesburg was home to about 2400 people per square km (250). This discrepancy in density has resulted from the Apartheid era where people of colour were displaced to land outside the cities where they faced substandard infrastructure given to them by the government. Unsupported, residents have endured challenges like widespread unemployment, overcrowding and inadequate housing. Moreover, women in this setting encounter added social and physical susceptibilities that may diminish their ability to withstand public health challenges (193). They are susceptible to experiencing intimate partner and gender-based violence, traumatic events, increased risk of HIV infection, and depression (190,251–253).



Figure 3: Map illustrating the location of Soweto in South Africa

2.2 Research sample

This PhD research was nested within the PLAY (Play, Love and You) study which was run by Dr Alessandra Prioreschi at the SAMRC/Wits Developmental Pathways for Health Research Unit (DPHRU) situated in the Department of Paediatrics and Child Health in the School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand. The PLAY study was a randomised controlled trial designed to improve infant development by encouraging maternal self-efficacy using behavioural feedback, content provision and supportive guidance. As part of the intervention, mothers received input with regards to breastfeeding, maternal mental health, play and development to facilitate early parenting. See the PLAY study information and consent form in appendix B.

2.2.1 Research sample for objective 1

A Community Advisory Group (CAG) was initially established (n=15) to pilot aspects of the main PLAY study and to co-develop intervention material. Mothers were approached at a large, central taxi rank in Soweto outside of the Chris Hani Baragwanath Academic Hospital and

invited to participate. We chose taxi ranks as suitable locations for random selection of participants because over 80% of township dwellers in South Africa use taxis as their only mode of transport (254). Mothers were eligible if they resided in Soweto, could obtain transport (reimbursed) to and from the study site at the Chris Hani Baragwanath Academic Hospital, if they were >=18 years, if they spoke and read English, and if they were the primary caregiver, and had given birth to a single full-term infant within the last 4 months. Mothers or infants with physical disabilities and those with premature births were excluded for methodological and ethical reasons. These conditions are linked to unique challenges, such as increased psychological distress and different bonding patterns, which could confound findings. If eligible, we provided pamphlets containing important information about the voluntary nature of the study, the reason for such research and the details regarding how and when information would be gathered. If mothers agreed to partake, we asked for their contact details and left them with the pamphlets that detailed information for the next steps. After making telephonic contact with participants, data were collected at a meeting room at the Chris Hani Baragwanath Hospital in May 2022 in order to achieve objective 1 of this PhD. We used this sample of mothers to explore the perceptions of mental health and the understanding of postpartum depression and anxiety as well as perceptions of the mother-infant dyad.

2.2.2 Research sample for objectives 2 and 3

The main PLAY study (n=207) had the same eligibility criteria as the CAG, but mothers were recruited when their infants were <14 days old. These mothers were recruited at Chiawelo Community Healthcare Centre and Lilian Ngoyi Clinic in Soweto, South Africa at delivery or three-day checkup visits. They too were given information, told about the voluntary nature of the study and invited to participate. Objectives 2 and 3 of this PhD were conducted using the combined sample of mothers in the intervention and control groups during their four-month study visit.

2.3 Ethical approval

All participants were given an information sheet at recruitment, and had the study explained to them by trained research assistants. Women were told of the voluntary nature prior to inclusion, and written informed consent was obtained by trained research assistants. All this was

communicated in English, yet further explanation was available in the vernacular. Participant data were kept confidential by assigning participant IDs. The CAG, PhD (as a sub study) and PLAY studies, were approved by the University of the Witwatersrand's (WITS) Human Research Ethics Committee (CAG study clearance no: M210846; PhD study clearance no: M220787 and PLAY study clearance no: M220217 in appendices C-E).

2.4 Methodology

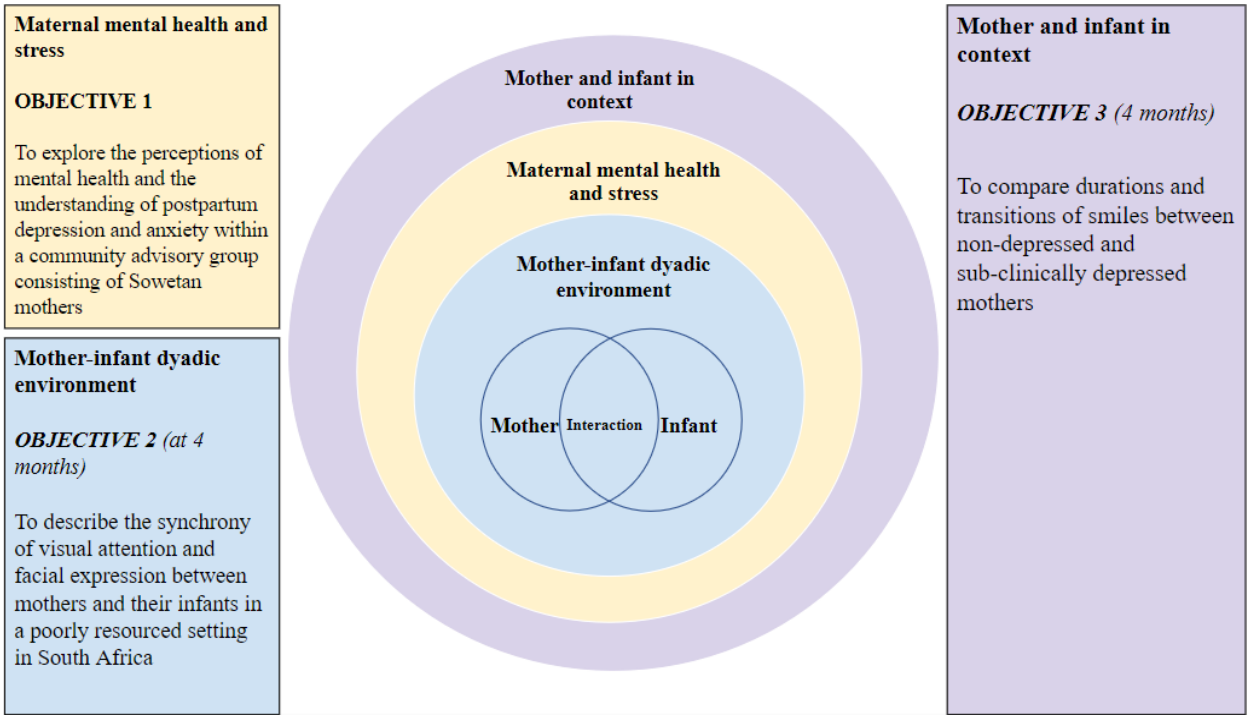


Figure 4: The spheres of influence that shape the dyadic mother-infant relationship with objectives

2.4.1 Measurement tools

Questionnaires

Based on my clinical experience, I chose a sociodemographic questionnaire, and questionnaires around childhood trauma, maternal depression, posttraumatic stress symptomology, bonding, social support and social stress to explore the topic of maternal mental health. Firstly, the sociodemographic questionnaire (SDQ, appendix F) was administered. I recorded details of the participant's age, relationship status, level of secondary and tertiary education, employment

status, household density, the gender of her infant and socio-economic status. Instead of asking specific questions about poverty and income, I calculated a score of household assets to describe the group in terms of economic status. Participants attained a score out of 13 common assets (fridge, electricity, vacuum cleaner, stove, washing machine, DVD player, satellite TV, TV, landline telephone, car, cell phone, internet access and computer/laptop/tablet). These factors have proven to be pivotal in the economic evaluation of the household and are responsive to fluctuations over time (255,256).

The Adverse Childhood Experience questionnaire [ACE (210) appendix G] assessed childhood abuse, neglect, and challenges. The assessment looks at three categories of adverse experience: childhood abuse, neglect, and household challenges. Participants confirm either the presence of this kind of experience described by each item by writing a number 1 or they leave it blank if there was no such experience. A score from 0-10 is based on how many types of adverse experiences are reported. While the ACE questionnaire has not undergone formal validation in the South African context, it has been used extensively in local health and social science studies (257) and has demonstrated practical relevance and comprehensibility when administered sensitively within diverse South African populations (209,258).

The Edinburgh Postnatal Depression screen (EPDS) in appendix H is a widely used instrument used to detect postnatal depressive symptoms. Scores range from nil to three on a 4-point Likert scale and scores are added together to get an overall total. Some of the items are reverse scored. EPDS scores were analysed both as a categorical variable (0-5 = no depression; 6-13 = sub-clinical depression; 14-30 = moderate to severe depression) [(247,259,260)] and as a continuous sum score for more granular analyses. It has been rigorously validated in various South African populations, demonstrating robust psychometric properties (261).

The Postpartum bonding questionnaire [PBQ, (262) appendix I] was administered to detect the quality of early mother-infant bonding. The tool consists of 4 subscales and analysed as a categorical variable (impaired mother-infant bonding', 'rejection and anger', 'anxiety about care', and the 'risk of abuse'). Questions are rated on a 6-point Likert scale, ranging from 0 (always) to 5 (never). Averages n(%) and standard deviations (SD) were done to summarise

participant characteristics and to describe the population. There is evidence of validity and reliability of all these tools in the South African context (212,261,263).

The Post-traumatic Checklist for DSM-5 (PCL-5) in Appendix J uses the Diagnostic and Statistical Manual [DSM; (264)] to reference corresponding criteria of PTSD such as presence of intrusive symptoms, negative changes in cognitions and mood, and alterations in arousal and reactivity. Rating scale descriptors are: 'Not at all,' 'A little bit,' 'Moderately,' 'Quite a bit,' and 'Extremely.' A total symptom severity score is found by adding up the item scores which range from 0–80. Cut-off scores for likely PTSD can be between 23–38 and are reliant upon the population in which the score was validated. In our analysis, we employed a cut-off score of 33 on the PCL-5 to indicate probable PTSD, based on validation research conducted within a Zimbabwean population (265), providing a regionally appropriate threshold. It is important to note that our data collection preceded the publication of a recent South African study by Gulbicki et. al, 2024 (266) which defined elevated PTSD symptoms as a PCL-5 score of ≥ 31 in the context of maternal mental health and bonding. There is evidence of validity and reliability of this tool in the South African context (263).

Social support and social stressor questionnaires were administered [(201,267), appendix K which are questionnaires, formerly developed at the Developmental Pathways for Health Research Unit at the University of the Witwatersrand]. The 25 questions ask about support and stressors that require a yes/no response, and scores are summed to generate an overall stress score. The closest cut-off point to yield the top 15% was 4, and so a score of 4 or more was taken as indicative of high levels of stress in a study by Ramchandani et al., 2010 (267). The tool is used to enquire about the antenatal phase but there is no statement directed towards pregnancy. Added to this, all questions refer to general stressors and so this assessment can be used for this paper. Ramchandani et al., 2010 (267) expand their analyses to separate stressful events into four groups: maternal stress, family stress, economic stress and societal stress and have developed a social stress questionnaire.

The following Table 1 gives details of each questionnaire used including the theorist, the type of scale, number of items, time to complete each assessment, outcomes and scoring used.

Table 1: Details of questionnaires used

Tools summary	**Adverse Childhood Experiences questionnaire (ACEs)**	**Edinburgh Postnatal Depression Scale (EPDS)**	**Postpartum bonding questionnaire (PBQ)**	**PTSD Checklist for DSM-5 (PCL-5)**	**Sociodemographic questionnaire (SDQ)**	**Social support and stress questionnaires (SSSQ)**
Theorist	Felliti, et al., 1998	Cox, et al., 1987	Brockington, et al., 2001	Weathers, et al., 2013	N/A	N/A
Type of scale	Self-report, 5-point Likert type scale	Self-report, 4-point Likert scale	Self-report, 6-point Likert scale	Self-report, 5-point Likert scale	Questionnaire	Two questionnaires. One of 16 and the other 9 questions
No. of items	10	10	25	20	13	25
Time to complete	5 minutes	5 minutes	10 minutes	10 minutes	10 mins	10 mins
Outcomes	A single point is scored for each trauma. The higher the number, the higher the level of childhood trauma	0-5 indicate no depression, 6-13 suggest sub-clinical depression and 14-30 show moderate and severe depression	Impaired mother-infant bonding; rejection and anger; anxiety about care and risk of abuse	Post traumatic symptoms as described in the DSM -5 (intrusion, avoidance, negative alterations in cognitions and mood, and alterations in arousal and reactivity)	Details of her age, relationship status, level of secondary and tertiary education, employment status, socio-economic status and household density	Perceived social support and stress
Scoring	Totals between 0 and 10	0-3 scores are summed to get an overall score out of 30. Some items are reverse scored	Impaired bonding scores 12; rejection and pathological anger scores 13; Infant -focused anxiety scores 10; Incipient abuse scores 3	0 (not at all) to 4 (extremely). Total severity score between 0-80. Cut off scores for probable PTSD range is 33 and above	Data were summarised using frequencies (percentages) for categorical variables and means (standard deviations) for continuous variables	Qualitative measure

Focus group discussions

I recruited a facilitator who was fluent in the vernacular, namely Zulu and Xhosa, to conduct the discussions. We went through a semi-structured discussion guide (appendix F) that I designed which outlined key thematic areas related to maternal mental health. Practically, this guide included concepts that would allow for flexibility to explore emergent themes. We discussed environment setting (ensuring a comfortable and private space for discussions, fostering an atmosphere of trust and openness), establishing rapport (beginning each session with warm introductions and an emphasis on confidentiality to encourage participants to share openly), open ended questioning (questioning that would open up conversation), and employing active listening, non-verbal encouragement, and specific probing questions to elicit rich and detailed responses. I asked the facilitator to ensure that all participants had an opportunity to speak. I explained to the facilitator the notion of nonmaleficence (268). We made use of Vygotsky's (269) concept of scaffolding to support participants with emotional regulation when retelling their stories. These principles of bioethics assert an obligation not to inflict harm.

I set up the venue and organised refreshments. After explicit consent was given, the focus group discussions (FGDs) were conducted and lasted approximately one to two hours each. I was taking notes throughout the FGDs to note observed processes which would supplement the information gained by the audio that was recorded. After transcribing the audio, I reviewed all transcripts to ensure accuracy and completeness. This meticulous approach ensured that the focus groups yielded rich, nuanced qualitative data, reflecting the participants' authentic perceptions and experiences within their specific socio-cultural context.

Headcams

Headcams were the tools used to collect video footage of mothers and infants interacting face-to-face. Each round camera is mounted on a headband and has an on/off and start/stop button. The cameras record audio and video in AVI format. They are WearCams manufactured by UCam 247. The devices have a resolution of 1280 x 720, a field view of 85 degrees and a frame rate of 30 frames per second. Skinner et al., 2023 (270) discuss analyses of the improved performance of these wearable cameras for researching parent-child interactions as opposed to older models.

Wrottesley et al., 2021 (271) have recently reported that the headcams are feasible when used with mothers and their infants in Soweto, South Africa.

In-person instruction and handling of the headcams was explained to all mothers and a demonstration was given. Every mother was asked to use the devices at her home by placing one headcam on her head and the other on her infant's head. She was asked to switch on both devices, and it was explained that the cameras would capture footage of the dyadic interactions as the pair engaged in a 1-5-minute-long simple task of engaging in free play with each other. A mother was asked to repeat the task 3 times within the space of one week (75).

While the activity was naturalistic to preserve ecological validity, the task was standardised across dyads in terms of general instructions (i.e., to play as they normally would) and duration. No specific prompts or scripts were provided to allow for authentic interaction and observation of typical dyadic behaviour. Devices were collected from mothers by the research assistants after seven days and returned to Chris Hani Baragwanath Academic Hospital where data in the form of recorded video footage was downloaded. Once downloaded and stored, camera footage would be deleted from each camera.

2.4.2 Specific methodology for each objective

For objective 1, after making telephonic contact with participants from the CAG (see '2.2.1' for research sample), data were collected at a meeting room over two consecutive days in May 2022 at the Chris Hani Baragwanath Academic Hospital. Fifteen mothers (272) who were randomly divided into two focus groups, gave written informed consent. The sample size was intentionally selected to align with the goals of a case-oriented qualitative analysis (273) which focuses on exploring specific cases in depth rather than generalizing to a larger population (273,274). In qualitative research, this approach emphasizes the importance of gathering detailed, nuanced data to fully understand participants' perspectives and experiences. A smaller, focused sample allows researchers to collect richly textured information, which is essential for meaningful interpretation and insight. On both days, the same method was utilised.

The research team member, who was fluent in the vernacular, welcomed the group. She introduced me and the group was told that I was there to take notes on the observed process.

Furthermore, she showed the participants the audio recorder, informing them that the audio would supplement the information gained. After asking permission to begin, the recording started.

To explore perceptions of mental health issues and of relationships with infants, we first defined maternal mental health. In this context, mental health was defined as the presence or absence of psychological distress - particularly symptoms of postpartum depression and anxiety - as understood and described by the participants themselves, rather than through diagnostic criteria. This subjective understanding was used to capture culturally and contextually relevant perceptions of maternal mental well-being.

We then characterised the sample by requesting completion of the sociodemographic questionnaire. After administering the ACEs, EPDS, PBQ, PCL-5, social support and stress questionnaires; we offered a 20-minute break where muffins, tea and coffee were served. Thereafter, we conducted FGDs. One theme of enquiry was aimed at understanding mothers' perceptions regarding the causes of postpartum depression and anxiety, and the other to explore the perceived impact of maternal mental health on the dyadic relationship. After one round of discussions, we repeated the method with the second group of mothers the next day and saturation was reached (275).

Due to the sensitive nature of the topic through which participants would reveal highly triggering events of violence and abuse from a young age, we structured small groups. I am a qualified community-based counselling psychologist, and I was there not only to take notes but to be present to contain the emotional well-being of participants. Additional therapy sessions were offered to women who either displayed distress or who requested face-to-face assistance.

For objective 2, I examined mother-infant synchrony by observing visual attention and facial expressions. Objective measures were collected from n=57 mothers (please refer to 2.2.2 for research sample for objectives 2 and 3).

After research assistants collected sociodemographic data at enrolment at the clinics, telephonic contact was made at four months. Researchers drove to mothers' dwellings in Soweto to conduct headcam data collection. After two cameras (one for the mother and one for the infant) were

handed over to the mother and instructions were given, the interactions between the dyad were recorded within the next week and devices were collected. At the Chris Hani Baragwanath Academic Hospital, data was downloaded. Once downloaded and stored as MP4 files, camera footage was deleted from each camera.

Video processing started with the downloaded MP4 files of the recorded interactions. The amount of light, the angles of head-mounted cameras and the clarity of the images were considered as criteria to determine the acceptability of each video. For the footage to be usable, both mother and infant had to be clearly visible with the appropriate levels of luminosity in order to capture micro behaviour such as direction of gaze and the subtleties of affect shown in the expressions on faces. Since mothers were asked to record themselves more than once in the week, the first usable 3 minutes of uninterrupted footage were selected for analysis, ensuring an unbiased sampling of footage. Choosing the first uninterrupted segment of suitable length helps eliminate subjective decision-making and enhances the consistency and reproducibility of observational data analysis (276). After selection, 57 matched videos of mothers and infants were available for analysis. After aligning the timing of each video using the software syncing feature (Adobe Premiere Pro ®) based on audio, the two videos were placed side by side on the screen with a split screen view. Any unsynchronised portions were trimmed and deleted.

I coded data of visual attention and facial expression on every second of video footage to identify specific behaviours exhibited by the mother and her infant. We followed the Mental Health Intergenerational Transmission Process Manual [MHINT manual (277) and the micro-coding scheme provided by Observer XT 16 ® developed by Noldus Information Technology in Wageningen, The Netherlands (90). The coding scheme consisted of separate codes for each mother and each infant, codes for each behaviour (visual attention and facial expression) and modifier codes that provided additional details for each behaviour (277,278). Modifier codes included descriptions such as the direction of visual attention (gaze to mother-infant, gaze to distraction, focus object, to another person in room, to another child/sister/sibling in the room and not able to code visual attention) and facial expression (alert/worried, concentration, disgust, face not visible, mock surprise, negative, neutral, positive and smile). Refer to Table 2 explaining the method of coding using 'The Observer' (90) and the MHINT manual (277).

Table 2: Method of coding using "The Observer" and the MHINT manual

Coding step	**Explanation**
1. Choose a perspective	Choose one of the many perspectives that The Observer and the MHINT manual are able to code. (The key behaviours for this study were visual attention and facial expression). Upload all available footage of the chosen activity to 'The Observer'.
2. Start coding	Micro code one behaviour at a time (visual attention and facial expressions separately). Code first the mother and then the infant.
3. Use slow motion	Play the video in slow motion when replaying perspectives. It is likely that many behaviours will change within single frames of footage and so slowing down the motion to capture millisecond shifts within an interaction will offer an extremely accurate picture of behaviour.

I used a two-pass method a two-pass method was used whereby the first video viewing focused solely on the mother's behaviour for coding until completion, and in the second viewing the infant's behaviour was coded. To demarcate the beginning and end of each behaviour in each video, a timestamp was assigned, for instance, if the infant glanced at a distraction, and then shifted attention to another point of focus, the behaviour 'infant gaze at distraction' was time-stamped until the transition occurred (279). In the instance where the coder could not see the infant's face or eyes on the screen, likely because of poor video quality or the camera failing to capture the face at a particular moment, it was recorded as 'not possible to code infant visual attention'. This approach was applied to all focus behaviours exhibited by the mother and the infant. The entire duration of the mother-infant interaction was thus exhaustively coded, and the Observer XT 16 ® (90) software stored the time-stamped behaviours and modifiers for each participant. Figure 5 shows an example of output data and coded behaviour for mother-infant visual attention and facial expressions. The number and duration of each behaviour is visualised by the blocks in colour in Observer XT 16 ® (90).

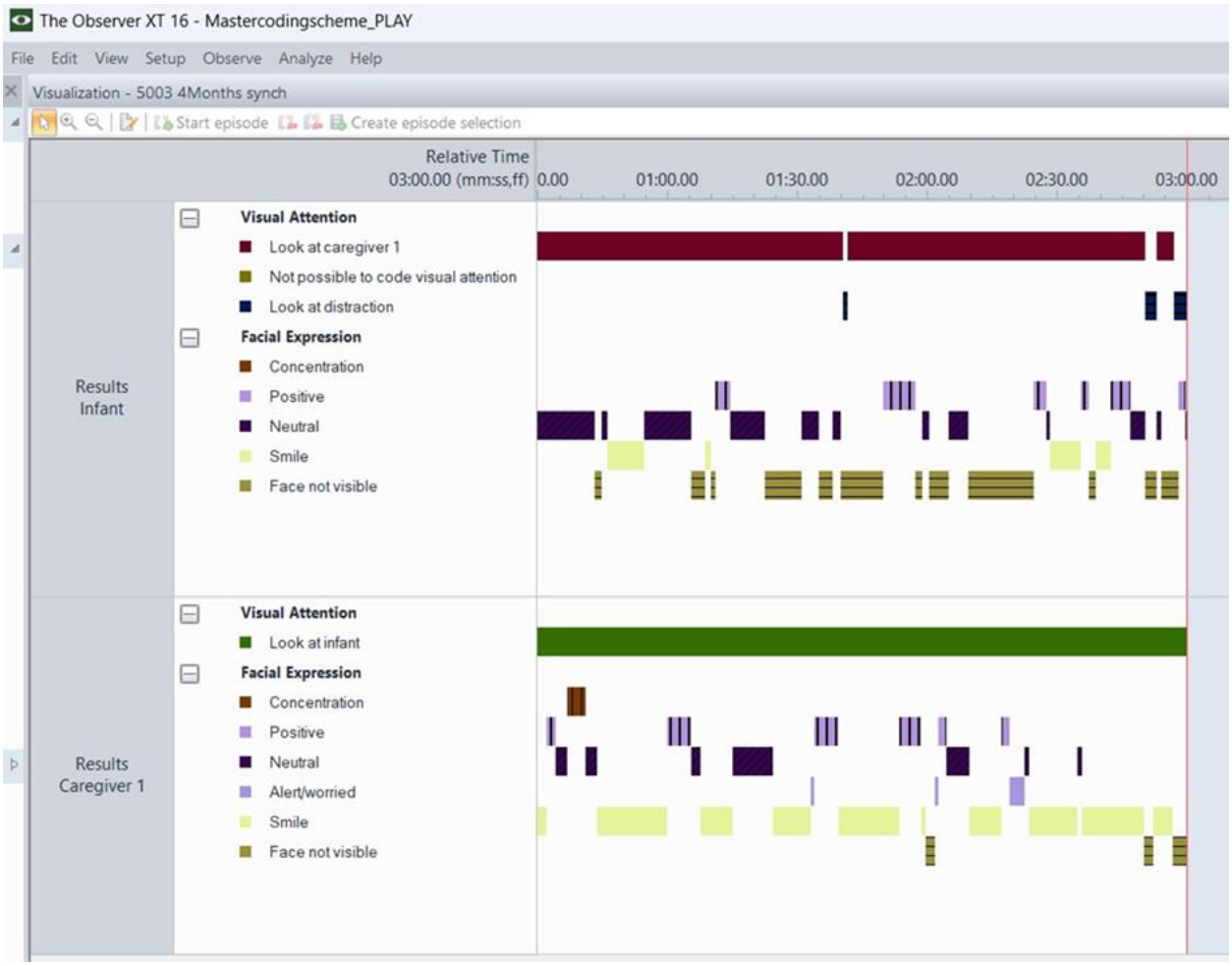


Figure 5: Example of micro coded data on the behavioural domains of visual attention and facial expressions for mother and infant with timestamps

In this project, I identified and coded visual attention and facial expression of mother and infant behaviours and the timing of these behaviours. Wrottsley et al., 2021 (271) have conducted a pilot study titled: The headcam mother-infant interaction assessment tool: testing and feasibility and acceptability in Soweto, South Africa, using participatory engagement. Data from this research offered as a guide towards identifying key behaviours. With regards to coding synchrony, simultaneous behaviours between mother and infant and sequential patterns of behaviours were investigated. With a paucity of research within this realm, this project was the first of its kind in Africa.

For objective 3, I collected data from n=57 mothers (please refer to 2.2.2 for research sample for objectives 2 and 3). After research assistants collected sociodemographic data at enrolment, telephonic contact was made at 4 months. Researchers drove to mothers' dwellings in Soweto to

collect maternal mental health data and headcam data. Maternal mental health data were collected by administering the EPDS. Headcam data were collected, stored and coded using "The Observer" and MHINT as described in objective 2.

In summary, table 3 shows which measuring tools were used for which objectives and Table 4 is a tabulated summary of these measuring tools and how they were used methodologically to collect data.

Table 3: Measuring tools used for specific objectives

	SDQ	ACE	EPDS	PBQ	PCL-5	SSSS	FGD	Headcam
Objective 1	x	x	x	x	x	x	x	
Objective 2	x							x
Objective 3	x		x					x

Table 4: Summary of methodologies, measuring tools and data collected

Objective	Description	Details	Data collected
1	To explore maternal perspectives on poor mental health and the impact that this has on mother-infant relationships within a community advisory group of Sowetan mothers	• n = 15 • Data collection from CAG, recruited from the taxi rank • In-person questionnaire administration and focus group discussions with the help of a translator at Chris Hani Baragwanath Academic Hospital • Sociodemographic questionnaire (SDQ) • Adverse Childhood Events (ACE) • Edinburgh Postnatal Depression scale (EPDS) • Postnatal bonding questionnaire (PBQ) • PTSD Checklist - 5 (PCL-5) • Social stress questionnaire • Social support questionnaire	• SDQ • ACE • EPDS • PBQ • PCL-5 • Social stress • Social support
2	To describe the synchrony of visual attention and facial expression between mothers and their infants in a poorly resourced setting in South Africa .	• n = 57 • Recruitment at clinics when infants were <14 days old • Demographics collected • Data collection of video footage at 4 months in mothers' homes • In-person and helped by research assistants to control headcam usage • Instructions on filming for 5 minutes, 3 times in 1 week. The pair was asked to play freely Each mother was given one camera for herself and another for her infant • Coded video footage of gaze and facial expressions of both mother and infant of matching and timed sequenced behaviours (synchrony)	• SDQ • Headcam footage at 4 months • The Observer (to analyse) • MHINT manual (to analyse)
3	Durations and transitions of smiles: A comparative study of non-depressed and sub-clinically depressed mothers while interacting with their infants	• n=57 • Edinburgh postnatal depression (EPDS) administered • Analysed demographics, EPDS, facial expression total duration and lag analysis of 1,2 and 3 seconds of maternal facial expressions	• SDQ • EPDS • Headcam footage • The Observer • MHINT manual

2.5 Analyses

Objective 1 was a qualitative study. Measurement tools were used to describe the sample and thematic analysis to extrapolate data from focus group discussions. Objectives 2 and 3 were quantitative studies and below is a description of the analyses used.

To analyse objective 1, demographic data were summarised using frequencies (percentages) for categorical variables and means (standard deviations) for continuous variables. To describe the population, we analysed the mental health questionnaires. Total scores for multi-item Likert scale questionnaires were treated as continuous measures (i.e., PCL-5, EPDS, and PBQ). Continuous measures were reported as medians and interquartile ranges. Categorical data, including categories created by cutting questionnaire total scores according to pre-specified thresholds (see Table 1), were analysed using frequencies, with the mode used as a measure of central location for ordinal scales.

To analyse data from the focus group discussions, we used qualitative methodologies aligned with anthropological inquiry-informed analyses. Focus group discussions and observations of women led to an inductive style of research, and narratives were recorded (280). Main emerging themes and sub-themes were identified by coding transcripts line by line and then categorising quotes into themes and subthemes. The frequency of certain keywords was noted and contributed to the strength and therefore the validity of a theme. A second researcher performed the analysis independently to promote objectivity and to confirm theme identification. Both researchers compared their analyses and restructured themes until a consensus was reached. Results were consolidated and themes and subthemes were described.

Although the central objective was to allow themes to emerge inductively from the mothers' accounts, the analysis also incorporated a complementary deductive dimension. Specifically, psychodynamic theory served as a sensitising lens, helping to attune the analysis to underlying meanings and repeated dynamics, particularly around constructs like mentalisation and projective processes. This blended approach supported the construction of interpretations that were both theoretically coherent and firmly rooted in the participants' subjective experiences.

To address objective 2, all plots and variable summaries were completed using R v4.4.0 (2024). I summarised demographic data using frequencies (percentages) for categorical variables, and median and the first and third quantiles [median (Q1, Q3)] for continuous variables.

I coded mother-infant interaction using Noldus Observer XT (90) whereby this data for visual attention and facial expressions was automatically generated and exported to Microsoft Excel. Data were measured in terms of frequency, duration and temporal parameters. Our research focused on examining the frequency (freq), mean duration (MD), total duration (TD) and lag sequential analysis (LSA) of visual attention and facial expressions within these interactions.

In terms of frequency analysis, I calculated the percentage of total recording time for each partner in a dyad for each coded facial expression and visual attention behaviour [100 * (total duration of a behaviour / total recording time)]. The total recording time included time when there was no codable visual attention or where faces could not be seen to code facial expressions. For each group (mother or infant) and coded behaviour combination, the percentages were summarised using median (Q1, Q3). For plotting purposes, the data are shown as box plots (Q1, median, Q3) with Tukey whiskers [extending the lower whisker from Q1 by Q1 minus 1.5 * interquartile range (IQR) or to the minimum value (whichever comes first), extending the upper whisker from Q3 by Q3 plus 1.5 * interquartile range (IQR) or to the maximum value (whichever comes first)]. The individual data points were then overlaid over the box-and-whisker plots.

To characterise mother and infant interactions for the duration analyses, I calculated the MD and TD of different visual attention points and facial expressions. Mean duration of behaviour was defined as the average amount of time each incident of visual attention and facial expression lasted (e.g. each smile occurred for an average of 3s). The total duration of a behaviour was calculated by multiplying the mean duration for the behaviour by the number of times that the behaviour occurred over the recording period (e.g., if there were 5 smiles, with a mean duration of 3 s, over the entire duration of the video clip, then the total duration would be: 3 * 5 = 15 s).

Using lag sequential analysis, I wanted to determine who was 'leading' the interaction and who was 'following' in both the visual attention and facial expression domains by analysing the probability of the infant or the mother leading the occurrences of matching behaviours within a

time frame of 3 seconds. Lag analysis was performed to determine the ongoing coordinated adjustment of the timing and patterns of actions and affect between engaged dyads in an interaction, defined as synchrony (62). This would assist me to see if mother and infant were both responsive to shifts in each other's behaviour and would assist with exploring interactional patterns of these dyadic relationships in low-income cohorts. Stern, 1971 (86), Beebe, 1982 (84) and Cohn and Beebe, 1990 (85) have observed that the interval between the commencement of an individual's actions and the commencement of their partner's actions typically falls within the range of half a second and thus, time-series analyses and lag times of 3 seconds in sequences have been used and have defined synchrony (94). Observer XT 16 ® software (90) was used to generate the probability of the mother or infant leading a matching behaviour for each facial expression and visual attention behaviour, and the data were then exported from Observer XT 16 ® (90) into R v4.4.0. For each group (mother or infant) and coded behaviour combination, the probability of the infant leading and the probability of the mother leading were summarised using median (Q1, Q3). For plotting purposes, the data are shown as box plots (Q1, median, Q3) with Tukey whiskers. The individual data points were then overlaid over the box-and-whisker plots.

To address objective 3, I completed all plots and statistics using R v4.4.0 (2024). To describe the population, demographic data were summarised using frequencies (percentages) for categorical variables and median and the first and third quantiles [median (Q1, Q3)] for continuous variables. To compare groups of mothers with varying degrees of depression, I assigned participants to a non-depressed group or a sub-clinical depression group using the aforementioned cut-off scores. Observer XT 16 automatically calculated the total durations for maternal facial expressions. After data extraction, I used a quantile regression with a conditional median and controlled for the length of the video footage to assess differences between the non-clinical depression and sub-clinical depression groups. I extracted lag sequential data for 1-, 2- and 3-second periods for each maternal facial expression transition from neutral to positive; neutral to smile, and positive to smile. Transition probabilities for the non-depressed and sub-clinically depressed groups were modelled using 0 and 1-inflated beta regression, using a Bayesian framework (uninformative priors, chains = 4, iterations = 4000 with a warm-up of 1000, and backend = CmdStan). For reproducibility, the random seed was set at ‘1234’.

In addition to the 0 and 1-inflated beta regression, which models the transition probabilities on a continuous scale, I conducted a supplementary analysis of the transition probabilities using a frequentist ordinal regression approach. For this supplementary analysis, I cut the transition probabilities into quintiles and modelled the quintiles (dependent variable) against group membership (non-depressed vs sub-clinically depressed; independent variable). The quintiles did not have any meaning but to break the sample into equal groups with the objective being to determine whether a quintile was more likely to have higher transition probabilities in the sub-clinically vs non-depressed mothers.

For all frequentist models, I interpreted $p < 0.05$ as being statistically significant. For the Bayesian models, I interpreted differences in modelled transition probabilities between the non-depressed and the sub-clinically depressed groups as being meaningful when there was no overlap in 95% credible intervals, where 95% credible intervals indicate the range within which the true transition probability is expected to fall with 95% probability.

2.6 Ethical considerations

Given the high levels of violence and trauma in the communities where the participants lived, there were crucial ethical considerations in conducting this study. The research sought to explore the mental and emotional experiences of mothers in these environments, which carried the risk of triggering distress during discussions of trauma. To mitigate potential harm, the study prioritized sensitivity, emotional containment, and ethical responsibility throughout its design and implementation.

Both the research assistants and the mothers involved in the study required appropriate support to safely engage with the emotionally charged material. I provided the research team with psychoeducation, including a 30-minute talk on listening skills and role-play sessions to prepare them for sensitive interactions. For the mothers, brief, face-to-face counselling was offered during the initial screening and focus group stages. These crisis-oriented interventions were provided to those who either requested support or showed signs of distress. Three mothers made use of this offer, while one, despite multiple scheduling attempts, was ultimately unable to attend sessions and declined virtual support.

A structured referral process was put in place to ensure that any participant needing ongoing mental health care could access it after the study. Pamphlets with emergency contact information and details of nearby clinics and mental health services were distributed (see Appendix L). While additional short-term counselling was offered during the early stages of the study, participants requiring continued care were directed to these local resources. In preparation for this, I personally contacted and met with every psychiatrist and psychologist at the identified clinics to inform them about the study, establish a collaborative link, and exchange cell phone numbers to facilitate communication if needed. As part of the trial, we (281) collected data on participants in the intervention group (pertaining to mothers in objective 2 and 3) whereby qualitative work revealed poor support from the referral service with most mothers being turned away. It is important to acknowledge the context in which this referral process occurred - South Africa's public health clinics, including those in Soweto, are known to face significant resource limitations and have notoriously long waiting lists, which then impacted on participants' ability to access timely care.

As for the filming of headcam data, confidentiality could not be completely maintained due to the nature of headcam video recording. First person observation using wearable cameras is becoming more common in public health behaviour research, and so researchers working on the PLAY study and on this PhD, were guided by these studies and ethical frameworks were followed for the use of wearable cameras [as outlined in (282). A number of preventative measures were put in place to ensure that confidentiality was maintained as much as possible, and that participants had complete control over their video footage. Participants were fully in control of what, when and where they recorded material. Additionally, data were downloaded and videos immediately deleted on each device to maintain confidentiality. The use of the headcams had been approved by the Wits HREC previously under the PLAY study (Ethics number: M190236) and was found to be acceptable by mother-infant dyads in Soweto.

2.7 Researcher reflexivity

As a white, middle-class female psychologist, and a mother of three, I aimed to approach this research with both professional expertise and lived experience of caregiving. While these identities provided valuable insight into the study of mother-infant synchrony, they also

positioned me as an outsider in many respects. Having spent time in my childhood in rural KwaZulu-Natal, and having worked in townships in Gauteng in South Africa, I was aware of the structural inequalities and power dynamics at play. My goal was to be reflexive about how these might shape both participants' disclosures and my interpretations.

My clinical experience in community mental health settings strongly informed the study design, particularly the choice of a mixed-methods approach, the use of Bronfenbrenner's ecological framework, and the selection of measures such as the EPDS and PCL-5. My interest and previous work in infant observation, in developmental psychopathology and dyadic processes like synchrony guided the study's focus. While this lens enriched the analysis, I recognised the risk of imposing Western psychological constructs and therefore took deliberate steps to enhance methodological rigor and cultural sensitivity - including triangulating data sources, using a data-driven thematic analysis, recruiting a facilitator in my research and seeking ongoing peer debriefing.

In data collection, my training in empathetic listening and rapport-building was instrumental in creating a safe, respectful environment - particularly during focus groups and sensitive discussions. I was mindful of potential interviewer effects and the influence of my dual role as both clinician and researcher. To mitigate these, I used open-ended questioning, maintained a non-judgemental stance, and ensured confidentiality throughout. The use of head-mounted cameras in observational work reflected a conscious trade-off between ecological validity and participant comfort, aimed at capturing naturalistic interactions while minimising intrusion. Throughout the research process, I kept a reflective journal to document decisions, assumptions, and potential biases. This helped maintain transparency and supported trustworthiness and confirmability in the qualitative analysis. Ultimately, I aimed to balance clinical insight with cultural humility and analytical rigour, acknowledging that my positionality both informed and constrained the knowledge produced.

SECTION 2: EMPIRICAL CHAPTERS

CHAPTER 3

Maternal perspectives of poor mental health and the impact on mother-infant relationships

“When a mother cow is agitated, it’s calf struggles to drink milk”

(Kenyan proverb)

The work in this chapter has now been published (1). See appendix R.

Cantrell, S. J., Pearson, R. M., & Prioreschi, A. (2025). Maternal perspectives on poor mental health and the impact on mother-infant relationships. *Journal of Reproductive and Infant Psychology*, 1-18.

This chapter has been modified post publication, based on examiner feedback.

3.1 Introduction

Depression is a leading cause of disability worldwide (283) and is particularly prevalent among women during the postpartum period. Postpartum depression (PPD) has a global prevalence rate of 17.22% with regional variations, the highest being reported in Southern Africa at 39.96% (284). Maternal mental health issues are associated with poor emotional, social and cognitive outcomes in both mothers and children (285). The manifestation of such issues in specific contexts is still not understood and the impact of postpartum mental health on the relationship with the child is varied (286). Mothers' own traumas are likely to be an important part of this pathway of risk. With poor uptake and engagement with family interventions globally, contextual understanding is important to improve engagement and access to appropriate support in specific settings (287).

In South Africa, the pervasive conditions of poverty, violence, and patriarchy (288) have exposed vulnerable women and children to significant challenges, including widespread physical and emotional abuse, gender-based violence (289), post-traumatic stress (192), depression (290), and suicide (291). Extreme societal stressors such as witnessing dangerous crimes and experiencing difficulties with a partner are the strongest independent determinants of PPD (201). Redinger et al., 2018 (202) found that mothers who perceived their partner as making life more challenging were three times more likely to experience depression (202). Similarly, Cohen et al., 2020 (204) found that household-centered issues impacted the amount of chronic anger, stress, depression and suicidal ideation as well as material and relational hardships experienced by mothers living in Soweto. Relational stress is exacerbated by the fact that mothers and their families in South Africa live in 'extended households' which are multi-generational households in which aunts, grandfathers, sisters and cousins may also be considered part of the home (203).

Relational difficulties are often associated with Adverse childhood experiences [ACEs, (292)]. Such experiences can have far-reaching consequences, particularly within complex living arrangements, where a mother's hostile experiences from childhood may have a detrimental impact her mental health. A South African study utilizing door-to-door sampling demonstrated a significant increase in suicide attempts among adolescents exposed to ACEs, such as physical, emotional, or sexual abuse, neglect, or threats. Suicide attempts were reported by 1.9% of

adolescents with no ACEs, compared to 6.3% among those with more than 5 ACEs (293). In a related study conducted in KwaZulu-Natal, South Africa, interviews with mothers aged 18-45, one week postpartum, revealed that higher ACE exposure was significantly associated with perinatal alcohol and tobacco use (257). Moreover, research has established links between ACEs and the development of depression (294) and anxiety (295) .These findings underscore the pervasive and enduring effects of adverse childhood experiences on mental health, extending into parenthood.

Postpartum mental health issues can be a barrier to healthy dyadic relationships (296) and healthy bonding due to misattunement between the pair, whereby emotional difficulties make it challenging to respond to the infant's needs often expressed through distress (297). A study by Murray et al., 1996 (298) compared mothers of two-month-old infants who reported no mental health issues with mothers experiencing depression. The findings revealed that depressed mothers faced greater challenges in sensitively attuning to their infants. They reported more negative experiences with their children and demonstrated fewer affirming behaviors within the mother-infant relationship (298). A depressed mother may demonstrate rejection, anger, fear, hostility (299,300) and intrusive behaviour or disengagement (298) when interacting with her infant (224,225). As a result of difficulties in attunement, an infant may feel rejected, confused or angry (301) feeding back into the dysfunctional interactional dynamic that characterizes the dyadic relationship style. Furthermore, dissonance in early mother-infant interaction and insecure attachment has predicted poorer cognitive outcomes and social and emotional growth in the offspring (302). As the relationship between mother and infant is transactional and bi-directional, the mother's mental health affects both individuals and thus is an important aspect of the dyadic relationship and long-term infant development.

See Figure 1 for the influences of maternal mental health on interactional style and attachment.

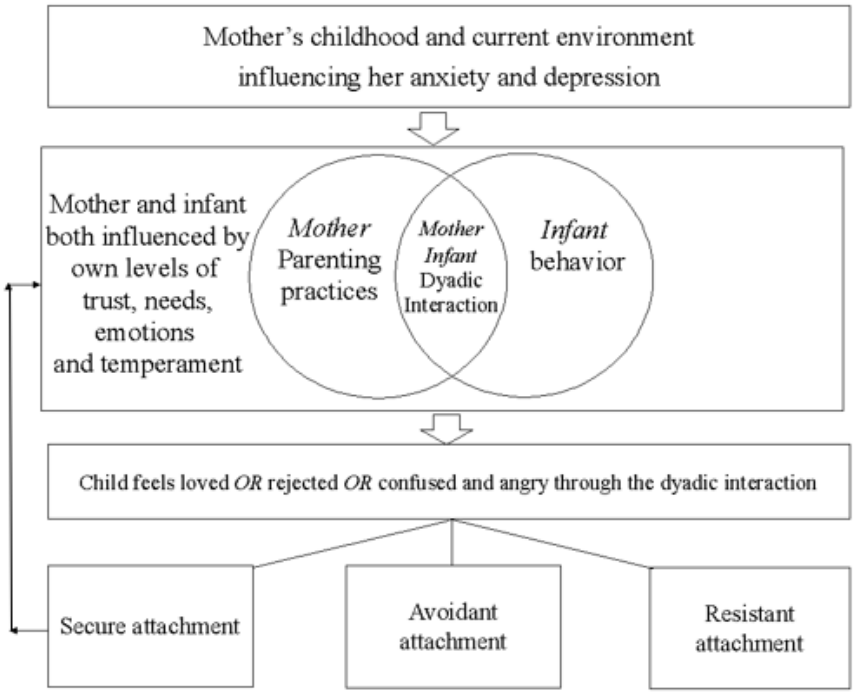


Figure.2**:** Influences of maternal mental health on interactional style and attachment [adaption of Bowlby's Internal Working Model, in Bretherton & Munholland, 1999 (35)]

The paper will focus on the mother and her relationship with her four-month-old infant. Research by Beebe et al., 2010 (64) demonstrates that specific interaction patterns at four months can predict attachment outcomes at 12 months, underscoring the significance of social exchanges during this developmental period. This evidence forms the basis for selecting four months as a key inclusion criterion for this study.

Extensive research has explored maternal mental health issues in low-income areas of Soweto, but little is known about how mothers perceive their mental health and its impact on the mother-infant relationship. This study seeks to address this limitation through in-depth interviews, offering insights into maternal and infant mental health in this context. The findings aim to deepen understanding and inform the development of targeted interventions to support the dyad.

3.2 Methods

Setting and participants

Two research assistants and I approached mothers at taxi ranks in Soweto, asking them if they would like to participate in the study. I chose taxi ranks as suitable locations for random selection of participants because over 80% of township dwellers in South Africa use taxis as their only mode of transport (254). These public taxi ranks not only coordinate travel but serve as markets. They are surrounded by stores where informal traders sell food and clothing. We provided pamphlets to women containing important information about the voluntary nature of the study, the reason for such research and the details regarding how and when information would be gathered. Additionally, we explained that mothers were eligible if they resided in Soweto, could obtain transport (reimbursed) to and from the study site at the hospital, if their ages were >=18 years, if they had given birth to a single, full-term infant in the past 4 months, and if they were the primary caregiver. If mothers were eligible and agreed to partake, we asked for their contact details. After making telephonic contact with participants, data were collected at a meeting room at the Chis Hani Baragwanath Academic Hospital over two consecutive mornings in May 2022.

I structured small groups because of the sensitive nature of the topic whereby participants could reveal highly triggering events of violence and abuse from a young age. Added to this, the sample size was chosen to support the depth of this case-oriented analysis (273) which is fundamental to qualitative enquiry to attain richly textured information (274)(280). Fifteen mothers were divided into two groups (n=7 and n=8), gave written informed consent to the inclusion of material pertaining to them. All were informed that they would not be identifiable. After the first group's discussion, I repeated the method with the second group of mothers and saturation was reached (272,275).

I made use of Vygotsky's concept (269) of scaffolding to support participants with emotional regulation when retelling their stories. I was also guided by the notion of nonmaleficence. This principle of bioethics asserts an obligation not to inflict harm. I am a qualified community-based counselling psychologist and was present to contain the emotional well-being of participants. Therapy sessions were offered as containment to women who either displayed distress or who requested face-to-face assistance. This study was approved by the University of the

Witwatersrand's (WITS) Human Research Ethics Committee (clearance no: M220787 under sub-study M210846).

Questionnaires

To understand the population, participants first completed a sociodemographic questionnaire.

Mothers were asked about any previous mental health diagnoses and to further characterise the group, the PTSD Checklist for DSM-5 [PCL-5, (303)] was administered to determine the presence of Post-Traumatic Stress symptoms (PTSD symptoms**).** A total symptom severity score is found by adding up the item scores which range from 0–80. Cut-off scores for likely PTSD can be between 23–38 and are reliant upon the population in which the score was validated. The cut-off score is 33 in an African population from Zimbabwe (265) and was used in this study. The Edinburgh Postnatal Depression Scale [EPDS, (304)] tested for PPD**.** Scores range from nil to three on a 4-point Likert scale and scores are added together to get an overall total. Some of the items are reverse scored. EPDS scores of 0-6 indicate no depression, 7-13 show sub-clinical depression, 14-18 moderate and 19-30 severe depression. The Adverse Childhood Experience questionnaire [ACE, (210)] assessed childhood abuse, neglect, and challenges. The assessment looks at three categories of adverse experiences: childhood abuse, neglect, and household challenges. Participants confirm either the presence of this kind of experience described by each item by writing a number one or they leave it blank if there was no such experience. A score from 0-10 is based on how many types of adverse experiences are reported. Two questionnaires, formerly developed at the Developmental Pathways for Health Research Unit (DHRU) at WITS were used to explore social support and social stressors (201,267). The Postpartum bonding questionnaire, [PBQ, (262)] was administered to detect the quality of early mother–infant bonding. The tool consists of 4 subscales: 'impaired mother/infant bonding', 'rejection and anger', 'anxiety about care', and the 'risk of abuse.' These questions are rated on a 6-point Likert scale, ranging from 0 (always) to 5 (never). Averages n(%) and standard deviations (SD) were done to summarise participant characteristics and to describe the population.

There is evidence of the validity and reliability of all these tools in the South African context (212,261,263). The PCL-5 has shown strong psychometric properties in diverse populations, including studies in African contexts, with high internal consistency (Cronbach's alpha between

0.90 and 0.94) and good convergent and discriminant validity (305). The EPDS has similarly undergone extensive validation in South Africa, demonstrating good internal consistency (Cronbach's alpha typically ranging from 0.82 to 0.89) and concurrent validity with clinical diagnoses of depression in local populations (306,261,307). The social support and social stressor questionnaires, developed locally at the University of the Witwatersrand, have been employed in numerous South African studies and, while not subjected to a formal psychometric validation paper, have demonstrated good face validity and consistent utility in capturing relevant social determinants of health within similar community settings (267), providing contextually appropriate measures for this study. The PBQ has also been shown to be a reliable and valid screening tool for bonding difficulties, with acceptable internal consistency (Cronbach's alpha ranging from 0.70 to 0.90 for its subscales) and good discriminant validity in detecting bonding impairments (308). With the assessment being used infrequently in Africa [for example in Ethiopia by Hailemeskel et. al., 2021 (309)], this gap supports the rationale for performing a local validation in South Africa.

Focus Group Discussions

Two trained members of the research team facilitated the FGDs. One member was fluent in the vernacular (Zulu and Xhosa) and I was the other and took notes on the observed process which would supplement the information gained by the audio that was recorded. The two groups of participants had separate, 1-2 hour sessions. One theme of enquiry was aimed at understanding mothers' perceptions regarding the causes of postpartum depression and anxiety, and the other was to explore the perceived impact of maternal mental health on the dyadic relationship.

3.3 Qualitative analysis

The qualitative methodology employed in this study was grounded in anthropological inquiry, using FGDs and observational data to guide an inductive, narrative-based approach to analysis. Thematic analysis, following the six-phase guide outlined by Braun and Clarke, 2006 (310) was chosen for its flexibility and its capacity to identify, analyse, and report patterns within the qualitative data, thereby offering rich contextual understanding of the participants' experiences.

While the primary aim was to inductively capture themes emerging directly from mothers' narratives, a complementary deductive element was also present. In particular, a psychodynamic theoretical lens acted as a sensitising framework, guiding attention to latent content and recurring patterns related to concepts such as mentalisation and projective identification. This mixed analytic strategy enabled the development of theoretically informed interpretations while remaining grounded in participants' lived experiences.

Data collection began with an initial FGD, from which a preliminary coding framework was developed through line-by-line coding of transcripts. As additional FGDs were conducted, new data were compared against this framework, allowing for the refinement and expansion of codes to capture emerging nuances. Over time, the analysis reached thematic saturation - no new codes were generated, and existing themes were consistently reaffirmed - indicating that further data collection would not have significantly altered the findings (275).

Throughout the process, the frequency of key terms was noted to strengthen the reliability and validity of theme identification. Quotes were grouped into main themes and subthemes based on recurring content and patterns. To ensure rigor and objectivity, a second researcher independently conducted a thematic analysis of the data. Both researchers then compared their findings and collaboratively refined the structure of themes and subthemes until consensus was reached. The final results were consolidated, with clearly defined categories supported by direct participant quotes.

Table 5 outlines the step-by-step process used to identify and structure the emerging themes.

Table 5: Themes and correlating subthemes

First order codes	Themes	Subthemes
Mental health issues	Understanding terms like anxiety and depression	Stress, worry and sadness
	Perceived causes	Partner conflict Family conflict Poor community support Lack of trust in the healthcare system Lack of resources
Maternal perceptions of mental health on the dyadic relationship	Bidirectionality	Existence of two-way relationship
	Mentalisation	Routines affected Developmental delays Physical growth stunting Lessened ability to parent

3.4 Results

Participant demographics

The average age of participants was 28 years old. It was found that 73% were single or never married. Slightly over half of the women had completed grades 8 to 11 and 60% were reportedly unemployed. Forty-seven percent of the participants were first-time mothers. Women lived with an average of 7 other people in extended households, mostly in a house (versus a shack), and 73% lived without a partner. No mental health disorders had previously been diagnosed across participants. Fifty-three percent of the infants were boys, and the average age was 15.4 weeks. Table 6 shows the sample characteristics of the participants.

Table 6 Characteristics of mothers and their infants (n=15)

Characteristics	# (SD)	n (%)
Age (years)	28 (8.7)	
Marital status		

Single or single never married		11 (73)
Not married but in a marriage-type relationship		3 (20)
Married		1 (7)
Education		
Completed grades 8-11		8 (53)
Employment		
Unemployed		9 (60)
Parity (child/ren < 18 years)		
1		7 (47)
2		2 (13)
3		3 (20)
Previous mental health diagnoses		0 (0)
House		
How many people live in the house	7 (2.7)	
Not living with partner in the house		11 (73)
Living in a house (vs a shack or a shelter)		10 (67)
Infant		
Boy		8 (53)
Age (weeks)	15.4 (6.8)	

Eighty percent of the mothers presented with scores indicative of PTSD symptomology. Results from the EPDS indicated that 67% of these mothers were either moderately or severely depressed. There was an average of 4 ACEs reported per participant and 67% reported having been humiliated or physically threatened by an adult in childhood. A further 53% stated that they did not feel loved or that their family was not close. Thirteen percent had been sexually touched or raped before the age of 18. Every participant reported that either they or a close family member was unemployed within the past 6 months, 80% indicated they had too little money for food, rent or clothes, while 67% reported overwhelming financial debt. Over half (53%) of the participants disclosed that either they or a close family member suffered from substance abuse and the same number of mothers said that they had experienced serious conflict with a spouse or partner in the last 6 months. Fifty-three percent said that if they had a 'really big' problem and needed help with money, the children, or accommodation, there would be no one who could help. Eighty percent stated that they were either unsure or did feel that the father of their child

made things harder for them because of the way he acted. PBQ results revealed that 60% of the group had impaired bonding with their infants. Table 7 shows results of assessments.

Table 7: Analysis of assessments

Assessment	Concept	%
PCL - 5	Posttraumatic stress	80
EPDS	Moderate or severe depression	67
ACES	Childhood averse events	40 (4 events per participant)
	Humiliation or physical threat as child	67
	Did not feel loved as a child	53
	Touched or raped as a child	13
Stress Questionnaire	Self or family member unemployed	100
	Too little money for essentials as adult	80
	Overwhelming financial debt	67
	Either she or family member abusing substances	53
	Recent serious conflict with partner	53
	No one to help if in serious need	53
Support questionnaire	Yes or unsure that father makes things more difficult	80
PBQ	Impaired bonding	60

Focus Group Discussions

The understanding of mental health terminology

Less than half the participants knew what the words ‘anxiety’ and ‘postpartum depression’ meant. However, most of the participants agreed that worry, stress and feeling sad were closely related. The most frequently repeated word was ‘stress’ when exploring the definitions of these concepts.

Perceived causes of maternal mental health issues

The following 5 key themes were identified as factors that mothers thought could contribute towards maternal mental health issues in Soweto:

1. Partner conflict: Partners denying paternity was the most prevalent theme. Some expressed concern for their children as their partners were absent fathers and caused mothers to feel like they were not coping. In many cases, mothers expressed anger and feelings of abandonment describing their partners as untrustworthy and unfaithful.

   '…like the father of my child said he is infertile, yoh, I lost my mind, I asked him if he's infertile, how did I fall pregnant? He insisted he's infertile and that the doctor told him so (FGD 2).'

   '…you hear men say: 'she's still young, I won't hold her', and others [partners] *finding an opportunity to cheat while you're raising his child* (FDG 1).*'*

2. Family conflict: Female family members and in-laws were said to cause emotional hardships, and the recurring theme of questioned paternity re-emerged as a source of conflict. Family environments were described as untrustworthy spaces where women were treated as liars. Verbal abuse and accusations of the mothers sleeping around caused emotional distress and a threat to self-identity.

   '…in-laws! Have you ever had your in-laws dispute your children's paternity as if they were there when you were making love and… controlling the whole thing..? I was heartbroken… they said …this baby is not their family which means I'm sleeping around (FGD 2).'

3. Poor community support: Discussions revealed that unsupportive community members were a source of sadness and anxiety. Mothers expressed feelings of judgment as neighbours would gossip about each other *'…where we come from they talk; you do right, they talk, you do wrong, they talk, you do nothing at all, they talk* (FDG 2);" and shout and hit their children: *"When they hit them* [my children] *in the streets; we fight yoh, it's bad* (FGD 2).'

4. Lack of trust in the healthcare system: Most mothers highlighted concerns relating to the poor healthcare system available to mothers in Soweto and maintained that there was a lack of programmes, counsellors and support groups. Most agreed that clinic nurses were found to be unprofessional and untrustworthy: *'...they* [clinic nurses] *are rude ...they are not approachable; that doesn't develop trust or make it easy for us to have a sit-down discussion where we talk...where I tell you my business* (FDG 2).'

   They elaborated that these facilities exacerbated the problem of mental health as some staff members seemed to have a lack of understanding of health care itself: *'...when I was pregnant, we were getting tested for HIV, this lady asked me* [shouting]: *"Is your boyfriend circumcised?" I was like "what does that have to do with anything?" ... she shouted: "it* [his penis] *went in without you seeing it?! That means they chowed you* [slept with you] *in the dark." There are so many people in the room, and she's making a joke out of me...*(FGD 2).'

5. Lack of resources: Mothers reported great anxiety regarding the scarcity of food and clothes which extended to their worries that they may not be able to provide for their children.

   'Hunger is difficult to deal with. Let's say you're pregnant, sometimes you just sit and think, "what am I going to eat today?" With others the food is simply not there (FGD 2).'
   'What makes me anxious is when my baby does not have diapers, that's when I really get worried (FGD 1).'

Table 8 offers more detailed quotes from mothers who spoke about their perceptions as to the causes of maternal mental struggles.

Table 8: Exemplar quotes regarding perceived causes of maternal mental health

Main themes and subthemes			
What is 'anxiety'	"They [anxiety and depression]	"It's about when someone feels	"I think it's things that we go through

Anxiety and depression	**and 'depression'**	are like if you don't get like support from your family, partner or community" (FGD 2).	unsettled and stressed about something or life" (FGD 2).	when we are pregnant, things that give us stress even after giving birth to the baby" (FGD 1).		
	Perceived causes	*Partner conflict*	*Family conflict*	*Poor community support*	*Lack of trust in the healthcare system*	*Lack of resources*
		"…how come do you want to name my child - you claimed this isn't your child. You ejaculate Sprite, right? So, you don't have a child, consider yourself a man with no children who supports other men's children" (FDG 2).	"…his family and friends are saying: 'that's not your child.' His mother supported him and said her son is infertile and [she] would curse me every day…saying that I'm a whore" (FGD 2).	"…where we come from they talk; you do right, they talk, you do wrong, they talk, you do nothing at all, they talk" (FDG 2).	[The nurse] "…would speak about me in front of other women in the queue saying: 'I heard Patrick doesn't want to report the pregnancy' and other people would look at me." (FGD 1).	"Hunger is difficult to deal with in this world. Let's say you're pregnant, sometimes you just sit and think, 'what am I going to eat today?' With others the food is simply not there" (FGD 2).
		"…you often hear men say: 'she's still young, I won't hold her', and others [partners] finding an opportunity to cheat while you're raising his child" (FDG 1).	"The granny once said to me that I have an evil heart…'We'll know after three months; we'll look at the baby's hands.' It showed that they didn't believe this child is their family." (FGD 1).	" [Neighbours] hit my child or shouts at them" (FGD 1).	"They [clinic nurses] can't keep a secret. I'd never talk to anyone; you can write ten referrals, I would never go" (FGD 2).	"We are single parents, so you just think about what you're going to put together for your baby…when my baby doesn't have diapers, that's when I get worried" (FGD 1).
		"…when you look at your child… the father of my first child said he is infertile, yoh, I lost my mind, I asked him if he's infertile, how did I fall pregnant? He insisted he's infertile and that the doctor told him so" (FGD 2).	"Have your in-laws disputed your children's paternity as if they were there when you were making love and they were controlling the whole thing?... I was heartbroken …they said …this baby is not their family which means I'm sleeping around" (FGD 2).	"The one thing that makes you get stressed and find yourself crying is the fact that you need a lot of things and you don't have anyone to talk to close by, so you end up talking to yourself and crying and feeling like you are not a mother or you are not useful to your baby" (FGD 1).	"…when I was pregnant, this nurse shouted: 'Is your boyfriend circumcised?... it [his penis] went in without you seeing it?! That means they chowed you [sleep with you] in the dark'. She's making a joke out of me…" (FGD 2).	" [It's about]… finances; that in most cases you feel stressed and not able to sleep enough is mainly caused by the fact that you are not able to provide" (FGD 1).

Maternal perceptions of the effect of mental health on the dyadic relationship

Most participants had a clear understanding of the existence of a bidirectional relationship between mother and infant. Most mothers acknowledged that their own emotions influenced those of their infants, and few mothers spoke candidly about how unprocessed emotional distress could strain the dyad. Others illustrated how stressors - particularly difficult relationships with partners - appeared to negatively affect their children. There was also widespread acknowledgement that maternal mood could influence not only emotional attunement but also daily routines, developmental progress, and even physical health. Most participants seemed to grasp that sensitive caregiving involves responding to the infant's cues and discomfort in an attuned manner. This reflects a degree of mentalisation and the developing insight that mother and infant are distinct individuals (311).

However, not all mothers were able to maintain this separation. Some appeared to project their own unresolved emotional pain onto their infants, interpreting the infant's behaviour as intentional provocation. One mother described: "My baby loves crying, likes attention. No matter how much they try to irritate me, I fight to heal…" Another expressed: "…no matter how hard he tries to destroy me, I fight…once you touch him, you are starting war." A strong theme of maternal persecution emerged in these accounts, suggesting the intrusion of past trauma into the present caregiving experience.

There were also moments that hinted at the intergenerational transmission of disrupted caregiving models. For instance, one participant reflected: "Yes, just like me I wasn't raised by my mother…with my baby I have that fear that I don't want to be like my mom… I want to be there for my children (FGD 2)." This statement points to a conscious effort to interrupt negative patterns from the past, while also demonstrating the emergence of separateness - a recognition that the mother is not destined to repeat her own early experiences. Although such reflections were powerful, there was insufficient data across participants to code a distinct theme of intergenerational transmission of disrupted parenting.

Refer to Table 9 for the exemplar of quotes regarding perceptions of the effect of maternal mental health on the dyad.

Table 9: Exemplar quotes regarding perceptions of the effect of maternal mental health issues on the dyad

Main themes and subthemes					
Maternal perceptions on dyadic relationship	**Bidirectionality**	"For me it's like when you're in love with a person in a relationship, when you feel like this person loves me, you feel the warmth" (FGD 2).	"…even if she were to cry now and someone else holds her, once I hold her, she keeps quiet at same time, and it shows that mom is holding her now" (FGD 2).		
	Perceptions of mother's emotions affecting infant	"If I am happy, she also laughs but…when I shout at her, she cries. Sometimes she just cries for nothing. I end up being irritated and shout at her then she keeps quiet and becomes scared" (FGD 1).	"…I had an altercation with the baby daddy… and right there…the baby cried massively and wouldn't feed…after calming down, he also did… there's a very strong bond" (FGD 2).	"…development… baby needs to exercise, get his bones going. When you're… stressed you'll tell yourself that you don't want to play with him, he'll become lazy, you'll think there's something wrong with him…" (FGD 2).	"…you are stressed…you end up forgetting that you have a child, …they could cry. You… can't hear the child…your mind is not there" (FGD 1).
	Mentalisation	*Parental practices*	*Separateness*	*Misattunement & persecution*	
		"When my baby cries, I check what could be the cause of her tears. It's either she's hungry, if she doesn't want to be breastfed, I try to change her nappy and I see what she does" (FGD 2).	"The things that I did when I was pregnant were different, so I started learning that we are different" (FGD 1).	"My baby loves crying, likes attention. No matter how much they try to irritate me, I fight to heal…if she doesn't want to stop, I just leave her there because I might end up hurting her" (FGD 2).	
		"…I literally find a way to calm him down, be it dance, jump…I know there's certain things he doesn't like but I try them thinking that this will help…" (FGD 2).	"Yes, just like me I wasn't raised by my mother…with my baby I have that fear that I don't want to be like my mom… I want to be there for my children" (FGD 2).	"… no matter how hard he tries to destroy me, I fight…once you touch him, you are starting war. He gets easily irritated…you will get your head messed up" (FGD 2).	

3.5 Discussion

Relationship difficulties appeared to be the predominant source of perceived mental health issues as women spoke of their stresses originating from unfaithful partners denying paternity, unsupportive families, gossiping neighbours and judgmental clinic staff. At the root of all these challenges is the concept of distrust. Not only had participants lost faith in people but also in

their fragile physical environments where women were unemployed and financially insecure with no resources to contain them.

This finding was underscored by the 80% that reported that they had too little money for essentials, that 67% said that they were in overwhelming financial debt, and 60% reporting their own unemployment, indicating reported financial strain. This ties in with the idea that absent fathers, due to paternity denial, not only break the trust in the parental relationship but also increase stress as mothers are denied the ability to claim maintenance (312) and have the pressure of being a single, often unemployed parent (313). Nduna et al., 2011 (314), found that undisclosed paternal identity affected 31.5% of the sample in families in Alexandra Township, South Africa. Children also suffer as a result - not only are they denied paternal ancestral protection, (312) but the abandonment issues, loss of identity (315,316) and blame towards the mother (317) are bound to have adverse psychological consequences on the mother-child relationship. In the Nduna et al., 2011 (314) study, mothers reported that a further breakdown in trust stemmed from mothers-in-law who supported their sons in evading responsibility as fathers. Mothers reported feeling isolated and rejected, with reduced emotional support - all of which have strong associations with the onset of depression (318).

Many mothers described their living environments as uncontained and abusive, with frequent experiences of adverse childhood events (ACEs) before the age of 18. Participants commonly reported feelings of humiliation, physical threats, and emotional neglect. These traumatic backgrounds are closely linked to the substance abuse issues reported by many participants, reflecting well-documented connections between ACEs and later substance abuse (294). Furthermore, the reported feelings of self-blame, strong negative self-beliefs, anger, guilt, and shame should be considered in the context of this particularly depressed group of women where 67% reported moderate to severe depression. Findings can be interpreted in light of Freudian theory particularly as articulated in ‘Mourning and Melancholia (319),’ which suggests that depression is linked to unexpressed, often repressed, rage associated with unresolved grief and mourning. This framework posits that in melancholia (depression), the loss of an object is unconsciously experienced as a loss within the ego itself, leading to a harsh and self-critical superego. This internalised critique is often seen as stemming from the introjection of an overly critical or rejecting parental figure from early development, where aggression that would

normally be directed outwards towards the lost or frustrating object is instead turned back upon the self. Many participants described feeling overwhelmed by worry and sadness, highlighting the profound emotional impact of their experiences. These emotions may have been intensified by groupthink dynamics within their social environments - particularly in close-knit or high-pressure communities - where dissent or emotional vulnerability is discouraged, and dominant narratives of blame or failure are accepted without question. Such social conformity can amplify internalised shame and inhibit emotional processing, further entrenching depressive symptoms.

Depressed mothers have been found to be less sensitively attuned to their infants (298) as are traumatised mothers who tend to see their children more negatively, such as viewing the relationship with the child to be disappointing or dysfunctional or being distressed in the parental role (320,321). This could have detrimental effects on the dyad.

In the present study, the section 'maternal perceptions of the effect of mental health on the dyadic relationship' appeared less developed in comparison to preceding sections. This was due to the limited data that emerged on this theme during analysis. Findings were intentionally reported in proportion to the strength and frequency of themes derived from the data. There was little narrative or explicit evidence from participants that would have allowed for deeper analysis or expansion of this subsection without over-interpreting the data. In spite of this, some mothers maintained healthy bonds with their infants, while others, burdened by past and present trauma, experienced dyadic relationships marked by distrust and feelings of maternal persecution. This was supported by the high rates of postpartum health issues and impaired bonding as evident in the results from the PBQ. We found that some participants believed that their infants were attempting to provoke conflict intentionally. This persecution reflected the deep-seated intra-psychic trauma that some mothers had, projecting feelings onto their newborns; with the compromised ability to see themselves as separate from their infants and thus formation of insecure bonds (322). The term 'primary maternal persecution' has been coined by Raphael-Leff, 2010 (323) whereby the theorist looked into mothers' subjective experiences of child rearing and explored their subjective experiences of feeling trapped. Unconsciously the infant represents split-off enraged and/or deprived parts of herself stemming from her early experiences of the manner in which she was raised, which affects her own parenting style (3). As attachment theory suggests that the internalisation of our early relational experiences influences how we participate

in the social world (324), the effect of post-Apartheid socioeconomic inequalities could be evident in mothers from low-income communities who feel financially and emotionally unready to have children and could be vulnerable to 'primary maternal persecution' (325).

3.6 Limitations

This study, while offering rich and contextually grounded insights into maternal mental health, is not without its limitations. One key limitation lies in the interpretative nature of qualitative research, particularly in relation to the positionality of the research team. As researchers, we inevitably bring our own biases, cultural frameworks, and professional training into the analytical process. My own training as a psychologist within a psychodynamic framework may have influenced how I interpreted and organized the qualitative data. Although reflexivity and the involvement of a second independent analyst were used to reduce subjectivity, the interpretive nature of thematic analysis remains shaped by the researchers' worldviews.

Another limitation concerns the representativeness of the sample. While the sample size was appropriate for a case-oriented qualitative inquiry, and saturation was reached, the findings cannot be generalized to the broader population of mothers in South Africa. The nature of focus group discussions (FGDs) also brings additional complexity. Group dynamics may have influenced participants' willingness to share openly, or led to certain voices dominating the conversation, thereby affecting the breadth of perspectives captured. Moreover, the FGDs were conducted in local vernacular languages and later translated into English. Despite efforts to maintain fidelity to participants' expressions, some meaning and cultural nuance may have been lost in translation.

A further contextual limitation relates to the overwhelming socio-economic and relational stressors described by participants. The women in this study lived in environments marked by poverty, unemployment, food insecurity, inadequate housing, and strained relationships. These chronic stressors were central to their lived experience and frequently shaped how they spoke about their mental health. While clinical screening tools such as the EPDS and PCL-5 were used to identify symptoms aligned with depression and PTSD, the qualitative data often reflected distress as a rational and adaptive response to systemic hardship, rather than a clinical pathology per se. Participants rarely used diagnostic language such as "depression" or "anxiety," instead

referring to their experience as “stress,” rooted in daily survival. As such, interpreting their narratives strictly through a Western clinical lens may risk misrepresenting their reality. It is therefore important to understand the effects of maternal mental health on caregiving not solely as outcomes of psychiatric disorders, but also as expressions of chronic and unrelenting environmental stress. Future research and interventions would benefit from embracing locally meaningful frameworks - such as stress relief or well-being promotion - that address social determinants alongside clinical symptomatology.

3.7 Conclusion

This study uniquely explored mothers’ perceptions of mental health in Soweto and how emotional distress affects the mother-infant relationship. The findings highlight a need for community-based interventions - such as programs led by trained counsellors, peer support networks, or trusted local figures - that help mothers process trauma and build emotional insight. Initiatives that help link past experiences to present emotional responses could strengthen maternal self-awareness and reduce unconscious emotional projection onto infants, promoting healthier attachment. The study also highlights that clinical or psychological interventions alone are not enough. Pervasive poverty, housing insecurity, unemployment, and partner absence deeply shape maternal distress and caregiving. Therefore, broader policy changes are urgently needed, including stronger social safety nets, access to dignified work, affordable housing, and the enforcement of paternity responsibilities.

To truly support mothers and children in urban townships like Soweto, multi-level responses are essential - combining mental health support with structural interventions that address the root causes of distress. Investment in such integrated approaches is critical for breaking cycles of intergenerational trauma and fostering secure, trusting relationships from the earliest stages of life.

CHAPTER 4

Describing the synchrony of visual attention and facial expression between mothers and their infants in a poorly resourced setting

“Where the mother dances, the child finds the rhythm”

West African proverb

4.1 Introduction

Infant brain development (326) school performance (327), socio-emotional growth (328,329), affect regulation, (330) and psychopathology (163) hinge on the vital role of early coordinated interactions between mothers and their infants (331). From a dynamic systems perspective (332,333) both mother and infant contribute to the interactive system's organization through moment-to-moment regulation of behaviours such as visual attention and facial expressions (68).

Facial communication is a 'dance' of ongoing coordinated adjustments of timing and patterns of action and affect between engaged dyads; and is known as mother-infant synchrony (62). It is believed that a moderate degree of synchrony is a sign of adaptive mother-infant interactions and predicts social connectedness, regulation (334) and positive outcomes in children (51,62,69). A heightened (58,91) or lowered degree of synchrony (162,176) pose difficulties for infant development.

Typically, to investigate the social relatedness between mother and infant, the video stream of each partner's behaviour in face-to-face communication has been filmed, micro-analysed and micro-coded to quantify the parameters of the 'dance' between mother and infant (2,335). Researchers differentiate between matching behaviours [the occurrence of the same behaviours] and the degree of synchrony [changing behaviour relative to the individual's partner (57). Micro-coding salient behaviours of mother-infant interactions works like a 'social microscope' to identify behaviours that underpin synchrony with a more precise lens (64).

Previous research on mother-infant interaction has frequently been conducted in clinical or structured environments, such as hospitals, where data collection typically involves a third-party observer or videographer. While these settings allow for control and standardisation, they may compromise ecological validity by influencing maternal behaviour and reducing the naturalness of interactions through social desirability bias, for example (77). To address these concerns, more recent studies have employed wearable head-mounted cameras to capture first-person perspectives of parent-infant interactions within the home environment (75). This approach offers several advantages, including the elimination of a third-party observer and increased

ecological validity, potentially allowing for a more accurate depiction of spontaneous non-verbal and affective exchanges.

Despite their unobtrusive design, these devices may still introduce a degree of behavioural reactivity (271,336) particularly in early phases of filming, as mothers may become more performative and infants more distracted or curious. Studies have attempted to mitigate this by including acclimatisation periods and promoting naturalistic play, though residual observer effects may persist. Additional methodological concerns reported in the literature include technical constraints such as limited field of view, missed footage when participants move out of frame, and practical issues related to lighting and battery life. These findings suggest that while head-mounted cameras offer important methodological improvements for capturing naturalistic dyadic interaction, researchers must remain attentive to their limitations and carefully consider these trade-offs in study design and interpretation.

Prior research on synchrony has concentrated on facial interactions in four-month-old infants, as this age represents the peak of the social development phase. At this stage, gaze serves as the primary means of interpersonal connection (337) situated between touch and play in its significance (64). At this developmental phase, infants scan faces by identifying the most emotionally meaningful areas - the eyes and mouth (338,339). Infants exhibit a heightened sensitivity to the direct gaze of their mothers, particularly engaging in reciprocal eye contact as early as three months of age (120). They also start to discriminate between concrete emotions and show a preference towards happy facial expressions (340,341).

Behaviours and interaction processes differ across cultures (173,342). Research suggests that caregivers from Western cultures use vocalisation, object presentation and gaze in more coordinated sequences versus parents from societies that may attribute more value to their communities such as in Africa and the Middle East (343). Some literature gives evidence that African communities provide less gaze, less voice and object use, and add more bodily movement in mother-infant interaction (174) but there is little supporting evidence.

The coordination of mother-infant interaction has been studied extensively in first-world countries in communities that are Western, educated, industrialised, rich and democratic

[WEIRD, (344)]. Thus, results may not be relevant to low-income or culturally diverse environments (345) resulting in paucity of research in poorer, African communities (346). To illustrate this, Tomlinson et al., 2014 (347) wrote about differences in the knowledge about infant mental health in poor and wealthy countries and reviewed studies focusing on dyadic interaction and their outcomes, only to find that less than 2.5% of all reviewed work published; comprised data from low- to middle-income countries where 90% of the world's infants reside (347,348).

A poor socio-economic environment, common for many South Africans, is often marked by poverty, unsupportive social structures, and abuse (349). These factors can hinder a mother's ability to meet the needs of her infant (28) as she may be physically or psychologically less available to her child. These environments are therefore linked to suboptimal developmental outcomes (350). To address these gaps, this study explores the real-world, home-based dynamics of mother-infant interaction using head-mounted camera (271) technology in a low-income South African setting. Specifically, we examine the visual attention and facial expressions of mothers and their four-month-old infants to assess the frequency, duration, and likelihood of coordinated (synchronous) behaviour. Based on the literature on synchrony and early development (351), I hypothesise that (1) mothers will exhibit a higher frequency and longer duration of positive facial expressions and direct gaze toward their infants compared to infants toward mothers; (2) both mothers and infants will engage in matched behaviours (e.g., mutual gaze, mutual smiling), but mothers will more frequently lead these matched behaviours than infants; and (3) the probability of synchronous behaviours occurring within a three-second window will be significantly greater than chance, indicating temporal coordination. These hypotheses are informed by prior research indicating that synchrony is typically initiated by caregivers and that four-month-old infants are particularly responsive to facial and visual cues, especially in naturalistic settings.

4.2 Methods

Setting and participants

This research was nested within the PLAY (Play, Love and You) study, a randomised controlled trial conducted at the SAMRC/Wits Developmental Pathways for Health Research Unit (DPHRU) at the University of the Witwatersrand. The PLAY study aims to improve infant development by enhancing maternal self-efficacy through behavioural feedback, content provision, and supportive guidance. Mothers were recruited shortly after delivery (within 3 days) at Chiawelo Community Healthcare Centre and Lilian Ngoyi Clinic in Soweto, South Africa. Eligible participants resided in Soweto, were aged 18 or older, had delivered a full-term, singleton infant, were the primary caregiver, and could travel to the Chris Hani Baragwanath Academic Hospital (with transport reimbursed).

Participants in the current study were drawn from both the control and intervention arms of the PLAY trial. Mothers in the control group received the Road to Health booklet and the Side-by-Side services offered by the National Department of Health. These resources are grounded in knowledge pillars of love, nutrition, healthcare, protection, and extra care, and support caregiver-healthcare collaboration by tracking child growth. In addition, control participants received bimonthly telephone check-ins offering health referrals and were invited to participate in anthropometric, developmental, interactional, and movement assessments every four months.

Mothers in the intervention group received the same core information on bonding, breastfeeding, and play, but delivered through weekly sessions over a 12-month period with greater support on breastfeeding within the first 4 months. Additionally, the behavioural feedback intervention component (which was designed to improve self-efficacy) only occurred after the 4-month visit. Importantly, headcam data analysed in this study were collected when infants were four months old - meaning only a third of the intervention had been administered at that point. As both groups had been exposed to similar content by this stage, albeit via different modes of delivery, the differences in maternal behaviours between the groups were likely negligible. This partial exposure and content similarity suggest that any influence of group allocation on mother-infant

interactions observed at four months would have been minimal. This study included PLAY participants who had valid headcam data at the 4-month assessment point (n = 57).

Ethical clearance

This study was approved by the University of the Witwatersrand's Human Research Ethics Committee (clearance no: M220886 - PLAY study and M220787 - sub study). Participants provided informed consent to participate; and gave permission for their video footage to be collected and shared with the research team for analysis.

Data collection

Demographic data were collected at enrolment. Each mother reported her age, relationship status, level of secondary and tertiary education, employment status, socio-economic status, household density and gender of her infant. Socio-economic status (SES) was estimated by asking mothers 13 questions about their access to electricity, refrigeration, stove, vacuum cleaner, washing machine, Mnet decoder for television streaming, DVD player, motorcar, television, landline telephone, mobile telephone, computer or laptop, and internet access and calculating a summative score / 13. These factors are proven to be valid in the economic evaluation of the household and are responsive to fluctuations over time (255,256). Additionally, household density was computed by dividing the reported number of individuals in a household by the total number of rooms for sleeping in the dwelling. Furthermore, we asked mothers about their infants in terms of gestational weeks at delivery and sex of their children.

Headcam data were collected when infants were four months old, whereby mothers and infants were each given a head-mounted WearCams camera manufactured by UCam 247. The cameras recorded audio and video in AVI format. The devices had a resolution of 1280 x 720, a field view of 85 degrees and a frame rate of 30 frames per second and were specifically designed and developed for mother-infant observation following piloted work in the United Kingdom and South Africa (75,271). Skinner et al., 2023 (270) discuss analyses of the improved performance of these wearable cameras for researching parent-child interactions as opposed to older models. Specifically, they discuss how newer models offer enhanced features such as higher resolution, improved battery life and storage capacity, reduced size and weight and wider field of view and

image stabilisation. A research assistant demonstrated how to use the headcams during home visits. Mothers were asked to place a headcam on their infant's forehead and then to put one on her own forehead and to record at least three 3-minute clips of her interacting with her infant during free play at home within a one-week period (75). I requested 3 minutes of recording to ensure we had enough time for coding, as the standardised duration for micro-analytic coding of videotape is set at 150 seconds for statistical purposes (61,95) and interactions achieve good test-retest reliabilities (161,352). After seven days, the cameras were collected, footage was downloaded and converted into MP4 files and saved. The use of these headcams was previously found to be feasible and acceptable in a South African setting (271).

Data processing and coding

Video processing started with the downloaded MP4 files of three-minute interactions between mothers and their infants. The amount of light, the angles of head-mounted cameras and the clarity of the images were considered as criteria to determine the acceptability of each video. For the footage to be usable, both mother and infant had to be clearly visible with the appropriate levels of luminosity in order to capture micro behaviour such as direction of gaze and the subtleties of affect shown in the expressions on faces. Since mothers were asked to record themselves more than once in the week, the first usable three minutes of uninterrupted footage were selected for analysis, ensuring an unbiased sampling of footage.

After selection, 57 matched videos of mothers and infants were available for analysis. After aligning the timing of each video using the software syncing feature (Adobe Premiere Pro ®) based on audio, the two videos were placed side by side on the screen with a split screen view. Any unsynchronised portions were trimmed and deleted.

Detailed second-by-second micro-coding of maternal and infant behaviours was conducted using video footage to assess visual attention and facial expression. Coding followed the Mental Health Intergenerational Transmission Process [MHINT Manual, (277)]. Manual and employed the Observer XT 16® software by Noldus Information Technology in Wageningen, The Netherlands (90). Separate behavioural codes were applied to mothers and infants, with additional modifier codes (277,278) capturing details such as direction of gaze (e.g., to each other, to distractions, to

objects or others in the room) and facial expressions (e.g., neutral, positive, concentration, smile, alert/worried, disgust).

Observation of gaze direction was chosen because it is fundamental to assessing joint attention, shared engagement, and withdrawal in mother-infant interactions (51,57). It provides a direct measure of the dyad's attentional focus and their capacity for intersubjective engagement. The selected facial expressions were derived from the Baby Facial Action Coding System [BabyFACS, (179)] and the broader literature on infant and adult affect displays (353). These particular expressions were chosen because they represent a core set of universal emotional signals relevant to early social communication and are reliably discriminable in infant and adult faces.

A two-pass method was used whereby the first video viewing focused solely on the mother's behaviour for coding until completion, and in the second viewing the behaviour of the infant was coded. To demarcate the beginning and end of each behaviour in each video, a time-stamp was assigned, for instance, if the infant glanced at a distraction, and then shifted attention to another point of focus, the behaviour "infant gaze at distraction" was time-stamped until the transition occurred (279). In the instance where the coder could not see the infant's face or eyes on the screen, likely because of poor video quality or the camera failing to capture the face at a particular moment, it was recorded as 'not possible to code infant visual attention.' This approach was applied to all focus behaviours exhibited by the mother and the infant. The entire duration of the mother–infant interaction was thus exhaustively coded, and the Observer XT 16 ® software stored the time-stamped behaviours and modifiers for each participant. Figure 5 shows an example of output data and coded behaviour for mother-infant visual attention and facial expressions. The coloured blocks are visual representations of the number and duration of each behaviour as seen in Observer XT 16 ® (90).

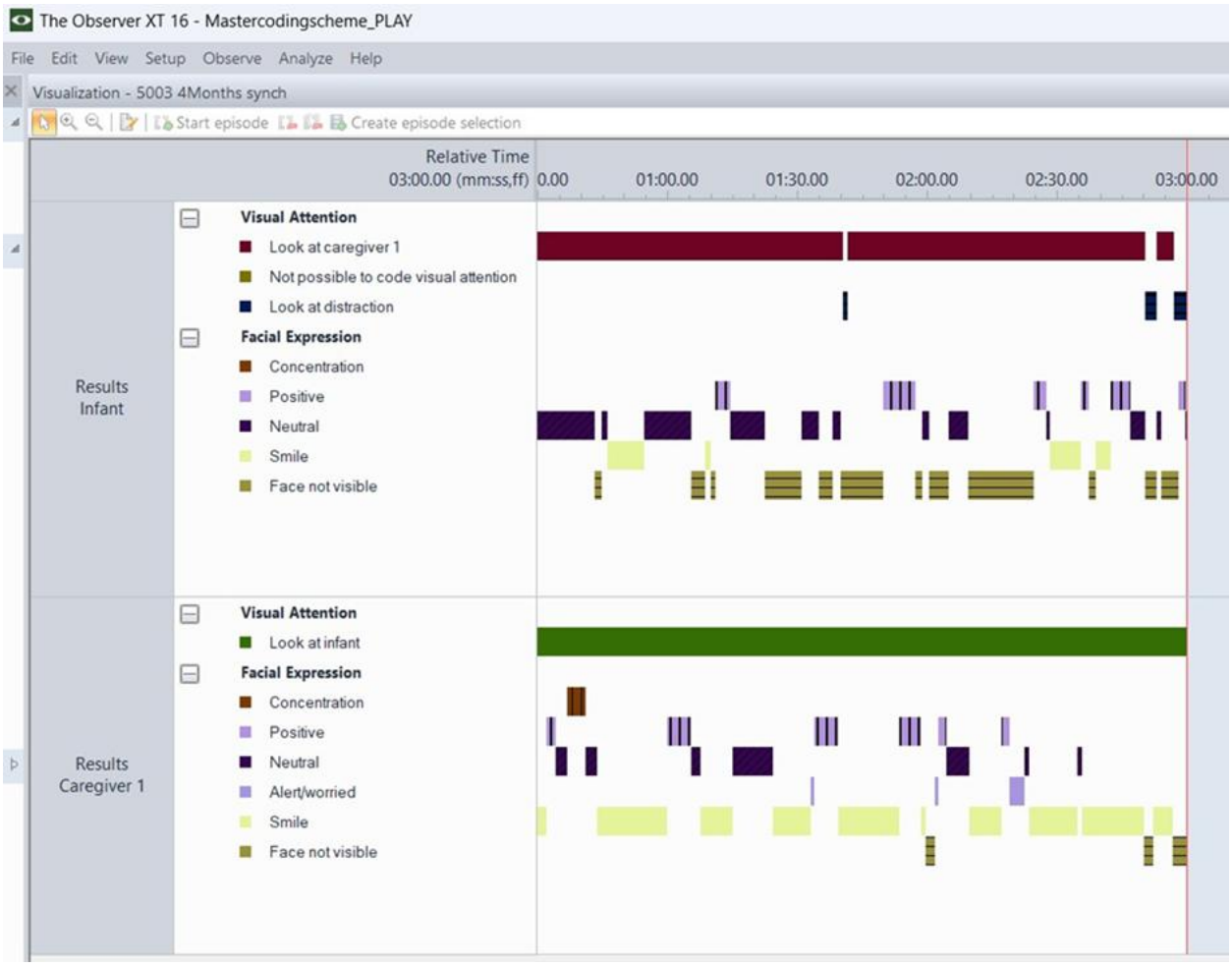


Figure 5: Example of micro coded data on the behavioural domains of visual attention and facial expressions for mother and infant with timestamps

Reliability

After extensive training on Observer XT 16 ® (90) on how to code behaviours and to apply modifiers to visual attention (354) and facial expression (355); I coded all videos (SC), and a second researcher (Prof Rebecca Pearson at Manchester Metropolitan University, psychology department) re-coded a third of these videos to assess reliability at the start and then at the end of the coding project (to allow for coding drift). The aim was to see if both coders identified the same actual behaviours, the frequencies, and durations of each. Inter-rater reliability (356) was conducted, and the duration/sequence comparison method was used, with a two second tolerance. To establish whether two observations coincided, this approach examined the alignment of temporal spans between events (351). When comparing the simultaneous observations of mother and infant, the time intervals in an observation where no event was

scored for a particular behaviour, were taken into account. These gaps between behaviours served as the basis for comparison. To establish a comparative framework, I opted for the time-based intersection method, which involved comparing the video segments that both coders scored. This approach facilitated the comparison of observations of varying durations, focusing solely on behaviours occurring during the shared time span. I used Cohen's Kappa coefficients to gauge levels of inter-rater reliability (356). After an analysis of all the video segments (n=57) I found an average Cohen's Kappa coefficient of 0.71 (range 0.65 to 0.89). Bakeman and Quera, 2011 (357) emphasise that point-by-point agreements - typically reflected in Cohen's kappa values above 0.60 - are considered robust and sufficient for complex behavioural coding.

Statistical analysis

All plots and variable summaries were completed using R v4.4.0 (2024). Demographic data were summarised using frequencies (percentages) for categorical variables, and median and the 1st and 3rd quantiles [median (Q1, Q3)] for continuous variables.

Mother–infant interactions were measured in terms of frequency, duration, and temporal parameters (69). Our research focused on examining the frequency (freq), mean duration (MD), total duration (TD) and lag sequential analysis (LSA) of visual attention and facial expressions within these interactions.

In terms of frequency analysis, I calculated the percentage of total recording time for each partner in a dyad for each coded facial expression and visual attention behaviour [100 * (total duration of a behaviour / total recording time)]. The total recording time included time when there was no codable visual attention or where faces could not be seen to code facial expressions. While the specific behavioural content of non-codable periods remains unknown, their inclusion ensures that the calculated proportions and rates accurately reflect the true relative frequency of observable behaviours within the entire recorded observational window, thereby offering a more truthful representation of the dyadic interaction. This approach aligns with best practices in observational research aiming for ecological generalisability (357). For each group (mother or infant) and coded behaviour combination, the percentages were summarised using median (Q1, Q3). For plotting purposes, the data are shown as box plots (Q1, median, Q3) with Tukey whiskers [extending the lower whisker from Q1 by Q1 minus 1.5 * interquartile range (IQR) or

to the minimum value (whichever comes first), extending the upper whisker from Q3 by Q3 plus 1.5 * interquartile range (IQR) or to the maximum value (whichever comes first)]. The individual data points were then overlaid over the box-and-whisker plots.

To characterise mother and infant interactions for the duration analyses, we calculated the MD and TD of different visual attention points and facial expressions. Mean duration of behaviour was defined as the average amount of time each incident of visual attention and facial expression lasted (e.g. each smile occurred for an average of 3s). The total duration of a behaviour was calculated by multiplying the mean duration for the behaviour by the number of times that the behaviour occurred over the recording period (e.g., if there were five smiles, with a mean duration of three seconds, over the entire duration of the video clip then, the total duration would be: 3 * 5 = 15 s).

Using lag sequential analysis, I wanted to determine who was "leading" the interaction and who was 'following' in both the visual attention and facial expression domains by analysing the probability of the infant or the mother leading the occurrences of matching behaviours within a time frame of three seconds. Lag analysis was performed to determine the ongoing coordinated adjustment of the timing and patterns of actions and affect between engaged dyads in an interaction, defined as synchrony (62). This would assist us in seeing if mother and infant were both responsive to shifts in each other's behaviour and would assist with exploring interactional patterns of these dyadic relationships in low-income cohorts. Stern (86), Beebe (84) and Cohn and Beebe (85) have observed that the interval between the commencement of an individual's actions and the commencement of their partner's actions typically falls within the range of half a second and thus, time-series analyses and lag times of 3 seconds in sequences have been used and have defined synchrony (94). This 3-second window is a commonly adopted standard in micro-analytic observational research to encompass both immediate reciprocal exchanges and short-term contingent behavioural chains that define interactional synchrony beyond mere simultaneous occurrence (358). Observer XT 16 ® software was used to generate the probability of the mother or infant leading a matching behaviour for each facial expression and visual attention behaviour, and the data were then exported from Observer XT 16 ® into R v4.4.0. For each group (mother or infant) and coded behaviour combination, the probability of the infant leading and the probability of the mother leading were summarised using median (Q1, Q3). For

plotting purposes, the data are shown as box plots (Q1, median, Q3) with Tukey whiskers. The individual data points were then overlaid over the box-and-whisker plots.

4.3 Results

Feasibility issues

Assessing data collection feasibility revealed several challenges with headcam availability and functionality. Starting with 20 headcams, 10 malfunctioned, leaving only 10 operational units. However, this did not interfere with data but increased time taken for data collection, which ended up being 524 minutes of video footage. Replacements were impossible to procure as the supplier of the WearCam stopped production. Despite detailed usage instructions given to participants, improper camera use resulted in 35% of footage being positioned poorly. Exposure inconsistencies were caused by frequent blackouts and houses with limited windows. This led to 14% of videos included in the analysis having suboptimal (yet acceptable) lighting conditions. Consequently, approximately 20%-25% of the total recorded video footage was deemed un-codable for detailed visual attention and facial expression analyses, with 75%-80% remaining codable.

Demographics

The average age of study participants was 30 years. Forty-four percent of the participants identified as single or never married. Seventy percent of the participants had completed grades 8 to 12. The unemployment rate during the data collection period was substantial at 79%. Notably, 63% of the infants within the dyads were boys. See Table 10 for sample characteristics.

Table 10: Demographic characteristics for mothers and their infants

Characteristic	**Overall** (N = 57 dyads)
MOTHERS	
Age (years) [Median (Q1, Q3)]	30.0 (28.0, 33.0)
Access to: [n (%)]	
Home electrical connection	56 (98%)

MNET/DSTV/satellite TV	40 (70%)
Internet	41 (72%)
Access to household items: [n (%)]	
Computer (laptop)	23 (40%)
DVD player	18 (32%)
Fridge	54 (95%)
Motorcar	22 (39%)
Stove	56 (98%)
Telephone (cellphone)	57 (100%)
Telephone (landline)	1 (1.8%)
Television	53 (93%)
Vacuum cleaner	4 (7.0%)
Washing machine	33 (58%)
Socioeconomic score [Median (Q1, Q3)]	8.0 (7.0, 9.0)
Household: [Median (Q1, Q3)]	
Number of people in the home	5.0 (4.0, 7.0)
Number of people per bedroom	2.5 (1.5, 3.0)
Education: [n (%)]	
Completed secondary school	40 (70%)
Employment: [n (%)]	
Ever had a job	38 (67%)
Currently have a job	12 (21%)
Ever been unemployed	34 (60%)
Current relationship status: [n (%)]	
Single	25 (44%)
In a relationship	15 (26%)
Living with a partner	12 (21%)

Married	5 (8.8%)
INFANTS	
Gestational age (weeks) [Median (Q1, Q3)]	39.0 (38.0, 40.0)
Sex: [n (%)]	
Female	21 (37%)
Male	36 (63%)

Video footage

A total of 37 871 seconds [median (Q1, Q3): 180 (168, 180) seconds per dyad] of footage depicting interactions between mothers and their infants were coded and micro-analysed from moment to moment.

Visual attention frequency

Figure 6 illustrates the percentage of time spent that visual attention was directed on each focus point for infants and mothers.

Generally, infants showed a greater range of time spent on different points of focus than mothers, who typically stayed focused on their infants. This indicates mothers were more visually attentive to their infants, while the infants' visual attention was more scattered.

Infants directed their visual attention towards their mothers for 47% (24, 74) of the recorded time, whereas mothers spent almost the entire duration [92% (79, 96)] of each interaction with visual attention on their infants. A notable percentage [17% (8, 33)] of the interaction was spent by infants looking at distractions in the environment, while mothers spent 1.8% (0, 5.5) of their time at distractions. Visual attention was infrequently directed at focus objects (i.e.: toys) or other people.

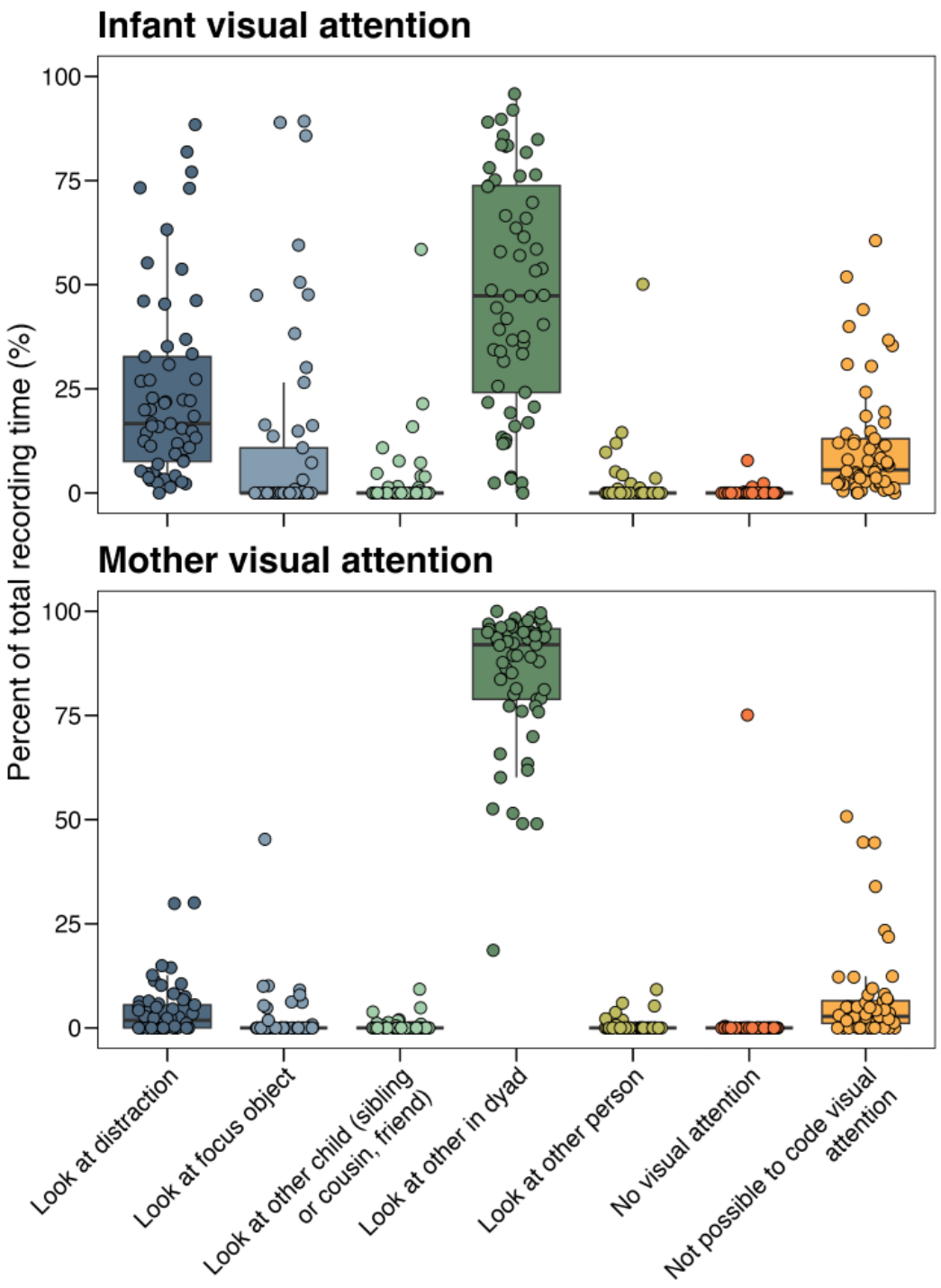


Figure 6: The percentage of time spent with visual attention on each focus point for infants and mothers (57 dyads)

Facial expressions frequency

Figure 7 shows the percentage of time that mothers and infants showed different facial expressions.

Generally, facial expressions for mothers were more positive than those of the infants, such that infants smiled much less frequently than mothers [Infants: 9% (1, 23) versus mothers: 59% (32, 76)]. The most frequent facial expression in infants was a neutral expression, accounting for 34% (16, 48) of each interaction. In contrast, mothers spent only 4% (0, 11) of each interaction with a neutral expression. Other facial expressions were not frequently observed and thus are not reported on. It does, however, bear noting that the faces of the infants and mothers were not visible to code facial expressions for a large percentage of recording time [infants: 31% (13, 49), mothers: 26% (11, 41)].

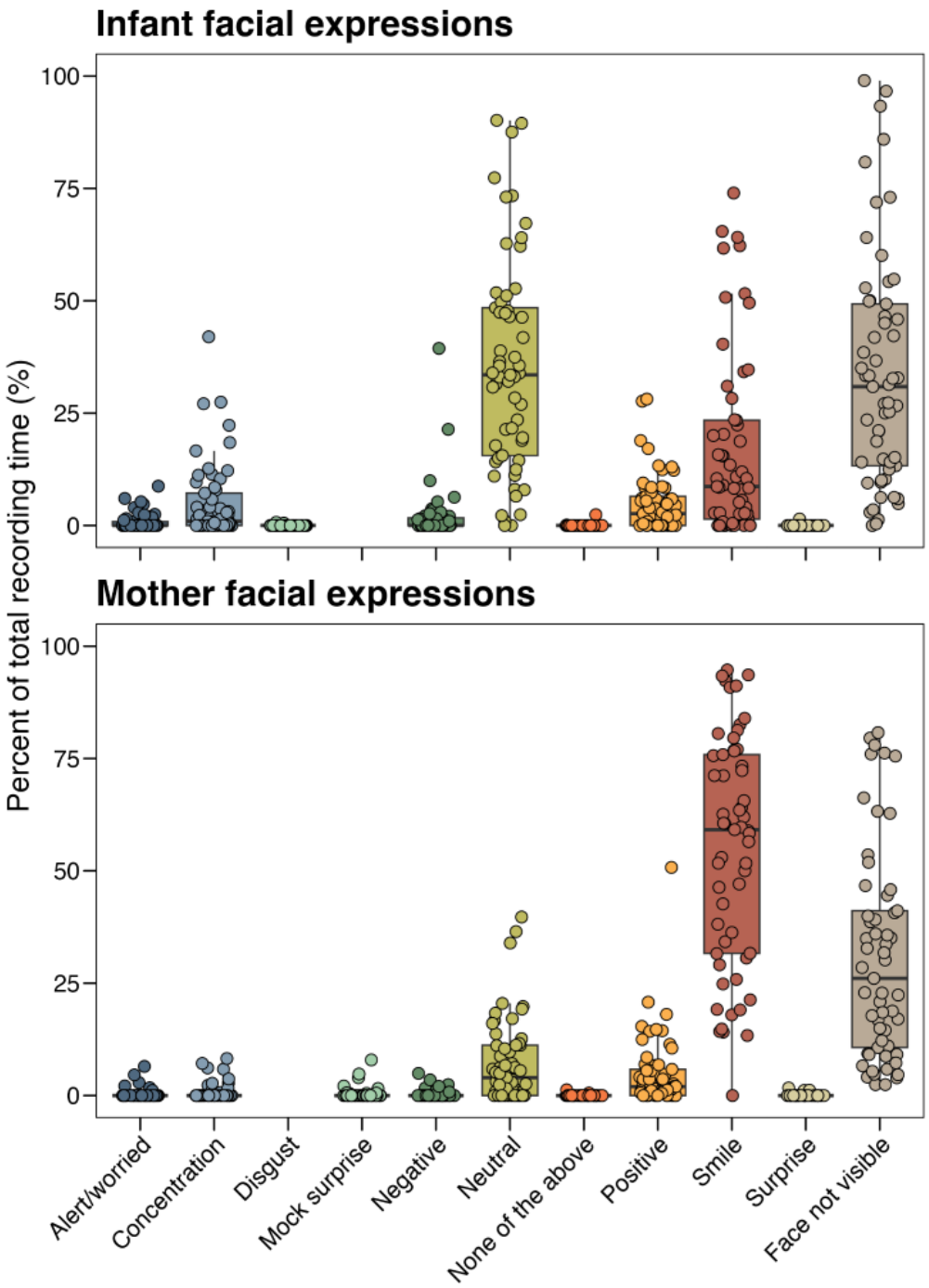


Figure 7: Percentage of time that mothers and infants showed with different facial expressions. Only mothers could engage in "Mock surprise"

Visual attention (mean duration and total duration)

Table 11 shows mean durations, number of occurrences, and total durations for visual attention for infants and mothers. Two behaviours, namely visual attention towards each other and visual attention towards a distraction, are discussed below. Times and occurrences for the other visual attention behaviours were negligible and are not discussed further.

The mean duration that infants looked at their mothers was 8.8 seconds (4.3, 13.6), and it was the most frequent visual attention behaviour [on average 7 occurrences per interaction (5, 11)], with a total duration of 75.2 seconds (37.2, 121.1). For mothers, looking at their infant was also the most common visual attention behaviour such that the mean duration for mothers looking at their infants was 34.2 seconds (18, 57.7), and it was the most frequent visual attention behaviour [on average 4 occurrences per interaction (3, 7)], with a total duration of 146.7 seconds (116, 168.3).

The mean duration of time spent by infants looking at distractions was 4.2 seconds (3.1, 8.2), while mothers spent far less time than their infants looking at distractions [1.8 seconds (0, 3.5)]. Similarly, whereas infants engaged in an average of 6 episodes (3, 10) of looking at distractions per recording, mothers looked at distractions for on average 1 episode (0, 3) per interaction. Thus, the total duration for looking at distractions for infants was 27.7 seconds (13.6, 48.8), and for mothers was 3.3 seconds (0, 10).

Table 11: Mean durations, number of occurrences, and total durations for visual attention of infants and mothers (n = 57 dyads)

Behaviour	**Mean duration** [Median (Q1, Q3)]	**Number of occurrences [Median (Q1, Q3]**	**Total duration** [Median (Q1, Q3)]
INFANTS			
Look at distraction (s)	4.2 (3.1, 8.2)	6 (3, 10)	27.7 (13.6, 48.8)
Look at focus object (s)	0 (0, 6.1)	0 (0, 2)	0 (0, 15.3)
Look at mother (s)	8.8 (4.3, 13.6)	7 (5, 11)	75.2 (37.2, 121.1)
Look at other child (s) (sibling or cousin, friend)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Look at other person (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)

No visual attention (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Not possible to code visual attention (s)	3.1 (1.7, 5.5)	3 (1, 5)	9 (3.6, 20.9)
MOTHERS			
Look at distraction (s)	1.8 (0, 3.5)	1 (0, 3)	3.3 (0, 10)
Look at focus object (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Look at infant (s)	34.2 (18, 57.7)	4 (3, 7)	146.7 (116, 168.3)
Look at other child (s) (sibling or cousin, friend)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Look at other person (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
No visual attention (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Not possible to code (s) visual attention (s)	2.4 (1, 4.1)	2 (1, 3)	4.3 (1.5, 11.7)

Facial expressions (mean duration and total duration)

Table 12 shows mean durations and total durations of facial expressions of infants and mothers. Two facial expressions, smiles, and neutral expressions, are discussed below. Results for other facial expressions were too infrequent to warrant discussion. As noted for the frequency data for facial expressions, infants' and mothers' faces were not visible for relatively long periods during the recording time [TD; infants: 45.6 seconds (21.3, 75.3), mothers: 40.3 seconds (16.8, 71.9)]. Both a relatively high occurrence and a relatively long mean duration per occurrence contributed to the high total duration for the 'face not visible' coding.

The mean duration for infants smiling was 3.8 seconds (1.4, 5.7), and it occurred on average 4 times per interaction (1, 8), giving a total duration of 15.1 seconds (1.7, 42.2) for the behaviour. Smiling was the most common facial expression shown by mothers, such that the mean duration for mothers smiling was 9.6 seconds (6.5, 17.8), and it was the most frequent facial expression [on average 7 occurrences per interaction (6, 11)], giving a total duration of 90 seconds (55.1, 130.2) for the behaviour.

Infants spent a mean duration of 5.8 seconds (4, 7.2) displaying a neutral expression, at a median (IQR) of 8 occurrences (5, 12) per recording period, yielding a total duration of 57.8 seconds (26.9, 85). The display of a neutral expression was thus the dominant expression of all the codable facial expressions when the face was visible. As we have already noted, the dominant facial expression of mothers was smiling, and so there were few instances when a neutral expression was observed during the recording period [median of 2 occurrences per interaction (0, 5)], and each occurrence was maintained for a short period [2.2 seconds (0, 3.5)], and therefore the total duration for having a neutral expression was short [6.1 seconds (0, 20.2)].

Table 12: Mean durations, number of occurrences, and total durations for facial expressions for infants and mothers (n = 57 dyads)

Behaviour	**Mean duration [Median (IQR)]**	**Number of occurrences [Median (IQR)]**	**Total duration [Median (IQR)]**
INFANTS			
Alert/worried (s)	0 (0, 1.4)	0 (0, 1)	0 (0, 1.5)
Concentration (s)	1.5 (0, 4.3)	1 (0, 2)	1.7 (0, 9.8)
Disgust (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Negative (s)	0 (0, 1.8)	0 (0, 1)	0 (0, 2.5)
Neutral (s)	5.8 (4, 7.2)	8 (5, 12)	57.8 (26.9, 85)
Positive (s)	1.9 (0, 2.4)	2 (0, 5)	3.5 (0, 11.7)
Smile (s)	3.8 (1.4, 5.7)	4 (1, 8)	15.1 (1.7, 42.2)
Surprise (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Face not visible (s)	5.2 (3.4, 7.8)	7 (3, 12)	45.6 (21.3, 75.3)
None of the above (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
MOTHERS			
Alert/worried (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Concentration (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Disgust (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Mock surprise (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Negative (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Neutral (s)	2.2 (0, 3.5)	2 (0, 5)	6.1 (0, 20.2)

Positive (s)	1.4 (0, 3.1)	2 (0, 4)	2.6 (0, 10.5)
Smile (s)	9.6 (6.5, 17.8)	7 (6, 11)	90 (55.1, 130.2)
Surprise (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)
Face not visible (s)	5.2 (3.2, 8.7)	6 (4, 92)	40.3 (16.8, 71.9)
None of the above (s)	0 (0, 0)	0 (0, 0)	0 (0, 0)

Lag sequential analysis

Visual attention and facial expression synchrony were analysed by calculating the probability of infant and mother matching behaviours within a time frame of 3 seconds. In general, the probability of behavioural synchrony was low for all visual attention and facial expressions with sufficient data to analyse (visual attention: looking at each other and looking at a distraction; facial expressions: smiling and having a neutral expression). In addition, where there was synchrony of behaviours, it tended to be the infant following the mother.

Effective sample sizes for specific lag sequential analyses varied across behavioural sequences, as indicated by differing *n* values. This variability reflects both the frequency of particular behaviours within dyads and the availability of codable footage. Since lag sequential analysis depends on the presence of identifiable antecedent and target behaviours, sequences involving infrequent events were only analyzable in dyads where these behaviours occurred.

Figure 8 illustrates the visual attention lag sequence between mothers and infants when looking at each other. When the infant led the interaction and looked at the mother, the median (IQR) probability that the mother would then look back at the infant within 3 seconds was 0.00 (0.00, 0.12). There was a probability of 0.25 (0.00, 0.41) for when the mother led the interaction and looked at the infant, that the infant would follow and look back within 3 seconds.

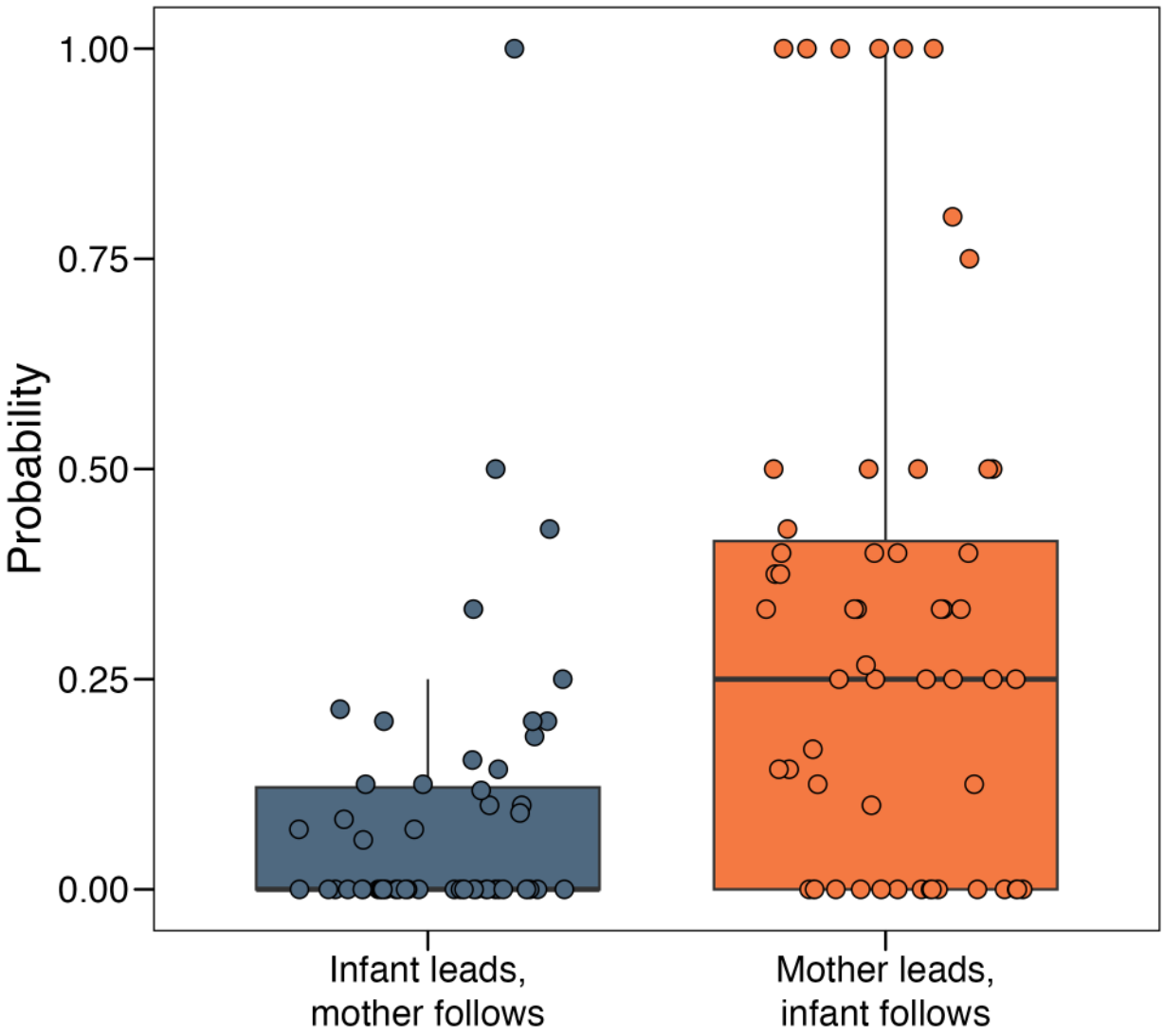


Figure 8: The probability of the infant leading the interaction of looking at the mother and having the mother follow (blue grey), and the probability of the mother leading the interaction of looking at the infant and having the infant follow (orange), within 3 seconds. Sample size = 55 dyads with sufficient data to analyse both mother leading infant and infant leading mother within a dyad

Figure 9 illustrates the visual attention lag sequence involving visual attention being drawn to distractions for mothers and infants. When the infant led the interaction and looked at the distraction first, the probability that the mother then looked at the distraction within 3 seconds was 0.00 (0.00, 0.07). There was a probability of 0.00 (0.00, 0.08) that when the mother led the behaviour of looking at a distraction, the infant would follow by also looking within 3 seconds.

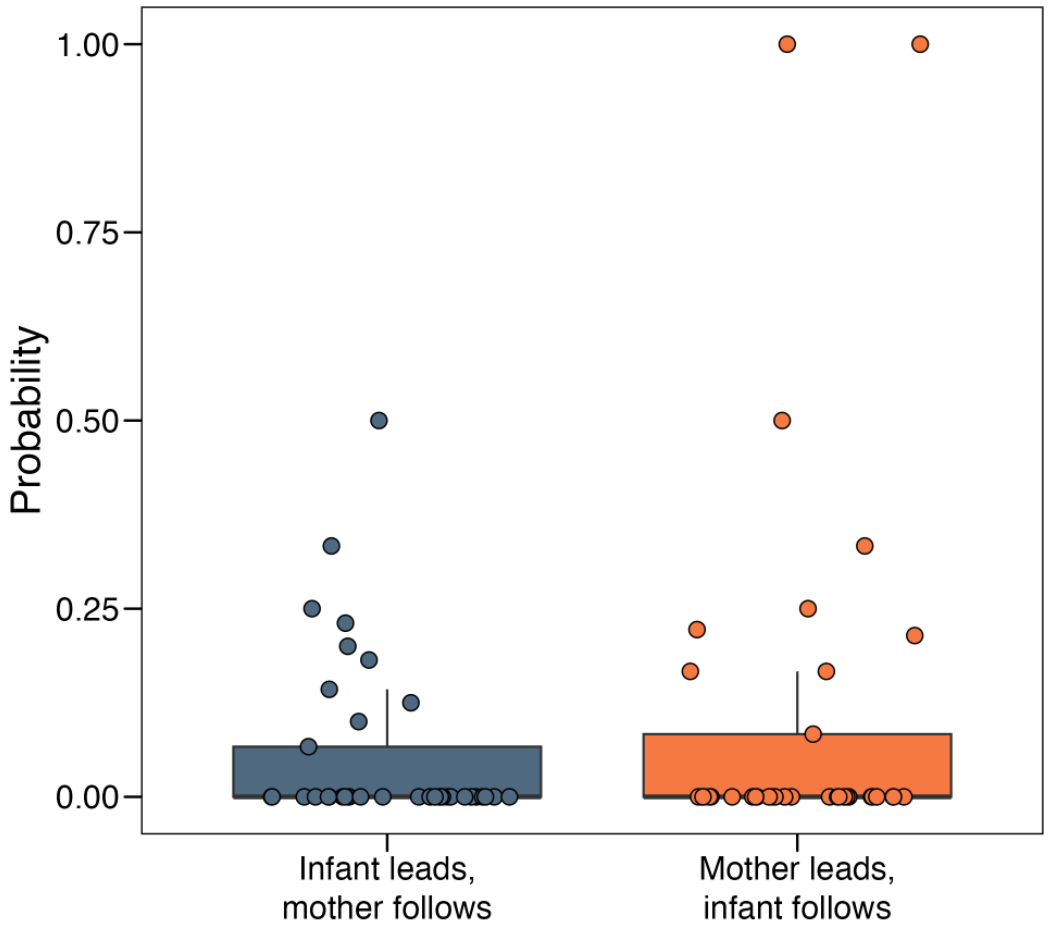


Figure 9: The probability of the infant leading the interaction of looking at a distraction and having the mother follow (blue grey), and the probability of the mother leading the interaction of looking at a distraction and having the infant follow (orange), within 3 seconds. Sample size = 37 dyads with sufficient data to analyse both mother leading infant and infant leading mother within a dyad

Figure 10 illustrates the facial expression lag sequence involving smiles between mothers and infants. When the infant led the interaction and smiled first, the probability that the mother then smiled within 3 seconds was 0.13 (0.00, 0.25). There was a probability of 0.14 (0.00, 0.25) that when the mother led the behaviour, the infant would follow by smiling within 3 seconds.

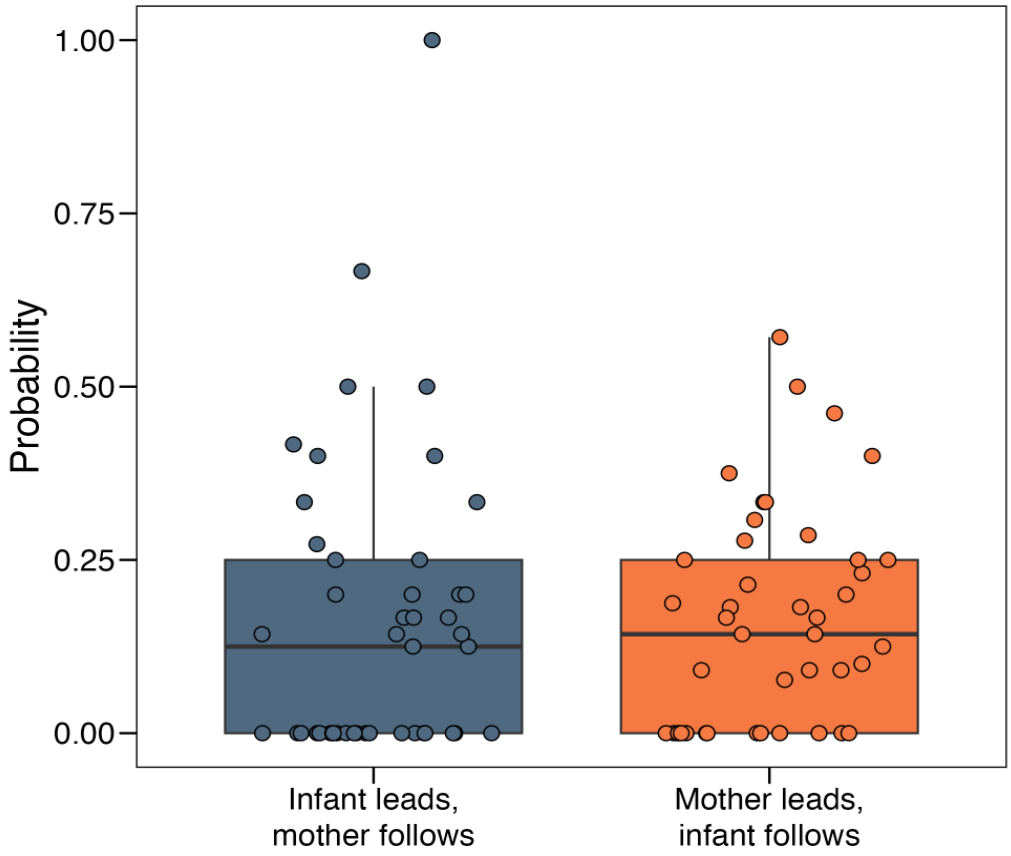


Figure 10: The probability of the infant leading the interaction with smiling and having the mother follow (blue grey), and the probability of the mother leading the interaction with smiling and having the infant follow (orange), within 3 seconds. Sample size = 45 dyads with sufficient data to analyse both mother leading infant and infant leading mother within a dyad

Figure 11 illustrates the lag sequence of neutral facial expressions between mothers and infants. When the infant led the interaction with a neutral facial expression, the probability that the mother then reciprocated within 3 seconds was 0.00 (0.00, 0.16). There was a probability of 0.00 (0.00, 0.28) that when the mother led the behaviour, the infant would follow by taking on a neutral facial expression within 3 seconds.

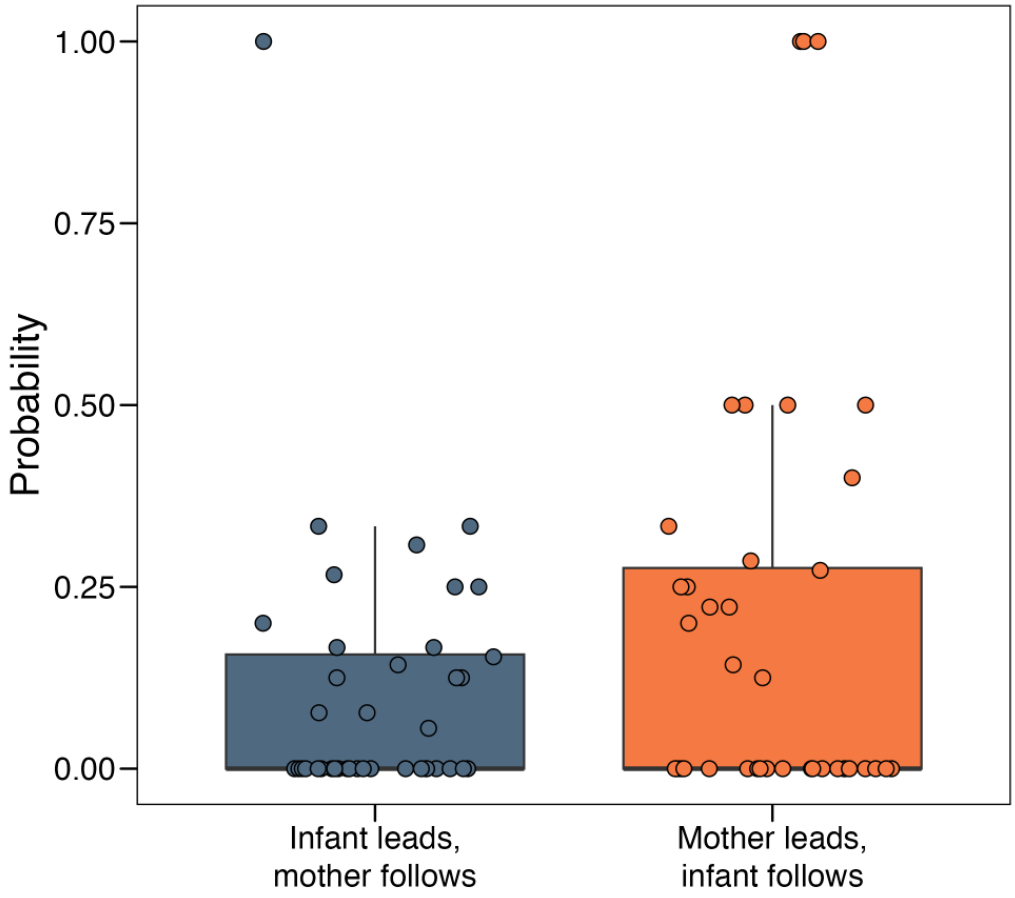


Figure 11: The probability of the infant leading the interaction of having a neutral expression and having the mother follow (blue grey), and the probability of the mother leading the interaction of having a neutral expression and having the infant follow (orange), within 3 seconds. Sample size = 40 dyads with sufficient data to analyse both mother leading infant and infant leading mother within a dyad

4.4 Discussion

In the field of mother-infant observation, the direct study of behaviours is considered to yield more sensitive and accurate data compared to the use of interviews and questionnaires (359). However, techniques were originally developed for high-income and Western populations, limiting their applicability to low-income groups with ethnic diversity (344). Western researchers have not yet fully understood the experiences of African women (360) and it has been proposed that African mothers exhibit distinct behaviours with their infants compared to their Western counterparts (348). These noted variances have sparked inquiries into the dynamics of adult-infant interactions (21). Our research aimed to obtain firsthand observations of unstructured

interactions between mothers and their infants within the home-based setting of a poor socio-economic group in Soweto. This study represents the first use of headcams to measure mother-infant synchrony in South Africa, offering a novel approach to understanding these interactions in a diverse and underrepresented population.

The socioeconomic circumstances of this sample highlighted several factors. The unemployment rate among our participants was alarmingly high at 79%, significantly exceeding the national unemployment rate of 36.8% for Black South Africans (188). This disparity is likely due to recent motherhood contributing to unemployment as only 33% of the participants had never been employed which falls more in line with the national rates. Given that the average age of participants was 30 years, this statistic likely reflects the broader socio-economic challenges prevalent in the country. Alternatively, it is in line with an ideology that was revealed in a Master's dissertation named 'Narratives of motherhood: voices of selected South African women' whereby van Doorene's, 2009 (361) found that an ideology existed in a group of mothers whereby 'good mothers' were thought to be unconditionally available and that working mothers were inadequate mothers (361) .The same belief was also found by Dale, 2013 (362) when she interviewed Black mothers in Alexandra Township. Additionally, research indicates that often, African women make extensive efforts to have children of their own as religions view infertility as a disgrace and believe it is a consequence of wrongdoing (363). Extensive research indicates that South African women face significant pressure to conceive and give birth (364) in comparison to women in more developed/wealthier societies.

Additionally, nearly half of the participants were single and not cohabitating with a partner. In a paper by Hetherington and Stanley-Hagan, 1999 (365) , they wrote of the repercussions of single parenthood which is often financial hardship, and this demographic detail underscores the environmental stressors associated with caregiving in that context. The combination of unemployment, lack of employment history, and single parenthood provides a stark illustration of the complex and multifaceted stressors faced by mothers in South Africa. These factors can have detrimental effects on the quality of caregiving as maternal psychological health and social support contribute towards a mother's capacity to interact synchronously with her infant (366). It is likely that these components could be contributing towards our results which showed low levels of synchrony after conducting sequential analysis on the data.

Lag sequential analysis of visual attention in our sample showed that there was a 25% probability that when mothers looked at their infants; the infants would look back at their mothers within 3 seconds and that there was a 14% chance that when the caregivers smiled at their infants, the infant would follow with a smile. With so many differing methodologies to analyse synchrony, it was challenging to compare results to prior studies. Additionally, we found that there was little opportunity to analyse lag sequences on the data as there were few transitions between mother and infant facial exchange due to the mothers looking at infants for the majority (92%) of the time. The brief 8% of time when mothers were not looking at their infants was too short to accurately measure behaviour patterns owing to lack of variation of to-and-fro visual attention.

Stern, 1971 and 1974 (86,120) reiterates that mothers look at their infants for the majority of the time and that the tendency is for mothers to direct their visual attention towards the infant's face for extended durations, while it is the infant who usually initiates a cyclic pattern of visual attention, alternating between periods of fixation on the mother's face, diverting their visual attention, and subsequently returning their focus (86,120). The same was found by Messer and Vietze, 1984 (367) in their research on timing and transitions in mother-infant gaze. Our investigation substantiates such observations in that mothers were more visually attentive to infants than the infants were towards their mothers, as seen by the scattered distribution of results for the frequency of infant behaviours versus caregiver behaviours. The large proportion of time mothers spent looking at their infants (total duration of 146.7 seconds) and smiling at them (total duration of 90 seconds) may be explained by what Beebe, 1974 (143) has called ‘eye love’, which is described as periods of positive emotions where mothers and infants can engage in prolonged gaze (143,144). Infants followed more of a distractible pattern of gaze, alternating fixation on mothers’ faces (47% of the time), to looking at distractions (17%) as well as other people and focus objects in the room for the remainder of the time. This could be explained by Field, 1981 (145) who wrote that infants employ a deliberate pattern of looking and looking away to manage their level of arousal. Field, 1981 (145) observed infants' heart rates while they engaged in face-to-face play and found that when an infant looked away, it was usually preceded by a sudden increase in arousal within the preceding 5 seconds. Following this gaze aversion, the infant's heart rate returns to its baseline within the next 5 seconds, and the infant resumes gazing

at their mother's face. Consequently, infant gaze aversion emerges as a critical mechanism for infants to self-regulate their arousal levels.

Contrary to Stern, 1971, 1974 (86,120) Adamson and MacArthur, 1995 (368) propose that, for the first nine months, it is primarily the mother who adjusts her gaze to the interests of the infant rather than vice versa to foster an engaged relationship. We understand Adamson and MacArthur's, 1995 (368) stance in this study, by hypothesising that the mothers in our research were attempting to foster engagement with their infants by holding prolonged gazes and trying to keep the attention of their infants. In her qualitative thesis entitled 'A Narrative Understanding of the Maternal Experience of urban Black South African Mothers,' Dale, 2013 (362) found that there was an emphasis of mothers to focus less on the physical aspects of mothering and to provide for their infants in more emotional ways. The stated rationale was to give quality parenting in an environment that was economically and socially deprived. Van Doorene's, 2009 (361) study also reported that mothers' wishes to be available to her children, stemmed from the unavailability of their own mothers (361). This may in part explain why participants in our study looked at their infants and smiled at them for such prolonged times as they wanted to engage their infants attempting to be 'good' mothers (361,362). However, this could also be a pattern that may be influenced by the Hawthorne Effect, as their awareness of being observed could have amplified their expressions of warmth and engagement.

Typically, mothers display more positive facial expressions than their infants (58). Mothers in this study exhibited smiles for 59% of the time, with an average of 90 seconds of smiling. A recent study in South Africa had a similar result when measuring the frequency of moments of shared pleasure and found shared pleasure in 20.5% of 78 participants and their 2–6-month-old infants in a low-income group in Cape Town, South Africa when filmed during free play (348). Shared pleasure in mother-infant interactions can be called a sharing of positive affect in synchrony between the pair. Puura et al., 2005 (369) has shown its correlation with attachment security and states that it is regarded as highly malleable in the first year of the infant's life (370), which holds promise for the ability to intervene and improve mother-infant interactions. However, a mother who consistently displays high levels of positive affect during interactions with her infant might not be attuned to the infant's cues. This lack of responsiveness can hinder

the dynamic process of mismatch and repair, which is crucial for the infant's learning of social contingency (371,372).

Given the overwhelming amount of maternal visual attention and smiles towards the infant, it may be speculated that there is an intrusive element characterising interactions in our study. Intrusive mothering is characterised by excessive maternal stimulation that overrides the infant's signaling - such as when the mother continues to engage despite cues for rest - and this style tends to correlate with higher maternal anxiety (234,373). Intrusive mothering involves excessive stimulation and exchanges that are driven more by the mother's own needs and preferences than by the infant's signals and cues (374). It is also possible that this element reflects a culturally embedded relational style of mother-infant interaction, rather than an indication of intrusiveness per se. Research in African contexts highlights that close physical proximity, frequent maternal engagement, and affective exchanges are normative caregiving practices that foster bonding and social development (375). For example, in many African cultures, infants are often carried on their mother's body for extended periods, maintaining constant contact and facilitating ongoing emotional and communicative interaction (376). What might be considered intrusive in Western frameworks can instead represent culturally adaptive responsiveness aligned with communal caregiving values common in many African communities (377). These findings align with the broader concept of the 'developmental niche,' (378) which emphasizes how cultural settings shape parenting behaviors and infant development, underscoring the importance of interpreting mother-infant interactions within their cultural context (379).

Our findings indicate that despite adverse contexts, mothers often show positive engagement with their infants - such as sustained gaze and frequent smiling - aligning with global research (146). However, the relatively low frequency of immediate, complex bidirectional synchrony suggests that micro-level affective exchanges may be less precise, possibly due to chronic stress and maternal mental health challenges. Still, the presence of significant lagged interactions (e.g., maternal gaze followed by infant gaze) highlights that core elements of reciprocity are intact. This suggests a resilient foundation of maternal engagement, shaped but not erased by contextual adversity, offering insight into the dynamics of mother–infant interaction in this South African sample.

Maternal adverse experiences from childhood through adulthood, along with mental health challenges, can impair a mother's ability to see and respond to an infant's needs (67). Although this study did not specifically address these factors, the necessity for further research in this area is apparent.

4.5 Strengths

A key strength of this study lies in its novel application of moment-to-moment micro-analytic coding to examine mother-infant synchrony in an African context. While prior work (271) explored the feasibility of using headcams to assess mother-infant interactions in Soweto, this study is the first to systematically apply frame-by-frame coding of nonverbal behaviours - specifically facial expressions and visual attention - across an extended sample to explore interactional synchrony using Beebe et. al., 2010, 'social microscope' framework (64). Unlike Lachman et al., 2022 (350), who used stationary video cameras in a healthcare facility to study shared pleasure; this study employed head-mounted cameras in mothers' homes to better capture natural behaviours. Our approach used detailed micro-coding to reveal unconscious behaviours that shape relationships, with individual actions lasting 1/4 to 1/3 of a second (84–86), providing a precise measure of dynamics in the mother-infant relationship. This research also opens opportunities for digital innovation, such as mobile applications which could make analysis of interactional processes more accessible for mothers. This could greatly benefit low-income mothers who face high transport costs or cannot attend appointments at health care facilities.

4.6 Limitations

This study faced several limitations that impact the generalisability and interpretation of findings. Feasibility issues - including camera faults, transport challenges, and improper use - reduced the sample size. Head-mounted cameras, though offering unique first-person perspectives, presented challenges: on average, 20–25% of footage was uncodable due to participants moving out of frame or being obscured. Moreover, due to the time-consuming nature of micro-analytic coding, mothers were asked to record a set amount of minutes of footage, much of which captured the setup process rather than sustained interaction. This approach mirrors standard practice in similar research conducted by Pearson and colleagues in the UK

(75). As a result, certain behaviors - particularly rare expressions or interactional sequences - yielded zero probabilities, possibly reflecting true absence or simply limited observability within the measured time frame. Synchrony was also difficult to measure due to the minimal behavioural transitions within the short three-minute segments and the prolonged, sustained nature of some interactions (e.g., mothers smiling continuously at their infants). While the extent to which the camera setup influenced natural behaviour is uncertain, in-home observation remains preferable to lab-based alternatives (380,381). Additionally, the absence of a standardised method for measuring synchrony complicates cross-study comparisons.

Despite these limitations, our sample size of 57 mother-infant dyads, aligns with comparable studies on parent-infant interactions (62,107,382) and the dataset - comprising 37,871 seconds of moment-to-moment coded footage across these dyads - remains robust. The detailed micro-analytic approach and low variability within the sample suggest the findings are stable and provide valuable insights into early dyadic interaction. Future research should seek to address these limitations to enhance reliability and cross-study comparability.

4.7 Conclusion

This study used head-mounted cameras to observe mother-infant interactions in a low-income population in Soweto. Synchrony was challenging to measure due to few transitions of to-and-fro behaviours between the pair. Despite high unemployment and single parenthood, mothers remained emotionally engaged, showing prolonged episodes of visual attention and positive facial expressions, which may be an adaptive response to their challenges. These findings highlight the resilience of these mothers and the need for interventions that address broader socio-economic issues to support positive mother-infant dynamics. This research enhances our understanding of these interactions in underrepresented populations and guides future studies and interventions worldwide.

CHAPTER 5

Durations and transitions of smiles: A comparative study of non-depressed and sub-clinically depressed mothers while interacting with their infants

“The eye never forgets what the heart has seen”

African proverb

5.1 Introduction

The formation of human relationships is marked by the infant's capacity to connect its sense of self to its perceptions of the primary caregiver (132). This connection precedes the co-constructing of meaning within dyadic interactions (69,176) setting the stage for how infants understand and interact with the world around them. This process, known as primary intersubjectivity (132), is integral to mother-infant bonding and is thought to be supported through maternal sensitivity (11), responsive caregiving (30), and reflective function (41). Maternal sensitivity - the ability to accurately perceive and appropriately respond to infant cues - enables the caregiver to meet the infant's emotional and physical needs in a timely and attuned manner, fostering a sense of safety and predictability. Responsive caregiving, which involves consistent and contingent reactions to the infant's behaviours, strengthens early patterns of trust and reciprocity. Reflective function, the caregiver's capacity to consider the infant's internal mental states, further supports emotional attunement and helps the infant begin to form a coherent sense of self. Through these intertwined processes, mothers and infants engage in a dynamic to-and-fro exchange of non-verbal, emotional and social communication (383), which over time shapes the quality of their attachment relationship (11) and lays the groundwork for the infant's emerging emotional regulation and social understanding.

A key element in the mother-infant interaction is the mother's tendency to exaggerate and mirror her infant's facial expressions selectively. This mirroring process enables the infant to develop predictable patterns in their own expressions, aligning their emotional feedback with their internal states - a concept referred to as social biofeedback (384). By doing so, maternal mirroring becomes essential in fostering the infant's emotional regulation, which involves managing and modulating internal arousal in response to heightened emotions (385). Studies in natural environments further highlight how maternal expressions subtly shape infant behaviour, influencing their emotional regulation (386).

Naturalistic studies have closely examined the intricately choreographed exchanges between mothers and infants by casting a microscope (383) over the to-and-fro of behaviours between the dyad at 3-4 months postpartum. When social relatedness peaks at this age, infants begin to

demonstrate remarkable capacities for social referencing and affective attunement, though they have yet to develop curiosity about objects (387). Researchers, using micro-analysis, have observed the timing of gaze and facial expressions to assess affective synchrony during interactions (69,176). This approach has provided valuable insights into the emotional experiences shared in the dyadic relationship and allows for the determination of behavioural synchrony between the pair. Behavioural synchrony is analysed by examining the frequency, duration, and timing of interactions, often through lag sequential analysis (62). For instance, Skotheim et al., 2013 (247) used lag analysis to assess the synchrony between mothers and their 3-month-old infants, coding visual gaze and negative, neutral and positive facial expressions using the Observer XT 9 software; revealing that infants could detect asynchronous interactions. Such disruptions led to decreased visual attention and reduced smiling from the infant (105,247). This is particularly relevant in the context of maternal depression, where mothers often present with flatter affect and more negative facial expressions, leading to slower responsivity and less positive interaction (95,122).

Depression often manifests in subtle ways that standard diagnostic criteria may miss, leading to many affected individuals remaining undiagnosed (388). Thus, psychiatric conditions are increasingly viewed as dimensional rather than categorical, (389) supporting the notion that depression exists on a spectrum, with postnatal depression potentially preceding or following less severe mood disorders (390). Sub-clinical depression has often been overlooked, despite its global prevalence of 25% (259,391) and approximate 22.5 % in rural South Africa (392); yet it has been linked to challenges in parenting in the postpartum period (227). For example, Hummel et al., 2016 (393) coded positive and negative affect in mothers and toddlers during an interactional clean-up task. Sequential analyses revealed that mothers with no depression displayed mutual positive affect with their toddlers, whereas mothers with sub-clinical depression did not. Sub-clinical depression has also been associated with poorer mother-to-infant attachment (394) and has negative effects on maternal facial expressions and emotional availability during interactions (246,247,395).

Interestingly, while depressed mothers typically show lower levels of positive affect (244), some studies indicate they maintain similar levels of contingent behaviour with their infants when compared to non-depressed mothers, possibly due to habituation in interaction styles

(244,245,247). However, Beebe, et al., 2008 (109) found that mothers with more severe depressive symptoms exhibited higher levels of synchrony of facial expressions with their infants than did mothers experiencing less severe symptoms. Lotzin, et al., 2015 (68,243) suggest that the way a mother regulates her emotions may be a key route through which her psychopathology is transmitted. For example, via interference in the dyads facial affect synchrony; and so maternal emotion regulation (385) is critical in this context. The three-component model of affective processes in parenting (396) suggests that the quality of parenting is determined by the capacity to regulate emotions adaptively, instead of the experienced emotion per se. The impact of these emotions on the synchrony between a mother's and infant's facial expressions may hinge on the mother's ability to manage them effectively (396).

A formative paper describing synchrony of facial expressions between mothers and 4-month-old infants in Soweto, South Africa found that mothers displayed mainly neutral and positive facial expressions and spent much of the time smiling at their infants [refer to chapter 4 for the manuscript written by Cantrell et al., 2024, (397)]. Findings are supported by research indicating that mothers present with positive facial expressions and smile frequently during interactions, attempting to maximise simultaneous smiling (398). However, there is a notable gap in this area of research, and to our knowledge, no empirical studies have specifically examined maternal transitions of affect within the context of social communication between dyads. This study therefore aimed to examine the dynamic evolution from one maternal facial expression to the next, by comparing transitions in neutral, positive and smiling facial expressions between mothers with no depression and those with sub-clinical depression. I hypothesised that mothers with sub-clinical depressive symptoms may be less adaptive/flexible in their emotional regulation and slower in their responses to their infants. Thus, my objectives were firstly to compare the total duration of maternal neutral, positive, and smiling facial expressions between non-depressed vs sub-clinically depressed mothers. Secondly, I aimed to compare facial expression transitions between the two groups of mothers by analyzing the probability of transitioning from neutral to positive facial expressions, neutral to smiles, and positive expressions to smiles within three seconds.

5.2 Methods

Setting and participants

This study was embedded within the broader PLAY (Play, Love and You) project, a randomised controlled trial led by the SAMRC/Wits Developmental Pathways for Health Research Unit (DPHRU) at the University of the Witwatersrand. The overarching goal of the PLAY trial is to support early child development by strengthening maternal self-efficacy through behavioural feedback, accessible educational content, and guided support (281). Mothers were enrolled within four days, on average, of giving birth at Chiawelo Community Healthcare Centre and Lilian Ngoyi Clinic, both located in Soweto, South Africa. To be eligible, participants had to be 18 years or older, reside in Soweto, be the primary caregiver of a full-term singleton infant, and be able to attend sessions at Chris Hani Baragwanath Academic Hospital (with transport costs reimbursed).

Participants in the present analysis were selected from both arms of the PLAY study (281). Those in the control arm received the standard Road to Health booklet alongside the Side-by-Side services offered by the National Department of Health. These tools are structured around five key areas: love, nutrition, healthcare, protection, and extra care, and are designed to promote collaboration between caregivers and healthcare providers. Additionally, the control group received bimonthly phone check-ins with referral support and were invited to participate in regular assessments of child growth, development, movement, and interaction. The intervention group was provided with the same foundational messages around bonding, breastfeeding, and early stimulation, but these were delivered through weekly sessions over a year. Within the first four months, the greatest support was around breastfeeding. Furthermore, the behavioural intervention feedback component was only presented after the four-month visit. It is important to note that the headcam recordings used in this study were collected when infants were four months old - roughly one-third into the intervention timeline. As a result, both groups had received comparable information by this point, although via different formats. Given the limited intervention exposure and overlapping content, group allocation was unlikely to have significantly influenced maternal interaction behaviours at the time of data collection. This

analysis included only those PLAY participants who had valid headcam footage recorded during the 4-month visit (n = 57).

The study was approved by the University of the Witwatersrand's Human Research Ethics Committee (clearance no: M220886 - PLAY study and M220787 - sub-study). Participants provided written informed consent to participate and gave permission for their video footage to be collected, shared and analysed by the research team.

Measures

Sociodemographic variables

At enrolment, mothers reported demographic data, including age, relationship status, education level, employment and socio-economic status (SES). SES was determined by asking 13 questions about access to household items (e.g., electricity, refrigerator, car, computer) and calculating a score out of 13. This method is validated for economic assessment and responsive to changes over time (255,256).

Depressive symptoms

At four-months postpartum, maternal depression symptoms were evaluated using the Edinburgh Postnatal Depression Scale [EPDS, (304)]. Participants responded to ten questions on a 4-point Likert scale, with certain answers being reverse-scored. The total scores were obtained by summing up the scores of each item. The higher scores indicated greater levels of depressive symptoms. I applied cut-off scores of ≥ 5 indicating no depression, 6-13 indicating sub-clinical depression, and scores of 14 and above indicating moderate to severe depression. I then assigned participants to a non-depressed group or a sub-clinically depressed group. The EDPS cut-off scores chosen for this study have been previously used in measuring sub-clinical depression (247,259,260).

Facial expressions

Maternal facial expressions were captured at four months postpartum using head-mounted WearCams cameras, produced by UCam 247 worn by mothers and infants during free play sessions. To ensure ecological validity, the recordings focused on naturalistic interactions

between mothers and their infants in their homes, without the presence of an external observer (75). The cameras recorded audio and video in AVI format, with a resolution of 1280 x 720, an 85-degree field of view, and a frame rate of 30 frames per second. The head mounted devices were specifically designed for observing mother-infant interactions, based on pilot studies conducted in South Africa (271) and the United Kingdom (277). Studies by Lee et al., 2017 (75), Wrottesley et al., 2021 (270,271), and Skinner et al., 2023 (270) highlight the enhanced performance of these wearable cameras in researching parent-child interactions compared to older models. These newer models are noted for advancements including sharper image quality, longer battery duration, increased storage capabilities, more compact and lightweight designs, broader viewing angles, and enhanced image stability.

During home visits, a research assistant demonstrated the use of the headcams. Mothers were instructed to place a headcam on their infants' foreheads and to record at least three videos of their free play interactions at home with their infants within a one-week period (75). I requested a minimum of three minutes of recording to ensure sufficient data for coding, as the standardized duration for micro-analytic coding of video footage is set at 150 seconds for statistical analysis (61,95).

After seven days, the cameras were retrieved, and the footage was downloaded, converted into MP4 format, and stored. To determine whether a video was suitable for coding, criteria such as lighting conditions, camera angles, and image clarity were assessed. The mother needed to be clearly visible with sufficient light to capture the nuances of her facial expressions. Since mothers were instructed to record multiple times during the week, the first usable three minutes of uninterrupted footage were chosen for analysis to ensure an unbiased selection. Following this process, 57 videos of mothers were deemed appropriate for analysis.

Maternal facial expressions were meticulously coded for every second of video footage. I adhered to the guidelines outlined in the Mental Health Intergenerational Transmission Process Manual [MHINT Manual, Costantini et al., 2021 (277)] and used the micro-coding scheme from Observer XT 16® by Noldus Information Technology (90).The coding scheme included distinct codes for each maternal facial expression, such as alert/worried, concentration, disgust, face not visible, mock surprise, negative, neutral, positive, and smile (277,278). I was specifically

interested in neutral facial expressions meaning that the caregiver's face lacked clear indication of positive or negative affect. A neutral expression was defined as an overall relaxation of facial musculature, open eyes, and lips closed or slightly parted. A positive facial expression was identified when the caregiver displayed visible signs of emotions such as joy, interest, excitement, amusement, fun, happiness, or sensory pleasure. To qualify, the face needed to show at least one eye, the nose, and the mouth. Activation of the zygomaticus muscle - a key marker present across all types of positive or happy expressions (399) - was required for the expression to be classified as positive. Open-mouth expressions reflecting positive interest were also coded as positive facial expressions. Positive affect included both interest/excitement and enjoyment/joy. A broad and unmistakable smile was recorded when the caregiver showed a clear upward and outward movement of the mouth's corners, accompanied by focused, brightened eyes and relaxed or slightly lifted eyebrows. For a smile to be coded, it required visible engagement of both the zygomaticus and orbicularis muscles - indicating that both the mouth and eyes were actively involved in the expression (399).

While viewing the videos, I focused exclusively on coding the mother's facial expressions. Each change in expression was marked with a time stamp to denote the start and end of specific behaviours. For example, if the mother displayed a positive expression, it was time-stamped as 'mother facial expression positive' and when she shifted to a neutral expression, it was marked accordingly (279), indicating the timing of transitions. If the mother's face was not visible due to poor video quality or other factors, it was recorded as 'not possible to code mother facial expression.' This coding process was applied throughout the entire mother-infant interaction. The time-stamped data were stored in the Observer XT 16® software (90).

Figure 1 illustrates an example of the coded maternal expressions, where coloured blocks represent the number and duration of each expression.

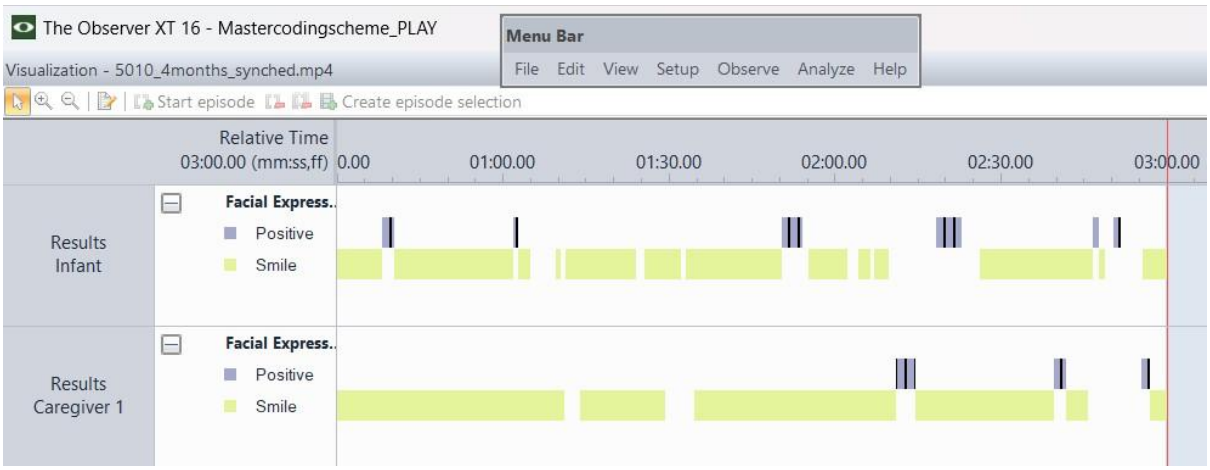


Figure 12: Example of micro-coded data on the behavioural domains of mother-infant facial expressions with timestamps. Only data for maternal neutral, positive and smiling facial expressions were used

For this study, I extracted only neutral, positive and smiling facial expressions based on formative research in this population (397). The mean duration (176) of facial expression is defined as the average amount of time each incident of facial expression lasts (e.g. each smile occurs for an average of 3 s). To ascertain the total duration of expressions, the mean duration for the facial expression is multiplied by the number of times that the expression occurred over the recording period (e.g., if there were 5 smiles, with a mean duration of 3s over the entire duration of the video clip, then the total duration would be: 3 * 5 = 15 s).

The probability of the mother transitioning from one facial expression to the next within specified time periods was calculated using lag sequential analysis in the Observer XT 16 (62). For example, Observer XT 16 calculated the probability of a mother's neutral facial expression occurring 3 seconds before the target facial expression a (i.e.: positive facial expression), based on all occurrences of that particular target facial expression (i.e., across all occurrences of a smile how likely is it that within 3 secs beforehand the mother showed a positive facial expression) for each observation. Typically, facial expressions evolve from neutral to positive to smiling, and transitions occur within 0.2 to 3.0 seconds (400), and so lag times of 1, 2 and 3 seconds were used to define a transition in this study.

Behavioural sequences were defined as the presence of a specific facial expression within the designated time window prior to the target expression, irrespective of whether the key behaviour occurred more than once. If the same key behaviour occurred repeatedly within the lag window,

it was still considered part of a single sequence contributing to the calculated probability. Intervening behaviors - such as brief returns to a neutral expression between positive and smiling - were not excluded but treated as part of the natural variability in transition patterns, as long as they occurred within the same time window. As the examined time window increased from 1 to 3 seconds, the analysis captured a broader range of potential transitions, allowing for more flexibility in detecting delayed affective responses and thus accounting for slower or more varied patterns of maternal emotional expression.

Reliability

After receiving extensive training on using Observer XT 16® (90) to code maternal facial expressions, I coded all the videos, while a second researcher (Prof Rebecca Pearson for Manchester Metropolitan University) re-coded one-third of them to assess reliability. The goal was to determine if both coders identified the same facial expressions (355), including the durations of each. Inter-rater reliability was measured using the duration/sequence comparison method, which examines the alignment of events' temporal spans. We employed the time-based intersection method to compare the video segments both coders analysed, focusing on behaviours occurring during the shared time span (351). I used Cohen's Kappa coefficients to gauge levels of inter-rater reliability (356). After an analysis of all the video segments (n=57) we found an average Cohen's Kappa coefficient of 0.71 (range 0.65 to 0.89). Landis and Koch, 1977 (401) suggest that scores between 0.41-0.60 demonstrate moderate agreement, 0.61-0.80 indicate substantial agreement, and 0.81-1.0 show almost perfect inter-rater reliability. Bakeman and Quera, 2011(357) emphasise that point-by-point agreements - typically reflected in Cohen's kappa values above 0.60 - are considered robust and sufficient for complex behavioural coding.

Statistical analyses

All plots and statistics were completed using R v4.4.0 (2024). To describe the population, demographic data were summarised using frequencies (percentages) for categorical variables; and median and the 1st and 3rd quantiles [median (Q1, Q3)] for continuous variables. To compare groups of mothers with varying degrees of depression, I assigned participants to a non-depressed group or a sub-clinical depression group using the aforementioned cut-off scores. Observer XT 16 (90) automatically calculated the total durations for maternal facial expressions.

After data extraction, I used a quantile regression with a conditional median and controlled for the length of the video footage to assess differences between the non-clinical depression and sub-clinical depression groups. I extracted lag sequential data for 1-, 2- and 3-second periods for each maternal facial expression transition from neutral to positive; neutral to smile, and positive to smile. Transition probabilities for the non-depressed and sub-clinically depressed groups were modelled using 0 and 1-inflated beta regression, using a Bayesian framework (uninformative priors, chains = 4, iterations = 4000 with a warm-up of 1000, and backend = CmdStan). For reproducibility, the random seed was set at '1234'.

In addition to the 0 and 1-inflated beta regression, which models the transition probabilities on a continuous scale, I conducted a supplementary analysis of the transition probabilities using a frequentist ordinal regression approach. For this supplementary analysis, we cut the transition probabilities into quintiles and modelled the quintiles (dependent variable) against group membership (non-depressed vs sub-clinically depressed; independent variable).

For all frequentist models, we interpreted $p < 0.05$ as being statistically significant. For the Bayesian models, I interpreted differences in modelled transition probabilities between the non-depressed and the sub-clinically depressed groups as being meaningful when there was no overlap in 95% credible intervals, where 95% credible intervals indicate the range within which the true transition probability is expected to fall with 95% probability. In conclusion, using the Bayesian models, we looked at overlap of the credible intervals and where there was no overlap, we concluded that they were substantively different from each other.

Finally, while an explicit a priori power analysis for every specific micro-level sequential analysis was not feasible given the exploratory nature of some of these analyses, the overall sample size of 57 mother-infant dyads for the observational studies (in chapters 4 and 5) was reviewed based on established guidelines for detecting moderate to large effect sizes in behavioural observational research (402). For studies comparing group differences in behavioural durations or frequencies, a sample size of n=50-60 typically provides sufficient power (e.g., 0.80 at $\alpha=0.05$) to detect medium to large effects (Cohen's $d \geq 0.5$). Similarly, for sequential analyses, a sample size within this range has been shown to be adequate for identifying statistically significant contingencies, especially for frequently occurring behaviours

(403). Given the challenges of recruiting and collecting high-quality observational data in this specific community setting, this sample size was considered sufficient to balance statistical power with practical feasibility (357).

5.3 Results

Demographics

The average age of the mothers was 31 years old (28.0-33.0), 21% were employed, and 42% of the mothers were single and not living with a partner.

Table 13: Demographic characteristics of the sample

Characteristic	**Overall** (N = 56)
MOTHERS	
Age (years) [Median (Q1, Q3)]	31.0 (28.0, 33.0)
Socio-economic score [Median (Q1, Q3)]	8.00 (7.00, 9.50) / 13
Employment: [n (%)]	
Currently have a job	9 (21%)
Current relationship status: [n (%)]	
Single	18 (42%)
In a relationship	25 (58%)

Maternal depression prevalence

One participant had an EPDS score of 14, thus exceeding the upper limit used to identify sub-clinical depression and was excluded from all further analyses. For the non-depressed group, the

sample size was 34 and the median EPDS score was 2 (1.3 to 3.0). For the sub-clinically depressed group, the sample size was 22 and the median EPDS score was 8.5 (7.0 to 10.8).

Duration of maternal facial expressions

The formative study (397) found that mothers presented mostly with neutral, positive and smiling facial expressions. Table 2 shows the mean duration, number of occurrences and total duration of each specific facial expression. More specifically, mothers' smiles presented most frequently and for the longest durations of the facial expressions.

Table 14: Mean durations, number of occurrences, and total durations for maternal facial expressions

Maternal facial expression	Mean duration [Median (IQR)]	Number of occurrences [Median (IQR)]	Total duration [Median (IQR)]
Neutral (s)	2.2 (0, 3.5)	2 (0, 5)	6.1 (0, 20.2)
Positive (s)	1.4 (0, 3.1)	2 (0, 4)	2.6 (0, 10.5)
Smile (s)	9.6 (6.5, 17.8)	7 (6, 11)	90 (55.1, 130.2)

Comparisons of total duration of maternal facial expressions

When comparing the total duration of maternal neutral, positive, and smiling facial expressions between the non-depressed and sub-clinically depressed groups; we found that there was no statistically significant association between depression status and the total time mothers spent with any of the aforementioned expressions.

Neutral: After controlling for total recording time, the sub-clinically depressed group spent a median of 4.8 seconds longer than the non-depressed group with a 95% confidence interval of -2.2 seconds to 11.7 seconds, and a p-value of 0.174 during mother-infant interaction.

Positive: After controlling for total recording time, the sub-clinically depressed group spent a median of 4.0 seconds longer than the non-depressed group with a 95% confidence interval of -0.7 seconds to 8.7 seconds, and a p-value of 0.093 during mother-infant interaction.

Smiles: After controlling for total recording time, the sub-clinically depressed group spent a median of 18.5 seconds less than the non-depressed group with a 95% confidence interval of -47.0 seconds to 10.0 seconds, and a p-value of 0.199 during mother-infant interaction.

Facial expression transitions

Table 15 shows how many participants transitioned at least once between different facial expressions and were included in each model - the total sample size varies as not all mothers presented with all facial expression transitions.

Table 15: Number of participants transitioning between different facial expressions

Depression category[1]	Number of participants transitioning between different facial expressions			
	Total	Neutral to Smile	Neutral to positive	Positive to smile
Non-depressed	34.0	22.0	17.0	23.0
Sub-clinical	22.0	19.0	16.0	17.0

[1]EPDS scores: None = ≤5, sub-clinically depressed = 6-13

Neutral to positive facial expression transition probabilities

Figure 13 illustrates the predicted probability distributions for non-depressed and sub-clinically depressed mothers for transitions from neutral to positive facial expressions for 1, 2, and 3-second lag periods. For a 1-second lag, the non-depressed group had a point estimate of 0.03 and a credible interval of 0.0 - 0.13, and the sub-clinically depressed group had a point estimate 0.03 and a credible interval of 0.0 - 0.14. For the 2-second lag, the non-depressed group had a point estimate of 0.12 and a credible interval of 0.03 - 0.27 and the sub-clinically depressed group had a point estimate 0.1 and a credible interval of 0.0 - 0.19. For the 3-second lag, the non-depressed group had a point estimate of 0.21 and a credible interval of 0.11 - 0.35 and the sub-clinically depressed group had a point estimate 0.1 and a credible interval of 0.02 - 0.21. Thus, while the point estimates for the 2-second and 3-second lag periods were lower for the sub-clinically depressed group as compared to the non-depressed group, there was considerable overlap in the interval estimates, and the outcome is inconclusive.

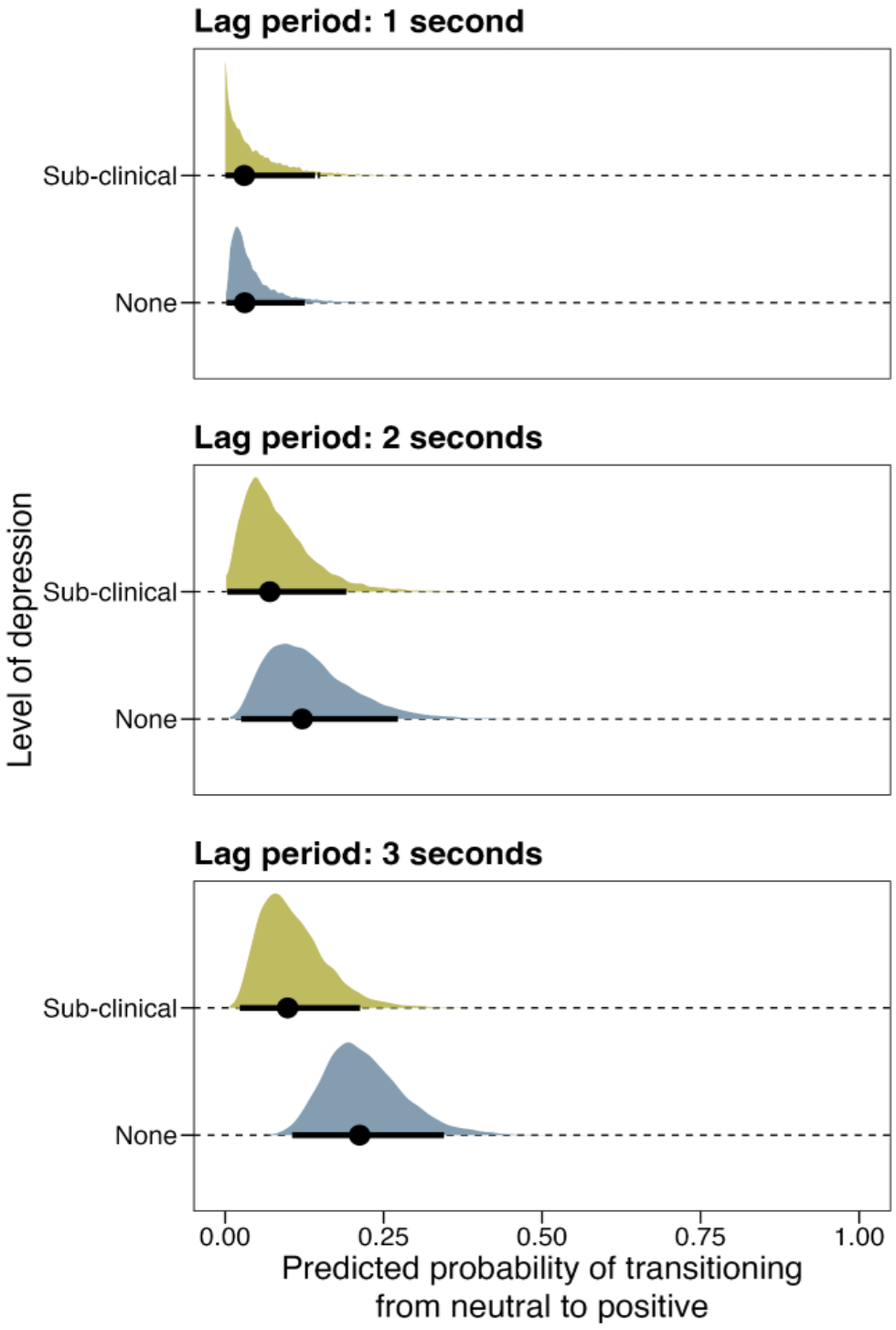


Figure 13: The predicted probability distributions showing differences in transitions from neutral to positive facial expressions between non-depressed and sub-clinically depressed mothers for 1, 2, and 3-second lag periods using Bayesian analysis

Consistent with the results of the Bayesian models, Table 16 shows that there was no significant relationship at 1, 2, and 3-second lag times in the ordinal regression analysis when examining transitions from neutral to positive facial expressions in mothers with no depression and mothers with sub-clinical depression.

Table 16: Ordinal regression analysis for maternal neutral to positive facial expression. Odds ratios indicate the odds of being in a higher quintile of transition probability in sub-clinically depressed mothers compared to non-depressed mothers

Lag time (seconds)	State of depression	Odds ratio	95% confidence interval	p-value
1	Sub-clinical	0.26	0.07-0.99	0.048
2	Sub-clinical	0.58	0.16-2.07	0.388
3	Sub-clinical	0.29	0.08-1.09	0.066

Neutral to smile facial expression transition probabilities

Figure 14 illustrates the predicted probability distributions for non-depressed and sub-clinically depressed mothers for transitions from neutral to smile facial expressions for 1,2, and 3-second lag periods. For a 1-second lag, the non-depressed group had a point estimate of 0.07 and a credible interval of 0.02 - 0.15 and the sub-clinically depressed group had a point estimate 0.04 and a credible interval of 0.01 - 0.13. For the 2-second lag, the non-depressed group had a point estimate of 0.25 and a credible interval of 0.15 - 0.39 and the sub-clinically depressed group had a point estimate 0.2 and a credible interval of 0.09 - 0.33. For the 3-second lag, the non-depressed group had a point estimate of 0.38 and a credible interval of 0.25 - 0.53 and the sub-clinically depressed group had a point estimate 0.32 and a credible interval of 0.2 - 0.44. Thus, while the point estimates for all lag periods were lower for the sub-clinically depressed group as compared to the non-depressed group, there was considerable overlap in the interval estimates, and the outcome is inconclusive.

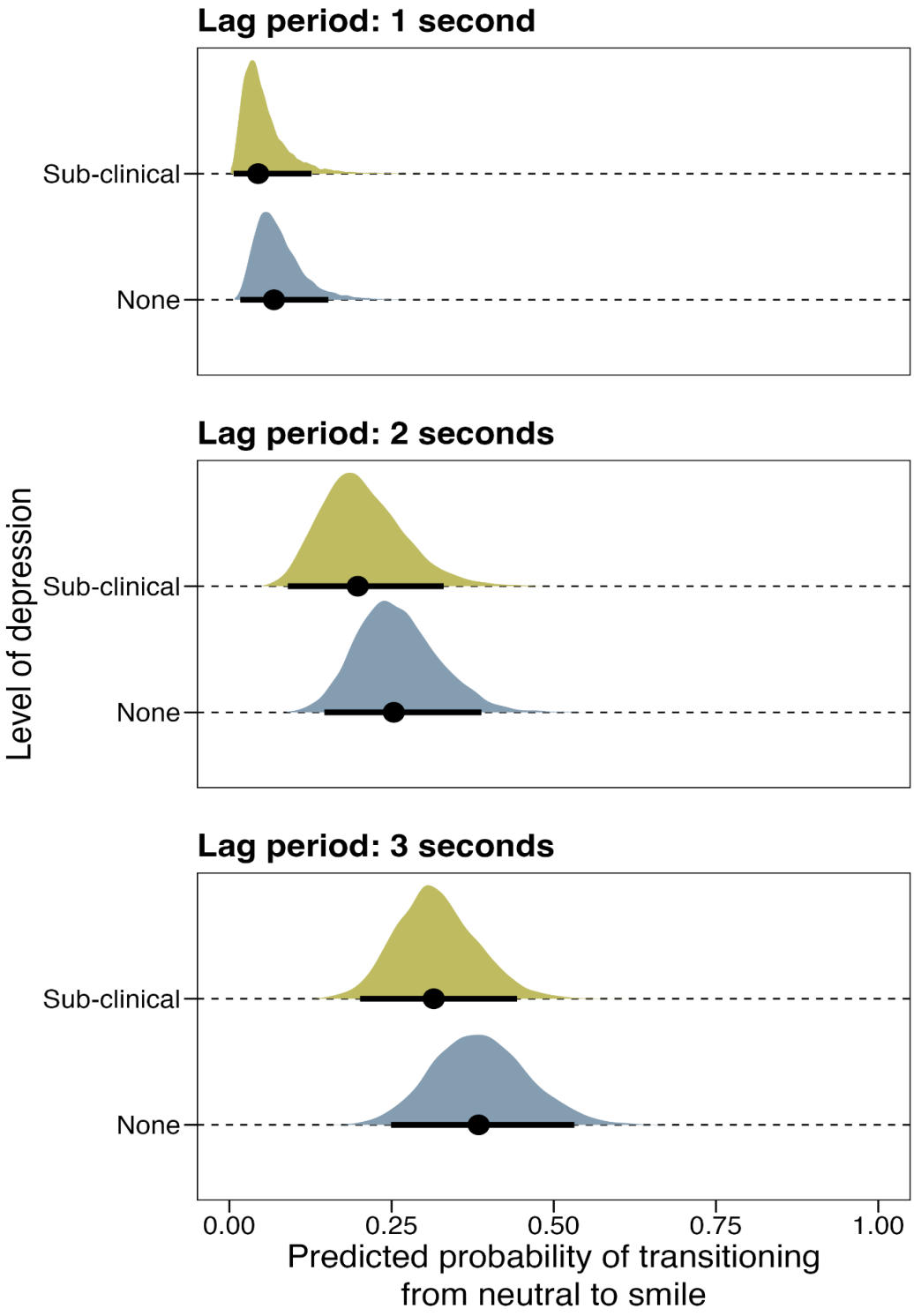


Figure 14: The predicted probability distributions showing differences in transitions from neutral to smile facial expressions between non-depressed and sub-clinically depressed mothers for 1, 2, and 3-second lag periods using Bayesian analysis

Consistent with the results of the Bayesian models, Table 17 shows that there was no significant relationship at 1, 2, and 3-second lag times in the ordinal regression analysis when examining transitions from neutral to smile facial expressions in mothers with no depression and mothers with sub-clinical depression.

Table 17: Ordinal regression analysis for maternal neutral to smile facial expression. Odds ratios indicate the odds of being in a higher quintile of transition probability in sub-clinically depressed mothers compared to non-depressed mothers

Lag time (seconds)	State of depression	Odds ratio	95% confidence interval	*p-value*
1	Sub-clinical	1.12	0.36-3.44	0.841
2	Sub-clinical	0.69	0.22-2.14	0.512
3	Sub-clinical	0.99	0.32-3.05	0.989

Positive to smile facial expression transition probabilities

Figure 15 illustrates the predicted probability distributions for non-depressed and sub-clinically depressed mothers for transitions from positive to smile facial expressions for 1,2, and 3-second lag periods. For a 1-second lag, the non-depressed group had a point estimate of 0.12 and a credible interval of 0.03 - 0.23 and the sub-clinically depressed group had a point estimate 0.02 and a credible interval of 0.0 - 0.12. For the 2-second lag, the non-depressed group had a point estimate of 0.38 and a credible interval of 0.24 - 0.53 and the sub-clinically depressed group had a point estimate 0.11 and a credible interval of 0.04 - 0.21. For the 3-second lag, the non-depressed group had a point estimate of 0.49 and a credible interval of 0.37 - 0.63 and the sub-clinically depressed group had a point estimate 0.15 and a credible interval of 0.06 - 0.26. Thus, while the point estimates for all lag periods were lower for the sub-clinically depressed group as compared to the non-depressed group, there was overlap in the interval estimates, for the 1 and 2-second time lags and the outcome is inconclusive. For the 3-second time lag, there was no overlap in the interval estimates between the two groups, concluding that there was a meaningful and robust difference between the probability distributions of the non-depressed and sub-clinically depressed groups.

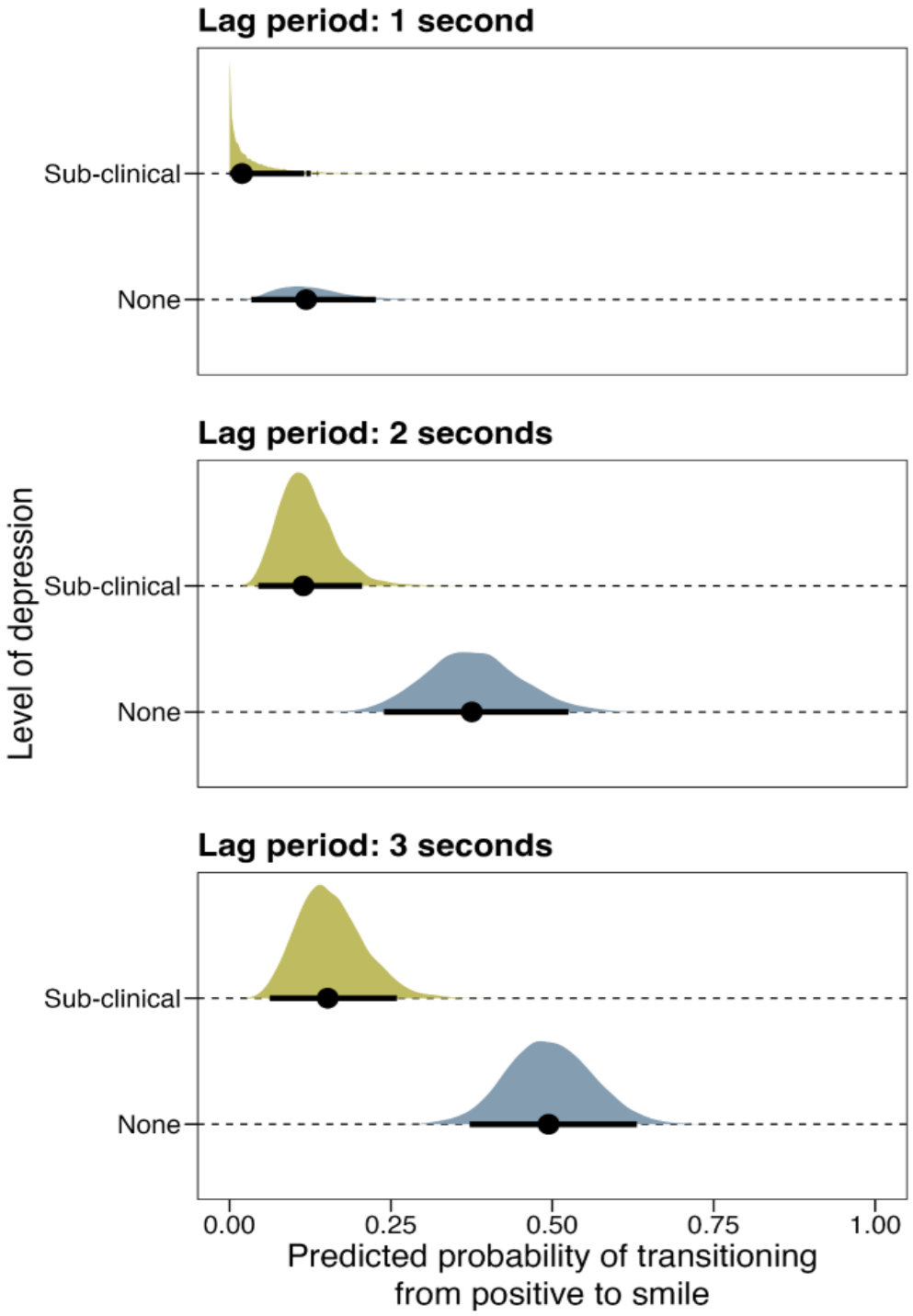


Figure 15: The predicted probability distributions showing differences in transitions from positive to smile facial expressions between non-depressed and sub-clinically depressed mothers for 1,2, and 3-second lag periods using Bayesian analysis

Consistent with the results of the Bayesian models, Table 18 shows that there was no significant relationship at 1 and 2-second lag times in the ordinal regression analysis when examining transitions from positive to smile facial expressions in mothers with no depression and mothers with sub-clinical depression. For the 3-second lag, the odds of being in a higher quintile for transitioning from positive to smile were substantially lower in the sub-clinically depressed group than those in the non-depressed group. The sub-clinically depressed group was 84% less likely to be in a higher quintile to transition from positive to smile within 3 seconds. There was strong evidence for this finding not being due to chance indicated by the low p value of 0.006.

Table 18: Ordinal regression analysis for maternal positive to smile facial expression. Odds ratios indicate the odds of being in a higher quintile of transition probability in sub-clinically depressed mothers compared to non-depressed mothers

Lag time (seconds)	State of depression	Odds ratio	95% confidence interval	*p-value*
1	Sub-clinical	0.31	0.1-1.02	0.053
2	Sub-clinical	0.31	0.09-1.01	0.052
3	Sub-clinical	0.16	0.04-0.57	0.006

5.4 Discussion

This comparative study explored the role of depressed mood on the dynamic evolution of maternal facial expressions, offering a novel approach to understanding mother-infant interactions. In comparing the total duration of maternal neutral, positive, and smiling facial expressions between non-depressed vs sub-clinically depressed mothers; I found no statistically significant association between depression status and the total time mothers spent with any of these expressions. After analysing the probability of transitioning between neutral to positive to smile within a 3 second time lag, I found that the sub-clinically depressed group was less likely to be in a higher quintile to transition from positive to smile within 3 seconds.

Grounded in the dynamic systems perspective (332,333) which posits that a dyad occupies one of many possible behavioural states at any given moment and then moves to another, (404) this study uniquely focuses on facial expression transitions within the mother, extending previous

research on state changes over time. The focus on maternal facial transitions within the dyadic system provides a foundation for understanding the nuances of emotional responsiveness in mother-infant interactions.

The study revealed that the overall duration of maternal facial expressions did not significantly differ between the non-depressed group and the sub-clinically depressed group. Similar findings were revealed by Costantini, 2023 (405), however comparing studies is difficult due to the different parameters and cultural contexts set for each study. Both these studies reveal findings that are contrary to the idea that depressive symptoms are associated with mothers exhibiting more neutral and negative emotional expressions toward their children (244) and low positive emotional expressions (406,407). An increased sample size may have revealed a more definitive relationship between maternal depressive symptoms and facial affect.

The most salient finding was that sub-clinically depressed mothers were less likely to be in a higher quintile to transition from positive to smile within 3 seconds. Thus, sub-clinically depressed mothers were less likely to display a positive facial expression within a 3-second time window before smiling, suggesting disruptions in emotional transitions when compared to non-depressed mothers. This aligns with broader patterns observed that mothers with depressive symptoms may exhibit emotional regulation challenges (385,396) displaying reduced emotional expressiveness and responsiveness when interacting with their infants (95,244,408,409). While affective inflexibility has often been cited as a key mechanism underlying disrupted emotional expression in mothers with depressive symptoms, additional factors may also play a significant role. Gross, 1999 (410) identified behavioural avoidance, distraction, and rumination as risk factors for impaired emotion regulation in postpartum depression, which may contribute to difficulties in modulating facial expressions. These regulatory challenges can be compounded by increased cognitive load, as the effort to manage internal distress may reduce the mental resources available for attending to infant cues and fluidly shifting affect (410). Emotional blunting, even in cases of sub-threshold depression, may further limit a mother's ability to express nuanced emotional responses. Moreover, while some mothers may outwardly adopt behaviours associated with the ‘good mother’ role, reduced intrinsic motivation for emotionally rich engagement and a self-focused orientation can impede the reciprocal nature of mother-infant interactions. Additionally, mothers with depressive symptoms show differences in the neural

networks of the pre-fontal regions and paralimbic systems (408) involved in emotion processing and responsive parenting behaviours, which may have contributed to the lower probability of transitions observed in this study.

Findings of such disruptions in emotional transitions are important, as maternal emotional regulation plays a key role in synchrony with the infant (396). If a mother's emotional regulation is compromised by depressive symptoms, the impact extends to her interactions with her infant. Supporting this notion, the still-face paradigm developed by Tronick et al., 1978 (169) illustrates how infants respond negatively when mothers show reduced emotional responsiveness in their facial expressions during interactions, with subsequent effects on attachment (122,411). Extending this study's methodology to analyse infant facial transitions is the next step in investigating dyadic interaction further.

Additional research on depressed mood, maternal facial expression transitions, and resilience could prove valuable. To define resilience for this context, it refers not to the absence of hardship, but to the capacity of mothers to maintain adaptive functioning, positive emotional regulation, and responsive caregiving despite confronting profound and persistent socio-economic adversities (412). It encompasses protective factors such as strong social support, personal coping mechanisms, and the ability to find meaning or hope amidst challenges. Exploring resilience would involve identifying what factors enable some mothers to maintain strong dyadic interactions even when facing similar stressors, whereas others struggle (412). Resilience is of particular significance in this population, considering that only 21% of the mothers were employed, potentially reflecting broader socioeconomic challenges. Additionally, 42% of the participants were single, which could have an impact on emotional and financial difficulties.

In this research, flexibility was observed in the context of the participants involved. Despite experiencing depressive symptoms, these mothers still smiled frequently, suggesting that emotional responsiveness was not entirely absent. However, it is possible that their facial expressions were less nuanced, with more positive emotional expressions and gradual transitions from neutral-positive-smiling requiring greater emotional effort. This suggests that emotional energy may significantly impact mothers' ability to convey a full range of emotions.

Considering our findings and further suggested research, it is essential to account for cultural factors that might influence maternal behaviours. The small sample size, coupled with the diversity of cultural practices in South African communities, makes it difficult to generalize our results across all mothers within these settings. In many of these communities, infants are often cared for by multiple caregivers, which can shape their socialization experiences (128). The collaborative co-parenting structures observed in these families may play a crucial role in the infant's early social and cultural adaptation (413). Furthermore, assessing maternal mental health in vulnerable populations remains challenging due to limited culturally appropriate tools (350,414).

Effective community-driven interventions, such as those designed by the Ububele Centre in Johannesburg (415) and Cooper et al., 2009 (416), are to be prioritised. Both models involve community workers with lived experience and cultural insight; and have demonstrated effectiveness in preventing the onset and persistence of postnatal depression. My findings suggest that such approaches may be particularly impactful, as I observed significant effects of sub-clinical depression on maternal affect transitions - an issue that would be overlooked in mass screening efforts within clinical settings that tend to focus only on clinical depression. Training community workers to support mothers in developing emotional regulation strategies - such as seeking emotional and instrumental support, engaging in cognitive reappraisal, and practicing acceptance (410) may be particularly valuable. Psychoeducation on mindfulness will also benefit mothers to orientate themselves in their feelings of neutral and emotional affect. Results indicate that the 3 second time window is most meaningful unit of analysis, highlighting the importance of encouraging mothers to pause and process difficult emotions rather than suppressing them or rushing through them. This insight not only has theoretical implications - given that mother-infant synchrony is often defined within a 3-second reciprocal window (38) but also practical ones for intervention. Training community workers to recognise and support the nuanced dynamics of mother-infant interaction should be considered a vital component of dyadic support (417). These strength-based, community-driven approaches (415,419) are designed to enhance flexibility and promote healthier emotional adjustment during the postpartum period, enabling mothers to manage the challenges of early parenting more effectively (410,420). By fostering these protective mechanisms, such interventions can benefit maternal well-being and infant emotional development.

While these findings are based on mothers with sub-threshold depressive symptoms, it is important to note that higher levels of depressive symptoms may have a different, possibly more pronounced, impact on emotional responsiveness. Future research and interventions might also benefit from including modules that explore and cultivate maternal resilience, which could further strengthen mother-infant relationships in high-risk communities.

5.5 Limitations

One significant limitation of this study lies in its dependence on short-term observational data, which captures only brief snapshots of mother-infant interactions. Such brief sessions may not fully capture the nuanced, evolving nature of relational patterns that occur across different contexts and times of day. Mother-infant dynamics are inherently fluid and influenced by multiple factors - including fatigue, feeding cycles, environmental stressors, and the infant's developmental stage - which may not be represented during a single observation period. Additionally, the act of being filmed may have introduced performance bias or social masking, where mothers may have modified their natural behaviour due to awareness of being observed. This reactivity can lead to an overrepresentation of socially desirable behaviours, such as increased displays of warmth or attentiveness, which might not reflect typical everyday interactions.

Moreover, although maternal mental health was assessed using a depression screening tool, this approach provided only a limited view of the psychological variables influencing maternal behaviour. Broader dimensions of maternal mental illness - such as anxiety, trauma history, or personality disorders - were not examined, despite their potential impact on caregiving. A more comprehensive psychological assessment could have enriched the understanding of how different emotional or cognitive profiles shape mother-infant exchanges.

To address these gaps, future research would benefit from adopting longitudinal designs that allow repeated observations over extended periods. Such designs would enable researchers to identify patterns of interaction stability or change, particularly in response to fluctuations in maternal mood. Expanding the sample size would also enhance the generalisability of findings and enable more robust statistical analyses, including subgroup comparisons (e.g., based on

severity or type of mental health symptoms). Ultimately, a more holistic and long-term approach would offer a deeper understanding of how maternal mood disturbances influence caregiving behaviour and, in turn, affect infant socio-emotional development.

5.6 Conclusion

This study revealed that mothers with sub-clinical depression were significantly less likely than non-depressed mothers to show positive facial expressions in the 3 seconds before smiling. This finding highlights how even mild depressive symptoms can disrupt the smooth transition of maternal facial expressions. Community workers with lived experience can play a key role in helping mothers practice moment-to-moment mindfulness, offering valuable support for emotional regulation. Such guidance could directly enhance the dynamic interaction between mothers and their infants.

SECTION 3: INTEGRATION

CHAPTER 6

Integrated discussion

“When spider webs unite, they can tie up a lion”

Ethiopian proverb

6.1 Introduction

In this chapter, I explore the intricate 'web' that often leaves mothers feeling trapped in their relational and environmental circumstances, making the challenges of motherhood harder to navigate. I will consolidate the findings of this PhD through an in-depth discussion of themes uncovered from both qualitative and quantitative analyses and aim to identify what is needed to strengthen and support mother-infant relationships within this particular population. My goal is to offer fresh insights that empower women, fostering improved relationships and well-being.

6.2 Study rationale

This PhD aimed to explore the impact of maternal mental health on mother-infant interactions. Literature underscores the crucial role of nurturing both mother and child in the early stages of development. Given that mothers serve as the child's first teacher, it becomes essential to address maternal sensitivity (32) and responsiveness in caregiving (421). By focusing on mothers' ability to attune to and reflect on their infant's needs, we can foster a healthy mother-infant bond. This bond, in turn, can act as a preventative measure, promoting the development of trust and emotional security within individuals, which can ripple outwards to strengthen societal cohesion. However, it is important to recognise that mothers are not always the sole or primary caregivers; fathers, grandparents, and other family members often play central roles in caregiving and early learning (203). Acknowledging these diverse caregiving arrangements allows for a more inclusive understanding of child development within varying familial and cultural contexts.

Although research has extensively explored the mother-infant relationship, a significant gap remains. It is well established that a regular amount of visual attention towards the other and healthy mirroring of facial expression from the mother is important for a healthy relationship and for infant social, cognitive and emotional development (84). It is also well documented that depressed mothers tend to be less responsive and exhibit more flattened affect in face-to-face communication with their infants. However, a significant paucity in research persists, as these findings are primarily derived from studies conducted in Western, educated, industrialised, rich, and democratic (WEIRD) societies (344). As this term was coined to describe the demographic bias in psychological and health science research, where most studies focus on participants from

these kinds of societies, the result is that findings from such research may not be representative of human behaviour globally. This concept highlights the limitations of generalised research findings where vulnerable groups are often outliers due to their cultural norms, values and social and structural environments when compared to global populations. Thus, this PhD sought to address this paucity of research by exploring whether these patterns of behaviour vary across more diverse cultural contexts, recognising that mental health is deeply influenced by an individual's environment.

6.3 Key findings

The mixed methodologies employed were purposefully designed and uniquely applied to capture the to-and-fro nature of relationships. Data was sought from verbal exchange in dialogue (for objective 1), interactional behavioural reciprocity (objective 2) and dynamic facial evolution (objective 3). Key findings from these objectives are discussed here.

To gain a deeper understanding of the environmental and cultural context of motherhood in Soweto, I initiated this PhD with a qualitative approach. This method was chosen as the foundation for the series of studies, enabling me to capture the nuanced experiences and challenges faced by mothers in this specific setting. Focus group discussions revealed themes of maternal perspectives on poor mental health and the impact that this would have on mother-infant relationships. Mothers thought that partner conflict - particularly paternal denial, family conflict, poor community support, lack of trust in the healthcare system and lack of resources - were strong contributors towards stress. Participants clearly understood the reciprocal relationship with their infants. However, a strong theme of maternal persecution emerged. Many mothers unconsciously projected past traumas onto their relationships with their infants and assumed their infants were hurting or punishing them. This projection may have served as a coping mechanism to avoid confronting their own mental health issues.

Within a similar context, but with a bigger sample size, I then aimed to investigate two key behaviours that underpin the development of the mother-infant relationship. In describing the synchrony of visual attention and facial expression between mothers and their infants in a poorly resourced setting in South Africa, I found that mothers spent most of the time (92%) looking at

their infants during face-to-face interactions and smiled for 59% of the time. Infants looked at their mothers for almost half the time, looked at distractions for 17% of the time and presented with more neutral expressions. Measurement of synchrony requires the identification of who would lead a face-to-face interaction and who would follow within a 3 second lag time. On reflection, this was challenging to measure as mothers were more often than not looking at their infants and smiling at them, leaving little variation of behaviour and little opportunity to measure the construct. I hypothesised that a mother's extended displays of positive affect may have reflected not only a cultural norm but also an attempt to be perceived as a 'good enough' mother within an under-resourced context. It is also plausible that these behaviours were influenced by social desirability bias, whereby mothers adjusted their responses to align with perceived expectations of appropriate caregiving. The knowledge that their interactions were being recorded and would later be viewed by others may have further contributed to a sense of needing to 'perform,' potentially shaping the authenticity of observed behaviors. I speculated that the little variation in maternal response suggests less attunement towards the infant which may hinder infant's learning of social contingency. However, I acknowledge that mothers may have felt under pressure to look at their infants and to smile at them, which may have skewed results. This must be taken into consideration when interpreting results.

To address that maternal adverse experiences and mental health challenges can impair a mother's ability to recognize and respond to an infant's needs, my last study in the PhD research series was to compare facial affect transitions of non-depressed and sub-clinically depressed mothers. I used data from the previous study where I found that mothers presented mainly with neutral, positive and smiling facial expressions. I wanted to investigate maternal smiles more deeply given that mothers presented with prolonged smiling with little variation between facial expressions as described in the previous chapter. While 39% of the participants in the study were sub-clinically depressed, I found no statistical difference between the two groups when assessing the total duration of the time that mothers spent displaying neutral, positive and smiling facial expressions. For a mother transitioning from a positive facial expression to a smile within 3 seconds, the odds of transitioning were significantly lower in the sub-clinical group than those in the non-depressed group. This may indicate that sub-clinical depressive symptoms disrupt maternal facial expression transitions and difficulties with affective flexibility needed for emotional co-regulation. See table 19 for an overview of study findings per objective.

Table 19: Overview of study findings per objective			
Chapter	**Study objective**	**Key findings**	**Conclusion**
3	To explore maternal perspectives on poor mental health and the impact this has on mother-infant relationships within a community advisory group of Sowetan mothers.	Key contributors to poor mental health included: • partner and family conflict (denial of paternity) • poor community support • lack of trust in the healthcare system • lack of resources. Mothers believed their mental health affected their ability to bond with their infants. A significant theme identified was perceived maternal persecution.	Interpersonal and financial stresses were perceived to significantly impact mothers' mental health in the early postpartum period. By understanding the perceived causes of postpartum depression and anxiety, and how poor mental health affects bonding, interventions that are culturally and contextually sensitive may be developed to support mothers and to foster trusting mother-infant relationships in this setting.
My finding revealed that some mothers perceived their infants' actions as intentionally hurtful, suggesting persecutory feelings. I hypothesised that helping mothers recognise their infant's gaze and the emotional connection it fosters could be beneficial for future intervention. This led me to shift my focus towards key behaviours of visual attention and facial expressions, which are fundamental to nurturing the mother-infant relationship.			
4	To describe the synchrony of visual attention and facial expression between mothers and their infants in a poorly resourced setting in South Africa.	Data for 37 871 seconds of mother-infant interactions were analysed. For visual attention: • infants looked at their mothers 47% of the time (mean duration = 8.8 secs), with a 25% chance of looking back within 3 seconds of their mothers looking at them. • Mothers looked at their infants 92% of the time (mean duration = 34.2 secs). • Infants spent 17% of their time looking at distractions • mothers spent 1.8% looking at distractions. For facial expressions:	Mothers were more visually attentive and smiled more, while infants were often distracted with neutral expressions. Mothers' prolonged displays of positive affect may be a cultural, interactional norm or this behaviour reflects a desire to be a 'good enough' mother in an under-resourced setting. Synchrony was challenging to measure due to few transitions of behaviour. Little variation in maternal affective response with infants reflected less attunement

		• infants smiled 9% of the time (mean duration= 3.8 secs). Infants had a probability of 14% to smile back within 3 seconds of their mothers smiling. • Mothers smiled 59% of the time (mean duration = 9.6 secs) with a probability of 13% chance of smiling back within 3 seconds of their infants smiling. • Infants had neutral expressions 34% of the time • mothers had neutral expressions 4% of the time.	towards the infant which may hinder the infant's learning of social contingency. These findings are the first to describe synchrony in this setting, highlighting the need for further research of culture specific, mother-infant interaction analysis.
Next, I wanted to address prior research indicating that mental health challenges can impair a mother's ability to respond to an infant's needs. I aimed to investigate maternal smiles more deeply given that mothers presented with prolonged smiling with little variation between facial expressions when interacting with their infants as described in chapter 4.			
5	To compare durations and transitions of smiles between non-depressed and sub-clinically depressed mothers.	• Nearly 40% showed sub-clinical depression • There was no significant difference in the total duration of facial expressions between the two groups for neutral, positive, or smiling expressions; nor in transitions from neutral to positive expression or neutral to smile • Sub-clinically depressed mothers were 84% less likely to transition from a positive expression to a smile ($p = 0.006$) within 3 seconds.	Sub-clinically depressed mothers were significantly less likely to transition from a positive expression to a smile, suggesting difficulties with affective flexibility, and mirroring. Mild depressive symptoms can disrupt affective engagement, influencing the infant's emotional and social development. Cultural diversity should be considered. The study's innovative methodology and diverse sample present possibilities for novel research and inclusive intervention.

6.4 Discussion

Most of the mothers who participated in this PhD study were born between 1992 and 1998, a generation whose parents grew up during the Apartheid era, which began in 1948. Their parents likely bore the full weight of systemic racial discrimination, including limited opportunities due to a deliberately poor-quality education system. During this time, Black students were subjected to the Bantu Education Act of 1953 - a key mechanism of oppression, designed to limit educational opportunities for Black South Africans by underfunding schools and ensuring curricula that discouraged aspirations beyond menial labor. This resulted in the migrant labour system, with men leaving the family for extended durations to work on mines and women and their children alone in poorly resourced areas. In response to the mandatory introduction of Afrikaans as a medium of instruction in schools, the 1976 Soweto Uprising occurred. This uprising became a pivotal moment, sparking further resistance that ultimately contributed to the end of Apartheid in 1994 and the beginning of a more integrated and equal society.

The prolonged isolation of Black South Africans had a disproportionate impact on women and children, subjecting these particularly vulnerable groups to profound social, economic and psychological harm (422). Recognising the intersection of this historical legacy and the long-term impact on families and caregiving practices (423), this research revealed a deep-seated issue of mistrust. Many men continue to work away from home, putting strain on the family unit. Mistrust is deepened when fathers deny paternity, leaving mothers to navigate the emotional, financial and practical challenges of raising infants. Perhaps exacerbated by a lack of trust in the community and in healthcare facilities; mothers further revealed a complex interplay of trust versus mistrust in their relationships with their infants in terms of the persecution felt. Erik Erikson (424) explains in his theory of psychosocial development, that with the inadequate establishment of trust, infants may perceive the world as unpredictable and unsafe, fostering anxiety. Such experiences have long lasting consequences, manifesting in adulthood depression, disengagement, and feelings of loneliness and rejection (424). It may be speculated that the mothers in this study interpreted their partner's absence as rejection and possibly feared being rejected by their own infants. This could explain the frequent displays of prolonged smiles and extended visual attention towards their infants, reflecting an intense effort to foster connection.

Perhaps this behaviour was rooted in the complexity of maternal identity and that desire to be 'good enough' (7). Good mothering is an idealized, socially constructed idea shaped by societal expectations of how mothers are supposed to parent (425). No matter their sociodemographic background, mothers often feel the pressure to meet the standards of being 'perfect' caregivers and experience anxiety and stress when they are unable to fulfill this socially constructed expectation (426). To exacerbate matters, mothers of colour, especially those who face mental health issues, domestic violence or substance abuse are often vilified as irresponsible caregivers (427). Those experiencing social disadvantages, such as limited resources, low income, inadequate housing, and unstable or unsupportive social environments, are also at a higher risk of experiencing maternal depression (428).

This study yielded surprising results when investigating the prevalence of depression in this group of mothers. Contrary to expectations from prior findings (in chapter 3), results indicated that mothers experienced much lower levels of depression in the trial sample. In fact, the discrepancy in depression scores between the two sample groups was stark. Among 15 women from the community advisory group, 67% scored as moderately to severely depressed on the Edinburgh Postnatal Depression Scale whereas among 57 participants from the trial sample, only 1.7% reported moderate to severe depression. Demographic similarities between the groups, such as age (n=15: 28 years vs n=56: 31 years) suggest that these differences were not attributable to substantial variations in participant profiles. However, key differences in employment rates (n=15: 40% vs n=56: 21%) and relationship status (n=15: 73% single vs n=56: 42% single) point to financial strain and reduced emotional support, as potential contributors to higher levels of depression in the community advisory group. Additionally, the context of the Edinburgh Postnatal Depression Scale administration likely influenced results. The community advisory group completed the scale at Chris Hani Baragwanath Academic Hospital during extended two-hour sessions, where a facilitator and a psychologist (myself) were present. Participants were asked in-depth questions about their feelings of depression and anxiety. In contrast, the trial group completed the depression scale without additional probing into their mental health. The structured setting of the hospital sessions may have provided the community advisory group with more space to express their emotional stress, potentially resulting in higher reported levels of depression. This could be explained by 'groupthink' (429) - which happens when a group of people prioritize harmony over critical evaluation - influencing data collection. In therapeutic

groups, ‘groupthink’ can impact focus group discussions and individuals may conform to dominant opinions. Psychologists being present (myself) may conform to a prevailing diagnostic trend. Additionally, researchers conducting qualitative research may be influenced by ‘groupthink’ leading to biased interpretations of mental health conditions (430).

Even though the severity of depressed mood varied, findings indicated that heightened depressive symptoms likely compromised a mother's emotional flexibility during interactions with her infant. This was assessed through the analysis of facial expression transitions, a method that capitalizes on the universal language of non-verbal communication. As Ekman's (431) research on basic emotions - happiness, anger, sadness, surprise and fear - demonstrates, facial expressions are universally recognized, transcending cultural boundaries and underscoring the strength of our approach. While cultural nuances exist - such as a smile not always signaling happiness - research on facial expressions in South Africa is limited.

For generations, many South Africans have remained unseen, unheard, and deprived of the opportunity to hope. Addressing intergenerational trauma requires a deeper understanding of the role of hope, as highlighted by Erikson (424), who identifies it as the core virtue emerging when trust outweighs mistrust (424). Higher levels of hope are associated with better outcomes in maternal mental health (432). It has been found that parents with a greater sense of hope express greater subjective well-being (433), report less stress (433), are more resilient (434), perceive their families in a more positive light (435), feel more competent as parents (436) and are more involved in their children’s lives (437). Yet still to be explored is the relationship between hope and emotional flexibility.

This mixed-methods study explored the essence of relationships - trust - capturing a brief yet intimate glimpse into the emotional dynamics within the dyad. By analyzing micro-behaviors, we uncovered hidden vulnerabilities that might have otherwise remained obscured. However, the extent to which maternal mental health directly impacts the infant in this context remains uncertain. While this study provides valuable insights, drawing upon existing literature can help shape meaningful directions for future studies, allowing us to deepen our understanding of this critical field of research.

CHAPTER 7

Conclusion

“It takes a village to raise a child’

African proverb

… but not every mother has a village

7.1 Introduction

Raising a child often requires the support of a village, yet many mothers lack access to such networks. This underscores the importance of collaboration in both nurturing future generations and addressing the challenges faced by socially vulnerable mothers. Similarly, research aimed at improving their lives needs collective effort to make a real impact. In this concluding chapter, we will review the study's strengths and limitations and propose future research questions to guide other researchers and healthcare workers in making a lasting difference for mothers and infants.

7.2 Strengths of the research

This research is both novel and groundbreaking. To date, no studies on synchrony in Africa have been identified. Provenzi et al., 2018 (63) conducted a systematic review of mother-infant interactions using search terms such as 'attunement', contingency' and 'synchrony'. Within the 82 relevant studies found, they reported one South African study, but no reference was given and no further mention was made in their review.

A further strength was founded in our methodology which captured the fluidity of interactions, aligning with the aim of contributing to the body of knowledge on relational exchange. Methods were deliberately designed and uniquely applied to gather data. The inclusion of focus group discussions allowed for a multidimensional exploration of participants' experiences of being mothers in Soweto. This setup encouraged a natural, conversational exchange of thoughts and emotions, enabling participants, facilitators, and myself to engage in reciprocal dialogue. The richness of these interactions offered deeper insights into the relational dynamics under study. The investigation of synchrony, referred to by Beebe, 2006 (2) as the 'dance' between two people, was used to capture behavioural exchange in real time to understand mother-infant relationships. By observing nuanced moments on video, the research shed light on the importance of timing and mutual responsiveness between the dyad - or rather the 'appropriateness' of responses (404). Lastly, the focus on transitions in facial expressions examined the dynamic evolution of non-verbal communication, rather than relying on static images. Introducing dynamic stimuli, where facial expressions shift naturally from neutral to

emotional over time, presents a promising new approach to research for several reasons. First, static images fail to accurately reflect real-life facial expressions. Using video sequences that depict the gradual development of emotion would offer a more realistic representation (400). Second, recent neuroimaging (438) and computational modeling research suggests that different brain regions are involved in recognizing dynamic versus static faces, further highlighting the value of dynamic stimuli in exploring the underlying mechanisms of emotion recognition. Third, empirical studies show that people are better at identifying emotions when they are presented dynamically, as opposed to static or sequential images (439). Despite the growing recognition of the importance of dynamic facial emotion displays, detailed information on the timing and evolution of these expressions remains limited (400).

A key strength of this research lies in the complementary nature of its qualitative and quantitative components. The focus group participants in Chapter 3 reported more frequent depressive symptoms than the 57 mothers involved in the observational studies in Chapters 4 and 5. This contrast allowed the study to capture both the rich, subjective experiences of mothers facing significant distress and the micro-level behavioural patterns of those with milder or sub-threshold symptoms. While the qualitative data offered depth and emotional context, the observational data provided objective insights into dyadic interaction. Together, this heterogeneity enriched the analysis, enabling Chapter 6 to synthesise diverse perspectives for a more comprehensive understanding of maternal mental health and mother-infant interaction.

7.3 Limitations of the research and suggestions for future investigation

While using headcams was a methodologically strong choice for capturing patterns of visual attention and facial expression, they were not optimal for detecting more subtle nuances in these behaviours in our sample. A study conducted in the United Kingdom by Constantini, 2023 (405) where mother-infant interactions were recorded using the same methodology applied in this PhD, revealed a significant difference in video footage. Videos from the United Kingdom showed that infants were frequently seated in feeding chairs, the lighting was optimal, and the video quality was high, making both the mother's and infant's faces easy to observe. This facilitated smoother coding of behaviours compared to the video data used in this PhD, where such ideal conditions were not consistently met, potentially impacting the clarity and reliability of observational

coding with mothers in our study. Homes in Soweto did not offer good light and infants were often lying in beds or on couches, which made filming difficult as the head-mounted cameras sometimes did not capture participants' faces. In future, researchers in low resource settings could walk around the participant's dwelling and discuss the optimal place to record the interaction, while pointing out how best to get light into the space for filming (e.g. discussing opening the curtains and switching on lights). However, this may also be challenging, as participants might be uncomfortable with researchers moving through their homes. Additionally, requiring mothers to film in a specific location could result in less natural behavior being captured in the videos. Furthermore, researchers could consider using an unobtrusive third camera positioned in the room for better recorded visuals and to capture the added behaviour of touch between the pair.

Secondly, in critically appraising the study, it is essential to account for social desirability bias (341), which occurs when participants alter their behaviour to align with what they believe is expected or acceptable when being recorded and observed. In this study, the mothers spent 92% of the recorded time looking at their infants, which could reflect such a bias, as they may have been consciously or unconsciously modifying their behaviour due to the presence of the camera. Additionally, having a camera on the mother's head may have altered the infant's responses, and she may have tried to distract the infant by trying to keep the infant happy. This consistent level of attention towards the infant may have complicated the measurement of synchrony, which required behavioural variability to assess dynamic interaction. The lack of behavioural variation made it difficult to capture the natural flow of relational exchanges but could suggest less attunement towards the infant which may hinder infant's learning of social contingency. For future reference, researchers may consider reiterating to participants that they do not have to entertain their infants during filming and that they should be acting in their usual manner during interaction. Additionally, mothers can be asked to record every day for three minutes a day in hope that the task becomes less novel as the days pass and behaviour during interaction becomes more natural.

Thirdly, macro behaviours, such as postural orientations and gestures (440), are relatively easy to observe and quantify. However, the coding of micro-behaviours presents more difficulty. Micro-level, moment-by-moment coding of synchrony is often tedious, time-consuming (441), and

contentious (442,443). The process is inherently subjective, as human error is unavoidable. In this study, the interpretation and categorisation of non-verbal behaviours, such as visual attention and facial expressions, were influenced by personal judgment, adding an element of subjectivity to the analysis. Future directions in research may include the automation of coding of The Observer XT 16 (90). Alternatively, investigators may consider using an existing automated system to collect accurate data on facial expressions such as the 'FaceReader' (90).

Fourthly, in exploring synchrony within the dyadic relationship, some challenges became apparent. The operationalisation of synchrony warrants close attention. While the concept itself is clearly defined as the temporal coordination of behaviour between mother and infant, there are multiple methodologies used to calculate it. In terms of settings, mother-infant interactions have been studied in clinics, research laboratories, and home environments, using both first-person and third-person perspectives. With regards to analyses, three primary approaches have been applied in the literature: broad interaction scales incorporating dyadic elements, specialised synchrony scales, and micro-analyses using coded time-series data, the latter being employed in this study. The existence of these varied methods complicates comparisons across studies, as differing measurement approaches can lead to inconsistencies in how synchrony is quantified. This also highlights the need for a more standardized, validated framework for defining what constitutes 'low,' 'medium,' and 'high' levels of synchrony (64)(109)Thus, my results on lag sequencing did not give us rich information on the interactions I observed. In future research, establishing more defined parameters or thresholds would improve cross-study comparability and enhance the robustness of synchrony research.

Fifth, this research did not conduct a comprehensive investigation into participants' mental health histories and including questions pertaining to prior diagnoses may have offered valuable insights. Notably, many previous studies have overlooked the co-morbidity of psychopathology (243,444). Looking ahead, research should account for the concurrence of mental health disorders such as depression and anxiety, among others (445). Focusing on state anxiety and tools like the State-Trait Anxiety Inventory, may yield meaningful findings.

Lastly, this study was limited by certain cultural factors that may have been overlooked. While the primary investigators of both this study and the PLAY study Prioreschi et. al., 2023 (281)

lived near Soweto and were somewhat familiar with Sowetan culture, both were Caucasian and not fluent in the local languages spoken by participants. Additionally, after the first research assistant resigned, her successor, though a Sowetan resident fluent in these languages, was male. This may have influenced data collection as it is possible that participants found it difficult to divulge details of mothering. Future studies may benefit from a researcher with lived experience to support the field work and to foster culturally sensitive engagement. Furthermore, there is a diversity of caregiving practices across South African communities. For instance, infants are often cared for by multiple adults, which significantly influences their socialization experiences (128). This collaborative co-parenting structure may play a critical role when evaluating caregiving dynamics within the dyad (413). In the South African context, further studies may include grandmothers, and exploring interactions within triadic relationships may provide a more comprehensive understanding of interactions.

7.4 Recommendations for interventions in South Africa

To begin with, those implementing interventions should adopt a facilitative mindset. Equally important is identifying influential community gatekeepers within areas where vulnerable populations reside, as their support is key to fostering a collaborative environment. Establishing strong relationships with these individuals is essential for gaining trust and access to the community. Added to this, a deep understanding of the local culture, combined with lived experience, is invaluable for designing interventions that are both relevant and effective.

7.4.1. Interventions for supporting mothers

This research highlights a recurring theme that mothers receive insufficient support. Addressing this issue through targeted interventions for clinic staff during postnatal care could significantly benefit both mothers and their infants. Nurse training programs focused on cultivating empathetic care are promising approaches in teaching staff about rapport. Workshops to improve listening skills, coupled with regular debriefing sessions, can equip nurses with tools needed to provide compassionate support. Information can be shared on the importance of bonding, what it entails, and practical ways to strengthen the mother-infant relationship. This can be done by dispersing pamphlets with relevant information (appendix L) or making short videos (for

examples of topics that can be used, see appendix M,N,O). Teaching reflective functioning or mentalization to mothers can be incorporated into this too.

Similarly, father engagement can significantly influence the mental well-being of mothers. Research shows that mothers with partners who are actively involved tend to experience lower levels of antenatal depression (446,447). Conversely, decreased partner involvement after childbirth is associated with an increased risk of postnatal depression (448). Additionally, men's active participation during pregnancy and early childhood can result in enhanced developmental outcomes throughout a child's lifespan (449–451). Interventions may include the promotion of men's support groups, to offer care to the fathers in the community.

Research indicates that maternal sensitivity is linked to better developmental outcomes in children, particularly in challenging socio-economic contexts (452). By prioritizing the mother's perspective, we can address the underlying issues that may affect her capacity to engage effectively with her child. Ultimately, this approach not only supports mothers but also benefits infants, creating a more supportive environment for healthy development.

In a peri-urban settlement in Khayelitsha South Africa, researchers developed an intervention, delivered by previously untrained lay community workers from late pregnancy to six months postpartum (416). It aimed to promote sensitive parenting and secure infant attachment. Compared to the control group, mothers in the intervention group showed significantly more sensitivity and less intrusiveness in interactions with their infants at 6 and 12 months, and their infants had a higher rate of secure attachment at 18 months. Although maternal depressive disorder prevalence did not significantly change, there was a reduction in depressive mood on the Edinburgh Postnatal Depression Scale at 6 months (416). This study by Cooper, et al., 2009 (416) as well as work done at 'Ububele' in another peri-urban settlement in Alexandra, South Africa (415), is evidence that training lay community members to assist mothers is effective. 'Ububele' meaning 'compassion,' is a non-profit organisation that developed a community-based parent-infant mental health intervention. The Baby Mat Project brings together a psychologist and a social auxiliary worker to support mothers living near impoverished settlements. The initiative fosters reflective functioning (41) by engaging mothers in discussions while their infants rest on a mat placed between them (415).

7.5 Future research

While previous initiatives training community workers have made good progress in supporting dyads, more nuanced observational skills are necessary to effectively assist mothers and their infants in Soweto. Therefore, I propose the 'Model of Observing Mother and Infant (MOMI)' as a framework to explore what caregiving looks like in South African dyads and to guide future efforts in observing, benchmarking and serving dyads in distress. Future research will include a manual to direct this intervention into practice.

7.5.1 The Model of Observing Mother and Infant (MOMI)

In clinical practice, the psychologist listens attentively to the patient, focusing on underlying emotions and meanings beyond their words. Non-verbal cues are observed and provide valuable insights into the patient's condition. The next step is to conceptualize the case to guide effective interventions. Similarly, this PhD aims to undertake a parallel process of exploration using research to inform future treatment and practice. The findings of this PhD have led to a new framework to improve service towards mothers and infants and is illustrated below in Figure 16. Guidelines on observing and benchmarking the dyad with steps towards service are explained below. It can best be remembered by thinking of the word 'observe' (where 'O' stands for 'Observe', 'B' stands for 'Benchmark' and 'Serve' means to serve to dyad).

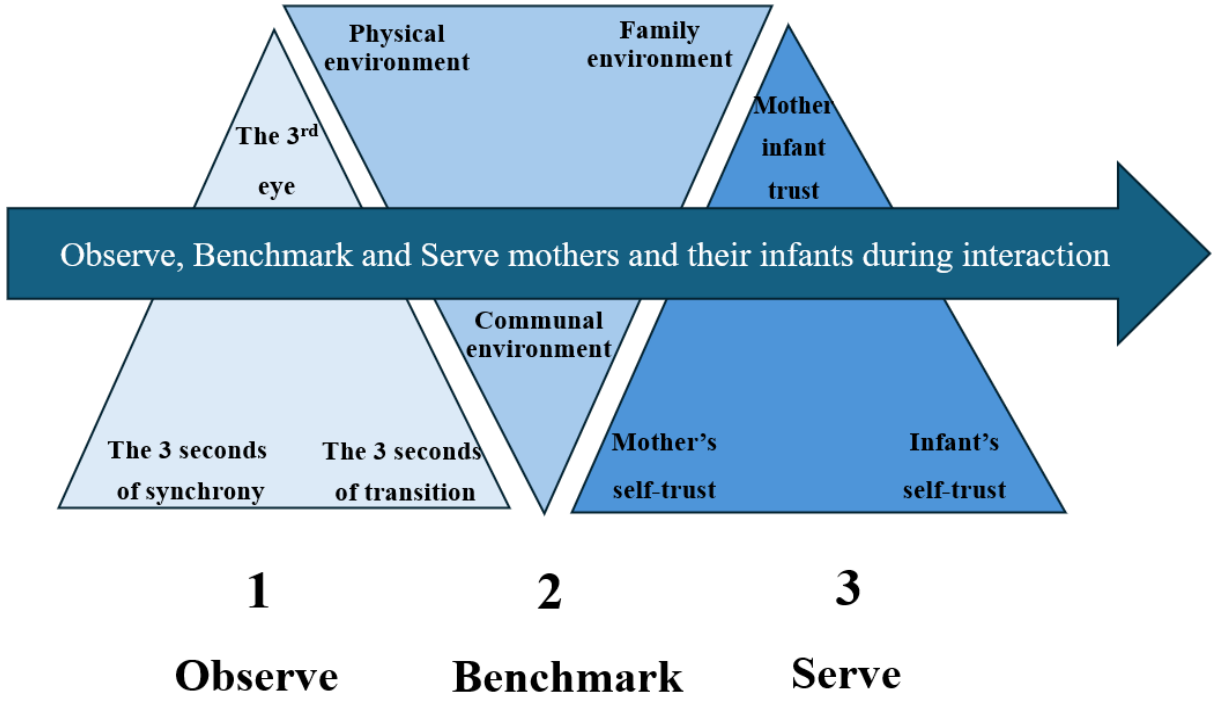


Figure 16: The Model of Observing Mother and Infant (MOMI)

Observing the dyad

The 3rd eye is the culturally aware community worker, researcher or the person behind the camera observing interaction. The observer, having examined his/her own childhood and triggers that have molded his/her personality, are important factors to consider. Actively practiced listening skills are imperative. Skills in observing nuances in the dyadic relationship and keeping an eye out for maternal responsive caregiving and bonding behaviours such as visual attention and facial expression are to be used.

The 3 seconds of synchrony are important to acknowledge as they capture the synchronicity or subtle dance of micro-behaviours between the pair, revealing insights into the sensitivity of the mother and the attunement between them. Despite an expected limited variation in the mothers' facial behaviour - where frequent gazing and smiling towards the infant has been found to be typical for the first 3-6 months postpartum - these micro-interactions provide valuable information about the dyad's connection.

The 3 seconds of emotional transition are helpful to gauge emotional responsivity. It is important to try to observe the mother's and infant's movements between different affective states as these give insight into the dynamic of dyadic interaction. It also gives information about the mother's mood.

In observing the dyad of the MOMI model, findings from Chapters 4 and 5 provide critical empirical grounding that may direct practical application. While mothers appeared visually attentive (92%) and smiled frequently (59%), infants showed less engagement, with higher rates of distraction and neutral expressions. This suggests that although mothers may appear engaged, true attunement and emotional co-regulation may be harder to detect, particularly when shaped by a desire to be perceived as a good enough mother. Sub-clinical depression may further impair affective flexibility, as shown by reduced likelihood of positive expressions preceding smiles. These patterns may reflect emotion regulation difficulties - such as behavioural avoidance, distraction, and rumination (410) - that are compounded by cognitive overload, emotional blunting, and diminished intrinsic motivation. Together, these findings support the MOMI model's focus on observing subtle shifts in emotional expression and considering how internal states affect maternal responsiveness.

Benchmarking the dyad

The dyad's physical environment: At the base of the hierarchy of needs, sits a fundamental human need for survival. An assessment of the pair's access to food and water is important to gauge when observing the dyad, as feelings of safety and security may affect interactional style. Additionally, benchmarking the pair in terms of health, housing, access to resources, socio-economic position and other measures of their well-being within their physical environment are important factors to note.

The dyad's family environment: It's essential to enquire about the mother's biological factors (such as genetic predisposition), psychological aspects (including family upbringing, past traumas and mental health conditions) and social dynamics (like her role within her family of origin and her family relationships including interactions with in-laws). It is helpful to consider how a dyad may be impacted by a lack of paternal support, considering that paternal denial was identified as a perceived source of stress contributing towards mental well-being in Soweto.

Additionally, the pair must be viewed within the broader context of extended families recognising the influence that these relationships have on the pair and the infant's development.

The dyad's communal environment: Thinking of the mother and infant within their specific culture and community is vital. Our findings revealed that mothers often perceived neighbours and health care facility staff as judgmental, which could adversely impact their mental well-being. Gathering information on these elements and thinking creatively on ways in which to identify community workers, church counsellors or small support groups may help empower the mother, having a positive effect on the dyad.

When benchmarking the dyad in the MOMI model, it is helpful to incorporate the contextual realities revealed in Chapter 3. The qualitative findings showed that experiences such as partner conflict (particularly paternal denial), family conflict, poor community support, lack of trust in the healthcare system, lack of resources and feelings of maternal persecution had a perceived impact on mothers' emotional well-being and their ability to respond sensitively to their infants. These stressors may shape the physical, familial, and communal environments in which dyads are embedded, underscoring the importance of assessing not only material conditions but also the relational and psychosocial landscape influencing early caregiving behaviors.

Serving the dyad

Mother's self-trust: For a mother to foster a connection between herself and her infant, she must first cultivate a sense of trust in herself. This self-trust is critical for her confidence, feelings of being good enough, emotional stability and her ability to respond sensitively to her infant. Interventions can include exploring past traumas, self-awareness, emotional regulation and emotional flexibility. Psychoeducation on mindfulness can help foster self-trust. Furthermore, skills training in activities that create space to help the mother to process her feelings can be taught. Teaching about the benefits of taking three seconds to pause when feeling emotional to acknowledge that specific feeling can be beneficial. Lastly, an intervention tailored towards emotional flexibility – helping mothers learn to accept and embrace factors beyond their control – could offer significant benefits to their well-being.

Infant's development of self-trust: To help cultivate an infant's sense of self-trust, an intervention around maternal mirroring and reflective function will be beneficial. These skills would help the development of the infant's internal working model which includes representations of the self, the caregiver, and the relationship between them. These representations are influenced by the quality of care and responsiveness received from caregivers during infancy.

Mother-infant trust: Interventions directed towards fostering secure attachment to develop mother-infant trust, would include the suggestions listed above. Incorporated into this would be encouragement for the flow of eye contact to and away from her infant and for the mother to become aware of her own emotional state and that of her infant's. Importantly, an intervention addressing the hope or hopelessness between the pair would help to foster resilience between them.

To serve the dyad, the concept of mother's self-trust within the MOMI model becomes especially significant when viewed through the lens of the findings from Chapters 3, 4, and 5. These chapters revealed that while mothers frequently smiled and maintained high levels of visual attention, this did not always translate into reciprocal affective engagement from their infants - particularly in cases where sub-clinical depressive symptoms were present. Furthermore, cultural norms and social desirability may lead mothers to perform behaviours associated with being 'good enough' without feeling genuinely connected. These insights underscore the need for interventions focused on enhancing emotional regulation, self-awareness, and affective flexibility. Cultivating a mother's self-trust not only empowers her to respond more authentically and sensitively but also supports the infant's development of trust and strengthens the emotional reciprocity necessary for secure attachment and dyadic resilience.

In conclusion, implementing the MOMI model must be grounded in the socio-economic and resource realities of the South African context, particularly in urban township settings like Soweto. Effective training in observational skills - whether for community health workers or lay counsellors - requires structured, ongoing supervision and cannot rely on one-off workshops. Training should be modular, culturally adapted, and focused on practical, observable signs of maternal distress and disengagement, rather than complex diagnostic criteria. Crucially,

observers must also engage in self-reflection, with appropriate emotional support, to sensitively carry out this work.

These recommendations acknowledge the structural limitations of the public health system while promoting realistic, scalable, and contextually appropriate strategies to support mother - infant wellbeing. Given that postpartum services in South Africa are frequently under-resourced and inconsistently delivered - particularly in low-income and rural communities - there is a clear policy imperative to strengthen maternal mental health care within primary health platforms. Integrating community-based, culturally informed interventions into existing service frameworks holds promise for bridging service gaps and improving early developmental outcomes. However, the practical feasibility of this approach within the South African context requires further investigation. Key areas for exploration include sustainable training models for community health workers, integration with existing clinic infrastructure, mechanisms for ongoing supervision, and the acceptability of such interventions among mothers and health professionals alike. Pilot studies assessing cost-effectiveness, fidelity, and uptake in diverse settings would be essential to inform future scale-up and policy formulation.

7.6 Conclusion

“With a little seed of imagination, you can grow a field full of hope’’

Nigerian Proverb

In the preface, I shared my early experiences as a psychologist working with orphans at Epworth Children’s Home. Sadly, on April 17, 2024, News24 reported that this 105-year-old institution is closing due to a lack of funding, operating at a deficit of R2 million. Epworth now faces the task of relocating its children into places of safety and foster homes. Many of these children will feel abandoned - again - which reminds us of the consequences that those deprived of sensitive caregiving may, metaphorically, 'burn the village just to feel its warmth’. Addressing this problem requires creativity and novelty while highlighting the need for solutions promoting trust and anchored in the enduring virtue of hope.

References

1. Cantrell SJ, Pearson RM, Prioreschi A. Maternal perspectives on poor mental health and the impact on mother-infant relationships. J Reprod Infant Psychol. 2025.
2. Beebe B. Co-constructing mother–infant distress in face-to-face interactions: Contributions of microanalysis. Infant Observation. 2006 Aug;9(2):151–64.
3. Fraiberg S, Adelson E, Shapiro V. Ghosts in the nursery. A psychoanalytic approach to the problems of impaired infant-mother relationships. J Am Acad Child Psychiatry. 1975;14(3):387–421.
4. Feldman R, Granat A, Pariente C, Kanety H, Kuint J, Gilboa-Schechtman E. Maternal Depression and Anxiety Across the Postpartum Year and Infant Social Engagement, Fear Regulation, and Stress Reactivity. J Am Acad Child Adolesc Psychiatry. 2009 Sep;48(9):919–27.
5. Yehuda R, Bierer LM. The relevance of epigenetics to PTSD: Implications for the DSM-V. J Trauma Stress [Internet]. 2009 Oct 1 [cited 2025 Jun 11];22(5):427–34. Available from: /doi/pdf/10.1002/jts.20448.
6. Bowers ME, Yehuda R. Intergenerational Transmission of Stress in Humans. Neuropsychopharmacology [Internet]. 2016 Jan 1 [cited 2025 Jun 11];41(1):232–44. Available: https://www.researchgate.net/publication/281143940_Intergenerational_Transmission_of_Stress_in_Humans.
7. Winnicott DW. Through paediatrics to psycho-analysis . New York: Basic Books; 1975.
8. Winnicott DW. The Maturational Processes and the Facilitating Environment: Studies in the Theory of Emotional Development. In: The International Psycho-Analytical Library. London: The Hogarth Press and the Institute of Psycho-Analysis; 1965. p. 1–276.
9. Harrist AW, Waugh RM. Dyadic synchrony: Its structure and function in children's development. Developmental Review. 2002;22(4):555–92.
10. Fonagy P, Steele M, Steele H, Moran GS, Higgit AC. The capacity for understanding mental states: The reflective self in parent and child and its significance for security of attachment. Infant Ment Health J. 1991;12:201–18.
11. Ainsworth MD. Object relations, dependency, and attachment: A theoretical review of the infant-mother relationship. Child Dev. 1969;40:969–1025.
12. De Wolff MS, Van Ijzendoorn MH. Sensitivity and Attachment: A Meta-Analysis on Parental Antecedents of Infant Attachment. Child Dev. 1997;68(4):571–91.

13. Bakermans-Kranenburg MJ, Van IJzendoorn MH, Juffer F. Less is More: Meta-Analyses of Sensitivity and Attachment Interventions in Early Childhood. Psychol Bull. 2003 Mar;129(2):195–215.
14. Stams GJJM, Juffer F, van IJzendoorn MH. Maternal sensitivity, infant attachment, and temperament in early childhood predict adjustment in middle childhood: the case of adopted children and their biologically unrelated parents. Dev Psychol. 2002;38(5):806–21.
15. Raby KL, Roisman GI, Fraley RC, Simpson JA. The Enduring Predictive Significance of Early Maternal Sensitivity: Social and Academic Competence Through Age 32 Years. Child Dev. 2015 May 1;86(3):695–708.
16. Leerkes EM, Nayena Blankson A, O'brien M. Differential Effects of Maternal Sensitivity to Infant Distress and Nondistress on Social-Emotional Functionin. Child Dev. 2009 May;80(3):762–75.
17. Feldman R, Eidelman AI, Rotenberg N. Parenting stress, infant emotion regulation, maternal sensitivity, and the cognitive development of triplets: A model for parent and child influences in a unique ecology. Child Dev. 2004;6(75):1774–91.
18. Fraley R.C, Roisman GI, Haltigan JD. Supplemental Material for The legacy of early experiences in development: formalizing alternative models of how early experiences are carried forward over time. Developmental psychology, 49(1), p.109. Dev Psychol. 2013;49(1):109.
19. Olson SL, Bates JE, Sandy JM, Lanthier R. Early Developmental Precursors of Externalizing Behavior in Middle Childhood and Adolescence. J Abnorm Child Psychol. 2000;28(2):119–33.
20. Shaw DS, Keenan K, Vondra JI. Developmental Precursors of Externalizing Behavior: Ages 1 to 3. Dev Psychol. 1994;30(3):355–64.
21. Richter LM. Are Early Adult-infant Interactions Universal?-A South African view. Southem AfJlcanJournal of Child and Adolescent Psychiatry. 1995;7(1).
22. Richter L. The importance of caregiver-child interactions for the survival and healthy development of young children: A review. Department of child and adolescent health and development. World Health Organisation. 2004.
23. Tomlinson M, Swartz L. Imbalances in the knowledge about infancy: The divide between rich and poor countries. Infant Ment Health J. 2003;24(6):547–56.
24. Alto ME, Petrenko CL. Fostering secure attachment in low-and middle-income countries: Suggestions for evidence-based interventions. Eval Program Plann. 2017;60:151–65.
25. Tomlinson M, Murray L, Cooper P. Attachment theory, culture, and Africa: Past, present, and future . In: Erdman P, Ng KM, (Eds) Family therapy and counselling series Attachment: Expanding the cultural connections. Taylor & Francis Group; 2010. p. 181–94.

26. Richter LM, Desmond C. Targeting AIDS orphans and child-headed households? a perspective from national surveys in South Africa, 1995-2005. AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV. 2008 Oct;20(9):1019–28.
27. Voges J, Berg A, Niehaus DJH. Revisiting the African origins of attachment research—50 years on from Ainsworth: A descriptive review. Infant Ment Health J. 2019 Nov 1;40(6):799–816.
28. World Health Organization, United Nations Children's Fund, World Bank Group. Nurturing Care for Early Childhood Development: A Framework for Helping Children Survive and Thrive to Transform Health and Human Potential [Internet]. Geneva; 2018 [cited 2024 Sep 12]. Available from: https://apps.who.int/iris/bitstream/handle/10665/272603/9789241514064-eng.pdf?ua=1
29. World Health Organization. Care for child development: improving the care of young children. Participant Manual World Health Organization https://www.who.int/publications/i/item/9789241548403. Cited on 6 May 2024. 2012 Jul.
30. Bornstein MH, Tamis-LeMonda CS. Maternal responsiveness and cognitive development in children. New Dir Child Adolesc Dev. 1989;43:49–61.
31. Ohara M, Okada T, Kubota C, Nakamura Y, Shiino T, Aleksic B, et al. Validation and factor analysis of mother-infant bonding questionnaire in pregnant and postpartum women in Japan. BMC Psychiatry. 2016 Jul 7;16(1):1–7.
32. Ainsworth M. The effects of maternal deprivation: A review of findings and controversy in the context of research strategy. Public Health Pap. 1962;(14):97–165.
33. Bowlby J. Attachment and loss (Vol. 1: Attachment). New York: Basic Books; 1969.
34. Klaus M, Kennell J. Parent-infant bonding. 2nd ed. St Louis: The C.V. Mosby Company; 1982.
35. Bretherton I, Munholland K. Internal working models revisited . In: J Cassidy, P Shaver (Eds), Handbook of attachment: Theory, research, and clinical applications. New York, NY: Guilford Press; 1999. p. 89–111.
36. Cassidy J, Woodhouse SS, Sherman LJ, Stupica B, Lejuez CW. Enhancing infant attachment security: An examination of treatment efficacy and differential susceptibility. Dev Psychopathol. 2011 Feb;23(1):131–48.
37. Hoffman KT, Marvin RS, Cooper G, Powell B. Changing toddlers' and preschoolers' attachment classifications: The circle of security intervention. J Consult Clin Psychol. 2006 Dec;74(6):1017–26.
38. Egeland B, Weinfield NS, Bosquet M, Cheng VK. Remembering, repeating, and working through: Lessons from attachment-based interventions. In: WAIMH handbook of infant mental health. 2000. p. 35–89.

39. Fearon RP, Bakermans-Kranenburg MJ, van IJzendoorn MH, Lapsley AM, Roisman GI. The significance of insecure attachment and disorganization in the development of children's externalizing behavior: A meta-analytic study. Child Dev [Internet]. 2010 Mar [cited 2025 Jun 11];81(2):435–56. Available from: https://pubmed.ncbi.nlm.nih.gov/20438450/.
40. Bowlby J. Attachment theory and its therapeutic implications. Adolesc Psychiatry. 1978;6:5–33.
41. Fonagy P, Target M, Steele H, Steele M. Reflective - functioning manual_ Version 5 for application to adult attachment interviews. 1998.
42. Baron–Cohen S, Tager–Flusberg H, Cohen DJ. Understanding other minds: Perspectives from autism. Oxford: Oxford University Press; 1993.
43. Morton J, Frith U. Causal modeling: A structural approach to developmental psychology. In: DCicchetti & D J Cohen (Eds), Developmental psychopathology Theory and methods. New York: John Wiley; 1995. p. 357–90.
44. Slade A, Grienenberger J, Bernbach E, Levy D, Locker A. Maternal reflective functioning, attachment, and the transmission gap: A preliminary study. Attach Hum Dev. 2005 Sep;7(3):283–98.
45. Bick J, Dozier M, Moore S. Predictors of treatment use among foster mothers in an attachment-based intervention program. Attach Hum Dev. 2012 Sep;14(5):439–52.
46. Priel B, Melamed-Hass S, Besser A, Kantor B. Adjustment among adopted children: The role of maternal self-reflectiveness . Fam Relat. 2000;49(4):389–96.
47. Sadler LS, Slade A, Close N, Webb DL, Simpson T, Fennie K, et al. Minding the baby: Enhancing reflectiveness to improve early health and relationship outcomes in an interdisciplinary home-visiting program. Infant Ment Health J. 2013 Sep;34(5):391–405.
48. Slade A. Parental reflective functioning: An introduction. Vol. 7, Attachment and Human Development. 2005. p. 269–81.
49. Rutherford HJV, Goldberg B, Luyten P, Bridgett DJ, Mayes LC. Parental reflective functioning is associated with tolerance of infant distress but not general distress: Evidence for a specific relationship using a simulated baby paradigm. Infant Behav Dev. 2013 Dec;36(4):635–41.
50. Beebe B, Lachmann FM. Infant Research and Adult Treatment. Co-Constructing Interactions. Hillsdale, NJ: The Analytic Press; 2002.
51. Stern DN. The interpersonal world of the infant: A view from psycho-analysis and developmental psychology. . New York: Basic Books; 1985.
52. Feldman R, Greenbaum CW. Affect regulation and synchrony in mother - infant play as precursors to the development of symbolic competence. Infant Mental Health Journal: Official Publication of The World Association for Infant Mental Health. 1997;18(1):4–23.

53. Fogel A. Developing through relationships. Chicago: University of Chicago Press; 1993.
54. Beebe B, Messinger D, Bahrick LE, Margolis A, Buck KA, Chen H. A Systems view of mother-infant face-to-face communication. Dev Psychol. 2016 Apr 1;52(4):556–71.
55. Braarud HC, Stormark KM. Expression of negative affect during face-to-face interaction: A double video study of young infants' sensitivity to social contingency. Infant Child Dev. 2006 May;15(3):251–62.
56. Jaffe J, Beebe B, Feldstein S, Crown CL, Jasnow MD. Rhythms of dialogue in infancy: Monographs for the society for research and child development. Vol. 66(serial#.264). Wiley-Blackwell; 2001. 1–132 p.
57. Tronick EZ, Cohn JF. Infant-Mother Face-to-Face Interaction: Age and Gender Differences in Coordination and the Occurrence of Miscoordination. Child Dev. 1989;60(1):85–92.
58. Moore GA, Calkins SD. Infants' vagal regulation in the still-face paradigm is related to dyadic coordination of mother-infant interaction. Dev Psychol. 2004 Nov;40(6):1068–80.
59. Murray L, De Pascalis L, Bozicevic L, Hawkins L, Sclafani V, Ferrari PF. The functional architecture of mother-infant communication, and the development of infant social expressiveness in the first two months. Sci Rep. 2016 Dec 14;6.
60. Lavelli M, Fogel A. Supplemental Material for Interdyad Differences in Early Mother–Infant Face-to-Face Communication: Real-Time Dynamics and Developmental Pathways. Dev Psychol. 2013;49(12):2257–71.
61. Cohn JE, Tronick EZ. Developmental Psychology Mother-Infant Face-to-Face Interaction: Influence is Bidirectional and Unrelated to Periodic Cycles in Either Partner's Behavior. Vol. 24. 1988.
62. Leclère C, Viaux S, Avril M, Achard C, Chetouani M, Missonnier S, et al. Why synchrony matters during mother-child interactions: A systematic review. Vol. 9, PLoS ONE. Public Library of Science; 2014.
63. Provenzi L, di Minico GS, Giusti L, Guida E, Müller M. Disentangling the dyadic dance: Theoretical, methodological and outcomes systematic review of mother-infant dyadic processes. Front Psychol. 2018 Mar 19;9(MAR).
64. Beebe B, Jaffe J, Markese S, Buck K, Chen H, Cohen P, et al. The origins of 12-month attachment: A microanalysis of 4-month mother-infant interaction. Attach Hum Dev. 2010 Jan;12(1–2):3–141.
65. Sameroff A. Developmental systems: Contexts and evolution. In: Kessen, W, editors Mussen's handbook of child psychology Vol 1. New York: Wiley; 1983. p. 237–94.

66. Sanders L. The regulation of exchange in the infant-caretaker system and some aspects of the context-content relationship. In: Lewis, M, Rosenblum, L, editors Interaction, conversation, and the development of language. New York: Wiley; 1977. p. 133–56.
67. Feldman R, Magori-Cohen R, Galili G, Singer M, Louzoun Y. Mother and infant coordinate heart rhythms through episodes of interaction synchrony. Infant Behav Dev. 2011 Dec;34(4):569–77.
68. Lotzin A, Schiborr J, Barkmann C, Romer G, Ramsauer B. Maternal emotion dysregulation is related to heightened mother-infant synchrony of facial affect. Dev Psychopathol. 2015 May 1;28(2):327–39.
69. Feldman R. Mother-infant synchrony and the development of moral orientation in childhood and adolescence: Direct and indirect mechanisms of developmental continuity. . American Journal of Orthopsychiatry. 2007;77(4):582–97.
70. Hill R, Flanagan J. The Maternal–Infant Bond: Clarifying the Concept. Int J Nurs Knowl. 2020 Jan 1;31(1):14–8.
71. Parke RD. Father involvement: A developmental psychological perspective. Marriage Fam Rev. 2000;29(2–3):43–58.
72. Beebe B. Daniel Stern: Microanalysis and the Empirical Infant Research Foundations. Psychoanal Inq. 2017 May 19;37(4):228–41.
73. Bernieri FJ, Reznick JS, Rosenthal R. Synchrony, Pseudosynchrony, and Dissynchrony: Measuring the Entrainment Process in Mother-Infant Interactions. J Pers Soc Psychol. 1988;54(2):243–53.
74. Cohn JF, Tronick EZ. Three-Month-Old Infants' Reaction to Simulated Maternal Depression. Vol. 54, Source: Child Development. 1983.
75. Lee R, Skinner A, Bornstein MH, Radford AN, Campbell A, Graham K, et al. Through babies' eyes: Practical and theoretical considerations of using wearable technology to measure parent–infant behaviour from the mothers' and infants' view points. Infant Behav Dev. 2017 May 1;47:62–71.
76. Heisenberg W. Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik. Zeitschrift für Physik. 1927;43(3):172–98.
77. Zaslow MJ, Weinfield NS, Gallagher M, Hair EC, Ogawa JR, Egeland B, et al. Longitudinal prediction of child outcomes from differing measures of parenting in a low-income sample. Dev Psychol. 2006;42(1):27.
78. Baum CG, Forehand R, Zegiob LE. A Review of Observer Reactivity in Adult-Child Interactions. J Behav Assess. 1979;1(2):167–78.

79. Zegiob LE, Arnold S, Forehand R. An examination of observer effects in parent-child interactions . Child Dev. 1975;509–12.
80. Weber SJ, Cook TD. Subject effects in laboratory research: An examination of subject roles, demand characteristics, and valid inference.273. Psychol Bull. 1972;77(4):273.
81. Bornstein MH, Arterberry ME. The Development of Object Categorization in Young Children: Hierarchical Inclusiveness, Age, Perceptual Attribute, and Group Versus Individual Analyses. Dev Psychol. 2010 Mar;46(2):350–65.
82. Sugden NA, Mohamed-Ali MI, Moulson MC. I spy with my little eye: Typical, daily exposure to faces documented from a first-person infant perspective. Dev Psychobiol. 2014 Feb;56(2):249–61.
83. Yurovsky D, Smith LB, Yu C. Statistical word learning at scale: The baby's view is better. Dev Sci. 2013 Nov;16(6):959–66.
84. Beebe B. Micro-timing in mother-infant communication: Nonverbal communication today. M.R. Key, editor. New York: : Mouton Publishers; 1982. 169–195 p.
85. Cohn J, Beebe B. Sampling interval affects time-series regression estimates of mother-infant influence. Infant Behav Dev. 1990;13:317.
86. Stern DN. A micro-analysis of mother-infant interaction behavior regulating social contact between a mother and her 3 1/2 Month-Old Twins. J Am Acad Child Psychiatry. 1971;10(3):501–17.
87. Lyons-Ruth K, Harrison AM, Morgan AC, Nahum JP, Sander L, Stern DN, et al. Implicit relational knowing: Its role in development and psychoanalytic treatment. Infant Ment Health J. 1998;19(3):282–9.
88. Owen MT, Barfoot B, Vaughn A, Domingue G, Ware AM. 54-month parent-child structured interaction qualitative rating scales. NICHD Study of Early Child Care Research Consortium. Washington DC; 1996.
89. Skuban EM, Shaw DS, Gardner F, Supplee LH, Nichols SR. The correlates of dyadic synchrony in high-risk, low-income toddler boys. Infant Behav Dev. 2006 Jul;29(3):423–34.
90. J J Noldus LP, Wallis de Vries MF, Kessenich PC-Slide van, J M Minkenberg OP, Dicke M, van Heiden M, et al. The Observer: A software system for collection and analysis of observational data Hardware for Observational Studies. Vol. 23, Behnvior Research Methods, Instruments. 1991.
91. Feldman R. Infant-mother and infant-father synchrony: The coregulation of positive arousal. Infant Ment Health J. 2003;24(1):1–23.
92. Karger RH. Synchrony in mother-infant interactions. . Child Dev. 1979;882–5.
93. Ham J, Tronick E. Relational psychophysiology: Lessons from mother–infant physiology research on dyadically expanded states of consciousness. Psychotherapy Research [Internet]. 2009 [cited

2024 Oct 12];19(6):619–32. Available from: https://www.tandfonline.com/doi/abs/10.1080/10503300802609672

94. Van Egeren LA, Barratt MS, Roach MA. Mother-infant responsiveness: timing, mutual regulation, and interactional context. Dev Psychol. 2001;37(5):684–97.

95. Cohn JF, Matias R, Tronick EZ, Connell D, Lyons-Ruth K. Face-to-face interactions of depressed mothers and their infants. . New Dir Child Dev. 1986;

96. Gordon I, Feldman MR. Synchrony in the triad: A microlevel process model of coparenting and parent-child interactions. Fam Process [Internet]. 2008;47(4):465–79. Available from: www.FamilyProcess.org

97. Gordon I, Zagoory-Sharon O, Leckman JF, Feldman R. Oxytocin, cortisol, and triadic family interactions. Physiol Behav. 2010 Dec 2;101(5):679–84.

98. Van Puyvelde M, Loots G. Tonal synchrony based on harmonic and pentatonic series: The tonal moment in mother-infant interaction. In: Finds and Results from the Swedish Cyprus Expedition: A Gender Perspective at the Medelhavsmuseet. 2010.

99. Farran DC, Kasari C. A longitudinal analysis of the development of synchrony in mutual gaze in mother-child dyads. J Appl Dev Psychol. 1990 Oct 1;11(4):419–30.

100. Messinger DS, Mahoor MH, Chow SM, Cohn JF. Automated measurement of facial expression in infant - Mother interaction: A pilot study. Infancy. 2009;14(3):285–305.

101. De Graag JA, Cox RFA, Hasselman F, Jansen J, De Weerth C. Functioning within a relationship: Mother-infant synchrony and infant sleep. Infant Behav Dev. 2012 Apr;35(2):252–63.

102. Isabella RA, Belsky J, von Eye A. Origins of infant-mother attachment: An examination of interactional synchrony during the infant's first year . Dev Psychol. 1989;25(1):12–21.

103. Gratier M. Expressive timing and interactional synchrony between mothers and infants: Cultural similarities, cultural differences, and the immigration exprerience. Cogn Dev. 2003;18(4):533–54.

104. Northrup JB, Iverson JM. The Development of Mother–Infant Coordination Across the First Year of Life. Dev Psychol. 2020;56(2):221–36.

105. Golds L, Gillespie-Smith K, Nimbley E, MacBeth A. What factors influence dyadic synchrony? A systematic review of the literature on predictors of mother–infant dyadic processes of shared behavior and affect. Vol. 43, Infant Mental Health Journal. John Wiley and Sons Inc; 2022. p. 808–30.

106. Feldman R, Eidelman AI. Maternal postpartum behavior and the emergence of infant-mother and infant-father synchrony in preterm and full-term infants: The role of neonatal vagal tone. Dev Psychobiol. 2007 Apr;49(3):290–302.

107. Field T, Healy B, Goldstein S, Guthertz M. Behavior-State Matching and Synchrony in Mother-Infant Interactions of Nondepressed Versus Depressed Dyads. Dev Psychol. 1990;26(1):7–14.
108. Granat A, Gadassi R, Gilboa-Schechtman E, Feldman R. Maternal depression and anxiety, social synchrony, and infant regulation of negative and positive emotions. Emotion. 2017 Feb 1;17(1):11–27.
109. Beebe B, Jaffe J, Buck K, Chen H, Cohen P, Feldstein S, et al. Six-week postpartum maternal depressive symptoms and 4-month mother-infant self- and interactive contingency. Infant Ment Health J. 2008;29(5):442–71.
110. Beebe B. Psychoanalytic Inquiry Coconstructing Mother-Infant Distress: The Microsynchrony of Maternal Impingement and Infant Avoidance in the Face-to-Face Encounter. 2008; Available from: https://www.tandfonline.com/action/journalInformation?journalCode=hpsi20
111. Feldman R, Greenbaum CW, Yirmiya N, Mayes LC. Relations between cyclicity and regulation in mother-infant interaction at 3 and 9 months and cognition at 2 years. J Appl Dev Psychol. 1996;17(3):347–65.
112. Feldman R. Parent-infant synchrony: Biological foundations and developmental outcomes. Curr Dir Psychol Sci. 2007 Dec;16(6):340–5.
113. Thompson LA, Trevathan WR. Cortisol reactivity, maternal sensitivity, and infant preference for mother's familiar face and rhyme in 6-month-old infants. J Reprod Infant Psychol. 2009;27(2):143–67.
114. Harrist AW, Pettit GS, Dodge KA, Bates JE. Dyadic synchrony in mother-child interaction: Relation with children's subsequent kindergarten adjustment. Fam Relat. 1994;417–24.
115. Lundy BL. Father– and mother–infant face-to-face interactions: Differences in mind-related comments and infant attachment? Infant Behav Dev. 2003 Apr 1;26(2):200–12.
116. Longhi E. Songese': Maternal structuring of musical interaction with infants. Psychol Music. 2009;37(2):195–213.
117. Lindsey EW, Mize J, Pettit GS. Mutuality in parent-child play: Consequences for children's peer competence. J Soc Pers Relat. 1997;14(4):523–38.
118. Booth C. L, Lyons N. B, Barnard K. E. Synchrony in mother–infant interaction: A comparison of measurement methods. Child Study Journal. 1984;14:95–114.
119. Garcia-Sellers M. J, Church K. Avoidance, frustration and hostility during toddlers' interaction with their mothers and fathers. Infant-Toddler Intervention. 2000;10:259–74.
120. Stern DN. Mother and infant at play: The dyadic interaction involving facial, vocal, and gaze behaviors. In: M Lewis & LA Rosenblum (Eds) The effect of the infant on its caregiver. New York: Wiley; 1974.

121. Isabella RA, Belsky J. Interactional synchrony and the origins of infant-mother attachment: A replication study. Child Dev. 1991;62(2):373–84.
122. Field T. Infants of Depressed Mothers. Vol. 18, INFANT BEHAVIOR AND DEVELOPMENT. 1995.
123. Lewis M, Feiring C. Infant, mother, and mother-infant interaction behavior and subsequent attachment. Child Dev. 1989;831–7.
124. Leyendecker B, Lamb ME, Fracasso MP, Schölmerich A, Larson C. Playful interaction and the antecedents of attachment: A longitudinal study of Central American and Euro-American mothers and infants. Merrill Palmer Q. 1997;24–47.
125. Malatesta CZ, Culver C, Tesman JR, Shepard B, Fogel A, Reimers M, et al. The development of emotion expression during the first two years of life. Monogr Soc Res Child Dev. 1989;54(1–2):i–136.
126. Cruz S, Lifter K, Barros C, Vieira R, Sampaio A. Neural and psychophysiological correlates of social communication development: Evidence from sensory processing, motor, cognitive, language and emotional behavioral milestones across infancy. Appl Neuropsychol Child. 2022;11(2):158–77.
127. Rochat P, Striano T, Blatt L. Differential effects of happy, neutral, and sad still faces on 2-, 4-, and 6-month-old infants. Infant Child Dev. 2002;11(4):289–303.
128. Lachman A. Shared pleasure in early infant interactions [Internet]. 2022. Available from: https://scholar.sun.ac.za
129. Grossmann T, Johnson MH, Lloyd-Fox S, Blasi A, Deligianni F, Elwell C, et al. Early cortical specialization for face-to-face communication in human infants. Proceedings of the Royal Society B: Biological Sciences. 2008 Dec 22;275(1653):2803–11.
130. Leong V, Byrne E, Clackson K, Georgieva S, Lam S, Wass S. Speaker gaze increases information coupling between infant and adult brains. Proc Natl Acad Sci U S A. 2017 Dec 12;114(50):13290–5.
131. Feldman R, Weller A, Zagoory-Sharon O, Levine A. Evidence for a neuroendocrinological foundation of human affiliation: plasma oxytocin levels across pregnancy and the postpartum period predict mother-infant bonding. Psychol Sci. 2007;18(11):965–70.
132. Trevarthen C. Trevarthen-Primary Intersubjectivity. 1979;
133. Winnicott DW. Mirror-role of mother and family in child development 1 . In: Parent-infant psychodynamics. Routledge; 2018. p. 18–24.

134. Fogel A. Temporal organization in mother-infant face-to-face interaction . In: HR Schaffer (Ed), Studies in mother-infant interaction: The Loch Lonond Symposium. London: Academic Press; 1977.
135. Tronick E, Als H, Brazelton TB. Monadic phases: A structural descriptive analysis of infant-mother face to face interaction. Merrill Palmer Q Behav Dev. 1980;26(1):3–24.
136. Frith C.D, Frith U. Social Cognition in Humans. Current Biology. 2007;17(16):724–32.
137. Crown CL, Feldstein S, Jasnow MD, Beebe B, Jaffe J. The Cross-Modal Coordination of Interpersonal Timing: Six-Week-Olds Infants' Gaze with Adults' Vocal Behavior. J Psycholinguist Res. 2002;31(1):1–23.
138. Doherty MJ. The development of mentalistic gaze understanding. Vol. 15, Infant and Child Development. 2006. p. 179–86.
139. Emery NJ. The eyes have it: the neuroethology, function and evolution of social gaze. Neurosci Biobehav Rev [Internet]. 2000;24(6):581–604. Available from: www.elsevier.com/locate/neubiorev
140. Shepherd S V. Following gaze: Gaze-following behavior as a window into social cognition. Front Integr Neurosci. 2010 Mar;4–5(March 2010).
141. Kaartinen M, Puura K, Mäkelä T, Rannisto M, Lemponen R, Helminen M, et al. Autonomic arousal to direct gaze correlates with social impairments among children with ASD. J Autism Dev Disord. 2012;42:1917–27.
142. Hobson RP, Bishop M. The pathogenesis of autism: Insights from congenital blindness. Philosophical Transactions of the Royal Society B: Biological Sciences. 2003 Feb 28;358(1430):335–44.
143. Beebe BA. Ontogeny of positive affect in the third and fourth months of the life of one infant (ProQuest Information & Learning) [Dissertation Abstracts International, 35(2), 1014B]. Columbia University; 1974.
144. Beebe B, Stern DN. Engagement-disengagement and early object experiences. In: Communicative structures and psychic structures: A psychoanalytic interpretation of communication. Boston, MA: Springer US; 1977. p. 35–55.
145. Field TM. Infant gaze aversion and heart rate during face-to-face interactions. Infant Behav Dev. 1981;4:307–15.
146. Brazelton TB, Koslowski B, Main M. The origins of reciprocity. In: M Lewis & L Rosenblum (Eds), The effects of the infant on its caregiver. New York: Wiley-Interscience; 1974. p. 137–54.
147. Ayers MY. Mother-infant attachment and psychoanalysis: The eyes of shame. Routledge; 2014.

148. Dodd B. Lip reading in infants: Attention to speech presented in- and out-of-synchrony. Cogn Psychol. 1979 Oct 1;11(4):478–84.
149. Herba C, Phillips M. Annotation: Development of facial expression recognition from childhood to adolescence: Behavioural and neurological perspectives. J Child Psychol Psychiatry. 2004 Oct;45(7):1185–98.
150. Watling D, Workman L, Bourne VJ. Emotion lateralisation: Developments throughout the lifespan. Laterality: Asymmetries of Body. Brain Cogn. 2012;17(4):389–411.
151. Cunningham JG, Odom RD. Differential Salience of Facial Features in Children's Perception of Affective Expression. Child Dev. 1986 Feb;57(1):136.
152. Field TM, Woodson R, Greenberg R, Cohen D. Discrimination and Imitation of Facial Expression by Neonates. Science (1979) [Internet]. 1982 [cited 2024 Oct 12];218(4568):179–81. Available from: https://www.science.org/doi/10.1126/science.7123230
153. Haviland J, Lelwica M. The induced affect response: 10-week-old infants' responses to three emotion expressions. Dev Psychol [Internet]. 1987 [cited 2024 Oct 12];23(1):97–104. Available from: https://psycnet.apa.org/record/1987-12944-001
154. Montague DP, Walker-Andrews AS. Peekaboo: a new look at infants' perception of emotion expressions. Dev Psychol. 2001;37(6):826–38.
155. Lewis M, Lamm C, Segalowitz SJ, Stieben J, Zelazo PD. Neurophysiological correlates of emotion regulation in children and adolescents. J Cogn Neurosci [Internet]. 2006 [cited 2024 Oct 12];18(3):430–43. Available from: https://direct.mit.edu/jocn/article-abstract/18/3/430/4114
156. Cohn JF, Elmore M. Effect of contingent changes in mothers' affective expression on the organization of behavior in 3-month-old infants. Infant Behav Dev. 1988 Oct 1;11(4):493–505.
157. Kahana-Kalman R, Walker-Andrews AS. The Role of Person Familiarity in Young Infants' Perception of Emotional Expressions. Child Dev. 2001;72(2):352–69.
158. Stack DM, Muir DW. Adult Tactile Stimulation during Face-to-Face Interactions Modulates Five-Month-Olds' Affect and Attention. Child Dev [Internet]. 1992 Dec 1 [cited 2024 Oct 12];63(6):1509–25. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/j.1467-8624.1992.tb01711.x
159. Feinman S, Lewis M. Social referencing at ten months: A second-order effect on infants' responses to strangers. Child Dev. 1983;878–87.
160. Sorce J, Emde R, Campos JJ, Klinnert MD. Maternal emotional signaling: its effect on the visual cliff behavior of 1-year-olds. Dev Psychol [Internet]. 1985 [cited 2024 Oct 12];21(1):195. Available from: https://psycnet.apa.org/fulltext/1985-14205-001.html

161. Cohn JF, Tronick EZ. Mother-Infant Face-to-Face Interaction: The Sequence of Dyadic States at 3, 6, and 9 Months. Dev Psychol. 1987;23(1):68–77.
162. Feldman R, Greenbaum CW, Yirmiya N. Mother-infant affect synchrony as an antecedent of the emergence of self-control. Dev Psychol. 1999;35(1):223–31.
163. Sroufe LA. The promise of developmental psychopathology: Past and present. Dev Psychopathol. 2013 Nov;25(4 PART 2):1215–24.
164. Gianino A, Tronick EZ. The mutual regulation model: The infant's self and interactive regulation and coping and defensive capacities. In: Stress and coping across development. Psychology Press; 2013. p. 47–68.
165. Nelson CA, Parker SW, Guthrie D, Zeanah CH, Smyke AT, Koga SF, et al. The discrimination of facial expressions by typically developing infants and toddlers and those experiencing early institutional care. Infant Behav Dev. 2006 Apr;29(2):210–9.
166. Jeon H, Moulson MC, Fox N, Zeanah C, Nelson CA. The effects of early institutionalization on the discrimination of facial expressions of emotion in young children. Infancy. 2010 Mar;15(2):209–21.
167. Pollak SD, Cicchetti D, Hornung K, Reed A. Recognizing emotion in faces: developmental effects of child abuse and neglect. Dev Psychol. 2000;36(5):679–88.
168. Abraham E, Hendler T, Shapira-Lichter I, Kanat-Maymon Y, Zagoory-Sharon O, Feldman R. Father's brain is sensitive to childcare experiences. Proc Natl Acad Sci U S A. 2014 Jul 8;111(27):9792–7.
169. Tronick E, Als H, Adamson L, Wise S, Brazelton TB. The Infant's Response to Entrapment between Contradictory Messages in Face-to-Face Interaction. J Am Acad Child Psychiatry. 1978 Dec 1;17(1):1–13.
170. Mesman J, van IJzendoorn MH, Bakermans-Kranenburg MJ. The many faces of the Still-Face Paradigm: A review and meta-analysis. Developmental Review. 2009 Jun;29(2):120–62.
171. Haley DW. Relationship disruption stress in human infants: A validation study with experimental and control groups. Stress. 2011 Sep;14(5):530–6.
172. Ham J, Tronick E. A procedure for the measurement of infant skin conductance and its initial validation using clap induced startle. Dev Psychobiol. 2008 Sep;50(6):626–31.
173. Carter CS, Keverne EB. The Neurobiology of Social Affiliation and Pair Bonding. Hormones, Brain and Behavior. 2002 Jan 1;299–337.
174. Keller H, Yovsi R, Borke J, Kärtner J, Jensen H, Papaligoura Z. Developmental consequences of early parenting experiences: Self regulations and self-recognition in three cultural communities. Child Dev. 2004;75:1745–60.

175. Maiello S. The cultural dimension in early mother-infant interaction and psychic development: An infant observation in South africa. Infant Observation. 2000 Feb;3(2):80–92.
176. Feldman R. Parent-infant synchrony and the construction of shared timing; physiological precursors, developmental outcomes, and risk conditions. Vol. 48, Journal of Child Psychology and Psychiatry and Allied Disciplines. 2007. p. 329–54.
177. Richman AL, Miller PM, Levine RA. Cultural and Educational Variations in Maternal Responsiveness. Dev Psychol. 1992;28(4):614–21.
178. Camras LA, Oster H, Campos J, Campos R, Ujiie T, Miyake K, et al. Production of Emotional Facial Expressions in European American, Japanese, and Chinese Infants. Dev Psychol. 1998;34(4):616–28.
179. Oster H. Baby FACS: Facial action coding system for infants and young children (Unpublished monograph and coding manual) . New York; 2006.
180. Kärtner J, Keller H, Yovsi RD. Mother-Infant Interaction During the First 3 Months: The Emergence of Culture-Specific Contingency Patterns. Child Dev. 2010 Mar;81(2):540–54.
181. Wörmann V, Holodynski M, Kärtner J, Keller H. A cross-cultural comparison of the development of the social smile. A longitudinal study of maternal and infant imitation in 6- and 12-week-old infants. Infant Behav Dev. 2012 Jun;35(3):335–47.
182. Keller H, Lamm B, Abels M, Yovsi R, Borke J, Jensen H, et al. Cultural models, socialization goals, and parenting ethnotheories: A multicultural analysis. Vol. 37, Journal of Cross-Cultural Psychology. 2006. p. 155–72.
183. Lamm B, Keller H, Yovsi RD, Chaudhary N. Grandmaternal and Maternal Ethnotheories About Early Child Care. Journal of Family Psychology. 2008 Feb;22(1):80–8.
184. Keller H, Otto H. The cultural socialization of emotion regulation during infancy. J Cross Cult Psychol. 2009 Nov;40(6):996–1011.
185. Holodynski M, Friedimeier W. Development of emotions and emotion regulation. Vol. 8. Springer Science & Business Media; 2006.
186. Bronfenbrenner U. The Ecology of Human Development: Experiments by Nature and Design. Cambridge: Harvard University Press; 1979.
187. Lefophane MH. Unemployment, Policy Responses and Challenges in South Africa: A Sectoral Analysis. 2021; Available from: www.intechopen.com
188. Statista. Unemployment rate in South Africa from Q1 2019 to Q2 2023, by population group [Internet]. 2023. Available from: www.statssa.gov.za,info@statssa.gov.za,Tel+27123108911
189. Mudau TJ, Obadire OS. The Role of Patriarchy in Family Settings and its Implications to Girls and Women in South Africa. Journal of Human Ecology. 2017 May 4;58(1–2):67–72.

190. Dunkle KL, Jewkes RK, Brown HC, Yoshihama M, Gray GE, McIntyre JA, et al. Prevalence and patterns of gender-based violence and revictimization among women attending antenatal clinics in Soweto, South Africa. Am J Epidemiol. 2004 Aug 1;160(3):230–9.
191. Campbell J. Health consequences of intimate partner violence. Lancet [Internet]. 2002;359:1331–6. Available from: www.thelancet.com1331
192. Magamela MR, Dzinamarira T, Hlongwa M. COVID-19 consequences on mental health. An African perspective. The South African Journal of Psychiatry [Internet]. 2021;(27):1611. Available from: https://doi.
193. Ware LJ, Kim AW, Prioreschi A, Nyati LH, Taljaard W, Draper CE, et al. Social vulnerability, parity and food insecurity in urban South African young women: the healthy life trajectories initiative (HeLTI) study. J Public Health Policy. 2021 Sep 1;42(3):373–89.
194. Mileti DS. Disasters by design : a reassessment of natural hazards in the United States. Joseph Henry Press; 1999. 351 p.
195. Network GGL. Community resilience and vulnerability in South Africa: Perspectives from civil society on local governance in South Africa. Cape Town; 2014.
196. Naidu T. The COVID-19 pandemic in South Africa. Psychol Trauma [Internet]. 2020 [cited 2021 Jul 27];12(5):559–61. Available from: https://psycnet.apa.org/journals/tra/12/5/559
197. Prioreschi A, Wrottesley SV, Slemming W, Cohen E, Norris SA. A qualitative study reporting maternal perceptions of the importance of play for healthy growth and development in the first two years of life. BMC Pediatr. 2020 Sep 9;20(1).
198. Five facts about poverty in South Africa | Statistics South Africa [Internet]. [cited 2021 May 1]. Available from: http://www.statssa.gov.za/?p=12075&gclid=Cj0KCQjw-LOEBhDCARIsABrC0TnVuKfkwfu07nefr62B-Q5NQUKqCHp8hgsimwLmGczaH5PohHi9cswaAupmEALw_wcB
199. Statistics South Africa. Child poverty in South Africa: A Multiple Overlapping Deprivation Analysis. South Africa. 2020 Jun.
200. Grantham-Mcgregor S, Cheung YB, Cueto S, Glewwe P, Richter L, Strupp B, et al. Child development in developing countries. Developmental potential in the first 5 years for children in developing countries. Lancet [Internet]. 2007;369:60–70. Available from: www.thelancet.com
201. Ramchandani PG, Richter LM, Stein A, Norris SA. Predictors of postnatal depression in an urban South African cohort. J Affect Disord. 2009;113(3):279–84.
202. Redinger S, Norris SA, Pearson RM, Richter L, Rochat T. First trimester antenatal depression and anxiety: prevalence and associated factors in an urban population in Soweto, South Africa. J Dev

Orig Health Dis [Internet]. 2018 Feb 1 [cited 2022 Apr 4];9(1):30–40. Available from: https://pubmed.ncbi.nlm.nih.gov/28877770/

203. Hall K, Richer L, Mokomane Z, Lake L (eds). South african Child Gauge 2018. Children, Families and the State Collaboration and contestation [Internet]. Cape Town; 2018. Available from: www.childrencount.uct.ac.za.
204. Cohen E, Ware LJ, Prioreschi A, Draper C, Bosire E, Lye SJ, et al. Material and relational difficulties: the impact of the household environment on the emotional well-being of young black women living in Soweto, South Africa. J Fam Issues. 2020;41(8):1307–32.
205. Main M. Introduction to the special section on attachment and psychopathology: 2. Overview of the field of attachment . J Consult Clin Psychol. 1996;64(2):237.
206. Farré-Sender B, Torres A, Gelabert E, Andrés S, Roca A, Lasheras G, et al. Mother–infant bonding in the postpartum period: assessment of the impact of pre-delivery factors in a clinical sample. Arch Womens Ment Health. 2018 Jun 1;21(3):287–97.
207. Fuchs A, Möhler E, Resch F, Kaess M. Impact of a maternal history of childhood abuse on the development of mother–infant interaction during the first year of life. Child Abuse Negl. 2015 Oct 1;48:179–89.
208. Racine N, Plamondon A, Madigan S, McDonald S, Tough S. Maternal adverse childhood experiences and infant development. Pediatrics. 2018;141(4).
209. Manyema M, Norris SA, Richter LM. Stress begets stress: the association of adverse childhood experiences with psychological distress in the presence of adult life stress. BMC Public Health [Internet]. 2018;18(1):835. Available from: https://doi.org/10.1186/s12889-018-5767-0
210. Felitti VJ, Anda RF, Nordenberg D, Williamson DF, Spitz AM, Edwards V, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The adverse childhood experiences (ACE) study. Am J Prev Med. 1998 May;14(4):245–58.
211. Villegas L, Mckay K, Dennis CL, Ross LE. Postpartum Depression Among Rural Women From Developed and Developing Countries: A Systematic Review. Journal of Rural Health. 2011 Jun;27(3):278–88.
212. Verkuijl NE, Richter L, Norris SA, Stein A, Avan B, Ramchandani PG. Postnatal depressive symptoms and child psychological development at 10 years: A prospective study of longitudinal data from the South African Birth to Twenty cohort. Lancet Psychiatry. 2014 Nov 1;1(6):454–60.
213. Barlow DH. Anxiety and its disorders. New York: Guilford Press; 2002.
214. Dennis CL, Falah-Hassani K, Shiri R. Prevalence of antenatal and postnatal anxiety: Systematic review and meta-analysis. Vol. 210, British Journal of Psychiatry. Royal College of Psychiatrists; 2017. p. 315–23.

215. Dennis CL, Falah-Hassani K, Shiri R. Prevalence of antenatal and postnatal anxiety: Systematic review and meta-analysis. Vol. 210, British Journal of Psychiatry. Royal College of Psychiatrists; 2017. p. 315–23.
216. Goodman SH. Annual Review of Clinical Psychology: Intergenerational Transmission of Depression. 2020 [cited 2021 Jul 27]; Available from: https://doi.org/10.1146/annurev-clinpsy-071519-
217. Grigoriadis S, VonderPorten EH, Mamisashvili L, Tomlinson G, Dennis CL, Koren G, et al. The Impact of Maternal Depression During Pregnancy on Perinatal Outcomes: A Systematic Review and Meta-Analysis. J Clin Psychiatry [Internet]. 2013 Apr 15 [cited 2024 Oct 13];74(4):8615. Available from: https://www.psychiatrist.com/jcp/impact-maternal-depression-during-pregnancy-perinatal
218. Sexton MB, Hamilton L, McGinnis EW, Rosenblum KL, Muzik M. The roles of resilience and childhood trauma history: Main and moderating effects on postpartum maternal mental health and functioning. J Affect Disord. 2015 Mar 15;174:562–8.
219. Lyons-Ruth K. The Two-Person Construction of Defenses: Disorganized Attachment Strategies, Unintegrated Mental States, and Hostjle/Helpless Relational Processes. J Infant Child Adolesc Psychother [Internet]. 2003 [cited 2025 Jul 7];2:105. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC2131723/
220. Leerkes EM, Wong MS. Infant Distress and Regulatory Behaviors Vary as a Function of Attachment Security Regardless of Emotion Context and Maternal Involvement. Infancy [Internet]. 2011 Sep [cited 2025 Jul 7];17(5):455. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC3422878/
221. Goodman SH, Gotlib IH. Risk for psychopathology in the children of depressed mothers: A developmental model for understanding mechanisms of transmission. Psychol Rev. 1999;106(3):458–90.
222. Cicchetti D, Toth SL. The Development of Depression in Children and Adolescents. 1998.
223. Weinberg MK, Tronick EZ. Section 4. Emotional care of the at-risk infant: Emotional Characteristics of Infants Associated With Maternal Depression and Anxiety. J Clin Psychiatry [Internet]. 1998;59(2):53–61. Available from: www.aappublications.org/news
224. Field T. Infants of depressed mothers. Dev Psychopathol. 1992;4(1):49–66.
225. Gelfand DM, Teti DM. The effects of maternal depression on children. Clin Psychol Rev. 1990 Jan 1;10(3):329–53.
226. Goodman SH, Brumley HE. Schizophrenic and Depressed Mothers: Relational Deficits in Parenting. Dev Psychol. 1990;26(1):31–9.

227. Lovejoy MC, Graczyk PA, O'Hare E, Neuman G. Maternal depression and parenting behavior: A meta-analytic review. Clin Psychol Rev. 2000 Aug 1;20(5):561–92.
228. Field T, Sandberg D, Garcia R, Vega-Lahr N, Goldstein S, Guy L. Pregnancy problems, postpartum depression, and early mother–infant interactions . Dev Psychol. 1985;21(6):1152.
229. Campbell S, Cohn J, Meyers T. Depression in first-time mothers: mother-infant interaction and depression chronicity. Dev Psychol [Internet]. 1995 [cited 2024 Oct 13];31(3):349. Available from: https://psycnet.apa.org/journals/dev/31/3/349.html?uid=1995-33215-001
230. Hart S, Field T, Del Valle C, Pelaez-Nogueras M. Depressed mothers interactions with their one-year-old infants. 1998.
231. Murray L, Cooper PJ. Effects of postnatal depression on infant development. Arch Dis Child. 1997;77(2):99–101.
232. Patel V, De Souza N, Rodrigues N. Postnatal depression and infant growth and development in low income countries: a cohort study from Goa, India. Arch Dis Child [Internet]. 2003;88:34–7. Available from: www.archdischild.com
233. Black MM, Baqui AH, Zaman K, McNary SW, Le K, Arifeen S El, et al. Depressive symptoms among rural Bangladeshi mothers: implications for infant development. Journal of Child Psychology and Psychiatry [Internet]. 2007 Aug 1 [cited 2021 May 1];48(8):764–72. Available from: http://doi.wiley.com/10.1111/j.1469-7610.2007.01752.x
234. Kaitz M, Maytal H. Interactions between anxious mothers and their infants: An integration of theory and research findings. Infant Ment Health J. 2005;26(6):570–97.
235. Murray L, Cooper P, Creswell C, Schofield E, Sack C. The effects of maternal social phobia on mother-infant interactions and infant social responsiveness. J Child Psychol Psychiatry. 2007 Jan;48(1):45–52.
236. Feldman R, Greenbaum CW, Mayes LC, Erlich SH. Change in Mother-Infant Interactive Behavior: Relations to Change in the Mother, the Infant, and the Social Context. Infant Behav Dev. 1997;20(2):63.
237. Kaitz M, Maytal HR, Devor N, Bergman L, Mankuta D. Maternal anxiety, mother-infant interactions, and infants' response to challenge. Infant Behav Dev. 2010 Apr;33(2):136–48.
238. Koen N, Brittain K, Donald KA, Barnett W, Koopowitz S, Maré K, et al. Maternal posttraumatic stress disorder and infant developmental outcomes in a South African birth cohort study. Psychol Trauma. 2017 May 1;9(3):292–300.
239. Enlow MB, Kitts RL, Blood E, Bizarro A, Hofmeister M, Wright RJ. Maternal Posttraumatic Stress Symptoms and Infant Emotional Reactivity and Emotion Regulation. Infant Behav Dev. 2011;34(4):487–503.

240. Field TM. Effects of early separation, interactive deficits, and experimental manipulations on infant-mother face-to-face interaction. Child Dev. 1977 Sep;48(3):763.
241. Beebe B, Badalamenti A, Jaffe J, Feldstein S, Marquette L, Helbraun E, et al. Distressed mothers and their infants use a less efficient timing mechanism in creating expectancies of each other's looking patterns. J Psycholinguist Res. 2008;37(5):293–307.
242. Feldman R, Granat A, Gilboa-Schechtman E. Maternal anxiety and depression, mother – infant synchrony, and infant regulation of negative and positive emotions. In: Paper presented in the biennial meeting of the Society for Research in Child Development. Atlanta, GA; 2005.
243. Lotzin A, Romer G, Schiborr J, Noga B, Schulte-Markwort M, Ramsauer B. Gaze Synchrony between Mothers with Mood Disorders and Their Infants: Maternal Emotion Dysregulation Matters. PLoS One. 2015 Dec 1;10(12).
244. Cohn JE, Campbell SB, Matias R, Hopkins J. Developmental Psychology Face-to-Face Interactions of Postpartum Depressed and Nondepressed Mother-Infant Pairs at 2 Months. Vol. 26. 1990.
245. Aktar E, Colonnesi C, De Vente W, Majdandžić M, Bögels SM. How do parents' depression and anxiety, and infants' negative temperament relate to parent-infant face-to-face interactions? Dev Psychopathol. 2017 Aug 1;29(3):697–710.
246. Hoffman Y, Drotar D. The impact of postpartum depressed mood on mother-infant interaction: Like mother like baby? . Infant Ment Health J. 1991;12(1):65–80.
247. Skotheim S, Braarud HC, Høie K, Markhus MW, Malde MK, Graff IE, et al. Subclinical levels of maternal depression and infant sensitivity to social contingency. Infant Behav Dev. 2013 Jun;36(3):419–26.
248. Beebe B, Jaffe J, Buck K, Chen H, Cohen P, Blatt S, et al. Six-Week Postpartum Maternal Self-Criticism and Dependency and 4-Month Mother-Infant Self- and Interactive Contingencies. Dev Psychol. 2007 Nov;43(6):1360–76.
249. Feldman R, Granat A, Gilboa-Schechtman E. Maternal anxiety and depression, mother-infant synchrony, and infant regulation of negative and positive emotions. In: In biennial meeting of the Society for Research in Child Development, Atlanta, GA. 2005.
250. City of Johannesburg. Population and people. 2024.
251. Closson K, Dietrich JJ, Nkala B, Musuku A, Cui Z, Chia J, et al. Prevalence, type, and correlates of trauma exposure among adolescent men and women in Soweto, South Africa: Implications for HIV prevention. BMC Public Health. 2016 Nov 25;16(1).
252. Fonck K, Els L, Kidula N, Ndinya-Achola J, Temmerman M. Increased risk of HIV in women experiencing physical partner violence in Nairobi, Kenya. AIDS Behav. 2005;9(3):335–9.

253. Tsai AC, Tomlinson M, Comulada WS, Rotheram-Borus MJ. Intimate Partner Violence and Depression Symptom Severity among South African Women during Pregnancy and Postpartum: Population-Based Prospective Cohort Study. PLoS Med. 2016;13(1).
254. Statistics South Africa. National Household Travel Survey: Statistical release. P0320 [Internet]. Pretoria, South Africa; 2020. Available from: www.statssa.gov.za,info@statssa.gov.za,Tel+27123108911
255. Barbarin OA, Khomo N. Indicators of economic status and social capital in South African townships. In: Childhood. London: SAGE Publications; 1997. p. 193–222.
256. Kabudula CW, Houle B, Collinson MA, Kahn K, Tollman S, Clark S. Assessing Changes in Household Socioeconomic Status in Rural South Africa, 2001–2013: A Distributional Analysis Using Household Asset Indicators. Soc Indic Res. 2017 Sep 1;133(3):1047–73.
257. Bhengu B, Tomita A, Mashaphu S, Paruk S. The role of adverse childhood experiences on perinatal substance use behaviour in Kwa-Zulu-Natal Province, South Africa. AIDS Behav. 2020;24:1643–52.
258. Manyema M, Richter LM. Adverse childhood experiences: prevalence and associated factors among South African young adults. Heliyon [Internet]. 2019 Dec 1 [cited 2025 Jul 7];5(12). Available from: https://pubmed.ncbi.nlm.nih.gov/31890957/
259. O'hara MW, Swain AM. Rates and risk of postpartum depression-a meta-analysis. International Review of Psychiatry. 1996;8(1):37–54.
260. Nadel J, Soussignan R, Canet P, Libert G, Gérardin P. Two-month-old infants of depressed mothers show mild, delayed and persistent change in emotional state after non-contingent interaction. Infant Behav Dev. 2005 Dec;28(4):418–25.
261. Lawrie T, Hofmeyr GJ, de Jager M, Berk M. Validation of the Edinburgh Postnatal Depression Scale on a cohort of South African women. South African Medical Journal. 1998;88:1340–4.
262. Brockington IF, Fraser C, Wilson D. The Postpartum Bonding Questionnaire: A validation. Arch Womens Ment Health. 2006 Sep;9(5):233–42.
263. Makhubela M. Latent structure of the Post-Traumatic Stress Disorder (PTSD) Checklist for DSM-5 (PCL-5) in South African mortuary workers. Journal of Psychology in Africa. 2018 May 4;28(3):206–11.
264. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders - Fourth ed, text revision (DSM-IV-TR). Washington D.C: American Psychiatric Association; 2000.
265. Verhey R, Chibanda D, Gibson L, Brakarsh J, Seedat S. Validation of the posttraumatic stress disorder checklist-5 (PCL-5) in a primary care population with high HIV prevalence in Zimbabwe.

BMC Psychiatry [Internet]. 2018;18(109):1–8. Available from: https://doi.org/10.1186/s12888-018-1688-9

266. Gulbicki L, Fertig M, Githaiga J, Gwangqa L, Kabel K, Lee J, et al. Exploring the effects of mental health on bonding and caregiving among pregnant and postpartum persons with likely depression and/or PTSD in South Africa: A qualitative analysis. Res Sq [Internet]. 2024 Oct 24 [cited 2025 Jul 6];rs.3.rs-5041479. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC11537343/
267. Ramchandani PG, Richter LM, Norris SA, Stein A. Maternal Prenatal Stress and Later Child Behavioral Problems in an Urban South African Setting. J Am Acad Child Adolesc Psychiatry. 2010 Mar;49(3):239–47.
268. Motloba P. Non-maleficence - a disremembered moral obligation. South African Dental Journal. 2019;74(1).
269. Vygotsky LS. The collected works of LS Vygotsky: Volume 1. Thinking and speaking. Vol. 1. New York: Plenum Press; 1987.
270. Skinner A, Costantini I, Stone C, Darios J, Gray M, Culpin I, et al. Identifying stakeholder priorities in use of wearable cameras for researching parent-child interactions. Frontiers in Child and Adolescent Psychiatry. 2023 Jun 23;2.
271. Wrottesley S V., Pearson R, Prioreschi A. The headcam mother-infant interaction assessment tool: testing the feasibility and acceptability in Soweto, South Africa, using participatory engagement. Pilot Feasibility Stud. 2021 Dec 1;7(1).
272. Braun V, Clarke V. To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. Vol. 13, Qualitative Research in Sport, Exercise and Health. Routledge; 2021. p. 201–16.
273. Sandelowski M. One is the liveliest number: The case orientation of qualitative research. Res Nurs Health. 1996;19(6):525–9.
274. Vasileiou K, Barnett J, Thorpe S, Young T. Characterising and justifying sample size sufficiency in interview-based studies: Systematic analysis of qualitative health research over a 15-year period. BMC Med Res Methodol. 2018 Nov 21;18(1).
275. Guest G, Bunce A, Johnson L. How Many Interviews Are Enough?: An Experiment with Data Saturation and Variability. Field methods. 2006;18(1):59–82.
276. Feldman Coding interactive behavior 1998 - Google Scholar [Internet]. [cited 2025 Jul 6]. Available from: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Feldman+Coding+interactive+behavior+1998&btnG=

277. Costantini I, Cordero M, Campbell A, Burgess R, Glen K, Moraitopoulou G, et al. Mental Health Intergenerational Transmission (MHINT) Process Manual *Use alongside the MHINT Micro-Coding Scheme provided as Observer XT© file. 2021.
278. Burgess R, Costantini I, Bornstein MH, Campbell A, Cordero Vega MA, Culpin I, et al. A Quantitative Evaluation of Thin Slice Sampling for Parent–Infant Interactions. J Nonverbal Behav. 2023 Jun 1;47(2):117–210.
279. Montague E, Xu J, Asan O, Chen P, Chewning B, Barrett B. Modeling Eye Gaze Patterns in Clinician-Patient Interaction with Lag Sequential Analysis. 2011.
280. Kathree T, Selohilwe OM, Bhana A, Petersen I. Perceptions of postnatal depression and health care needs in a South African sample: The "mental" in maternal health care. BMC Womens Health. 2014 Nov 12;14(1).
281. Prioreschi A, Pearson R, Richter L, Bennin F, Theunissen H, Cantrell SJ, et al. Protocol for the PLAY Study: A randomised controlled trial of an intervention to improve infant development by encouraging maternal self-efficacy using behavioural feedback. BMJ Open. 2023 Mar 7;13(3).
282. Kelly P, Marshall SJ, Badland H, Kerr J, Oliver M, Doherty AR, et al. An Ethical Framework for Automated, Wearable Cameras in Health Behavior Research. Am J Prev Med. 2013 Mar 1;44(3):314–9.
283. Friedrich MJ. Depression is the leading cause of disability around the world. J Am Med Assoc. 2017;317(15):1517–1517.
284. Wang Z, Liu J, Shuai H, Cai Z, Fu X, Liu Y, et al. Mapping global prevalence of depression among postpartum women. Translational Psychiatry 2021 11:1 [Internet]. 2021 Oct 20 [cited 2025 Jan 18];11(1):1–13. Available from: https://www.nature.com/articles/s41398-021-01663-6
285. Shuffrey LC, Sania A, Brito NH, Potter M, Springer P, Lucchini M, et al. Association of maternal depression and anxiety with toddler social-emotional and cognitive development in South Africa: A prospective cohort study. BMJ Open. 2022 Apr 13;12(4).
286. Baron EC, Hanlon C, Mall S, Honikman S, Breuer E, Kathree T, et al. Maternal mental health in primary care in five low- and middle-income countries: A situational analysis. BMC Health Serv Res. 2016 Feb 16;16(1).
287. Tol WA, Greene MC, Lasater ME, Le Roch K, Bizouerne C, Purgato M, et al. Impact of maternal mental health interventions on child-related outcomes in low- And middle-income countries: A systematic review and meta-analysis. Epidemiol Psychiatr Sci. 2020;
288. Mathews S, Benvenuti P. Violence against children in South Africa: Developing a prevention agenda. South African child gauge 1(2), 26-34. 2014.

289. Okafor CN, Barnett W, Zar HJ, Nhapi R, Koen N, Shoptaw S, et al. Associations of Emotional, Physical or Sexual Intimate Partner Violence and Depression Symptoms among South African Women in a Prospective Cohort Study. J Interpers Violence [Internet]. 2018 May 1 [cited 2025 Jan 18];36(9–10):NP5060. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC6486451/

290. Hung KJ, Tomlinson M, Le Roux IM, Dewing S, Chopra M, Tsai AC. Community-based prenatal screening for postpartum depression in a South African township. International Journal of Gynecology & Obstetrics [Internet]. 2014 Jul 1 [cited 2025 Jan 18];126(1):74–7. Available from: https://onlinelibrary.wiley.com/doi/full/10.1016/j.ijgo.2014.01.011

291. Maré KT, Pellowski JA, Koopowitz SM, Hoffman N, van der Westhuizen C, Workman L, et al. Perinatal suicidality: prevalence and correlates in a South African birth cohort. Arch Womens Ment Health. 2021 Oct 1;24(5):737–48.

292. Wheeler NJ, Daire AP, Barden SM, Carlson RG. Relationship Distress as a Mediator of Adverse Childhood Experiences and Health: Implications for Clinical Practice with Economically Vulnerable Racial and Ethnic Minorities. Fam Process. 2019 Dec 1;58(4):1003–21.

293. Cluver L, Orkin M, Boyes ME, Sherr L. Child and adolescent suicide attempts, suicidal behavior, and adverse childhood experiences in South Africa: A prospective study. Journal of Adolescent Health. 2015 Jul 1;57(1):52–9.

294. Merrick MT, Ports KA, Ford DC, Afifi TO, Gershoff ET, Grogan-Kaylor A. Unpacking the impact of adverse childhood experiences on adult mental health. Child Abuse Negl. 2017 Jul 1;69:10–9.

295. Goodman ML, Baker L, Maigallo AK, Elliott A, Keiser P, Raimer-Goodman L. Adverse childhood experiences, adult anxiety and social capital among women in rural Kenya. J Anxiety Disord. 2022;(91):102614.

296. Alves S, Fonseca A, Canavarro MC, Pereira M. Dyadic coping and dyadic adjustment in couples with women with high depressive symptoms during pregnancy. J Reprod Infant Psychol. 2018 Oct 20;36(5):504–18.

297. de Camps Meschino D, Philipp D, Israel A, Vigod S. Maternal-infant mental health: postpartum group intervention. Arch Womens Ment Health [Internet]. 2016 Apr 1 [cited 2025 Jan 18];19(2):243–51. Available from: https://pubmed.ncbi.nlm.nih.gov/26239582/

298. Murray L, Fiori-Cowley A, Hooper R, Cooper P. The impact of postnatal depression and associated adversity on early mother-infant interactions and later infant outcome. Child Dev. 1996;67(5):2512–26.

299. Slomian J, Honvo G, Emonts P, Reginster JY, Bruyère O. Consequences of maternal postpartum depression: A systematic review of maternal and infant outcomes. Vol. 15, Women's Health. SAGE Publications Ltd; 2019.
300. Brockington I. Postpartum psychiatric disorders . Lancet. 2004;363:303–10.
301. Murray L. The impact of postnatal depression on infant development. Journal of child psychology and psychiatry. 1992;33(3):543–61.
302. Rocha NACF, dos Santos Silva FP, dos Santos MM, Dusing SC. Impact of mother–infant interaction on development during the first year of life: A systematic review. https://doi.org/101177/1367493519864742 [Internet]. 2019 Jul 23 [cited 2025 Jan 19];24(3):365–85. Available from: https://journals.sagepub.com/doi/10.1177/1367493519864742?utm_source=chatgpt.com
303. Weathers FW, Litz BT, Herman DS, Huska JA, Keane TM. The PTSD Checklist (PCL): Reliability, Validity, and Diagnostic Utility. In: annual convention of the international society for traumatic stress studies. San Antonio, TX; 1993.
304. Cox JL, Holden JM, Sagovsky R. Detection of postnatal depression: development of the 10-item Edinburgh Postnatal Depression Scale. The British journal of psychiatry. 1987;150(6):782–6.
305. Kagee A, Bantjes J, Saal W, Sterley A. Predicting Posttraumatic Stress Disorder Caseness Using the PTSD Checklist for DSM-5 Among Patients Receiving Care for HIV. J Trauma Stress [Internet]. 2021 [cited 2021 Aug 15]; Available from: https://onlinelibrary.wiley.com/doi/full/10.1002/jts.22654
306. Cooper PJ, Tomlinson M, Swartz L, Woolgar M, Murray L, Molteno C. Post-partum depression and the mother-infant relationship in a South African peri-urban settlement. British Journal of Psychiatry [Internet]. 1999 [cited 2025 Jul 6];175(DEC.):554–8. Available from: https://pubmed.ncbi.nlm.nih.gov/10789353/
307. Rodriguez VJ, Mandell LN, Jones DL. Factor structure and differential item functioning of the Edinburgh Postnatal Depression Scale: A comparison of Zulu and English versions among ante- and postnatal women living with HIV in South Africa. Matern Child Health J [Internet]. 2022 Jul 1 [cited 2025 Jul 6];26(7):1576. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9372781/
308. Brockington IF, Oates J, George S, Turner D, Vostanis P, Sullivan M, et al. A screening questionnaire for mother-infant bonding disorders. Arch Womens Ment Health [Internet]. 2001 [cited 2025 Jul 6];3(4):133–40. Available from: https://link.springer.com/article/10.1007/s007370170010

309. Hailemeskel HS, Kebede AB, Fetene MT, Dagnaw FT. Mother-Infant Bonding and Its Associated Factors Among Mothers in the Postpartum Period, Northwest Ethiopia, 2021. Front Psychiatry. 2022 Jul 13;13.
310. Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol. 2006;3(2):77–101.
311. Beebe B, Lachmann FM, Markese S, Buck KA, Bahrick LE, Chen H, et al. On the origins of disorganized attachment and internal working models: Paper II. An empirical microanalysis of 4-month mother-infant interaction. Psychoanal Dialogues. 2012 May 1;22(3):352–74.
312. Nduna M. Factors that hinder paternity disclosure to children: South African mothers' perspectives. J Fem Fam Ther. 2014;26(4):218–35.
313. Denis P, Ntsimane R. Absent fathers: Why don't men feature in stories of families affected by HIV/AIDS in Kwazulu-Natal? In: L Richter, R Morrell (Eds), Baba: Men and fatherhood in South Africa. CapeTown: HSRC Press; 2006. p. 237–49.
314. Nduna M, Kasese-Hara M, Ndebele M, Pillay N, Manala L. Prevalence and characteristics of unresolved paternal identity in families of a South African community. Journal of Psychology in Africa. 2011;21(4):589–93.
315. Langa M. Adolescent boys' talk about absent fathers. Journal of Psychology in Africa. 2010;20(4):519–26.
316. Nduna M, Jewkes R. Undisclosed Paternal Identity in Narratives of Distress Among Young People in Eastern Cape, South Africa. J Child Fam Stud. 2011 Jun;20(3):303–10.
317. Phaswana ED. Experiences of rural Black South African adolescents who never met their own biological fathers. University of Johannesburg (South Africa). [South Africa]: University of Johannesburg; 2003.
318. Slavich GM, O'Donovan A, Epel ES, Kemeny ME. Black sheep get the blues: A psychobiological model of social rejection and depression. Neurosci Biobehav Rev. 2010 Sep 1;35(1):39–45.
319. Freud S. Mourning and melancholia. International Journal of Psychoanalysis. 1917;4(6):288–301.
320. Thakar D, Coffino B, Lieberman AF. Maternal symptomatology and parent–child relationship functioning in a diverse sample of young children exposed to trauma. J Trauma Stress. 2013;26(2):217–24.
321. Lang AJ, Gartstein MA, Rodgers CS, Lebeck MM. The impact of maternal childhood abuse on parenting and infant temperament. Journal of child and adolescent psychiatric nursing. 2010;23(2):100–10.
322. Iyengar U, Kim S, Martinez S, Fonagy P, Strathearn L. Unresolved trauma in mothers: intergenerational effects and the role of reorganization. 2014; Available from: www.frontiersin.org

323. Raphael-Leff J. Mothers' and fathers' orientations: patterns of pregnancy, parenting and the bonding process. In: Parenthood and mental health: A bridge between infant and adult psychiatry. 2010. p. 9–22.
324. Lazarus J, Kruger LM. Small meetings: reflections on the application of psychodynamic thought in community work with low-income South African children: part 1: reflections on the literature. Psycho-analytic Psychotherapy in South Africa. 2004;12(1):48–73.
325. Gerhardt S. Why Love Matters: How affection shapes a baby's brain. London: Routledge; 2004.
326. Bernier A, Calkins SD, Bell MA. Longitudinal Associations Between the Quality of Mother-Infant Interactions and Brain Development Across Infancy. Child Dev. 2016 Jul 1;87(4):1159–74.
327. Erickson MF, Sroufe LA, Egeland B. The Relationship between Quality of Attachment and Behavior Problems in Preschool in a High-Risk Sample. Vol. 50, Growing Points of Attachment Theory and Research. 1985.
328. Landy S, Menna R. Play between aggressive young children and their mothers. Clin Child Psychol Psychiatry. 2001;6(2):223–39.
329. Richter LM, Daelmans B, Lombardi J, Heymann J, Boo FL, Behrman JR, et al. Investing in the foundation of sustainable development: pathways to scale up for early childhood development. Vol. 389, The Lancet. Elsevier B.V.; 2017. p. 103–18.
330. Kobak RR, Sceery A. Attachment in late adolescence: Working models, affect regulation, and representations of self and others . Child Dev. 1988;135–46.
331. Feldman R. Sensitive periods in human social development: New insights from research on oxytocin, synchrony, and high-risk parenting. Dev Psychopathol. 2015 May 6;27(2):369–95.
332. Vallacher RR, Nowak A. The dynamics of human experience: Fundamentals of dynamical social psychology. . In: In S J Guastello, M Koopmans, & D Pincus (Eds), Chaos and complexity in psychology: The theory of nonlinear dynamical systems: New York: Cambridge University Press; 2009. p. 370–401.
333. Coburn SS, Crnic KA, Ross EK. Mother–infant dyadic state behaviour: Dynamic systems in the context of risk. . Infant Child Dev. 2015;24(3):274–97.
334. Brooks R, Meltzoff AN. Gaze following: A mechanism for building social connections between infants and adults. In: In M Mikulincer & P R Shaver (Eds), Mechanisms of social connection: From brain to group [Internet]. Washington, DC: American Psychological Association; 2014. p. 167–83. Available from: http://dx.doi.org/10.1037/14250-010.
335. Beebe B, Abdurokhmonova G, Lee SH, Dougalis G, Champagne F, Rauh V, et al. Mother-infant self- and interactive contingency at four months and infant cognition at one year: A view from microanalysis. Infant Behav Dev. 2024;74:101920.

336. Prioreschi A, James DM, Pearson RM, Smith A, Norris SA, Rennie KL. “I always wondered if my baby is able to feel my love for them” - Development and pilot testing of two behavioural feedback strategies designed to improve maternal self-efficacy. Wellcome Open Res [Internet]. 2025 [cited 2025 Jul 6];10. Available from: https://pubmed.ncbi.nlm.nih.gov/40443798/
337. De Pascalis L, Kkeli N, Chakrabarti B, Dalton L, Vaillancourt K, Rayson H, et al. Maternal gaze to the infant face: effects of infant age and facial configuration during mother-infant engagement in the first nine weeks. 2017.
338. Hunnius S, Geuze RH. Developmental Changes in Visual Scanning of Dynamic Faces and Abstract Stimuli in Infants: A Longitudinal Study. 2004.
339. Noonan CF, Hunter BK, Markant J. Dynamic emotional messages differentially affect 6-month-old infants’ attention to eyes and gaze cues. Infant Behav Dev. 2021 Aug 1;64.
340. Hunnius S, de Wit TCJ, Vrins S, von Hofsten C. Facing threat: Infants’ and adults’ visual scanning of faces with neutral, happy, sad, angry, and fearful emotional expressions. Cogn Emot. 2011 Feb;25(2):193–205.
341. Vaish A, Grossmann T, Woodward A. Not All Emotions Are Created Equal: The Negativity Bias in Social-Emotional Development. Psychol Bull. 2008 May;134(3):383–403.
342. Cote LR, Carey DC, Bornstein MH. Responsiveness in mother-infant social interactions among immigrant and nonmigrant families: Japanese, South Korean, South American, and European American. Infant Behav Dev. 2023 May 1;71.
343. Voges J, Berg A, Niehaus DJH. Revisiting the African origins of attachment research—50 years on from Ainsworth: A descriptive review. Infant Ment Health J. 2019 Nov 1;40(6):799–816.
344. Henrich J, Heine SJ, Norenzayan A. Most people are not WEIRD. Nature. 2010;466:9.
345. Cote LR, Bornstein MH. Synchrony in mother-infant vocal interactions revealed through timed event sequences. Infant Behav Dev. 2021 Aug 1;64.
346. Donald KA, Wedderburn CJ, Barnett W, Nhapi RT, Rehman AM, Stadler JAM, et al. Risk and protective factors for child development: An observational South African birth cohort. PLoS Med. 2019;16(9).
347. Tomlinson M, Bornstein MH, Marlow M, Swartz L. Imbalances in the knowledge about infant mental health in rich and poor countries: Too little progress in bridging the gap. Infant Ment Health J. 2014 Nov 1;35(6):624–9.
348. Lachman A, Niehaus DJH, Jordaan ER, Leppanen J, Puura K, Bruwer B. Shared Pleasure in early mother–infant interactions: a study in a high-risk South African sample. Early Child Dev Care. 2021;191(2):230–41.

349. Machisa MT, Christofides N, Jewkes R. Social support factors associated with psychological resilience among women survivors of intimate partner violence in Gauteng, South Africa. Glob Health Action. 2018 Dec 7;11(sup3).
350. Lachman A, Jordaan ER, Stern M, Donald KA, Hoffman N, Lake MT, et al. The Shared Pleasure Paradigm: A study in an observational birth cohort in South Africa. Arch Womens Ment Health. 2022 Feb 1;25(1):227–35.
351. Brown LF, Pridham KA, Brown R. Sequential observation of infant regulated and dysregulated behavior following soothing and stimulating maternal behavior during feeding. J Spec Pediatr Nurs. 2014 Apr 1;19(2):139–48.
352. Moore GA, Cohn JF, Campbell SB. Developmental Psychology Copyright 1997 by the American Psychological Association. Vol. 33. 1997.
353. Ekman P, Friesen W V., O'Sullivan M, Chan A, Diacoyanni-Tarlatzis I, Heider K, et al. Universals and Cultural Differences in the Judgments of Facial Expressions of Emotion. J Pers Soc Psychol. 1987;53(4):712–7.
354. Tomalski P, Malinowska-Korczak A. What Do Young Infants Do During Eye-Tracking Experiments? IP-BET – A Coding Scheme for Quantifying Spontaneous Infant and Parent Behaviour. Front Psychol. 2020 Apr 28;11.
355. Zaharieva MS, Salvadori EA, Messinger DS, Visser I, Colonnesi C. Automated facial expression measurement in a longitudinal sample of 4- and 8-month-olds: Baby FaceReader 9 and manual coding of affective expressions. Behav Res Methods. 2024 Sep 1;56(6):5709–31.
356. McHugh ML. Interrater reliability: The kappa statistic. Biochem Med (Zagreb). 2012;(22(3)):276–82.
357. Bakeman Roger, Quera V. Sequential analysis and observational methods for the behavioral sciences. Cambridge University Press; 2011. 183 p.
358. Sravish A V., Tronick E, Hollenstein T, Beeghly M. Dyadic Flexibility during the Face-to-Face Still-Face Paradigm: A dynamic systems analysis of its temporal organization. Infant Behav Dev [Internet]. 2013 Jun 1 [cited 2025 Jun 30];36(3):432–7. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0163638313000465
359. Aspland H, Gardner F. Observational measures of parent-child interaction: an introductory review. Child Adolesc Ment Health. 2003;8(3).
360. Nnoromele SC. Representing the African woman: Subjectivity and self in The Joys of Motherhood. Critique: Studies in Contemporary Fiction. 2002;43(2):178–90.
361. van Doorene S. Narratives of Motherhood: Voices of Selected South African Women. WITS; 2009.

362. Dale LK. A Narrative Understanding of the Maternal Experience of urban Black South African. WITS; 2012.
363. De Wit H, West G. African and European Readers of the Bible in Dialogue. In: De Wit H, West GO, editors. Quest of a shared meaning. Leiden, Netherlands: Brill; 2001.
364. Baloyi ME. Gendered character of barrenness in an African context: An African pastoral study. In die Skriflig/In Luce Verbi. 2017 Feb 27;51(1).
365. Hetherington EM, Stanley-Hagan M. The adjustment of children with divorced parents: A risk and resiliency perspective. The Journal of Child Psychology and Psychiatry and Allied Disciplines. 1999;40(1):129–40.
366. Belsky J. The Determinants of Parenting: A Process Model. Child Dev. 1984;55(1):83–96.
367. Messer DJ, Vietze PM. Timing and Transitions in Mother-Infant Gaze*. Vol. 7, INFANT BEHAVIOR AND DEVELOPMENT. 1984.
368. Adamson L, McArthur D. Joint Attention, affect, and culture. In: Joint attention: Its origins and role in development C Moore & P Dunham (Eds). 1995. p. 205–21.
369. Puura K, Davis H, Mäntymaa M, Tamminen T, Roberts R, Dragonas T. The outcome of the European early promotion project: mother-child interaction . Int J Ment Health Promot. 2005;7:82–94.
370. Mäntymaa M, Puura K, Luoma I, Latva R, Salmelin RK, Tamminen T. Shared pleasure in early mother–infant interaction: Predicting lower levels of emotional and behavioral problems in the child and protecting against the influence of parental psychopathology. Infant Ment Health J. 2015;36(2):223–37.
371. Tronick E. The neurobiological and social-emotional development of children . New York: Norton; 2007.
372. Moore GA, Quigley KM, Voegtline KM, DiPietro JA. Don't worry, be (moderately) happy: Mothers' anxiety and positivity during pregnancy independently predict lower mother-infant synchrony. Infant Behav Dev. 2016 Feb 1;42:60–8.
373. Atzil S, Hendler T, Feldman R. Specifying the neurobiological basis of human attachment: Brain, hormones, and behavior in synchronous and intrusive mothers. Neuropsychopharmacology. 2011 Dec;36(13):2603–15.
374. Endevelt-Shapira Y, Feldman R. Mother–Infant Brain-to-Brain Synchrony Patterns Reflect Caregiving Profiles. Biology (Basel). 2023 Feb 1;12(2).
375. Onyango S, Kitsao-Wekulo P, Langat N, Okelo K, Murdock DE, Utzinger J, et al. Maternal stimulation and early child development in sub-saharan Africa: evidence from Kenya and Zambia.

BMC Public Health [Internet]. 2023 Dec 1 [cited 2025 Jun 30];23(1):1–10. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-023-17235-w

376. Barnett W, Hansen CL, Bailes LG, Humphreys KL. Caregiver-child proximity as a dimension of early experience. Dev Psychopathol. 2022 May 25;34(2):647–65.
377. Akpa-Inyang F, Chima SC. South African traditional values and beliefs regarding informed consent and limitations of the principle of respect for autonomy in African communities: a cross-cultural qualitative study. BMC Med Ethics [Internet]. 2021 Dec 1 [cited 2025 Jun 30];22(1):1–17. Available from: https://bmcmedethics.biomedcentral.com/articles/10.1186/s12910-021-00678-4
378. Harkness S, Super CM. The developmental niche: A theoretical framework for analyzing the household production of health. Soc Sci Med. 1994;38(2):217–26.
379. Zaidman-Mograbi R, Le Roux LMP, Hall H. The influence of culture on maternal attachment behaviours: a South African case study. Children Australia [Internet]. 2020 Mar 1 [cited 2025 Jun 30];45(1):30–9. Available from: https://www.cambridge.org/core/journals/children-australia/article/abs/influence-of-culture-on-maternal-attachment-behaviours-a-south-african-case-study/186CCBCAC2B33F501FF1F31A8D2D1E6A
380. Tang Y, Triesch J, Deák GO. Variability in infant social responsiveness: Age and situational differences in attention-following. Dev Cogn Neurosci [Internet]. 2023 Oct 1 [cited 2025 Jul 6];63:101283. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC10450417/
381. Bronfenbrenner U. Toward an experimental ecology of human development. American Psychologist. 32(7). 1977;7(32):513–31.
382. Koulomzin M, Beebe B, Anderson S, Jaffe J, Feldstein S, Crown C. Infant gaze, head, face and self-touch at 4 months differentiate secure vs. avoidant attachment at 1 year: A microanalytic approach. Attach Hum Dev. 2002;4(1):3–24.
383. Beebe B. My journey in infant research and psychoanalysis: Microanalysis, a social microscope. Psychoanalytic Psychology. 2014 Jan;31(1):4–25.
384. Gergely G, Watson JS. The social biofeedback model of parental affect-mirroring . Int J Psychoanal. 1996;77(6):1181.
385. Kopp CB. Regulation of distress and negative emotions: A developmental view. Dev Psychol. 1989;25(3):353.
386. Murray L. Emotional regulation of interactions between two-month-olds and their mothers. Social perception in infants. 1985;177–97.
387. Rochat P, Passos-Ferreira C, Salem P. Three levels of intersubjectivity in early development. Enacting intersubjectivity: Paving the way for a dialogue between cognitive science, social cognition and neuroscience. 2009;173–90.

388. Angst J, Merikangas K. The depressive spectrum: diagnostic classification and course. J Affect Disord. 1997 Aug 1;45(1–2):31–40.
389. Shimada K, Kasaba R, Fujisawa TX, Sakakibara N, Takiguchi S, Tomoda A. Subclinical maternal depressive symptoms modulate right inferior frontal response to inferring affective mental states of adults but not of infants. J Affect Disord. 2018 Mar 15;229:32–40.
390. Benazzi F. Various forms of depression. Vol. 8, Dialogues in Clinical Neuroscience. 2006. p. 151–61.
391. Goecke TW, Voigt F, Faschingbauer F, Spangler G, Beckmann MW, Beetz A. The association of prenatal attachment and perinatal factors with pre- and postpartum depression in first-time mothers. Arch Gynecol Obstet. 2012 Aug;286(2):309–16.
392. Stellenberg EL, Abrahams JM. Prevalence of and factors influencing postnatal depression in a rural community in South Africa. Afr J Prim Health Care Fam Med. 2015;7(1).
393. Hummel AC, Kiel EJ, Zvirblyte S. Bidirectional Effects of Positive Affect, Warmth, and Interactions Between Mothers With and Without Symptoms of Depression and Their Toddlers. J Child Fam Stud. 2016 Mar 1;25(3):781–9.
394. Behrendt HF, Konrad K, Goecke TW, Fakhrabadi R, Herpertz-Dahlmann B, Firk C. Postnatal Mother-to-Infant Attachment in Subclinically Depressed Mothers: Dyads at Risk? Psychopathology. 2016 Oct 1;49(4):269–76.
395. Braarud HC, Skotheim S, Høie K, Markhus MW, Kjellevold M, Graff IE, et al. Affective facial expression in sub-clinically depressed and non-depressed mothers during contingent and non-contingent face-to-face interactions with their infants. Infant Behav Dev. 2017 Aug 1;48:98–104.
396. Dix T. The affective organization of parenting: Adaptive and maladaptative processes. Psychol Bull. 1991;110(1):3–25.
397. Cantrell SJ, Prioreschi A, Kamerman P, Pearson R. Describing the synchrony of visual attention and facial expression between mothers and their infants in a poorly resourced setting. Johannesburg; 2024.
398. Ruvolo P, Messinger D, Movellan J. Infants time their smiles to make their moms smile. PLoS One. 2015 Sep 23;10(9).
399. Landfald IC, Olewnik Ł. An Interdisciplinary Review of the Zygomaticus Muscles: Anatomical Variability, Imaging Modalities, and Clinical Implications. Journal of Clinical Medicine 2025, Vol 14, Page 4110 [Internet]. 2025 Jun 10 [cited 2025 Jul 6];14(12):4110. Available from: https://www.mdpi.com/2077-0383/14/12/4110/htm
400. Hoffmann H, Traue HC, Bachmayr F, Kessler H. Perception of Dynamic Facial Expressions of Emotion. 2006.

401. Landis JR, Koch GG. An application of hierarchical kappa-type statistics in the assessment of majority agreement among multiple observers. Biometrics. 1977;363-374.
402. Cohen J. Statistical Power Analysis for the Behavioral Sciences. Statistical Power Analysis for the Behavioral Sciences [Internet]. 2013 May 13 [cited 2025 Jun 30]; Available from: https://www.taylorfrancis.com/books/mono/10.4324/9780203771587/statistical-power-analysis-behavioral-sciences-jacob-cohen
403. Bakeman R, Gottman JM. Observing Interaction 2nd Edition: An introduction to sequential analysis [Internet]. 2nd ed. Cambridge University Press & Assessment; 1997 [cited 2025 Jul 6]. Available from: https://www.cambridge.org/us/universitypress/subjects/psychology/personality-psychology-and-individual-differences/observing-interaction-introduction-sequential-analysis-2nd-edition?utm_source=chatgpt.com
404. Cerezo MA, Trenado RM, Pons-Salvador G, Cerezo : M Angeles. Mother-infant Interaction and Quality of Child's Attachment: A Nonlinear Dynamical Systems Approach. Nonlinear Dynamics Psychol Life Sci. 2012;16(3):243–67.
405. Costantini I. Childhood internalising problems: a multi-method approach to explore intergenerational pathways. [Bristol]; 2023.
406. Feng X, Shaw DS, Skuban EM, Lane T. Emotional Exchange in Mother-Child Dyads: Stability, Mutual Influence, and Associations With Maternal Depression and Child Problem Behavior. Journal of Family Psychology. 2007 Dec;21(4):714–25.
407. Dix T, Meunier LN. Depressive symptoms and parenting competence: An analysis of 13 regulatory processes. Developmental Review. 2009 Mar 1;29(1):45–68.
408. Esposito G, Manian N, Truzzi A, Bornstein MH. Response to infant cry in clinically depressed and non-depressed mothers. PLoS One. 2017 Jan 1;12(1).
409. Field TM. Early Interactions Between Infants and Their Postpartum Depressed Mothers. Infant behaviour and development. 1984;7:517–22.
410. Gross JJ. Emotion Regulation: Past, Present, Future. Cogn Emot [Internet]. 1999 [cited 2024 Oct 15];13(5):551–73. Available from: https://www.tandfonline.com/doi/abs/10.1080/026999399379186
411. Śliwerski A, Kossakowska K, Jarecka K, Świtalska J, Bielawska-Batorowicz E. The effect of maternal depression on infant attachment: A systematic review. Vol. 17, International Journal of Environmental Research and Public Health. MDPI AG; 2020.
412. Schetter CD, Dolbier C. Resilience in the Context of Chronic Stress and Health in Adults. Soc Personal Psychol Compass [Internet]. 2011 Sep [cited 2025 Jul 7];5(9):634. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC4494753/

413. McHale J, Fivaz-Depeursinge E, Dickstein S, Robertson J, Daley M. New evidence for the social embeddedness of infants' early triangular capacities. Fam Process. 2008;47(4):445–63.
414. Keller H, Bard K, Morelli G, Chaudhary N, Vicedo M, Rosabal-Coto M, et al. The myth of universal sensitive responsiveness: Comment on Mesman et al.(2017). Child Dev. 2018;89(5):1921–8.
415. Frost K. The Ububele Baby Mat Project: a community-based parent-infant intervention at primary health care clinics in Alexandra Township, Johannesburg. Psychological Society of South Africa All rights reserved South African Journal of Psychology. 2012;42(4):608–16.
416. Cooper PJ, Tomlinson M, Swartz L, Landman M, Molteno C, Stein A, et al. Improving quality of mother-infant relationship and infant attachment in socioeconomically deprived community in South Africa: randomised controlled trial. BMJ [Internet]. 2009;1–8. Available from: www.reading.ac.uk/psychology/research/
417. Costantini I, López-López JA, Caldwell D, Campbell A, Hadjipanayi V, Cantrell SJ, et al. Early parenting interventions to prevent internalising problems in children and adolescents: a global systematic review and network meta-analysis. Vol. 26, BMJ Mental Health. BMJ Publishing Group; 2023.
418. Cooper PJ, Landman M, Tomlinson M, Molteno C, Swartz L, Murray L. Impact of a mother-infant intervention in an indigent peri-urban South African context. Pilot study. British Journal of Psychiatry. 2002;180(JAN.):76–81.
419. Cooper PJ, Tomlinson M, Swartz L, Landman M, Molteno C, Stein A, et al. Improving quality of mother-infant relationship and infant attachment in socioeconomically deprived community in South Africa: Randomised controlled trial. BMJ (Online). 2009 Apr 25;338(7701):997.
420. Verhelst P, Sels L, Lemmens G, Verhofstadt L. The role of emotion regulation in perinatal depression and anxiety: a systematic review. BMC Psychol [Internet]. 2024 Oct 2;12(1):529. Available from: https://bmcpsychology.biomedcentral.com/articles/10.1186/s40359-024-02033-9
421. Feldman R. The Neurobiology of Affiliation; Maternal-Infant Bonding to Life Within Social Groups. Encyclopedia of Behavioral Neuroscience, 2nd edition. 2022;518–31.
422. Adonis CK. Exploring the Salience of Intergenerational Trauma among Children and Grandchildren of Victims of Apartheid-Era Gross Human Rights Violations. Indo-Pacific Journal of Phenomenology. 2016 Nov 30;16(1–2):163–79.
423. Tomlinson M. Caring for the caregiver: A framework for support [Internet]. South African Child Gauge. 2013. Available from: www.khululeka.org.za.

424. Erikson EH. Theory of identity development. In: E Erikson, Identity and the life cycle [Internet]. New York: International Universities Press; 1959 [cited 2024 Oct 8]. Available from: http://childdevpsychology.yolasite.com/resources/theory%20of%20identity%20erikson.pdf
425. Keefe RH, Brownstein-Evans C, Rouland Polmanteer RS. Perspectives on good mothering from low-income mothers of color with maternal depression. J Hum Behav Soc Environ. 2018 Apr 3;28(3):271–85.
426. Henderson A, Harmon S, Newman H. The price mothers pay, even when they are not buying it: Mental health consequences of idealized motherhood. Sex Roles. 2016;74:512–26.
427. Elliott S, Powell R, Brenton J. Being a Good Mom: Low-Income, Black Single Mothers Negotiate Intensive Mothering. J Fam Issues. 2015 Feb 8;36(3):351–70.
428. Chavis L. Mothering and anxiety: Social support and competence as mitigating factors for first-time mothers. Soc Work Health Care. 2016;55(6):461–80.
429. Janis IL. Groupthink: Psychological Studies of Policy Decisions and Fiascoes. Vol. Second edition. New York: Houghton Mifflin; 1982.
430. DiPierro K, Lee H, Pain KJ, Durning SJ, Choi JJ. Groupthink among health professional teams in patient care: a scoping review. Med Teach [Internet]. 2021 [cited 2025 Feb 10];44(3):309. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9972224/
431. Ekman P, Freisen W V., Ancoli S. Facial signs of emotional experience. J Pers Soc Psychol. 1980 Dec;39(6):1125–34.
432. Tong EMW, Goh ECL, Wen D. Do Trait hope and Trait Gratitude Support the Mental Health of Mothers in low-income Families in Singapore? Int J Appl Posit Psychol. 2025 Mar 1;10(1).
433. Zahavi-Lupo T, Lazarus G, Pshedetzky-Shochat R, Bar-Kalifa E, Refoua E, Gleason MEJ, et al. His, hers, or theirs? Hope as a dyadic resource in early parenthood. Journal of Positive Psychology. 2023;18(4):557–72.
434. Yuan L, Gao Y, Pan B, Wang J, Wang Y, Gong C, et al. Resilience and Related Factors: A Comparison of Fathers and Mothers of Patients With Cleft Lip and/or Palate in China. Front Psychiatry. 2022 Jan 13;12.
435. Laslo-Roth R, George-Levi S, Rosenstreich E. Protecting children with ADHD against loneliness: Familial and individual factors predicting perceived child's loneliness. Pers Individ Dif. 2021 Oct 1;180:110971.
436. Davidson-Arad B, Aram-Fichman R, Bashan-Paz M, Gingis R, Klein-Katz T. Comparison of hope of maltreating parents whose children were removed from home with those whose children were kept at home. Child Youth Serv Rev. 2013 Dec 1;35(12):2040–8.

437. Cole BP, Ingram P, Dye A, Molloy S, Singley DB. Development and validation of the Hope for Parenting Scale. Couple and Family Psychology: Research and Practice. 2021;10(2):124–35.
438. Sato W, Kochiyama T, Yoshikawa S, Naito E, Matsumura M. Enhanced neural activity in response to dynamic facial expressions of emotion: An fMRI study. Cognitive Brain Research. 2004 Jun;20(1):81–91.
439. Ambadar Z, Schooler JW, Cohn JF. Deciphering the Enigmatic Face The Importance of Facial Dynamics in Interpreting Subtle Facial Expressions [Internet]. 2005. Available from: http://www.pitt.edu/$ambadar/stimuli.htm.
440. Lafrance M, Broadbent M. Group Rapport: Posture Sharing as a Nonverbal Indicator.
441. Kendon A. Movement coordination in social interaction: Some examples described. Acta Psychol (Amst). 1970;32:101–25.
442. Catewood JB, Rosenwein R. INTERACTIONAL SYNCHRONY: GENUINE OR SPURIOUS? A CRITIQUE OF RECENT RESEARCH.
443. Mcdowall JJ. Interactional Synchrony: A Reappraisal. Vol. 36, Journal of Personality and Social Psycholov. 1978.
444. Glasheen C, Richardson GA, Fabio A. A systematic review of the effects of postnatal maternal anxiety on children. Vol. 13, Archives of Women's Mental Health. 2010. p. 61–74.
445. Pollack MH. Mark H. Pollack Comorbid Anxiety and Depression. Vol. 66, J Clin Psychiatry. 2005.
446. Cheng ER, Kotelchuck M, Gerstein ED, Taveras EM, Poehlmann-Tynan J. Postnatal depressive symptoms among mothers and fathers of infants born preterm: Prevalence and impacts on children's early cognitive function. Journal of Developmental and Behavioral Pediatrics. 2016;37(1):33–42.
447. Maselko J, Hagaman AK, Bates LM, Bhalotra S, Biroli P, Gallis JA, et al. Father involvement in the first year of life: Associations with maternal mental health and child development outcomes in rural Pakistan. Soc Sci Med. 2019 Sep 1;237.
448. Lin WC, Chang SY, Chen YT, Lee HC, Chen YH. Postnatal paternal involvement and maternal emotional disturbances: The effect of maternal employment status. J Affect Disord. 2017 Sep 1;219:9–16.
449. Drysdale RE, Slemming W, Makusha T, Richter LM. Father involvement, maternal depression and child nutritional outcomes in Soweto, South Africa. Matern Child Nutr. 2021 Jul 1;17(S1).
450. Lamb ME. The development and significance of father-child relationships in two-parent families.The role of the father in child development. John Wiley & Sons.; 2010.

451. Walsh TB, Thomas A, Quince H, Buck J, Tamkin V, Blackwell D. Black fathers' contributions to maternal mental health. Arch Womens Ment Health. 2023 Feb 1;26(1):117–26.
452. Sroufe LA. Attachment and development: A prospective, longitudinal study from birth to adulthood. Attach Hum Dev. 2005 Dec 1;7(4):349–67.

Appendix A

Theoretical underpinnings of the study

Theorists	Background	Significant concepts in the theories
Harry Harlow	Experimental and comparative psychologist	Maternal contact in the growth and social development of infants. Studies extended social deprivation in the early years of life when working with infant monkeys and surrogate mothers made of terry cloth or wire.
John Bowlby	Psychiatrist and psychoanalyst	Attachment theory. Suggested that a child is born with programming that helps him/her to form an attachment to others. Said it may be an evolutionary trait that formed to help children survive. Spoke of attachment behaviours being instinctive. Said, that they become activated when a trigger is present. Actions or feelings like fear, separation or insecurity would all cause the attachment programming to activate, causing a child to look for the figure to whom he/she is attached. Concept of maternal deprivation hypothesis: effects of separating infant from mother leading to delinquency and affectionless children. "Internal working model" (IWM) is a cognitive model that uses mental representations to understand the world, self and others. A person's interactions with others in future are guided by memories and expectations from their developed IWM which influence contact with others.
Mary Ainsworth	Developmental psychoanalyst	Known for her work on attachment and looked at maternal separation and the effects of this on an infant's personality and development. Developed the "Strange Situation" standard laboratory observation procedure which looked at the patterns of interactions between infants and their mothers. She theorised that these patterns were related to responsiveness. The three response techniques include A: Avoidant, B: Securely attached and C: Resistant. She coined another term called "Maternal sensitivity" which is about a mother's ability to perceive and interpret accurately, her infant's signals and communications.
Donald Winnicott	Paediatrician and psychoanalyst	Winnicott's stance on maternal care is that there is no such thing as a baby - meaning that if an infant is without a mother, the infant is unable to exist. "Good enough" mother: The unconscious and conscious bodily and psychic attunement of an ordinary and devoted mother to her infant to adapt adequately in a good enough environment at different stages of the infant's growth, thus allowing for the establishment of two separate beings. "Holding environment" Psychical and physical space within which the infant is protected. A mother who doesn't provide a holding environment that is conducive to growth, or a mother who offers too much stimulation, can contribute to the cessation of development. The child experiences impingement. His/her desires have not been answered. "Primary maternal preoccupation" is the psychological and physiological preparedness of a mother with an infant for her journey into motherhood. Herein, she identifies closely and intuitively with her infant so that she can meet physical needs first and then emotional needs that allow for the start of integration and ego development.
Daniel Stern	Psychiatrist and psychoanalyst	Looked at the fine-grained view of the instant-by-instant interactive exchanges which make up the mother-infant relationship. Used micro-analysis of face-to-face communication between mother and infant to film each partner in relation to that of the other. The motherhood constellation: A mother's mental organisation and instinctual focus on her devotion to her infant as important for child development.

Peter Fonagy	Psychoanalyst	"Reflective functioning" is described as the ability to imagine mental states in the self and others. It includes the reflection and understanding of one's own behavioural responses, communicating inner mental states.
Selma Fraiberg	Psychoanalyst and social worker	Studied babies suffering from blindness. Her seminal paper "Ghosts in the nursery" refers to the concept of the relationship between a parent's early, often traumatic experiences of the manner in which she was raised, and her own parenting style.
Colwyn Trevarthen	Biologist and infant researcher	Researched brain development, infant communication, and emotional health. Studied play, interactions, dialogic relationship, non-verbal communication, intersubjectivity and musicality.
Mary Main	Psychologist	Attachment. Introduced 'disorganised infant' and the "Adult attachment Interview". Researched infant play, micro analysis, and mother-infant interaction.
Tiffany Field	Occupational therapist	Child studies, developmental psychology, postnatal depression, infant massage.
Lynne Murray	Psychopathologist	Postnatal depression, intergenerational transmission of psychopathology, developmental psychology.
Ed Tronick	Developmental psychologist	1978 development of the "Still face experiment". Describes a phenomenon whereby an infant, after three minutes of "interaction" with an expressionless mother, becomes agitated. He will attempt to resurrect the interaction into its former, reciprocal pattern. Other keywords: Infant primal social understanding, depressed mothers in interaction with infants and socio-emotional regulation.
Beatrice Beebe, Karin, and Klaus Grossmann, Karlen Lyons-ruth, Patricia Crittenden, Alan Fogel, Michael Lewis, Joe Jaffe, Steve Bennett, Frank Lachmann, Ruth Feldman	Varied	Mother-infant interactions and terms such as "synchrony" which is described as the "dance" of mutually responsive and temporal behaviours between a mother and her infant in the dyadic relationship (Feldman). Similar concepts are "mutuality ", "reciprocity", "turn taking" and "shared affect".

Appendix B

PLAY study Information and consent form

University of the Witwatersrand, Johannesburg

Developmental Pathways for Health Research Unit

Department of Paediatrics and Child Health

INFORMATION SHEET FOR PARTICIPANTS

Hello, my name is Sarah Cantrell, and I am a Researcher in the Department of Pediatrics at the University of Witwatersrand. Together with other colleagues from the University we are conducting research to understand how to support mothers in caring for their babies through a study called "Play and Love and You". As a psychologist in the WITS research team, my part of the study is to find out how mothers feel emotionally, what their social support is like at home and what experiences they went through when they were young children. I'm also interested to observe how mothers bond with their babies.

I would like to invite you to be part of this study because:

a) you have a baby aged between 0 months and 6 months

b) you are a Soweto community member

c) you are the primary caregiver for your baby

What is involved in the study?

If you are happy to participate in the research, we will first ask you to read this information sheet and sign the consent form.

At your baby's birth

You will be expected to fill in a few questionnaires at the hospital when your baby is born. They will be:

1. Demographics questionnaire with questions about yourself, your home, family and baby (5 minutes to answer).
2. A questionnaire about your feelings and your mental health (5 minutes).
3. Questions about what adverse experiences you had when you were a child (10 minutes).
4. A questionnaire about how you feel towards your baby (5 minutes).

<u>When your baby is 4 months old</u>

When your baby is 4 months old, you will be met at the hospital by myself and or a trained research assistant. We will hand over two cameras. One for yourself and one for your baby. These cameras will be attached to headbands that you will be using in the following week. We will explain to you how to use the headcams at home. You will be expected to film yourself and your baby interacting for five minutes, three times in that week. When this is done, you will then be required to answer the same questionnaires that you answered when your baby was born.

Benefits:

There is no direct benefit to you from participating in the study. You will, however, contribute to an understanding about how mothers experience their own mental health and what impact that has on their babies. You'll also be able to help other mothers try to improve the bond between themselves and babies in the Soweto community.

Risks:

The questionnaire that you fill out and the video footage that you record, will only be used for the purposes of this study, and will be kept in the strictest confidence. We will place a number on each recorded session that will not have any information that can identify you; and these clips will only be viewed by myself or trained research assistants. The recordings will be stored on a researcher's computer (password protected) and destroyed after five years following the completion of the project.

Some of the questions may cause psychological distress. If this is noticed by the interviewer or if it is reported by yourself, you will be given an appointment within the next week with me, a professional registered Psychologist, at the research unit at Baragwanath hospital in order to receive counseling as required. I have more than 15 years of experience in research and counselling. I can also refer you to another psychologist or organisation around Soweto for further management of any issues that may arise. You will be free to choose not to respond to any questions, or to stop the interview at any time.

Participation is voluntary:

Participation in this study is completely voluntary, and lack of participation will not have any negative consequences. You can choose not to complete any activities and assessments, fill in any questionnaires or talk to anyone on the phone if it will make you feel uncomfortable. You are able to withdraw at any point during the study.

Reimbursement:

You will be provided with R200 per visit to cover your transport expenses for your travel to the research unit.

Confidentiality:

Personal information will be handled with strictest confidentiality. Only myself and other trained research assistants have access to your questionnaires and video recordings. In my analysis, I give each person a number so that is in no way linked to your name. If results are published, they will not include any names or personal details that can lead to individual identification, and all published data will be completely anonymous.

Further information:

If you require any further information or have any questions/complaints about the study please contact the Human Ethics Committee of Witwatersrand 011 717 71234 or zanele.ndolvu@wits.ac.za

If you are happy to take part in the study please read and sign the attached consent form and we will commence with the questions.

Thank you for your time and attention

Kind regards, Sarah Cantrell

University of the Witwatersrand, Johannesburg

Developmental Pathways for Health Research Unit

Department of Paediatrics and Child Health

CONSENT FORM

I agree to be a participant in the study that looks at maternal mental health and the impact of synchrony on mother / infant interactions. The goals and methods of the study are clear to me. I understand that the study will involve answering questionnaires about myself, my feelings, my feelings towards my baby, my mental health, social support and childhood experiences. The filming of my interactions with my baby have been explained to me and I understand the risks that are involved. It has been explained to me that if I need psychological assistance, the researcher will help me to make an appointment with a psychologist or will assist in the referral to a nearby facility that will help me to relieve distress if brought about by questions in the study. All the details and purposes of this study have been explained to me. I understand that I have the right to refuse to participate in the study.

I agree to participation in this study on condition that:

I can withdraw from the study at any time voluntarily and that no adverse consequences will follow on withdrawal from the study.

I have the right not to answer any or all questions posed in interviews, focus groups and/ or questionnaires and not to participate in any or all of the procedures / assessments.

The University of the Witwatersrand Human Ethics committee has approved the study protocol and procedures.

All results will be treated with the strictest confidentiality.

The study team is committed to treating participants with respect and privacy through private and follow-up counselling available on request.

PARTICIPANT:

Printed Name **Signature / Mark or Thumbprint** **Date and Time**

WITNESS (required if thumbprint is used above):

Printed Name **Date and Time**

RESEARCH ASSISTANT:

Printed Name **Signature** **Date and Time**

CONSENT FORM FOR USING VIDEOTAPED MATERIAL

I have read and understood the project information sheet, and I understand that I will be videotaping myself and my baby. I understand that if at any point I do not wish to record further, I do not have to. I do not have to hand over any recordings that I do not wish to, and this will not in any way affect how the interviewer treats me. If a third person appears on the screen and I do not want that person to be recorded, I can stop recording and I understand that I do not need to hand over the material to the researcher. I understand that anything that is recorded, will be destroyed five years later. I understand that the information that I give will be treated in the strictest of confidence, and that my name will not be used when the research is written up.

PARTICIPANT:

Printed Name **Signature / Mark or Thumbprint** **Date and Time**

WITNESS (required if thumbprint is used above):

Printed Name **Date and Time**

RESEARCH ASSISTANT:

Printed Name **Signature** **Date and Time**

Appendices C-E

HREC ethical clearance certificate for:

The Community Advisory Group study

Sarah Cantrell's PhD

The Play, Love And You study

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG	HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Office of the Deputy Vice-Chancellor (Research and Innovation)

TO:	Dr A Prioreschi School of Clinical Medicine Department of Paediatrics and Child Health Developmental Pathways for Health Research Unit Chris Hani Baragwanath Academic Hospital E-mail: Alessandra.Prioreschi@wits.ac.za
CC:	Supervisor: Not applicable <> and <HREC-Medical Research Office@wits.ac.za>
FROM:	Mr Iain Burns Human Research Ethics Committee (Medical) Tel: 011 717 1252 E-mail: Iain.Burns@wits.ac.za
DATE:	2022/02/25
REF:	R14/49
PROTOCOL NO:	**M210846** (This is your ethics application reference number. Please quote it in all enquiries, oral or written, relating to this study.)
PROJECT TITLE:	*PLAY Study (Play and Love in the eArly Years)* *Community Advisory Group*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to Government funding of the University.

MSWorks2000/Iain0007/Clearscan.wps

UNIVERSITY OF THE
WITWATERSRAND
JOHANNESBURG

R49 Dr A Prioreschi

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M210846

NAME: (Principal Investigator)	Dr A Prioreschi
DEPARTMENT:	School of Clinical Medicine Department of Paediatrics and Child Health Developmental Pathways for Health Research Unit Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	*PLAY Study (Play and Love in the eArly Years)* *Community Advisory Group*
DATE CONSIDERED:	2021/08/27
DECISION:	Approved unconditionally
CONDITIONS:	
NOTE:	If contact information regarding student study participants is required, please contact the Registrar's office - <Nicoleen.Potgieter@wits.ac.za>
SUPERVISOR:	Not applicable
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2022/02/25

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **August** and therefore reports and re-certification will be due in the month of **August** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator Date

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R14/49 Mrs Sarah Cantrell

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M220787

NAME: (Principal Investigator)	Mrs Sarah Cantrell
DEPARTMENT:	School of Clinical Medicine
PROJECT TITLE:	The impact of maternal mental health on synchrony in mother/infant interactions
DATE CONSIDERED:	Ad hoc
DECISION:	Approved unconditionally
CONDITIONS:	Sub-study under M210846 and M220217
SUPERVISOR:	Dr A. Prioreschi
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	23/09/2022

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions.Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. I **agree to submit a yearly progress report.** The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **August** and will therefore be due in the month of **August** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix F

Sociodemographic questionnaire

DATE:
Study ID:

CONTACT DETAILS

Cell number 1: _____ Cell number 2: _____

Other contact number: _____

Home address: _____

Contact details of a relative or a friend who will **always** know where you live.

Name: _____ Relationship: _____

Landline number:_____ Cell number: _____

Work number: _____ Other: _____

Address: _____

SCREENING QUESTIONS

Are you older than 18?	(0) No (1) Yes	If No, EXCLUDE
Do you currently live in Soweto?	(0) No (1) Yes	If No, EXCLUDE
Are you the primary caregiver for your baby?	(0) No (1) Yes (7) Don't know	If No, EXCLUDE
Did you deliver a single baby (not twins)?	(0) No (1) Yes	If No, EXCLUDE
Was baby born at term?	(0) No (1) Yes (7) Don't know	If No, EXCLUDE

If screening criteria are passed – move on to the rest of the question

QUESTIONS FOR MOTHER

Mother:

Name:_____

Date of birth (calculate Age):_____

Infant:

Date of birth (calculate Age):_____

Infant gestation age (from birth records): _____

Infant Sex:_____

Relationship with partner:

Are you:

	Yes	No
1. Single		
2. In a relationship		
3. Living with a partner		
4. Married		

Parity:

Do you have any other children?

Yes/No

If yes, how many children do you have? (select 1-10)

If yes, how old are your children?

Education:

The first few questions ask about your experiences with schooling and education

Question	Responses
Do you have a matric?	(0) No (1) Yes (7) Don't know (8) Refuse to answer (9) Not applicable
If no, what is the last grade you successfully completed?	(1) Grade 5 or lower (2) Grade 6 (3) Grade 7 (4) Grade 8 (5) Grade 9 (6) Grade 10 (7) Grade 11 (77) Don't know (88) Refuse to answer (99) Not applicable
Since leaving formal full-time schooling, have you **ever** done any training or been registered with any training institution (including any training through employment and correspondence)?	(0) No (1) Yes (7) Don't know (8) Refuse to answer (9) Not applicable

Have you ever attended university or another post-matric college?	(0) No (1) Yes (7) Don't know (8) Refuse to answer (9) Not applicable
If yes, did you graduate?	(0) No (1) Yes (7) Don't know (8) Refuse to answer (9) Not applicable
If yes, what is the highest degree you have attained?	(1) Diploma (2) Bachelors (3 years) (3) Honors (4th year) (4) Masters (5) PhD
Are you currently enrolled in a university degree or college diploma program?	(0) No (1) Yes (7) Don't know (8) Refuse to answer (9) Not applicable
If yes, what is the level you are enrolled in?	(1) Diploma (2) Bachelors (3 years) (3) Honors (4th year) (4) Masters (5) PhD

Occupation/ Employment:

1. Have you **ever** had a job? By job we mean any work done to earn money or to gain skills. This includes casual/informal work & volunteer work.

Yes	No (Skip to Q3)

2. Do you currently have a job? By job we mean any work done to earn money or to gain skills. This includes casual/informal work & volunteer work.

Yes	No

3. Are you currently looking for a job?

Yes	No

4. Have you been unemployed and seeking work for a month or more during the past 6 months?

Yes	No

SOCIO-DEMOGRAPHICS

Socioeconomic status:

Which of the following do you have in your current home (place where you spent most nights in the past three months)? It does not matter who owns/pays for these things. (*Answer all questions*)

	Item	**In current home**	
		Yes	**No**
a.	Electricity		
b.	Fridge		
c.	Stove		
d.	Vacuum cleaner		
e.	Washing machine		
f.	MNet/DSTV/Satellite		
g.	DVD Player		
h.	Motorcar		
i.	Television		
j.	Telephone (landline)		
k.	Cell phone		
l.	Computer/laptop		

m.	Internet access		

- How many people currently (in the last 3 months) live in the home with you (spend most nights in the home per week)?

- How many rooms for sleeping are there in your current home (include outside rooms/cottages)?

- How many of the people currently living in your home are children (<18 years)?

Appendix G

Adverse Childhood Experience (ACE) Questionnaire

Finding your ACE Score ra hbr 10 24 06

While you were growing up, during your first 18 years of life:

1. Did a parent or other adult in the household **often** …
   Swear at you, insult you, put you down, or humiliate you?
   or
   Act in a way that made you afraid that you might be physically hurt?
   Yes No If yes enter 1 _____

2. Did a parent or other adult in the household **often** …
   Push, grab, slap, or throw something at you?
   or
   Ever hit you so hard that you had marks or were injured?
   Yes No If yes enter 1 _____

3. Did an adult or person at least 5 years older than you **ever**…
   Touch or fondle you or have you touch their body in a sexual way?
   or
   Try to or actually have oral, anal, or vaginal sex with you?
   Yes No If yes enter 1 _____

4. Did you **often** feel that …
   No one in your family loved you or thought you were important or special?
   or
   Your family didn't look out for each other, feel close to each other, or support each other?
   Yes No If yes enter 1 _____

5. Did you **often** feel that …
   You didn't have enough to eat, had to wear dirty clothes, and had no one to protect you?
   or
   Your parents were too drunk or high to take care of you or take you to the doctor if you needed it?
   Yes No If yes enter 1 _____

6. Were your parents **ever** separated or divorced?
   Yes No If yes enter 1 _____

7. Was your mother or stepmother:
   Often pushed, grabbed, slapped, or had something thrown at her?
   or
   Sometimes or often kicked, bitten, hit with a fist, or hit with something hard?
   or
   Ever repeatedly hit over at least a few minutes or threatened with a gun or knife?
   Yes No If yes enter 1 _____

8. Did you live with anyone who was a problem drinker or alcoholic or who used street drugs?
   Yes No If yes enter 1 _____

9. Was a household member depressed or mentally ill or did a household member attempt suicide?
   Yes No If yes enter 1 _____

10. Did a household member go to prison?
    Yes No If yes enter 1 _____

Now add up your "Yes" answers: _____ This is your ACE Score

Appendix H

The Edinburgh Postnatal Depression Scale (EPDS)

Name: …….

Address: …….

Your Date of Birth: …….

Baby's Date of Birth: …….

Phone: …….

As you are pregnant or have recently had a baby, we would like to know how you are feeling. Please check the answer that comes closest to how you have felt IN THE PAST 7 DAYS, not just how you feel today.

Here is an example, already completed.

I have felt happy:

0 Yes, all the time

0 Yes, most of the time *(If this one was ticked, this would mean: "I have felt happy most of the time" during the past week.)*

0 No, not very often

0 No, not at all

Please complete the other questions in the same way.

In the past 7 days:

1. I have been able to laugh and see the funny side of things

0 As much as I always could

0 Not quite so much now

0 Definitely not so much now

0 Not at all

2. I have looked forward with enjoyment to things

0 As much as I ever did

0 Rather less than I used to

0 Definitely less than I used to

0 Hardly at all

*3. I have blamed myself unnecessarily when things went wrong

0 Yes, most of the time

0 Yes, some of the time

0 Not very often

0 No, never

4. I have been anxious or worried for no good reason

0 No not at all

0 Hardly ever

0 Yes, sometimes

0 Yes, very often

*5 I have felt scared or panicky for no very good reason

0 Yes, quite a lot

0 Yes, sometimes

0 No, not much

0 No, not at all

*6. Things have been getting on top of me

0 Yes, most of the time I haven't been able to cope at all

0 Yes, sometimes I haven't been coping as well as usual

0 No, most of the time I have coped quite well

0 No, I have been coping as well as ever

*7 I have been so unhappy that I have had difficulty sleeping

0 Yes, most of the time

0 Yes, sometimes

0 Not very often

0 No, not at all

*8 I have felt sad or miserable

0 Yes, most of the time

0 Yes quite often

0 No, very often

0 No, not at all

*9 I have been so unhappy that I have been crying

0 Yes, most of the time

0 Yes quite often

0 Only occasionally

0 No, never

*10 The thought of harming myself has occurred to me

0 Yes, quite often

0 Sometimes

0 Hardly ever

0 Never

…….

Administered/Reviewed by: ……

Date: …….

Appendix I

The Postnatal bonding questionnaire (PBQ)

Please indicate how often the following are true for you. There are no 'right' or 'wrong' answers. Choose the answer which seems right in your recent experience:

	Always	Very often	Quite often	Sometimes	Rarely	Never
I feel close to my baby	**0**	**1**	**2**	**3**	**4**	**5**
I wish the old days when I had no baby would come back	**5**	**4**	**3**	**2**	**1**	**0**
I feel distant from my baby	**5**	**4**	**3**	**2**	**1**	**0**
I love to cuddle my baby	**0**	**1**	**2**	**3**	**4**	**5**
I regret having this baby	**5**	**4**	**3**	**2**	**1**	**0**
The baby doesn't seem to be mine	**5**	**4**	**3**	**2**	**1**	**0**
My baby winds me up	**5**	**4**	**3**	**2**	**1**	**0**
I love my baby to bits	**0**	**1**	**2**	**3**	**4**	**5**
I feel happy when my baby smiles or laughs	**0**	**1**	**2**	**3**	**4**	**5**
My baby irritates me	**5**	**4**	**3**	**2**	**1**	**0**
I enjoy playing with my baby	**0**	**1**	**2**	**3**	**4**	**5**
My baby cries too much	**5**	**4**	**3**	**2**	**1**	**0**
I feel trapped as a mother	**5**	**4**	**3**	**2**	**1**	**0**
I feel angry with my baby	**5**	**4**	**3**	**2**	**1**	**0**
I resent my baby	**5**	**4**	**3**	**2**	**1**	**0**
My baby is the most beautiful baby in the world	**0**	**1**	**2**	**3**	**4**	**5**
I wish my baby would somehow go away	**5**	**4**	**3**	**2**	**1**	**0**
I have done harmful things to my baby	**5**	**4**	**3**	**2**	**1**	**0**
My baby makes me feel anxious	**5**	**4**	**3**	**2**	**1**	**0**
I am afraid of my baby	**5**	**4**	**3**	**2**	**1**	**0**
My baby annoys me	**5**	**4**	**3**	**2**	**1**	**0**
I feel confident when caring for my baby	**0**	**1**	**2**	**3**	**4**	**5**

I feel the only solution is for someone else to look after my baby	**5**	**4**	**3**	**2**	**1**	**0**
I feel like hurting my baby	**5**	**4**	**3**	**2**	**1**	**0**
My baby is easily comforted	**0**	**1**	**2**	**3**	**4**	**5**

Postpartum Bonding Questionnaire Scoring

I feel close to my baby

I wish the old days when I had no baby would come back

The baby doesn't seem to be mine

My baby winds me up

I love my baby to bits

I feel happy when my baby smiles or laughs

My baby irritates me

My baby cries too much

I feel trapped as a mother

I resent my baby

My baby is the most beautiful baby in the world

I wish my baby would somehow go away

Impaired bonding (12=high)

I feel distant from my baby

I love to cuddle my baby

I regret having this baby

I enjoy playing with my baby

I feel angry with my baby

My baby annoys me

I feel the only solution is for someone else to look after my baby

Rejection and pathological anger (13=high)

My baby makes me feel anxious

I am afraid of my baby

I feel confident when caring for my baby

My baby is easily comforted

Infant-focused anxiety (10=high)

I have done harmful things to my baby

I feel like hurting my baby

Incipient abuse (3=high)

Appendix J

The PCL-5 Checklist

In the past month, how much were you bothered by:	*Not at all*	*A little bit*	*Moderately*	*Quite a bit*	*Extremely*
1. Repeated, disturbing, and unwanted memories of the stressful experience?	0	1	2	3	4
2. Repeated, disturbing dreams of the stressful experience?	0	1	2	3	4
3. Suddenly feeling or acting as if the stressful experience were actually happening again *(as if you were actually back there reliving it)*?	0	1	2	3	4
4. Feeling very upset when something reminded you of the stressful experience?	0	1	2	3	4
5. Having strong physical reactions when something reminded you of the stressful experience *(for example, heart pounding, trouble breathing, sweating)*?	0	1	2	3	4
6. Avoiding memories, thoughts, or feelings related to the stressful experience?	0	1	2	3	4
7. Avoiding external reminders of the stressful experience *(for example, people, places, conversations, activities, objects, or situations)*?	0	1	2	3	4
8. Trouble remembering important parts of the stressful experience?	0	1	2	3	4
9. Having strong negative beliefs about yourself, other people, or the world *(for example, having thoughts such as: I am bad, there is something seriously wrong with me, no one can be trusted, the world is completely dangerous)*?	0	1	2	3	4
10. Blaming yourself or someone else for the stressful experience or what happened after it?	0	1	2	3	4
11. Having strong negative feelings such as fear, horror, anger, guilt, or shame?	0	1	2	3	4
12. Loss of interest in activities that you used to enjoy?	0	1	2	3	4
13. Feeling distant or cut off from other people?	0	1	2	3	4
14. Trouble experiencing positive feelings *(for example, being unable to feel happiness or have loving feelings for people close to you)*?	0	1	2	3	4
15. Irritable behavior, angry outbursts, or acting aggressively?	0	1	2	3	4
16. Taking too many risks or doing things that could cause you harm?	0	1	2	3	4
17. Being "superalert" or watchful or on guard?	0	1	2	3	4
18. Feeling jumpy or easily startled?	0	1	2	3	4
19. Having difficulty concentrating?	0	1	2	3	4
20. Trouble falling or staying asleep?	0	1	2	3	4

Appendix K

Social Support and social stress questionnaires

Antenatal Stress Questionnaire (16)

Sometimes one's life and that of one's close family goes through periods of being very stressful. I'd like to ask you some questions about any stresses you might have experienced in the last few months.

1. During the last 6 months have you or a member of your close family been in real danger of being killed, in one of the following ways?

1 = By criminals
2 = By police, army or other 'officials'
3 = During political activities
4 = This has not happened at all

2. During the last 6 months did you witness a violent crime (e.g. murder, robbery, assault, rape)?

Yes = 1	No = 2

3. During the last 6 months have you found that you are in so much debt that you don't know how you will repay the money?

Yes = 1	No = 2

4. During the last 6 months have you or your close family ever had too little money for basics, such as food, rent, and clothes?

Yes = 1	No = 2

5. Have you or one of your close family not been able to find a job for more than 6 months?

Yes = 1	No = 2

6. During the last 6 months have you or anyone in your close family been seriously ill?

Yes = 1	No = 2

7. During the last 6 months did any member of your close family die?

Yes = 1	No = 2

8. Is there anyone in your close family with a serious disability (e.g. epilepsy, mental retardation, deafness, blindness, mental illness)?

9. Is there anyone in your close family who has a problem with drugs or alcohol?

Yes = 1	No = 2

10. During the last 6 months have you had a break-up with your husband or partner?

Yes = 1	No = 2

11. During the last 6 months has your husband or partner hit or beaten you?

Yes = 1	No = 2

12. During the last 6 months have you had any serious fight or alienation from members of your family or your close neighbours?

Yes = 1	No = 2

13. During the last 6 months have you or any member of your close family been arrested, had to go to court or consulted a lawyer on a non-routine matter?

Yes = 1	No = 2

14. During the last 6 months have you given help (money, accommodation etc.) to close family or friends in need?

Yes = 1	No = 2

15. During the last 6 months have you been separated unwillingly from any of your children (excluding holidays)?

Yes = 1	No = 2

16. During the last 6 months have you experienced any problems with your other children (such as schools closing, failure at school, problem behaviour, drugs, etc.)?

Yes = 1	No = 2	No other child = 3

If YES, specify problem _____

Social Support questions (9)

In order for us to be able to understand your particular circumstances better, we would like to know how much help and support you feel you get from your family and friends.

1. If you had a really big problem and needed help with money, the children, accommodation and so on, are there people who could help you?

Yes = 1	No = 2	

2. Can you talk to your parents, other family members or friends about any problems you may have?

Nobody = 1	Maybe / unsure = 2	A number of people = 3

3. Can you talk to your husband or partner about any problems you might have?

Never = 1	Sometimes = 2	Always = 3

4. Some people think the sisters at the clinic are always helpful, others think only sometimes and some say they are seldom helpful. How do you feel?

Always helpful = 1	Sometimes helpful = 2	Seldom helpful = 3

5. Do you feel that the father of your child or your partner makes things harder for you because of the way he acts?

Never = 1	Sometimes = 2	Always = 3

6. Do you belong to a church group or any other organisation?

Yes = 1	No = 2

7. How often do you go to meetings?

Regularly = 1	Irregularly = 2	

8. Do you have a friend who is also going to have a baby or has just had a baby?

Yes = 1	No = 2

9. If **YES**, how often do you see her?

Once a week = 1	Once a month = 2	Irregularly = 3

Appendix L

Infographic pamphlet about maternal mental health and bonding

Trauma/*ukuhlukumezeka* and Anxiety/*uvalo*

The word 'trauma' describes a significantly stressful event or experience that causes someone to become distressed or overwhelmed to a point where they may struggle to cope emotionally or physically with the situation. In IsiZulu you might say that *uzizwe ngathi uyahlukumezaka emoyeni*. Examples: violence; a car accident; a natural disaster; a house fire; hijacking; home robbery; childhood neglect and exploitation.

Experiencing distress after a traumatic event is **very common**. It is a **normal reaction** to an abnormal situation.
There are some common responses to trauma, such as anxiety (*ukuthuka / ukushaywa uvalo);* feeling sad or depressed (*umoya wam' uphukile);* having distressing thoughts and memories (*ukucabanga ngayo noma ukuphuma ngayo);* difficulty sleeping or sleeping too much (*akulaleki noma ulala kakhulu)* and/or thoughts that you want to do risky things or hurt yourself.

The good news is that there are tools that can help you cope with trauma. Some of these include talking to people about your experience (*khuluma ngento eyenzekhile nabantu obathembayo)*; crying (*khala);* laughing (*hlekha);* listening to music and doing art; reading a book (*funda incwadi);* prayer and/or meditation (*umthandazo nomkhuleko);* exercise (*ukujima noma ukujuxuza);* or any other healthy activity that makes you feel better. If you continue to feel distressed, please visit a mental healthcare professional.

Need help?

SADAG - Helpline: 0800212223; 080070800; 0800456789; sms 32312
Akeso Psychiatric Response Unit - 011 234 4837/079 480 4244
Funda Centre - 011 723 1347(Crisis line) 067 019 0845/074 129 6960
Zazi Clinic (Bara hospital) - 011 234 4837/08614387
A.D.A.P.T for sexual and domestic violence (Alexandra Clinic) - 011 440 4047
Right to Care (Helen Joseph Hospital) - 011 276 8850
People Opposed to Women Abuse (POWA) (Bara Hospital Nthabiseng Centre)
Teddy Bear Clinic (Protea Count Complex) - 011 933 8000
Rape Crisis Centre (Bara Hospital) - 011 642 4345/6 (Mofolo); 011 933 2333 (Bara)
NIRCO - 011 933 2333(Bara); 011 642 4345/6 (Mofolo)
Chiawelo 0119843275 psychiatrist Dr Chenth Herald; clinical psychologist Motheo Sekgobelo; registered counsellor Mbali Sithole



Depression *ukuhlukumezeka*



The word 'depression' is a term to describe deep sadness. If you feel like you want to cry a lot of the time; if you feel like things that once brought you joy, don't bring you joy anymore; if you are sleeping a lot more or a lot less than you are used to (not only because you have a new baby) or if you feel like you want to hurt yourself or you have frequent thoughts of death - then you may be experiencing depression. In IsiZulu you might say "ukucindezeleka".

More examples: Having angry outbursts or irritation about small things, weight loss or rapid weight gain, slowed thinking or body movements, feelings that you are worthless and difficulty concentrating (not only because you're tired from little sleep because of the baby).



Your relationship with your baby *ukubambisana kokubili*

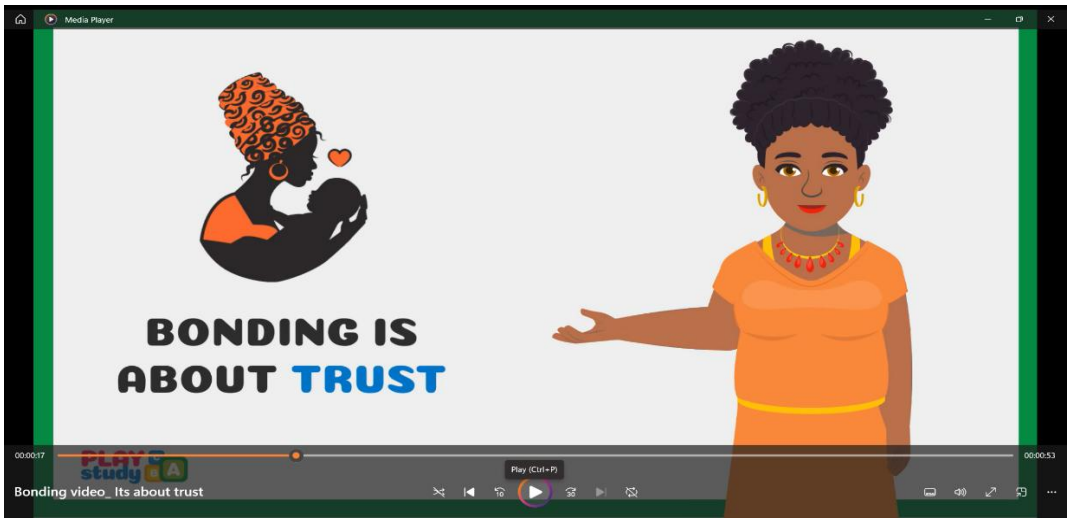


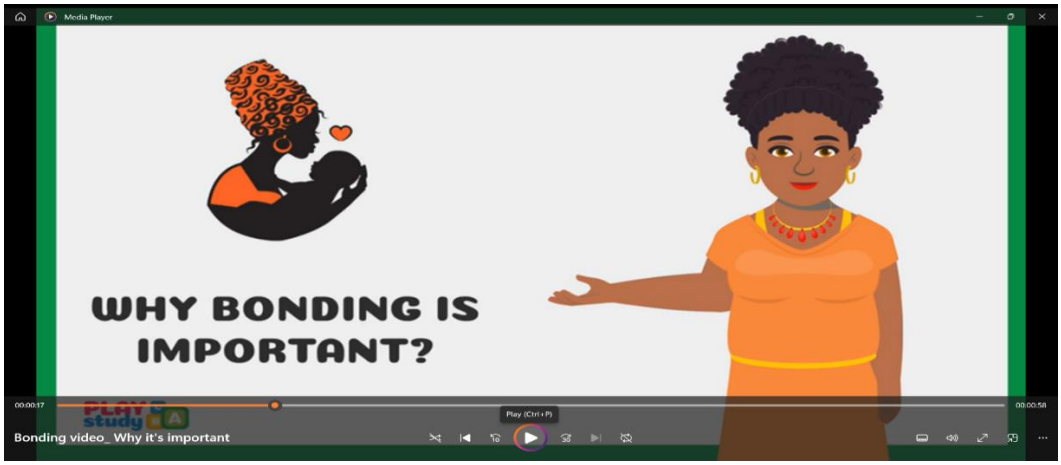
The word 'bonding' is a term to describe the relationship between a baby and a mother or carer. It is a feeling of closeness between the two. In IsiZulu you might say "ukubambisana kokubili".

Mothers can sometimes feel close to their babies and completely in love with them and sometimes they can feel irritated or distant from their children. Our babies can make us feel happy when they smile or play nicely or they can wind us up. We can also feel trapped, angry or anxious about our babies. If you ever feel like you want to hurt your baby or if you have done harmful things to your baby; call a trusted friend or a counsellor immediately. You need emotional or physical help and there will always be someone there to talk to.

Appendix M,N,O

Short videos







Appendix P

Student's contribution to article(s) and agreement of co-authors

Declaration: Student's contribution to article(s) and agreement of co-author(s)

I, Sarah Jane Cantrell, student number 0712062A, declare that this Thesis is my own work and that I contributed adequately towards research findings published in the article(s) stated below which are included in my Thesis.

Signature of Student: Date 20 January 2025

Name of Primary Supervisor: Dr Alessandra Prioreschi

Signature of Primary Supervisor Date 20 January 2025

Agreement by co-authors: By signing this declaration, the co-authors listed below agree to the use of the article(s) by the student as part of her Thesis. In cases where the student is not the 1st author of a published article, the primary supervisor must explain (under comments) why the student is entitled to use the paper for his/her degree purposes.

Article 1: Title: Early parenting interventions to prevent internalizing problems in children and adolescents: a global systematic review and network meta-analysis.

Journal name, year, volume and page numbers:
BMJ Mental Health, 2023, 26(1). Manuscript number: bmjment-2023-300811

Authors	Name	Signature	Date
1st author	Costantini, I	Ilaria Costantini	30/01/25
2nd author	López-López, J.A	.	
3rd author	Caldwell, D		
4th author	Campbell, A		
5th author	Hadjipanayi, V		
6th author	**Cantrell, S.J**		

Comments by primary supervisor:
30/01/25
- Signed by Prof. R. PEARSON AS Senior Author on behalf of all other authors.

Article 2: Title: Protocol for the PLAY Study: a randomised controlled trial of an intervention to improve infant development by encouraging maternal self-efficacy using behavioural feedback

Journal name, year, volume and page numbers: BMJ Open, 2023, 13(3).

Authors	Name	Signature	Date
1st author	Prioreschi, A		
2nd author	Pearson, R		30/01/25
3rd author	Richter, L		
4th author	Bennin, F		
5th author	Theunissen, H		
6th author	**Cantrell, S.J**		

Comments by primary supervisor:

1

Declaration: Student's contribution to article(s) and agreement of co-author(s)

I, Sarah Jane Cantrell, student number 0712062A, declare that this Thesis is my own work and that I contributed adequately towards research findings published in the article(s) stated below which are included in my Thesis.

Signature of Student:  Date 8 February 2025

Name of Primary Supervisor: Dr Alessandra Prioreschi

Signature of Primary Supervisor  Date 8 February 2025

Agreement by co-authors: By signing this declaration, the co-authors listed below agree to the use of the article(s) by the student as part of her Thesis. In cases where the student is not the 1st author of a published article, the primary supervisor must explain (under comments) why the student is entitled to use the paper for his/her degree purposes.

Article 1: Title: Early parenting interventions to prevent internalizing problems in children and adolescents: a global systematic review and network meta-analysis.

Journal name, year, volume and page numbers**:**

BMJ Mental Health, 2023, 26(1). Manuscript number: bmjment-2023-300811

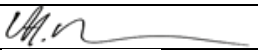
Authors	Name	Signature	Date
1st author	Costantini, I		
2nd author	López-López, J.A		
3rd author	Caldwell, D		
4th author	Campbell, A		
5th author	Hadjipanayi, V		
6th author	**Cantrell, S.J**		

Comments by primary supervisor: Please see attached document with signatures for article 1 included.

Article 2: Title: Protocol for the PLAY Study: a randomised controlled trial of an intervention to improve infant development by encouraging maternal self-efficacy using behavioural feedback

Journal name, year, volume and page numbers: BMJ Open, 2023, 13(3).

Authors	Name	Signature	Date
1st author	Prioreschi, A		18/12/2024
2nd author	Pearson, R		4/02/2025

3rd author	Richter, L		6/02/2025
4th author	Bennin, F		05/01/2025
5th author	Theunissen, H		02/01/2025
6th author	**Cantrell, S.J**		02/01/2025

Appendix Q

Turn it in report

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	Sarah Cantrell
Assignment title:	Final submission (all, regardless of course/programme)
Submission title:	The Impact of maternal mental health on synchrony in mother...
File name:	The_Impact_of_maternal_mental_health_on_synchrony_in_mot...
File size:	10.07M
Page count:	161
Word count:	43,728
Character count:	248,493
Submission date:	20-Feb-2025 09:08AM (UTC+0200)
Submission ID:	2593629429


THE IMPACT OF MATERNAL MENTAL HEALTH ON SYNCHRONY IN MOTHER-INFANT INTERACTIONS

Copyright 2025 Turnitin. All rights reserved.

The Impact of maternal mental health on synchrony in mother and infant relationship-2.docx

ORIGINALITY REPORT

4%	3%	3%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	cyberleninka.org Internet Source	<1%
2	research-information.bris.ac.uk Internet Source	<1%
3	Submitted to Manchester Metropolitan University Student Paper	<1%
4	wiredspace.wits.ac.za Internet Source	<1%
5	Submitted to University of Witwatersrand Student Paper	<1%
6	Kosnes, Liv, Robert Whelan, Aoife O'Donovan, and Louise A. McHugh. "Implicit measurement of positive and negative future thinking as a predictor of depressive symptoms and hopelessness", Consciousness and Cognition, 2013. Publication	<1%
7	www.frontiersin.org Internet Source	<1%
8	www.growgreat.co.za Internet Source	<1%
9	David J. Messer, Peter M. Vietze. "Timing and transitions in mother-infant gaze", Infant Behavior and Development, 1984 Publication	<1%
10	Beatrice Beebe. "Co-constructing mother–infant distress in face-to-face interactions: Contributions of microanalysis", Infant Observation, 2006 Publication	<1%
	www.science.gov	

11	Internet Source	<1 %
12	hdl.handle.net Internet Source	<1 %
13	www.penntwplanco.org Internet Source	<1 %
14	www.doria.fi Internet Source	<1 %
15	scholar.sun.ac.za Internet Source	<1 %
16	Annett Lotzin, Julia Schiborr, Claus Barkmann, Georg Romer, Brigitte Ramsauer. "Maternal emotion dysregulation is related to heightened mother–infant synchrony of facial affect", Development and Psychopathology, 2015 Publication	<1 %
17	orcid.org Internet Source	<1 %
18	open.uct.ac.za Internet Source	<1 %
19	"Blackwell Handbook of Infant Development", Wiley, 2004 Publication	<1 %
20	Jacob, Shiji. "Effects of Maternal Mental Health on Engagement in Health Practices During Pregnancy in a Selected Hospital, Mangaluru", Rajiv Gandhi University of Health Sciences (India), 2023 Publication	<1 %
21	Hanne Cecilie Braarud, Siv Skotheim, Kjartan Høie, Maria Wik Markhus et al. "Affective facial expression in sub-clinically depressed and non-depressed mothers during contingent and non-contingent face-to-face interactions with their infants", Infant Behavior and Development, 2017 Publication	<1 %

22	Bonwell, Krist. "An exploration of the relationships among postpartum depression, anxiety, maternal sensitivity, parenting stress, and infant development", Proquest, 2013. Publication	<1 %
23	Michael W. O'Hara. "Postpartum Depression", Springer Science and Business Media LLC, 1995 Publication	<1 %
24	Fiona Bennin, Helene Theunissen, Shane A. Norris, Alessandra Prioreschi. "Determining the perceived acceptability of an intervention designed to improve health literacy around developmentally appropriate play during infancy, with a community advisory group of mothers, in Soweto, South Africa", PLOS Global Public Health, 2024 Publication	<1 %
25	Potgieter, Karen. "The Influence of Skin-to-Skin Contact on Bonding and Touch", University of the Witwatersrand, Johannesburg (South Africa), 2025 Publication	<1 %
26	www.nzma.org.nz Internet Source	<1 %
27	Sharon R. Thomas, Kelly A. O'Brien, Tana L. Clarke, Yihao Liu, Andrea Chronis-Tuscano. "Maternal Depression History Moderates Parenting Responses to Compliant and Noncompliant Behaviors of Children with ADHD", Journal of Abnormal Child Psychology, 2014 Publication	<1 %
28	e-space.mmu.ac.uk Internet Source	<1 %
29	P. J Cooper, M. Tomlinson, L. Swartz, M. Landman, C. Molteno, A. Stein, K. McPherson, L. Murray. "Improving quality of mother-infant relationship and infant attachment in socioeconomically deprived community in	<1 %

	South Africa: randomised controlled trial", BMJ, 2009 Publication	
30	escholarship.org Internet Source	<1 %
31	Dianna T. Kenny. "Bringing up Baby - The Psychoanalytic Infant Comes of Age", Routledge, 2018 Publication	<1 %
32	Ramsoomar, Leane. "Risk and Protection: Alcohol Use Among Urban Youth Within the Birth to Twenty (BT20) Cohort", University of the Witwatersrand, Johannesburg (South Africa), 2025 Publication	<1 %
33	Watson, Estelle Dorothy. "Maternal Physical Activity: Influence on Maternal and Delivery Outcomes", University of the Witwatersrand, Johannesburg (South Africa), 2025 Publication	<1 %
34	core.ac.uk Internet Source	<1 %
35	scholarspace.manoa.hawaii.edu Internet Source	<1 %
36	Mkwanazi, Ntombizodumo Brilliant. "Maternal HIV-Disclosure to Uninfected Primary School-Aged Children: Motivations, Fears and Considerations in Sub-Saharan Africa", University of the Witwatersrand, Johannesburg (South Africa), 2025 Publication	<1 %
37	ijbnpa.biomedcentral.com Internet Source	<1 %
38	researchonline.ljmu.ac.uk Internet Source	<1 %
39	www.theownershipproject.com.au Internet Source	<1 %
40	Alexandra C. Hummel, Elizabeth J. Kiel, Silvija Zvirblyte. "Bidirectional Effects of Positive	<1 %

	Affect, Warmth, and Interactions Between Mothers With and Without Symptoms of Depression and Their Toddlers", Journal of Child and Family Studies, 2015 Publication	
41	www.futuremedicine.com Internet Source	<1%
42	Nadja Reissland. "The pitch of maternal voice: a comparison of mothers suffering from depressed mood and non-depressed mothers reading books to their infants", Journal of Child Psychology and Psychiatry, 2/2003 Publication	<1%
43	Submitted to Trinity College Dublin Student Paper	<1%
44	keep.lib.asu.edu Internet Source	<1%
45	Munthali, Richard Junganiko. "Longitudinal Analysis of Genetic Risk Factors for Cardiovascular Disease: The Birth to Twenty Plus Cohort", University of the Witwatersrand, Johannesburg (South Africa), 2025 Publication	<1%
46	Alessandra Prioreschi, Shane A. Norris. "Describing correlates of early childhood screen time and outdoor time in Soweto, South Africa", Infant and Child Development, 2022 Publication	<1%
47	Submitted to Macquarie University Student Paper	<1%
48	Submitted to University College London Student Paper	<1%
49	Submitted to University of Namibia Student Paper	<1%
50	Submitted to University of Stellenbosch, South Africa Student Paper	<1%
51	Submitted to University of Wales Swansea Student Paper	

		<1 %
52	academic.oup.com Internet Source	<1 %
53	Antonia L Wadley, Stella Iacovides, Johanna Roche, Karine Scheuermaier et al. "Working nights and lower leisure-time physical activity associate with chronic pain in Southern African truck drivers: a cross-sectional study", Cold Spring Harbor Laboratory, 2020 Publication	<1 %
54	Submitted to University of Glasgow Student Paper	<1 %
55	www.nature.com Internet Source	<1 %
56	Timmons, Lisa Nicole. "Facial Affect and Physiological Synchrony during Parent-infant Interactions and Influences on Later Developmental Outcomes.", Texas Christian University, 2018 Publication	<1 %
57	Wrottesley, Stephanie Victoria. "Maternal Nutrition During Pregnancy and Its Association with Birth Outcomes and Neonatal Body Composition in the Context of HIV in Urban Black South Africans", University of the Witwatersrand, Johannesburg (South Africa), 2025 Publication	<1 %
58	www.quotable-quotes.co.za Internet Source	<1 %
59	Gerrand, Priscilla A.. "The Legal Adoption of Unrelated Children: A Grounded Theory Approach to the Decision-Making Processes of Black South Africans", University of the Witwatersrand, Johannesburg (South Africa), 2025 Publication	<1 %
60	Kufe, Nyuyki Clement. "Insulin Sensitivity and Response in Middle-Aged Black South African	<1 %

	Men and Women: Associations With Body Fat Distribution, Menopause and Objectively Measured Physical Behaviours", University of the Witwatersrand, Johannesburg (South Africa), 2025 Publication	
61	Michelle N. Odonkor, Bhavya Pahwa, Jordina Rincon-Torroella, Nancy Abu-Bonsrah et al. "Effects of Gender and Country of Training on Perceived Access to Opportunities for Neurosurgical Research and Gender-Concordant Mentorship", World Neurosurgery, 2025 Publication	<1 %
62	eurjmedres.biomedcentral.com Internet Source	<1 %
63	www.mdpi.com Internet Source	<1 %
64	"Handbook of Emotional Development", Springer Science and Business Media LLC, 2019 Publication	<1 %
65	Andy Young. "Facial Expression Recognition - Selected works of Andy Young", Psychology Press, 2016 Publication	<1 %
66	Leclère, Chloë, Sylvie Viaux, Marie Avril, Catherine Achard, Mohamed Chetouani, Sylvain Missonnier, and David Cohen. "Why Synchrony Matters during Mother-Child Interactions: A Systematic Review", PLoS ONE, 2014. Publication	<1 %
67	Marín, Rosa. "An Examination of Types of Trauma, Resiliency Factors, and Strengths-Based Approaches to Treatment Among Undocumented Mexican Immigrants", Pepperdine University, 2024 Publication	<1 %
68	Okur, Sükran. "The Influence of Poverty on School Readiness of 5-Year-Old Children:	<1 %

	Mediating Roles of Home Environment and Parenting.", Middle East Technical University (Turkey), 2024 Publication	
69	Powell, Catherine. "EBOOK: Safeguarding and Child Protection for Nurses, Midwives and Health Visitors: A Practical Guide", EBOOK: Safeguarding and Child Protection for Nurses, Midwives and Health Visitors: A Practical Guide, 2015 Publication	<1 %
70	Rui P. Moreno. "Sepsis mortality prediction based on predisposition, infection and response", Intensive Care Medicine, 03/2008 Publication	<1 %
71	Skotheim, Siv, Hanne Cecilie Braarud, Kjartan Høie, Maria Wik Markhus, Marian Kjellevold Malde, Ingvild Eide Graff, Jan Øystein Berle, and Kjell Morten Stormark. "Subclinical levels of maternal depression and infant sensitivity to social contingency", Infant Behavior and Development, 2013. Publication	<1 %
72	Submitted to University of Bedfordshire Student Paper	<1 %
73	assets-eu.researchsquare.com Internet Source	<1 %
74	pure.manchester.ac.uk Internet Source	<1 %
75	worldwidescience.org Internet Source	<1 %
76	www.bib.irb.hr Internet Source	<1 %
77	www.researchgate.net Internet Source	<1 %

Exclude quotes	On	Exclude matches	< 8 words
Exclude bibliography	On		

Appendix R

Publication

JOURNAL OF REPRODUCTIVE AND INFANT PSYCHOLOGY
https://doi.org/10.1080/02646838.2025.2511797

Routledge
Taylor & Francis Group

OPEN ACCESS Check for updates

Maternal perspectives on poor mental health and the impact on mother-infant relationships

Sarah J Cantrell [a], Rebecca M Pearson [b] and Alessandra Prioreschi [a]

[a]SAMRC/Wits Developmetal Pathways for Health Research Unit, Department of Paediatrics, Faculty of Health Sciences, School of Clinical Medicine, University of the Witwatersrand, Johannesburg, South Africa; [b]Department of Psychology, Manchester Metropolitan University, Manchester, UK

ABSTRACT

Aim: The high prevalence of trauma, anxiety, and depression among postpartum women, particularly in low-income groups, poses a global health challenge. These mental health issues can strain the mother-infant relationship and negatively affect the infant's socio-emotional and cognitive development, with broader societal implications. This study aims to explore South African postpartum mothers' perceptions of mental health and their influence on mother-infant bonding to inform targeted support strategies.

Methods: Fifteen participants with infants under 4 months old were recruited from Soweto, South Africa. The mothers were divided into two focus groups ($n = 7$ and $n = 8$). In-depth discussions were conducted to explore mothers' views on the causes of postpartum mental health issues and their perceived effects on bonding. Following transcription, a thematic analysis was performed, whereby each script line was coded and categorised. The process included independent verification by a second researcher, resulting in the identification of key themes from the data.

Results: Mothers described mental health issues as experiences of 'stress' and 'worry'. Five key contributors included partner and family conflict (particularly paternity denial), lack of community and healthcare support, and insufficient resources. Mothers reported that these stressors hindered mothers' abilities to bond with their infants, with maternal persecution emerging as a prominent theme.

Conclusion: Interpersonal and financial stressors play a significant role in shaping postpartum mothers' mental health and influencing their relationships with their infants. Findings highlight culturally and contextually appropriate interventions to support mothers and to foster positive mother-infant relationships in resource-limited settings.

ARTICLE HISTORY
Received 4 July 2024
Accepted 20 May 2025

KEYWORDS
Postpartum mental health; qualitative insights; mother-infant; bonding; low-income

CONTACT Sarah J Cantrell sarahcantrellphd@gmail.com SAMRC/Wits Developmetal Pathways for Health Research Unit, Department of Paediatrics, Faculty of Health Sciences, School of Clinical Medicine, University of the Witwatersrand, DPHRU, corner of College & Clinic Roads, Chris Hani Baragwanath Academic Hospital, Private Bag X3 Wits, Johannesburg 2050, South Africa

Supplemental data for this article can be accessed online at https://doi.org/10.1080/02646838.2025.2511797

© 2025 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.
This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

Introduction

Depression is a leading cause of disability worldwide (Friedrich, 2017) and is particularly prevalent among women during the postpartum period. Postpartum depression (PPD) has a global prevalence rate of 17.22% with regional variations, the highest being reported in Southern Africa at 39.96% (Wang et al., 2021). Maternal mental health issues are associated with poor emotional, social and cognitive outcomes in both mothers and children (Shuffrey et al., 2022). The manifestation of such issues in specific contexts is still not understood and the impact of postpartum mental health on the relationship with the child is varied (Baron et al., 2016). Mothers' own traumas are likely to be an important part of this pathway of risk.

While South Africa is classified as an upper-middle-income country (World Bank, 2018), it continues to face high levels of inequality, with many communities – particularly in township areas such as Soweto – experiencing conditions comparable to those in low-income countries. Pervasive conditions of poverty, violence, and patriarchy (Mathews & Benvenuti, 2014) have exposed vulnerable women and children to significant challenges, including widespread physical and emotional abuse, gender-based violence (Okafor et al., 2018), post-traumatic stress (Magamela et al., 2021), depression (Hung et al., 2014), and suicide (Maré et al., 2021).

Extreme societal stressors such as witnessing dangerous crimes and experiencing difficulties with a partner are the strongest independent determinants of PPD (Ramchandani et al., 2009). Redinger et al. (2018) found that mothers who perceived their partner as making life more challenging were three times more likely to experience depression (Redinger et al., 2018). Similarly, Cohen et al. (2020) found that household-centred issues impacted the amount of chronic anger, stress, depression and suicidal ideation as well as material and relational hardships experienced by mothers living in the low-income township of Soweto. Relational stress is exacerbated by the fact that mothers and their families in South Africa live in 'extended households' which are multi-generational households in which aunts, grandfathers, sisters and cousins may also be considered part of the home (Hall et al., 2018). Relational difficulties are often associated with adverse childhood experiences (ACEs, Wheeler et al., 2019). Such experiences can have far-reaching consequences, particularly within complex living arrangements, where a mother's hostile experiences from childhood may have a detrimental impact her mental health.

Postpartum mental health challenges may hinder the development of healthy parent – child relationships (Alves et al., 2018). These issues can affect healthy bonding due to misattunement between the pair, whereby emotional difficulties make it challenging to respond to the infant's needs often expressed through distress (de Camps Meschino et al., 2016). A study by Murray et al. (1996) compared mothers of two-month-old infants who reported no mental health issues with mothers experiencing depression. The findings revealed that depressed mothers faced greater challenges in sensitively attuning to their infants. They reported more negative experiences with their children and demonstrated fewer affirming behaviours within the mother-infant relationship (Murray et al., 1996). A depressed mother may demonstrate rejection, anger, fear, hostility (Brockington, 2004; Slomian et al., 2019) and intrusive behaviour or disengagement (Murray et al., 1996) when interacting with her infant (Field, 1992; Gelfand & Teti, 1990). As a result of difficulties in

attunement, an infant may feel rejected, confused or angry (Murray, 1992) feeding back into the dysfunctional interactional dynamic that characterises the dyadic relationship style. Furthermore, dissonance in early mother-infant interaction and insecure attachment has predicted poorer cognitive outcomes and social and emotional growth in the offspring (Rocha et al., 2019).

Extensive research has explored maternal mental health issues in low-income areas in South Africa (Drysdale et al., 2021; Mabetha et al., 2024; Redinger et al., 2018). In the antenatal phase, relationships during pregnancy and network involvement are thought to be important to mothers' mental health when living in a township (Mabetha et al., 2024). It is reported that womens' experiences are shaped by motherhood responsibilities, health challenges, unstable support, trauma, and socioeconomic pressures (Soepnel et al., 2024). In the postnatal phase, predictors of depression include exposure to violence (Ramchandani et al., 2009) and difficulty with partners (Ramchandani et al., 2009; Redinger et al., 2018). Furthermore, factors such as poverty, food insecurity, unwanted pregnancies and lack of support have been perceived as factors leading to postpartum depression (Kathree et al., 2014).

There is lack of sufficient research as to how mothers perceive their mental health and its impact on the mother-infant relationship. This study seeks to address this limitation through in-depth interviews, offering insights into maternal and infant mental health in this context. The findings aim to deepen understanding and inform the development of targeted interventions to support the dyad.

Methods

Setting and participants

We approached mothers at taxi ranks in Soweto, asking them if they would like to participate in the study. We chose taxi ranks as suitable locations for random selection of participants because over 80% of township dwellers in South Africa use taxis as their only mode of transport (Statistics South Africa, 2020). These public taxi ranks not only coordinate travel but serve as markets. They are surrounded by stores where informal traders sell food and clothing. We provided pamphlets to women containing important information about the voluntary nature of the study, the reason for such research and the details regarding how and when information would be gathered. Mothers were included in the study if they met the following criteria: resided in Soweto, were aged 18 years or older, were the primary caregiver, could travel to and from the study site at the hospital with transport costs reimbursed, and had given birth to a single, full-term infant within the past 4 months. The decision to focus on the 4-month postnatal period was informed by research from Beebe et al. (2010) which shows that specific mother-infant interaction patterns at 4 months can predict attachment outcomes at 12 months. Mothers were excluded if they did not meet any of the above criteria. If mothers were eligible and agreed to partake, we asked for their contact details. After making telephonic contact with participants, data were collected at a meeting room at the Chis Hani Baragwanath Academic Hospital over two consecutive mornings in May 2022. Fifteen mothers were divided into two groups ($n = 7$ and $n = 8$). The sample size was chosen to support the depth of this case-oriented analysis (Sandelowski, 1996) which is fundamental to

qualitative enquiry to attain richly textured information (Vasileiou et al., 2018). Participants gave written informed consent to the inclusion of material pertaining to them. All were informed that they would not be identifiable. After the first group's discussion, we repeated the method with the second group of mothers and saturation was reached (Braun & Clarke, 2021; Guest et al., 2006).

We made use of Vygotsky's (1987) concept of scaffolding to support participants with emotional regulation when retelling their stories. We were also guided by the notion of nonmaleficence. This principle of bioethics asserts an obligation not to inflict harm. The first author is a qualified community-based counselling psychologist and was present to contain the emotional well-being of participants. Additional therapy sessions were offered to women who either displayed distress or to those whom requested face-to-face assistance.

Ethical statement

This study was approved by the University of the Witwatersrand's Human Research Ethics Committee in Johannesburg, South Africa (clearance no: M220787 under sub-study M210846). Additional approval was granted by the Research Committee of Johannesburg Health District (GP_202202_021). Participants provided written informed consent prior to being enrolled.

Questionnaires

To understand the population, participants first completed a sociodemographic questionnaire. Mothers were asked about any previous mental health diagnoses and to further characterise the group in terms of their mental health, the Post-traumatic Stress Disorder Checklist for DSM-5 (PCL-5, Weathers et al., 1993) was administered to determine the presence of Post-Traumatic Stress symptoms (PTSD symptoms). A total symptom severity score is found by adding up the item scores which range from 0–80. Cut-off scores for likely PTSD can be between 23–38 and are reliant upon the population in which the score was validated. The cut-off is 33 in an African population from Zimbabwe (Verhey et al., 2018) and was used in this study. The Edinburgh Postnatal Depression Scale (EPDS, Cox et al., 1987) tested for PPD. Scores range from nil to three on a 4-point Likert scale and scores are added together to get an overall total. Some of the items are reverse scored (Gollan et al., 2017). EPDS scores of 0–6 indicate no or minimal depression, 7–13 show mild depression, 14–18 moderate and 19–30 severe depression (McCabe-Beane et al., 2016). The Adverse Childhood Experience questionnaire (ACE, Felitti et al., 1998) assessed childhood abuse, neglect, and challenges. The assessment looks at three categories of adverse experiences: childhood abuse, neglect, and household challenges. Participants confirm either the presence of this kind of experience described by each item by writing a number 1 or they leave it blank if there was no such experience. A score from 0–10 is based on how many types of adverse experiences are reported. Two questionnaires, formerly developed at the university's research unit (The Developmental Pathways for Health Research Unit) were used to explore social support and social stressors (Ramchandani et al., 2009, 2010). The Postpartum Bonding Questionnaire (PBQ, Brockington et al., 2006), was administered to detect the quality of early mother – infant

bonding. The tool consists of 4 subscales 'impaired mother/infant bonding', 'rejection and anger', 'anxiety about care', and the 'risk of abuse'. These questions are rated on a 6-point Likert scale, ranging from 0 (always) to 5 (never). Averages n(%) and standard deviations (SD) were done to summarise participant characteristics and to describe the population. There is evidence of the validity and reliability of all these tools in the South African context (Lawrie et al., 1998; Makhubela, 2018; Verkuijl et al., 2014).

Focus group discussions

Two trained members of the research team facilitated the focus group discussions (FGDs). One member was fluent in the vernacular (Zulu and Xhosa) and the other took notes on the observed process which would supplement the information gained by the audio that was recorded. The two groups of participants had separate, 1–2 hour sessions. One theme of enquiry was aimed at understanding mothers' perceptions regarding the causes of PPD and anxiety, and the other was to explore the perceived impact of maternal mental health on the dyadic relationship.

Qualitative analysis

Qualitative methodologies aligned with anthropological inquiry-informed analyses. FGDs and observations of women; led to an inductive style of research and narratives were recorded. Main emerging themes and sub-themes were identified by coding transcripts line by line and then categorising quotes into themes and subthemes. The frequency of certain keywords was noted and contributed to the strength and therefore the validity of a theme. A second researcher performed the analysis independently to promote objectivity and to confirm theme identification. Both researchers compared their analyses and restructured themes until a consensus was reached. Results were consolidated and themes and subthemes were described.

Results

Participant demographics

The average age of participants was 28 years old (SD = 8.7). It was found that 73% ($n = 11$) were single or never married. Slightly over half of the women had completed grades 8 to 11 and 60% ($n = 9$) were reportedly unemployed. Forty-seven percent of the participants ($n = 7$) were first-time mothers. Women lived with an average of 7 (SD = 2.7) other people in extended households, mostly in a house (versus a shack), and 73% ($n = 11$) lived without a partner. No mental health disorders had previously been diagnosed across participants. Fifty-three percent ($n = 8$) of the infants were boys and the average age was 15.4 weeks. [See supplement Table S1 *Characteristics of mothers and their infants (n = 15)*].

Eighty percent ($n = 12$) of the mothers presented with scores indicative of PTSD symptomology. Results from the EPDS indicated that 67% ($n = 10$) of these mothers were either moderately or severely depressed. There was an average of 4 ACEs reported per participant and 67% ($n = 10$) reported having been humiliated or physically threatened by an adult in childhood. A further 53% ($n = 8$) stated that they did not feel loved or

that their family was not close. Thirteen percent ($n = 2$) had been sexually touched or raped before the age of 18. Every participant reported that either they or a close family member was unemployed within the past 6 months, 80% ($n = 12$) indicated they had too little money for food, rent or clothes, while 67% ($n = 10$) reported overwhelming financial debt. Over half (53%; $n = 8$) the participants disclosed that either they or a close family member suffered from substance abuse and the same number of mothers said that they had experienced serious conflict with a spouse or partner in the last 6 months. Fifty-three percent ($n = 8$) said that if they had a 'really big' problem and needed help with money, the children, or accommodation, there would be no one who could help. Eighty percent ($n = 12$) stated that they were either unsure or did feel that the father of their child made things harder for them because of the way he acted. PBQ results revealed that 60% ($n = 9$) of the group had impaired bonding with their infants. [See supplement Table S2 *Analysis of assessments (n = 15)*].

Focus group discussions

Participants were first asked about their understanding of mental health terminology. Thereafter, groups discussed perceived causes of mental health issues. Finally, maternal perceptions of the effect of mental health on the dyadic relationship were considered. Table 1 shows the process to derived themes and subthemes.

The understanding of mental health terminology

Less than half of the participants were familiar with the terms anxiety and postpartum depression. Nevertheless, the majority associated these conditions with feelings of worry, stress, and sadness. The term most used by participants when describing these experiences was 'stress'. While mothers spoke in their local languages, the words ukuhlukumezeka – meaning 'to be troubled' - and uvalo, which translates to 'being nervous or fearful', were used to articulate these emotional states.

Perceived causes of maternal mental health issues

The following 5 key themes were identified as factors that mothers thought could contribute towards maternal mental health issues in Soweto:

Table 1. Themes and correlating subthemes.

First order codes	Themes	Subthemes
Mental health issues	Understanding terms like anxiety and depression	Stress, worry and sadness
	Perceived causes	Partner conflict
		Family conflict
		Poor community support
		Lack of trust in the health care system
		Lack of resources
Maternal perceptions of mental health on the dyadic relationship	Bidirectionality	Existence of a two-way relationship
	Mentalisation	Routines affected
		Developmental delays
		Physical growth stunting
		Lessened ability to parent

1. Partner conflict: Partners denying paternity was the most prevalent theme. Some participants expressed concern for their children as their partners were absent fathers and caused mothers to feel like they were not coping. In many cases, mothers expressed anger and feelings of abandonment describing their partners as untrustworthy and unfaithful.

> . . . like the father of my child said he is infertile, yoh, I lost my mind, I asked him if he's infertile, how did I fall pregnant? He insisted he's infertile and that the doctor told him so (FGD 2).

> . . . you hear men say: 'she's still young, I won't hold her', and others [partners] finding an opportunity to cheat while you're raising his child (FDG 1).

2. Family conflict: Female family members and in-laws were said to cause emotional hardships, and the recurring theme of questioned paternity re-emerged as a source of conflict. Family environments were described as untrustworthy spaces where women were treated as liars. Verbal abuse and accusations of the mothers sleeping around caused emotional distress and a threat to self-identity.

> . . . in-laws! Have you ever had your in-laws dispute your children's paternity as if they were there when you were making love and . . . controlling the whole thing? I was heartbroken . . . they said . . . this baby is not their family which means I'm sleeping around (FGD 2).

3. Poor community support: Discussions revealed that unsupportive community members were a source of sadness and anxiety. Mothers expressed feelings of being judged as neighbours would gossip about each other.

> . . . where we come from they talk. You do right, they talk, you do wrong, they talk, you do nothing at all, they talk (FDG 2); and shout and hit their children. When they hit them [my children] in the streets, we fight yoh, it's bad (FGD 2).

4. Lack of trust in the healthcare system: Most mothers highlighted concerns relating to the poor healthcare system available to mothers in Soweto and maintained that there was a lack of programmes, counsellors and support groups. Most agreed that clinic nurses were found to be unprofessional and untrustworthy:' . . . *they* [clinic nurses] *are rude . . . they are not approachable; that doesn't develop trust or make it easy for us to have a sit-down discussion where we talk . . . where I tell you my business* (FDG 2) . . . '

> They elaborated that these facilities exacerbated the problem of mental health as some staff members seemed to have a lack of understanding of health care itself: ' . . . when I was pregnant, we were getting tested for HIV, this lady asked me [shouting]: "Is your boyfriend circumcised?" I was like "what does that have to do with anything?" . . . she shouted: "it [his penis] went in without you seeing it?! That means they chowed you [slept with you] in the dark". There are so many people in the room, and she's making a joke out of me . . .' (FGD 2).

5. Lack of resources: Mothers reported great anxiety regarding the scarcity of food and clothes which extended to their worries that they may not be able to provide for their children.

> Hunger is difficult to deal with. Let's say you're pregnant, sometimes you just sit and think, 'what am I going to eat today?' With others the food is simply not there (FGD 2).

> What makes me anxious is when my baby does not have diapers, that's when I really get worried (FGD 1).

Table 2 shows exemplar quotes regarding perceived causes of maternal mental health.

Table 2. Exemplar quotes regarding perceived causes of maternal mental health issues.

Main themes and subthemes						
Anxiety and depression	**What is 'anxiety' and 'depression'**	'They [anxiety and depression] are like if you don't get like support from your family, partner or community' (FGD 2).	'It's about when someone feels unsettled and stressed about something or life' (FGD 2).	'I think it's things that we go through when we are pregnant, things that give us stress even after giving birth to the baby' (FGD 1).		
	Perceived causes	*Partner conflict*	*Family conflict*	*Poor community support*	*Lack of trust in the healthcare system*	*Lack of resources*
		' . . . how come do you want to name my child – you claimed this isn't your child. You ejaculate Sprite, right? So, you don't have a child, consider yourself a man with no children who supports other men's children' (FDG 2).	' . . . his family and friends are saying: "that's not your child". His mother supported him and said her son is infertile and [she] would curse me every day . . . saying that I'm a whore' (FGD 2).	' . . . where we come from they talk; you do right, they talk, you do wrong, they talk, you do nothing at all, they talk' (FDG 2).	[The nurse] ' . . . would speak about me in front of other women in the queue saying: "I heard Patrick doesn't want to report the pregnancy" and other people would look at me'. (FGD 1).	'Hunger is difficult to deal with in this world. Let's say you're pregnant, sometimes you just sit and think, "what am I going to eat today?" With others the food is simply not there' (FGD 2).
		' . . . you often hear men say: "she's still young, I won't hold her", and others [partners] finding an opportunity to cheat while you're raising his child' (FDG 1).	'The granny once said to me that I have an evil heart . . . "We'll know after three months; we'll look at the baby's hands". It showed that they didn't believe this child is their family'. (FGD 1).	'[Neighbours] hit my child or shouts at them' (FGD 1).	'They [clinic nurses] can't keep a secret. I'd never talk to anyone; you can write ten referrals, I would never go' (FGD 2).	'We are single parents, so you just think about what you're going to put together for your baby . . . when my baby doesn't have diapers, that's when I get worried' (FGD 1).
		' . . . when you look at your child . . . the father of my first child said he is infertile, yoh, I lost my mind, I asked him if he's infertile, how did I fall pregnant? He insisted he's infertile and that the doctor told him so' (FGD 2).	'Have your in-laws disputed your children's paternity as if they were there when you were making love and they were controlling the whole thing?. . . I was heartbroken . . . they said . . . this baby is not their family which means I'm sleeping around' (FGD 2).	'The one thing that makes you get stressed and find yourself crying is the fact that you need a lot of things and you don't have anyone to talk to close by, so you end up talking to yourself and crying and feeling like you are not a mother or you are not useful to your baby' (FGD 1).	' . . . when I was pregnant, this nurse shouted: "Is your boyfriend circumcised?. . . it [his penis] went in without you seeing it?! That means they chowed you [sleep with you] in the dark". She's making a joke out of me . . . '(FGD 2).	'[It's about] . . . finances; that in most cases you feel stressed and not able to sleep enough is mainly caused by the fact that you are not able to provide' (FGD 1).

Maternal perceptions of the effect of mental health on the dyadic relationship

Most participants had a clear understanding of the existence of a bidirectional relationship between mother and infant. Most mothers acknowledged that their own emotions affected the emotions of their infants, and few mothers spoke of their overwhelming emotions that affected the dyad possibly due to unprocessed feelings negatively influencing the relationship. Others illustrated the damaging impact of stressful relationships with partners on infants. There was an acknowledgement that maternal mood affected daily routines, developmental milestones and physical growth. Discussions delved into a deeper and more concerning issue regarding mental ill health impacting a mother's ability to parent. Most participants had an understanding that attuned parental practices would meet the infant's needs when the infant displayed discomfort. With healthy mentalisation comes the insight that the mother and infant are separate beings. Some were misattuned and projected their own feelings onto their infants believing that their infants were purposefully attempting to annihilate them when in fact it was their own trauma that they had not yet processed. A strong theme of persecution prevailed. Refer to Table 3 for the exemplar of quotes regarding perceptions of the effect of maternal mental health on the dyad.

Discussion

This study highlights how interpersonal and structural challenges intersect to shape maternal mental health and the early mother – infant relationship in a low-resource South African context. Relationship difficulties – particularly those involving unfaithful partners, denial of paternity, unsupportive families, and judgemental community figures – emerged as central stressors. Consistent with previous research (Khaile et al., 2022), a pervasive sense of distrust extended beyond intimate relationships, encompassing the broader sociocultural environment in which these women care for their young.

While poverty does not inherently cause mental illness, it often gives rise to cognitive, emotional, and behavioural patterns that undermine maternal well-being and caregiving capacity (Wachs et al., 2009). In the present study, participants described profound uncertainty about their physical and economic environments, which were marked by chronic unemployment, food insecurity, and minimal social support (Dieterich et al., 2016). Many expressed a strong desire to work but reported that limited education, poor access to training, and a fragile job market stifled opportunity (Kathree et al., 2014). This economic dependency appeared to exacerbate feelings of powerlessness and despair.

These difficulties are deeply rooted in South Africa's sociohistorical context. The legacy of Apartheid-era policies – particularly the Bantu Education Act of 1953 and the migrant labour system – has contributed to ongoing educational deprivation, economic instability, and familial fragmentation (Smit, 2001). The Bantu Education Act was a key mechanism of structural oppression, deliberately designed to underfund Black schools and restrict curricula in ways that curtailed aspirations beyond menial labour. These educational restrictions were intimately tied to a labour system that extracted Black male workers from their communities for prolonged periods to work in mines and industrial sectors, leaving women and children in under-resourced and isolated environments. This

Table 3. Exemplar quotes regarding perceptions of the effect of maternal mental health issues on the dyad.

Main themes and subthemes					
Maternal perceptions on dyadic relationship	**Bidirectionality**	'For me it's like when you're in love with a person in a relationship, when you feel like this person loves me, you feel the warmth' (FGD 2).	' . . . even if she were to cry now and someone else holds her, once I hold her, she keeps quiet at same time, and it shows that mom is holding her now' (FGD 2).		
	Perceptions of mother's emotions affecting infant	'If I am happy, she also laughs but . . . when I shout at her, she cries. Sometimes she just cries for nothing. I end up being irritated and shout at her then she keeps quiet and becomes scared' (FGD 1).	' . . . I had an altercation with the baby daddy . . . and right there . . . the baby cried massively and wouldn't feed . . . after calming down, he also did . . . there's a very strong bond' (FGD 2).	' . . . development . . . baby needs to exercise, get his bones going. When you're . . . stressed you'll tell yourself that you don't want to play with him, he'll become lazy, you'll think there's something wrong with him . . . ' (FGD 2).	' . . . you are stressed . . . you end up forgetting that you have a child, . . . they could cry. You . . . can't hear the child . . . your mind is not there' (FGD 1).
	Mentalisation	*Parental practices* 'When my baby cries, I check what could be the cause of her tears. It's either she's hungry if she doesn't want to be breastfed, I try to change her nappy and I see what she does' (FGD 2). ' . . . I literally find a way to calm him down, be it dance, jump . . . I know there's certain things he doesn't like but I try them thinking that this will help . . . ' (FGD 2).	*Separateness* 'The things that I did when I was pregnant were different, so I started learning that we are different' (FGD 1). 'Yes, just like me I wasn't raised by my mother . . . with my baby I have that fear that I don't want to be like my mom . . . I want to be there for my children' (FGD 2).	*Misattunement & persecution* 'My baby loves crying, likes attention. No matter how much they try to irritate me, I fight to heal . . . if she doesn't want to stop, I just leave her there because I might end up hurting her' (FGD 2). ' . . . no matter how hard he tries to destroy me, I fight . . . once you touch him, you are starting war. He gets easily irritated . . . you will get your head messed up' (FGD 2).	

migration pattern persists today, with many men continuing to work away from home, often forming secondary relationships elsewhere (Smit, 2001). As reported by participants in this study, these dynamics are frequently experienced by mothers as abandonment, contributing to emotional distress, sadness, and anxiety. The enduring effects of these policies were evident in participants' reflections on present-day parenting, where caregiving responsibilities often fall solely on mothers, compounding their psychological and economic vulnerability.

The denial of paternity was a significant source of distress, not only denying mothers access to financial maintenance (Nduna, 2014), but also contributing to their identity as unsupported, single parents (Denis & Ntsimane, 2006). This study confirms earlier findings from Alexandra Township in South Africa, where 31.5% of a sample of households lacked disclosed paternal identity (Nduna et al., 2011). Participants also described mother in law who colluded with their sons in evading paternal responsibility. This maternal rejection by their in-laws, compounded their feelings of exclusion and isolation – both of which have well-established links to depression (Slavich et al., 2010). The psychological impact of paternal denial extends to children as well. Without access to paternal lineage or ancestral identity (Nduna, 2014), children may experience abandonment, loss of identity, and blame towards their mothers – all of which negatively affect the mother – child relationship (Langa, 2010; Nduna & Jewkes, 2011; Phaswana, 2003).

These family ruptures also appeared to affect the developing bond between mothers and infants. Consistent with Erikson's (Erikson, 1959) psychosocial theory, the disruption of basic trust – both in others and in the world – may affect how mothers engage in the earliest caregiving relationships. Some mothers in this study feared rejection from their own infants, possibly interpreting their partners' abandonment through the lens of anticipated relational failure. This aligns with literature suggesting that mothers with unresolved trauma may misinterpret infant cues and project distress into the parent – child dynamic (Iyengar et al., 2014).

Notably, 10 of the 15 participants scored in the moderate to severe range for depression. Many reported intense feelings of sadness, self-blame, guilt, and helplessness – emotions consistent with Freud's (Freud, 1917) view of depression as internalised anger. These experiences were often compounded by unintended pregnancies, which are associated with higher levels of maternal depression (Abajobir et al., 2016). Previous studies have shown that depressed mothers are less sensitively attuned to their infants (Murray et al., 1996), and traumatised mothers may view their children more negatively or as emotionally burdensome (Lang et al., 2010; Thakar et al., 2013).

Responses to the PBQ revealed that some mothers perceived their infants as intentionally difficult or rejecting – an indication of persecutory ideation within the dyadic relationship. This phenomenon echoes Raphael-Leff's (Raphael-Leff, 2010) concept of 'primary maternal persecution', in which the infant becomes a symbolic container for unmet or painful aspects of the mother's own early relational history. These projections, often unconscious, may impede maternal attunement and foster the development of insecure attachment (Fraiberg et al., 1975). As suggested by attachment theory, such patterns are likely to influence how mothers experience and engage with their children and their broader social worlds (Lazarus & Kruger, 2004).

The enduring effects of post-Apartheid socioeconomic inequality were evident throughout participants' narratives, revealing a layered vulnerability to both emotional

and practical unpreparedness for motherhood. This vulnerability may increase the risk for compromised maternal sensitivity and the development of insecure attachment in the infant. However, the study also identified a protective factor: hope. Erikson (Erikson, 1959) posits that hope emerges when trust outweighs mistrust, and higher levels of hope have been linked to improved maternal well-being (Tong et al., 2025), greater parenting confidence (Davidson-Arad et al., 2013), increased resilience (Yuan et al., 2022), reduced stress (Zahavi-Lupo et al., 2023) and stronger parental involvement (Cole et al., 2021).

Interventions aimed at rebuilding trust – both interpersonal and institutional – alongside those that foster hope and maternal agency, may support healthier mother – infant interactions. In settings marked by trauma and deprivation, these interventions must be contextually grounded and culturally sensitive to be effective.

Limitations

The authors acknowledge that their own biases, cultural influences, and professional training may have shaped their interpretations of the results. Given that the first author is trained as a psychologist within a psychodynamic framework, there is a possibility of over-analysis of the qualitative data. While the sample size was appropriate for the qualitative nature of the inquiry, the descriptive findings are not representative of the maternal population in Soweto nor do they represent the broader population in South Africa. Additionally, group discussion dynamics may have influenced the exchange of ideas, meaning the findings cannot be regarded as definitive truth. Lastly, the FGDs were conducted in the vernacular and later transcribed into English, which may have resulted in some loss of meaning or nuance during translation.

Conclusion

This study explored mothers' perceptions of mental health causes in Soweto and their impact on mother-infant relationships. Findings highlight the need for programmes led by trained counsellors, trusted community members, or peer support groups to help mothers process trauma and to lean into the concept of hope. The development of initiatives linking past experiences to current emotions could enhance maternal awareness of emotional projections onto infants. As secure attachment underpins trust development, urgent investment in interventions is required to promote healthy dyadic relationships. Further research, funding, and policy changes are essential to break cycles of transgenerational trauma and to improve relational trust in this underserved setting.

Acknowledgments

We thank the mothers and their infants who participated in the study, and Ms Lebo Motlhatlhedi for her assistance in conducting the FGDs. We also thank the Johannesburg District Research Committee for providing permission to conduct recruitment at community health clinics in Soweto, South Africa.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the National Institute for Health Research (NIHR) (using the UK's Official Development Assistance (ODA) Funding) and Wellcome [222007/Z/20/Z] under the NIHR-Wellcome Partnership for Global Health Research. The views expressed are those of the authors and not necessarily those of Wellcome, the NIHR or the Department of Health and Social Care. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

ORCID

Sarah J Cantrell http://orcid.org/0000-0003-2508-2498
Rebecca M Pearson http://orcid.org/0000-0001-8527-3400
Alessandra Prioreschi http://orcid.org/0000-0002-6913-0706

Author contributions

Sarah Cantrell: conceptualisation, methodology, analysis, conclusion, writing – original draft. Rebecca Pearson: supervision, writing, review and editing Alessandra Prioreschi: conceptualisation, attaining funding, supervision, writing, review and editing.

Data availability statement

All data are available from the PI where a reasonable request for access to data is made.

Consent to participate

Written informed consent was gained from all the participants in this study. We fully anonymised them and they understood that they could not be identified via the paper.

Ethics approval

This study received approval from the Human Research Ethics Committee (Medical), at the University of the Witwatersrand, Johannesburg, South Africa, with clearance certificate no M220787.

Disclaimer

The views expressed in this paper are those of the authors and not particularly those of the Department of Psychiatry in Manchester, the Departmental Pathways of Health Research Unit or WITS medical school.

Abbreviations

EPDS Edinburgh Postnatal Depression Scale;
PPD Postpartum depression;
PTSD Posttraumatic Stress Disorder;
ACE Adverse Childhood Event;
PBQ Postpartum Bonding Questionnaire;
FGDs Focus group discussions.

References

Abajobir, A. A., Maravilla, J. C., Alati, R., & Najman, J. M. (2016). A systematic review and meta-analysis of the association between unintended pregnancy and perinatal depression. *Journal of Affective Disorders*, *192*, 56–63. https://doi.org/10.1016/J.JAD.2015.12.008

Alves, S., Fonseca, A., Canavarro, M. C., & Pereira, M. (2018). Dyadic coping and dyadic adjustment in couples with women with high depressive symptoms during pregnancy. *Journal of Reproductive and Infant Psychology*, *36*(5), 504–518. https://doi.org/10.1080/02646838.2018.1490496

Baron, E. C., Hanlon, C., Mall, S., Honikman, S., Breuer, E., Kathree, T., Luitel, N. P., Nakku, J., Lund, C., Medhin, G., Patel, V., Petersen, I., Shrivastava, S., & Tomlinson, M. (2016). Maternal mental health in primary care in five low- and middle-income countries: A situational analysis. *BMC Health Services Research*, *16*(1). https://doi.org/10.1186/s12913-016-1291-z

Beebe, B., Jaffe, J., Markese, S., Buck, K., Chen, H., Cohen, P., Bahrick, L., Andrews, H., & Feldstein, S. (2010). The origins of 12-month attachment: A microanalysis of 4-month mother-infant interaction. *Attachment and Human Development*, *12*(1–2), 3–141. https://doi.org/10.1080/14616730903338985

Braun, V., & Clarke, V. (2021). To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. *Qualitative Research in Sport, Exercise & Health*, *13*(2), 201–216. https://doi.org/10.1080/2159676X.2019.1704846

Brockington, I. (2004). Postpartum psychiatric disorders. *Lancet*, *363*(9405), 303–310. https://doi.org/10.1016/S0140-6736(03)15390-1

Brockington, I. F., Fraser, C., & Wilson, D. (2006). The postpartum bonding questionnaire: A validation. *Archives of Women's Mental Health*, *9*(5), 233–242. https://doi.org/10.1007/s00737-006-0132-1

Cohen, E., Ware, L. J., Prioreschi, A., Draper, C., Bosire, E., Lye, S. J., & Norris, S. A. (2020). Material and relational difficulties: The impact of the household environment on the emotional well-being of young black women living in Soweto, South Africa. *Journal of Family Issues*, *41*(8), 1307–1332. https://doi.org/10.1177/0192513X19887524

Cole, B. P., Ingram, P., Dye, A., Molloy, S., & Singley, D. B. (2021). Development and validation of the Hope for Parenting Scale. *Couple and Family Psychology: Research and Practice*, *10*(2), 124–135. https://doi.org/10.1037/CFP0000164

Cox, J. L., Holden, J. M., & Sagovsky, R. (1987). Detection of postnatal depression: Development of the 10-item Edinburgh Postnatal Depression Scale. *The British Journal of Psychiatry*, *150*(6), 782–786. https://doi.org/10.1192/bjp.150.6.782

Davidson-Arad, B., Aram-Fichman, R., Bashan-Paz, M., Gingis, R., & Klein-Katz, T. (2013). Comparison of hope of maltreating parents whose children were removed from home with those whose

children were kept at home. *Children and Youth Services Review*, *35*(12), 2040–2048. https://doi.org/10.1016/J.CHILDYOUTH.2013.09.011

de Camps Meschino, D., Philipp, D., Israel, A., & Vigod, S. (2016). Maternal-infant mental health: Postpartum group intervention. *Archives of Women's Mental Health*, *19*(2), 243–251. https://doi.org/10.1007/S00737-015-0551-Y

Denis, P., & Ntsimane, R. (2006). Absent fathers: Why don't men feature in stories of families affected by HIV/AIDS in Kwazulu-Natal? In L. Richter & R. Morrell (Eds.), *Baba: Men and fatherhood in South Africa* (pp. 237–249). HSRC Press.

Dieterich, C., Huang, A., & Thomas, A. (2016). *Women's opportunities and challenges in sub-Saharan African job markets* (WPIEA2016118; Working Paper No. 2016/118).

Drysdale, R. E., Slemming, W., Makusha, T., & Richter, L. M. (2021). Father involvement, maternal depression and child nutritional outcomes in Soweto, South Africa. *Maternal and Child Nutrition*, *17*(S1). https://doi.org/10.1111/mcn.13177

Erikson, E. H. (1959). *Identity and the life cycle*. International Universities Press. http://childdevpsychology.yolasite.com/resources/theory%20of%20identity%20erikson.pdf

Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., Koss, M. P., & Marks, J. S. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The adverse childhood experiences (ACE) study. *The American Journal of Preventive Medicine*, *14*(4), 245–258. https://doi.org/10.1016/S0749-3797(98)00017-8

Field, T. (1992). Infants of depressed mothers. *Development and Psychopathology*, *4*(1), 49–66. https://doi.org/10.1017/S0954579400005551

Fraiberg, S., Adelson, E., & Shapiro, V. (1975). Ghosts in the nursery. A psychoanalytic approach to the problems of impaired infant-mother relationships. *Journal of the American Academy of Child Psychiatry*, *14*(3), 387–421. https://doi.org/10.1016/S0002-7138(09)61442-4

Freud, S. (1917). Mourning and melancholia. *International Journal of Psychoanalysis*, *4*(6), 288–301.

Friedrich, M. J. (2017). Depression is the leading cause of disability around the world. *Journal of the American Medical Association*, *317*(15), 1517–1517. https://doi.org/10.1001/jama.2017.3826

Gelfand, D. M., & Teti, D. M. (1990). The effects of maternal depression on children. *Clinical Psychology Review*, *10*(3), 329–353. https://doi.org/10.1016/0272-7358(90)90065-I

Gollan, J. K., Wisniewski, S. R., Luther, J. F., Eng, H. F., Dills, J. L., Sit, D., Ciolino, J. D., & Wisner, K. L. (2017). Generating an efficient version of the Edinburgh Postnatal Depression scale in an urban obstetrical population. *Journal of Affective Disorders*, *208*, 615–620. https://doi.org/10.1016/j.jad.2016.10.013

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough?: An experiment with data saturation and variability. *Field Methods*, *18*(1), 59–82. https://doi.org/10.1177/1525822X05279903

Hall, K., Richter, L., Mokomane, Z., & Lake, L. (Eds.). (2018). *South African child gauge 2018: Children, families and the state - collaboration and contestation*. Children's Institute, University of Cape Town. https://www.childrencount.uct.ac.za

Hung, K. J., Tomlinson, M., Le Roux, I. M., Dewing, S., Chopra, M., & Tsai, A. C. (2014). Community-based prenatal screening for postpartum depression in a South African township. *International Journal of Gynecology & Obstetrics*, *126*(1), 74–77. https://doi.org/10.1016/J.IJGO.2014.01.011

Iyengar, U., Kim, S., Martinez, S., Fonagy, P., & Strathearn, L. (2014). Unresolved trauma in mothers: Intergenerational effects and the role of reorganization. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.00966

Kathree, T., Selohilwe, O. M., Bhana, A., & Petersen, I. (2014). Perceptions of postnatal depression and health care needs in a South African sample: The "mental" in maternal health care. *BMC Women's Health*, *14*(1). https://doi.org/10.1186/s12905-014-0140-7

Khaile, F. T., Roman, N. V., October, K. R., Staden, M. V., & Balogun, T. V. (2022). Perceptions of trust in the context of social cohesion in selected rural communities of South Africa. *Social Sciences*, *8*(11), 359. https://doi.org/10.3390/socsci

Lang, A. J., Gartstein, M. A., Rodgers, C. S., & Lebeck, M. M. (2010). The impact of maternal childhood abuse on parenting and infant temperament. *Journal of Child and Adolescent Psychiatric Nursing*, *23*(2), 100–110. https://doi.org/10.1111/j.1744-6171.2010.00229.x

Langa, M. (2010). Adolescent boys' talk about absent fathers. *Journal of Psychology in Africa*, *20*(4), 519–526. https://doi.org/10.1080/14330237.2010.10820410

Lawrie, T., Hofmeyr, G. J., de Jager, M., & Berk, M. (1998). Validation of the Edinburgh Postnatal Depression scale on a cohort of South African women. *South African Medical Journal*, *88*(10), 1340–1344.

Lazarus, J., & Kruger, L. M. (2004). Small meetings: Reflections on the application of psychodynamic thought in community work with low-income South African children: Part 1: Reflections on the literature. *Psycho-Analytic Psychotherapy in South Africa*, *12*(1), 48–73.

Mabetha, K., Soepnel, L., Klingberg, S., Mabena, G., Motlhatlhedi, M., Norris, S., & Draper, C. (2024). Young women's social support networks during pregnancy in Soweto, South Africa. *African Journal of Primary Health Care & Family Medicine*, *1*(16). https://doi.org/10.4102/phcfm.v16i1.4146

Magamela, M. R., Dzinamarira, T., & Hlongwa, M. (2021). COVID-19 consequences on mental health. An African perspective. *The South African Journal of Psychiatry*, *27*, 1611. https://doi.org/10.4102/sajpsychiatry

Makhubela, M. (2018). Latent structure of the post-traumatic stress disorder (PTSD) checklist for DSM-5 (PCL-5) in South African mortuary workers. *Journal of Psychology in Africa*, *28*(3), 206–211. https://doi.org/10.1080/14330237.2018.1475909

Maré, K. T., Pellowski, J. A., Koopowitz, S. M., Hoffman, N., van der Westhuizen, C., Workman, L., Zar, H. J., & Stein, D. J. (2021). Perinatal suicidality: Prevalence and correlates in a South African birth cohort. *Archives of Women's Mental Health*, *24*(5), 737–748. https://doi.org/10.1007/s00737-021-01121-8

Mathews, S., & Benvenuti, P. (2014). Violence against children in South Africa: Developing a prevention agenda. *South African Child Gauge*, *1*(2), 26–34.

McCabe-Beane, J. E., Segre, L. S., Perkhounkova, Y., Stuart, S., & O'Hara, M. W. (2016). The identification of severity ranges for the Edinburgh Postnatal Depression scale. *Journal of Reproductive and Infant Psychology*, *34*(3), 293–303. https://doi.org/10.1080/02646838.2016.1141346

Murray, L. (1992). The impact of postnatal depression on infant development. *Journal of Child Psychology and Psychiatry*, *33*(3), 543–561. https://doi.org/10.1111/j.1469-7610.1992.tb00890.x

Murray, L., Fiori-Cowley, A., Hooper, R., & Cooper, P. (1996). The impact of postnatal depression and associated adversity on early mother-infant interactions and later infant outcome. *Child Development*, *67*(5), 2512–2526. https://doi.org/10.2307/1131637

Nduna, M. (2014). Factors that hinder paternity disclosure to children: South African mothers' perspectives. *Journal of Feminist Family Therapy*, *26*(4), 218–235. https://doi.org/10.1080/08952833.2014.965114

Nduna, M., & Jewkes, R. (2011). Undisclosed paternal identity in narratives of distress among young people in Eastern Cape, South Africa. *Journal of Child and Family Studies*, *20*(3), 303–310. https://doi.org/10.1007/s10826-010-9393-4

Nduna, M., Kasese-Hara, M., Ndebele, M., Pillay, N., & Manala, L. (2011). Prevalence and characteristics of unresolved paternal identity in families of a South African community. *Journal of Psychology in Africa*, *21*(4), 589–593. https://doi.org/10.1080/14330237.2011.10820503

Okafor, C. N., Barnett, W., Zar, H. J., Nhapi, R., Koen, N., Shoptaw, S., & Stein, D. J. (2018). Associations of emotional, physical or sexual intimate partner violence and depression symptoms among South African women in a prospective cohort study. *Journal of Interpersonal Violence*, *36*(9–10), NP5060. https://doi.org/10.1177/0886260518796522

Phaswana, E. D. (2003). *Experiences of rural Black South African adolescents who never met their own biological fathers*. University of Johannesburg (South Africa). University of Johannesburg.

Ramchandani, P. G., Richter, L. M., Norris, S. A., & Stein, A. (2010). Maternal prenatal stress and later child behavioral problems in an Urban South African setting. *Journal of the American Academy of Child & Adolescent Psychiatry*, *49*(3), 239–247. https://doi.org/10.1097/00004583-201003000-00007

Ramchandani, P. G., Richter, L. M., Stein, A., & Norris, S. A. (2009). Predictors of postnatal depression in an urban South African cohort. *Journal of Affective Disorders*, *113*(3), 279–284. https://doi.org/10.1016/j.jad.2008.05.007

Raphael-Leff, J. (2010). Mothers' and fathers' orientations: Patterns of pregnancy, parenting and the bonding process. In A. O. Alay & A. W. Frank (Eds.), *Parenthood and mental health: A bridge between infant and adult psychiatry* (pp. 9–22). Wiley-Blackwell.

Redinger, S., Norris, S. A., Pearson, R. M., Richter, L., & Rochat, T. (2018). First trimester antenatal depression and anxiety: Prevalence and associated factors in an urban population in Soweto, South Africa. *Journal of Developmental Origins of Health and Disease*, *9*(1), 30–40. https://doi.org/10.1017/S204017441700071X

Rocha, N. A. C. F., Santos Silva, F. P., dos Santos, M. M., & dos Dusing, S. C. (2019). Impact of mother-infant interaction on development during the first year of life: A systematic review. *Journal of Child Health Care*, *24*(3), 365–385. https://doi.org/10.1177/1367493519864742

Sandelowski, M. (1996). One is the liveliest number: The case orientation of qualitative research. *Research in Nursing & Health*, *19*(6), 525–529. https://doi.org/10.1002/(SICI)1098-240X(199612)19:6<525::AID-NUR8>3.0.CO;2-Q

Shuffrey, L. C., Sania, A., Brito, N. H., Potter, M., Springer, P., Lucchini, M., Rayport, Y. K., Du Plessis, C., Odendaal, H. J., & Fifer, W. P. (2022). Association of maternal depression and anxiety with toddler social-emotional and cognitive development in South Africa: A prospective cohort study. *BMJ Open*, *12*(4), e058135. https://doi.org/10.1136/bmjopen-2021-058135

Slavich, G. M., O'Donovan, A., Epel, E. S., & Kemeny, M. E. (2010). Black sheep get the blues: A psychobiological model of social rejection and depression. *Neuroscience & Biobehavioral Reviews*, *35*(1), 39–45. https://doi.org/10.1016/J.NEUBIOREV.2010.01.003

Slomian, J., Honvo, G., Emonts, P., Reginster, J. Y., & Bruyère, O. (2019). Consequences of maternal postpartum depression: A systematic review of maternal and infant outcomes. *Women's Health*, *15*, 1745506519844044. https://doi.org/10.1177/1745506519844044 .

Smit, R. (2001). The Impact of Labor Migration on African Families in South Africa: Yesterday and Today. *Journal of Comparative Family Studies*, *4*(32), 533–548. https://www.jstor.org/stable/41603777?utm_source=chatgpt.com

Soepnel, L. M., Mabetha, K., Norris, S. A., Motlhatlhedi, M., Nkosi, N., Klingberg, S., Lye, S., & Draper, C. E. (2024). The role of a community health worker-delivered preconception and pregnancy intervention in achieving a more positive pregnancy experience: The Bukhali trial in Soweto, South Africa. *BMC Women's Health*, *24*(1). https://doi.org/10.1186/s12905-024-02982-8

Statistics South Africa. (2020). *National household travel survey: Statistical release*. P0320. www.statssa.gov.za, info@statssa.gov.za

Thakar, D., Coffino, B., & Lieberman, A. F. (2013). Maternal symptomatology and parent-child relationship functioning in a diverse sample of young children exposed to trauma. *Journal of Traumatic Stress*, *26*(2), 217–224. https://doi.org/10.1002/jts.21799

Tong, E. M. W., Goh, E. C. L., & Wen, D. (2025). Do trait hope and trait gratitude support the mental health of mothers in low-income families in Singapore? *International Journal of Applied Positive Psychology*, *10*(1). https://doi.org/10.1007/s41042-024-00205-x

Vasileiou, K., Barnett, J., Thorpe, S., & Young, T. (2018). Characterising and justifying sample size sufficiency in interview-based studies: Systematic analysis of qualitative health research over a 15-year period. *BMC Medical Research Methodology*, *18*(1). https://doi.org/10.1186/s12874-018-0594-7

Verhey, R., Chibanda, D., Gibson, L., Brakarsh, J., & Seedat, S. (2018). Validation of the posttraumatic stress disorder checklist-5 (PCL-5) in a primary care population with high HIV prevalence in Zimbabwe. *BMC Psychiatry*, *18*(109), 1–8. https://doi.org/10.1186/s12888-018-1688-9

Verkuijl, N. E., Richter, L., Norris, S. A., Stein, A., Avan, B., & Ramchandani, P. G. (2014). Postnatal depressive symptoms and child psychological development at 10 years: A prospective study of longitudinal data from the South African Birth to Twenty cohort. *The Lancet Psychiatry*, *1*(6), 454–460. https://doi.org/10.1016/S2215-0366(14)70361-X

Vygotsky, L. S. (1987). *The collected works of LS Vygotsky: Volume 1. Thinking and speaking* (Vol. 1). Plenum Press.

Wachs, T. D., Black, M. M., & Engle, P. L. (2009). Maternal depression: A global threat to children's health, development, and behavior and to human rights. *Child Development Perspectives*, *3*(1), 9. https://doi.org/10.1111/j.1750-8606.2008.00077.x

Wang, Z., Liu, J., Shuai, H., Cai, Z., Fu, X., Liu, Y., Xiao, X., Zhang, W., Krabbendam, E., Liu, S., Liu, Z., Li, Z., & Yang, B. X. (2021). Mapping global prevalence of depression among postpartum women. *Translational Psychiatry*, *11*(1), 1–13. https://doi.org/10.1038/s41398-021-01663-6

Weathers, F. W., Litz, B. T., Herman, D. S., Huska, J. A., & Keane, T. M. (1993, October). *The PTSD checklist (PCL): Reliability, validity, and diagnostic utility*. Annual Convention of the International Society for Traumatic Stress Studies.

Wheeler, N. J., Daire, A. P., Barden, S. M., & Carlson, R. G. (2019). Relationship distress as a Mediator of adverse childhood experiences and health: Implications for clinical practice with economically vulnerable racial and ethnic minorities. *Family Process*, *58*(4), 1003–1021. https://doi.org/10.1111/FAMP.12392

World Bank. (2018). *An assessment of drivers, constraints and opportunities overcoming poverty and inequality in South Africa*. www.worldbank.org

Yuan, L., Gao, Y., Pan, B., Wang, J., Wang, Y., Gong, C., Wang, W., & Li, X. (2022). Resilience and related factors: A comparison of fathers and mothers of patients with cleft lip and/or palate in China. *Frontiers in Psychiatry*, *12*, 12. https://doi.org/10.3389/fpsyt.2021.791555

Zahavi-Lupo, T., Lazarus, G., Pshedetzky-Shochat, R., Bar-Kalifa, E., Refoua, E., Gleason, M. E. J., & Rafaeli, E. (2023). HundefinedIs, hers, or theirs? Hope as a dyadic resource in early parenthood. *The Journal of Positive Psychology*, *18*(4), 557–572. https://doi.org/10.1080/17439760.2022.2093780