Universidade do Minho
Escola de Psicologia

Joana Carolina Simões Antunes

Neurodevelopmental outcomes of being born during the COVID-19 pandemic and the role of early tactile experiences

dezembro de 2021

Neurodevelopmental outcomes of being born during the COVID-19 pandemic and the role of early tactile experiences

Joana Antunes

UMinho | 2021

Universidade do Minho
Escola de Psicologia

Joana Carolina Simões Antunes

Neurodevelopmental outcomes of being born during the COVID-19 pandemic and the role of early tactile experiences

Dissertação de Mestrado
Mestrado Interuniversitário em Neuropsicologia Clínica e Experimental

Trabalho efetuado sob a orientação da
Professora Doutora Adriana Sampaio
e da
Professora Doutora Ana Mesquita

dezembro de 2021

DIREITOS DE AUTOR E CONDIÇÕES DE UTILIZAÇÃO DO TRABALHO POR TERCEIROS

Este é um trabalho académico que pode ser utilizado por terceiros desde que respeitadas as regras e boas práticas internacionalmente aceites, no que concerne aos direitos de autor e direitos conexos.
Assim, o presente trabalho pode ser utilizado nos termos previstos na licença abaixo indicada.
Caso o utilizador necessite de permissão para poder fazer um uso do trabalho em condições não previstas no licenciamento indicado, deverá contactar o autor, através do RepositóriUM da Universidade do Minho.

Licença concedida aos utilizadores deste trabalho

Atribuição

CC BY

https://creativecommons.org/licenses/by/4.0/

Universidade do Minho, dezembro de 2021

Acknowledgments

First and foremost, I would like to thank Professor Adriana Sampaio for welcoming me into the Psychological Neuroscience Laboratory and for supporting my will to deepen my knowledge on neurodevelopment.

I express my thankfulness towards Professor Ana Mesquita for including me in her research projects, which introduced me to a vast research and clinical networks. Thank you for being available to always hear one more question from me.

A special thank you to Marlene Sousa, for her never-ending availability to listen to my experiences, always providing me the word I most need to hear to proceed towards the best path.

Without Alberto González-Villar, I could not have implemented the EEG protocol and respective analyses so promptly. For your availability to help me, I thank you. The help of Sara Cruz was also crucial for the best implementation of the EEG with infants. Thank you for your willingness to meet my struggles. As a representative of the Mentalab, I would also like to thank to Laura Hainke, for providing access to the EEG device and encouraging its use.

To Sara Almeida Girão, thank you so much for enriching my clinical experience and for your contributions to this dissertation.

I also want to leave a note of consideration for Conceição Santos for having carried out the last collections in the face-to-face study.

To all the institutions that received me and made it possible to carry out the work presented in this dissertation, namely the University Hospital Centre of São João, the Psychological Neuroscience Laboratory of the University of Minho, the Psychology Association of the University of Minho, the Institute of Neurodevelopment (IND), and the Faculty of Psychology and Education Sciences of the University of Porto, I share my appreciation.

My utmost gratitude goes to all the children that I had the pleasure to meet, as well as to their families. Every single one of them helped me to learn more about neuropsychology by sharing a little of their lives. For all your smiles in the moments I needed the most, I say thank you.

Finally, I want to express my gratefulness to my family, especially my mother and father, for all your support and encouragement to keep on persisting and gift me with a new opportunity for my life. To my nephew, although he may not yet be aware, thank you for being my role model for infant development. To Joaquim, I am grateful for always sharing your optimistic view and for your everlasting help on this endeavor.

Funding

This Master Dissertation was supported through an individual Research Fellowship to Joana Antunes (UMINHO/BIM-CNCG/2021/28). The work was conducted within the scope of the activities of the Psychology Research Centre (UI1662), University of Minho, framed by the Multiannual Funding of R&D Units (UIDB/01662/2020), and supported by Fundação para a Ciência e a Tecnologia (FCT) / Ministério da Ciência, Tecnologia e Ensino Superior (MCTES) through national funds (PIDDAC).

STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

University of Minho, December 2021

Resultados neurodesenvolvimentais de nascer durante a pandemia de COVID-19 e o papel das experiências táteis precoces

Estudos recentes sugerem um nível elevado de stress durante o período perinatal associado ao contexto da pandemia de COVID-19, o que pode ter repercussões negativas no neurodesenvolvimento das crianças. As experiências precoces de toque, tal como o contacto pele-com-pele, poderão ter efeitos protetores relevantes face ao stress materno no contexto da pandemia de COVID-19, devido ao seu efeito na regulação fisiológica e ao seu papel promotor na trajetória neurodesenvolvimental.

Para compreender melhor a relação entre o neurodesenvolvimento e o toque afetivo durante a pandemia de COVID-19, foram realizados dois estudos. O primeiro consistiu no questionário online BabiesDuringCOVID, administrado a mães (n=524) cujos filhos nasceram durante a pandemia. O objetivo foi caracterizar o desenvolvimento e temperamento das crianças expostas ao contexto pandémico e explorar o efeito moderador das experiências precoces de toque na relação entre o stress perinatal devido à COVID-19 e a trajetória desenvolvimental das crianças. Por último, foi realizado um estudo presencial com vista a comparar o neurodesenvolvimento de crianças expostas in utero ao SARS-CoV-2 (n=29), cujas mães foram diagnosticadas com COVID-19 no momento do parto, com um grupo de controlo (n=36) de crianças, também elas nascidas durante a pandemia.

Os resultados sugerem que crianças expostas à conjuntura pandémica apresentam um desenvolvimento semelhante a uma amostra intercultural de referência avaliada antes da pandemia. Não existiram diferenças significativas entre crianças expostas in utero ao vírus e o grupo de controlo em termos de desenvolvimento, temperamento, processamento sensorial tátil e densidade espectral de potência para as bandas alpha e theta, através da análise de eletroencefalograma em estado de repouso. A exceção foi uma afetividade positiva significantemente mais elevada no grupo de controlo, embora próxima do limiar de significância. O stress perinatal devido à COVID-19 foi associado a competência socioemocional inferior e a emocionalidade negativa mais elevada. Os resultados também sugerem que o contexto pandémico dificultou as experiências de toque entre a mãe e o recém-nascido durante a hospitalização, com possível perturbação na trajetória desenvolvimental. A separação entre mãe e recém-nascido, que envolve uma ausência de experiências táteis, revelou um efeito moderador na relação entre o stress perinatal devido à COVID-19 e o desenvolvimento socioemocional. Com base nos resultados, sugere-se considerar as experiências táteis da própria mãe para melhor compreender o efeito do toque afetivo nas trajetórias neurodesenvolvimentais das crianças.

Palavras-chave: COVID-19; infância; neurodesenvolvimento; temperamento; toque.

Neurodevelopmental outcomes of being born during the COVID-19 pandemic and the role of early tactile experiences

Recent findings suggest that increased levels of distress during the perinatal period have been experienced during the COVID-19 pandemic, which can lead to negative repercussions on infants' neurodevelopmental outcomes. Early tactile experiences, such as skin-to-skin contact, might have a particular relevance on buffering the effects of maternal distress during the context of COVID-19 pandemic, through its effects on infants' physiological regulation and its supporting role in the neurodevelopmental trajectory.

To address the interplay between neurodevelopmental outcomes and affective touch during the COVID-19 pandemic, two studies were conducted. The first study consisted of the BabiesDuringCOVID online survey, administered to mothers (n = 524) that gave birth during the COVID-19 pandemic. It aimed to characterize the developmental and temperamental outcomes of infants exposed to the COVID-19 environment and to explore the moderating role of early tactile experiences on the relationship between COVID-19-related perinatal distress and infants' developmental trajectory. A second face-to-face study was conducted to compare the neurodevelopmental outcomes of infants exposed in utero to SARS-CoV-2 (n = 29), whose mothers were diagnosed with COVID-19 at delivery, against a control group (n = 36) of infants also born during the pandemic.

Our findings suggest that infants exposed to the pandemic environment presented a similar developmental pattern compared to a cross-cultural reference sample assessed prior to the COVID-19 pandemic. No significant differences emerged between infants exposed in utero to SARS-CoV-2 and the control group in terms of development, temperament, touch sensory processing, and power spectral density for the alpha and theta bands, assessed through resting-state electroencephalogram. The exception was a significant higher positive affectivity reported for the control group infants, albeit close to the significance threshold. COVID-19-related perinatal distress was associated to lower socio-emotional ability and higher negative emotionality. Our results also suggest that COVID-19 harmed the early tactile experiences between mother-newborn during hospitalization, with possible impairments in infants' outcomes. Mother-newborn separation, which prevents touch experiences, revealed a moderating effect on the relationship between COVID-19-related perinatal distress and infants' socio-emotional development. Based on our findings, we also propose to consider mothers' own tactile experiences to better understand the effect of affective touch on infants' neurodevelopmental trajectories.

Key-words: COVID-19; infancy; neurodevelopment; temperament; touch.

Contents

Index of Appendices, Tables and Figures

Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), responsible for the COVID-19 disease, has caused more than 5 million deaths worldwide (World Health Organization, 2021) and devastating social and economic consequences (United Nations Development Programme, 2020). The World Health Organization (2020a) declared the COVID-19 as a pandemic in March 2020 and advised all countries to implement preventive measures, such as social distancing, confinement, and quarantine.

Although global preventive measures might have helped to limit the spread of the SARS-CoV-2 virus and to alleviate the pressure on health-care systems unintended consequences were observed at prenatal and delivery care practices (Buekens et al., 2020; Green et al., 2021; Jardine et al., 2021). Indeed, many pregnant women have attended prenatal appointments alone (Ionio et al., 2021), and were restricted to have a significant person present during delivery or to receive visits during hospitalization. When positive to SARS-CoV-2 at delivery, some women faced even more restricted care policies, such as mother-newborn separation, no direct/indirect breastfeeding and skin-to-skin contact was discouraged (Direção Geral da Saúde [DGS], 2020; Poon et al., 2020; Puopolo et al., 2020; Wang, L., et al., 2020). These more conservative policies were particularly implemented at the beginning of the pandemic when data regarding virus transmission and newborn illness was still scarce.

Studies on the impact and transmission of COVID-19 during perinatal period suggest that pregnant women do not have an increased risk for contracting SARS-CoV-2 (Easterlin et al., 2021; Trocado et al., 2020). Although infected pregnant women are commonly asymptomatic, it appears that they may be at increased risk for severe illness from COVID-19, especially in the third trimester (Royal College of Obstetricians and Gynaecologists, 2021). Reported data suggested a higher risk for preterm birth when pregnant women are positive to SARS-CoV-2 (Huntley et al., 2020; Kyle & Dumitriu, 2021; Sánchez-Luna et al., 2021). However, newborns of positive mothers are generally healthy, with sequelae, when present, being related to the prematurity condition rather than to the infection (Easterlin et al., 2021; Norman et al., 2021). Virus transmission to newborns from infected mothers is rare and, in case of perinatal infection, newborns reveal mild or asymptomatic disease (Kyle & Dumitriu, 2021). Nevertheless, literature suggest that developmental impairments due to utero exposure to other infections and/or maternal immune activation can emerge later throughout development, which is the case of uninfected children exposed to Human Immunodeficiency Virus (HIV) (Boivin et al., 2019; Wedderburn et al., 2019).

The authors of a literature review on the COVID-19 effects on newborns suggested that "the real risk of the pandemic for most newborns may not be the virus itself, but its effect on the world" (Kyle & Dumitriu, 2021, pp. 618-619). This is relevant since children are particularly susceptible to environmental exposures, since pregnancy and during the first years of their lives (Howland et al., 2020; Stein et al., 2014). A recent systematic review (Van den Bergh et al., 2020) on prenatal exposure to maternal distress clearly highlighted the possible negative repercussions on children's outcomes and developmental trajectories. In fact, perinatal distress experienced during natural disasters (Buthmann et al., 2019; Guo et al., 2020; Laplante et al., 2008; Nomura et al., 2019; Walder et al., 2014) or global events, such as pandemics (Almond, 2006; Fan et al., 2021), can leave developmental scars, still present during adulthood (Van den Bergh et al., 2018).

A study with pregnant women during the COVID-19 pandemic, resident in the United States, Ireland, or United Kingdom, revealed normative general stress, but higher pregnancy-specific stress and COVID-19 related stress (Pope et al., in press). The authors suggested that pregnancy during the COVID-19 pandemic could be conceptualized as a contextual stressor. In fact, the already available data points to higher prevalence of psychopathological symptomatology during the perinatal period compared to levels prior to the pandemic (Filippetti et al., 2021; King et al., 2021; Ostacoli et al., 2020; Xie et al., 2021). In a recent multinational study (Mesquita et al., 2021) involving 12 countries, including Portugal, the rates of post-partum clinical depressive and anxiety symptomatology during the COVID-19 pandemic were 32.7% and 26.6%, respectively.

The COVID-19-related perinatal distress might then result in a "hidden pandemic" (Provenzi et al., 2021b), affecting children's developmental trajectories, even without contracting the infection. This is in line with Araújo et al. (2021) suggestion to understand the COVID-19 pandemic as a source of adverse childhood experience. As postulated by Giesbrecht et al. (2021), it can be expected that a greater exposure to COVID-19-related perinatal distress will be associated with worst outcomes for children.

The available literature on neurodevelopmental outcomes of children born during the COVID-19 pandemic is still scarce. One study (Deoni et al., 2021) compared the developmental scores of children born in the United States during the COVID-19 pandemic and prior to the pandemic, through the administration of the Mullen Scales of Early Learning. After controlling for age, gender and sociodemographic variables, Deoni et al. reported a declining in the overall cognitive functioning in children beginning in 2020. Data also suggested that males were more impacted than females and higher maternal education buffered this negative impact. Developmental scores of children whose

mothers were pregnant during the pandemic, at least during the last trimester of pregnancy, were in the same direction. However, data revealed no changes in maternal stress, neither an association between maternal stress and developmental scores. Although these results contradicted the expected findings, Deoni et al. hypothesized that it could be caused by a general insensitivity of the maternal stress measure to pandemic-related stress. A study from the COVID-19 Mother Baby Outcomes Initiative in the United States (Shuffrey et al., 2021), which compared infants exposed in utero to SARS-CoV-2 against unexposed infants, at 6 months of age, found no differences in the scores of the Ages and Stages Questionnaire, 3rd Edition (ASQ-3), neither an association between SARS-CoV-2 severity during pregnancy and ASQ-3 scores. However, when the overall pandemic-born cohort was compared with a pre-pandemic cohort, infants born during the COVID-19 pandemic revealed significantly lower gross motor, fine motor, and personal-social scores. Gestation at an early stage during the peak of the pandemic was also associated with lowest personal-social scores. The authors suggested that COVID-19-related stress could be a potential underlying mechanism responsible for these results' pattern. This is in line with findings from a longitudinal study conducted in Italy under MOM-COPE project (Provenzi et al., 2021b), where COVID-19-related prenatal stress was positively associated to infants' serotonin transporter gene (SLC6A4) methylation, which predicted infants' surgency at 3 months of age. Other study from the MOM-COPE project (Provenzi,et al., 2021a) reported that maternal parenting stress and mother-infant bonding mediated the association between prenatal maternal anxiety symptomatology and infants' reduced regulatory capacity at 3 months of age. Data from other longitudinal study (Buthmann & Gotlib, 2021) conducted in the United States under the Stanford COVID-19 Perinatal Experiences (COPE) project, reported a positive association between infants' negative affect and mothers' prenatal somatization symptoms, number of people in the household with COVID-19 symptoms, and postnatal depressive symptoms. Postnatal maternal depression also mediated the association between prenatal somatization symptoms and infants' negative emotionality, while controlling for relevant demographic variables. In contrast to the reported findings, Imboden et al. (2021) did not observe significant differences in total and domains ASQ-3 scores for 6-months-old through 36-months-old children compared to children assessed prior to the pandemic in the United States. However, Imboden et al. (2021) found a decrease in problem-solving scores among 6-month-olds and a slight decrease in communication scores among some infants in the 6-month and 12-month age groups, which corresponded to the age groups that were exposed to the pandemic environment during all or most of their lives.

One central dimension that suffered from the restrictions during pandemic was touch. As one of the main channels of SARS-CoV-2 infection transmission, there was a particular focus on preventing tactile contact and on the precautions to be taken in case of touch (e.g., hand sanitization and disinfection) (World Health Organization, 2020b). During the COVID-19 pandemic, particularly at its onset, skin-to-skin contact was mostly discouraged or omitted in practice guidelines (DGS, 2020; Ionio et al., 2021), or impossible due to mother-newborn separation when mothers were SARS-CoV-2 positive. However, current findings suggest that skin-to-skin contact should be allowed in case of infection (Sánchez-Luna et al., 2021) and infants and mothers should room-in together (Rao et al., 2021), independently of the COVID-19 disease. In its turn, parents were generally worried about their children getting infected (Wang, C., et al., 2020) and many pregnant women reported concern about their babies becoming unwell due to COVID-19 (Pope et al., in press). In this sense, it should not be overlooked the impact that COVID-19 may have had on the early tactile experiences of the newborn during the pandemic, even if the mother was not infected.

Considered the first sensory modality to develop (Montagu, 1986), touch is fundamental for the development of secure attachment (Duhn, 2010) and social relationships (Morrison et al., 2010). In face of caregiver's touch deprivation, there is an increased risk for sensory processing problems, including touch aversion (Lin et al., 2005; Wilbarger et al., 2010). Furthermore, the perceptual distinction between self and other might also be compromised in face of altered touch perception (Bremner & Spence, 2017), which can also have an impact throughout development in terms of social responses and abilities (Cascio et al., 2019). Altered touch sensitivity has also been concernedly pointed out in neurodevelopmental disorders, such as autism spectrum disorder (Cascio et al., 2016; Foss-Feig et al., 2012; Hyman et al., 2020; Kaiser et al., 2016).

Skin-to-skin contact is an early tactile experience in which the naked newborn is placed on the mother's abdomen or chest, and it is recommended to be uninterrupted implemented after delivery for at least one hour (World Health Organization, 2017). A Cochrane Review (Moore et al., 2016) highlighted the potential benefits of skin-to-skin contact for infants' physiological regulation and promotion of breastfeeding. The authors concluded that early skin-to-skin contact should be facilitated, particularly for healthy newborns, including those born by cesarean. In terms of neurodevelopmental outcomes, early tactile experiences, such as skin-to-skin contact, were associated to greater left frontal alpha asymmetry in healthy full-term infants (Hardin et al., 2020), which reflects emotional processing and cognitive maturation (Davidson, 2000; Saby & Marshall, 2012), and to stronger neural responses in preterm infants (Maitre et al., 2017).

A “social touch system” has been conceptualized based on the close relationship between socially relevant touch and low-threshold unmyelinated mechanoreceptive peripheral afferent C-touch or C-tactile fibers (Cascio et al., 2019; Gordon et al., 2013; McGlone et al., 2014). These fibers show a preference to slow (1-10 cm/s), gentle stroking (Olausson et al., 2010) and to temperatures typical of the human skin (Ackerley et al., 2014). They are distributed primarily in the hairy skin and in the face (McGlone et al., 2012). Distinctively, myelinated Aβ-fibers are related to discriminative touch, which can encode the objective tactile characteristics (Smirni et al., 2019). These Aβ-fibers conduct impulses with a higher velocity (50 m/s) and are mainly distributed in the glabrous skin. There is a growing interest in studying the possible effects of social and affective touch on the development of the human brain, as well as the possible role of C-tactile fibers (Cascio et al., 2019). By using functional near-infrared spectroscopy (fNIRS), Miguel et al. (2019b) found that infants with 7 months revealed an increase in oxy-hemoglobin and decrease in deoxy-hemoglobin only in the somatosensory region in response to both affective and discriminative touch. At the age of 12-months-old, a significant increase in hemodynamic activity was observed in channels placed over the temporal region for affective touch, compared to 7-months-old infants (Miguel et al., 2019a). Furthermore, a significant hemodynamic response increase in oxy-hemoglobin to affective touch was observed in the superior temporal sulcus for 12-months-old infants with less aversive behavioral responses to tactile stimuli (Miguel et al., 2020). These studies in infancy points not only for a developmental trajectory of affective touch processing, but also highlights the possibility to precociously identify markers of nonnormative trajectories based on the affective touch processing.

Despite this evidence, the underlying neurobiological mechanisms of early tactile experiences, such as skin-to-skin contact, need further understanding (Ionio et al., 2021; Takahashi, 2011). In the literature review by Carozza and Leong (2021), it is evidenced the outcome of early tactile experiences on infants’ physiological regulation, including the hypothalamic-pituitary-adrenal (HPA) axis activity and parasympathetic nervous tone. Maternal touch has been reported as having a multidimensional effect on regulation and stress response by exerting a more immediate response on the autonomic system and a more delayed response on the HPA axis (Feldman et al., 2010). Hardlin et al. (2020) found that when mothers implemented the Kangaroo Care (i.e. skin-to-skin contact) after delivery during one hour per day for 6 weeks, infants at 3 months of age revealed decreases in cortisol reactivity, suggesting enhanced stress regulation. Takahashi et al. (2011) explored the effects of skin-to-skin contact circumscribed to a period immediately after birth, revealing that skin-to-skin contact beginning within 5 minutes post birth and implemented for more than one hour until two hours post birth are beneficial for

stability of cardiopulmonary dynamics and enabled a decrease on salivary cortisol levels. Heart rate stabilization is other autonomic change observed in skin-to-skin contact that is consistent with an increased vagal tone (Carozza & Leong, 2021).

Following the proposition by Greenough et al. (1987) of the experience-expectant nature of brain development, the regulatory buffer effects of early tactile experiences might have a particular relevance in the context of being born during the COVID-19 pandemic, especially considering the reported levels of COVID-19-related perinatal distress and the higher rates of maternal psychopathological symptomatology during the perinatal period.

To better understand the neurodevelopmental outcomes of being born during the COVID-19 pandemic and the possible role of early tactile experiences, the present dissertation aims to answer the following questions: 1) What are the developmental outcomes of infants exposed to the COVID-19 pandemic environment?; 2) Do the neurodevelopmental outcomes of infants exposed in utero to SARS-CoV-2 infection differ from the outcomes of unexposed infants?; 3) Were the early tactile experiences disturbed due to the COVID-19 pandemic?; and 4) Do the early tactile experiences moderate developmental outcomes? For this purpose, two studies were conducted. The first study consisted of the BabiesDuringCOVID online survey, administered to mothers that gave birth during the COVID-19 pandemic in Portugal. It aims to characterize infants born during the pandemic and to explore the impact of COVID-19-related perinatal distress on infant's development and temperament, as well as the role of early tactile experiences on those outcomes. A second face-to-face study was conducted to compare the neurodevelopmental outcomes of a clinical group of infants whose mothers tested positive for SARS-CoV-2 at delivery against a control group also born during the pandemic. To this purpose, differences between groups were explored regarding infants' development, temperament, and touch sensory processing. Brain electroencephalographic activity was also assessed through resting state electroencephalogram, considering its potential to provide a better understanding of the brain functioning and to predict cognitive developmental outcomes during childhood (Perone & Gartstein, 2019), particularly in the study of atypical brain development and at-risk children (Vasung et al., 2019). The two groups were also characterized in terms of perinatal and early tactile experiences. Considering that the research on children's developmental trajectories during the COVID-19 pandemic is still at an early stage, an exploratory approach for data analysis was mainly employed. Nevertheless, based on the available literature, we expect to find a worst impact on the neurodevelopmental trajectory in children whose mothers reported higher levels of COVID-19-related perinatal distress. We also expect to

clarify the potential protective role of early tactile experiences on the impact of COVID-19-related perinatal distress for children born during the COVID-19 pandemic.

Study 1

Methods

Participants and procedures

A total of 524 mothers participated in the study 1 by filling the BabiesDuringCOVID online survey (http://prochildcolab.pt/babies-during-covid/). Mothers were considered eligible to the present study if they were at least 18-years-old, resident in Portugal, and their children were born during the pandemic in Portugal, with ages up to 12-months-old. Mothers were excluded in case of twin or multiple pregnancy, if the delivery was not in an Hospital or Maternity, if the infant was born preterm or with less than 1500g, if the Apgar score at 5 minutes was less than 7 or unknown, and when the infant's development measure was not complete. Duplicated entries, verified through contact, identification code and IP address, were excluded from the study. Cases with improbable pattern of responses in variables of interest, verified manually and through inspection of extreme points in the boxplots, were also excluded.

The sample was recruited through a follow-up invitation to mothers who had previously completed the Portuguese version of the MomsDuringCOVID online survey (Motrico et al., 2021) (n = 196) and through the dissemination on social networks, mainly on maternity groups (n = 328). Mothers completed the online survey on Qualtrics (https://www.qualtrics.com/) from February 5 to July 9, 2021. The present study was conducted under the research project "Perinatal experiences during the COVID-19 pandemic: Assessing the impact on women's mental health and children's developmental trajectories", approved by the Ethics Committee for Research in Life and Health Sciences of the University of Minho (CEICVS 045/2020), and following the Declaration of Helsinki.

Measures

Sociodemographic variables and newborn outcomes

The first section of the BabiesDuringCOVID online survey is composed of questions to characterize family context and newborn outcomes, namely: mother, father and infant's age; mother and father's educational level; mother's birth country; living with partner; household monthly income;

maternal history of mood and/or anxiety disorders; mother current and previous mental health treatment; sibling position; first pregnancy; planned pregnancy; high-risk pregnancy; cesarean delivery; gestational age; birth weight; birth length; Apgar score at 5th minute; and NICU care.

Perinatal experiences during the COVID-19 pandemic and mother-newborn early tactile experiences

To characterize the perinatal experiences during the COVID-19 pandemic, we selected a group of questions from the Coronavirus Perinatal Experiences – Impact Survey (COPE-IS; Thomason, Graham, & VanTieghem, 2020; translated to Portuguese by Mesquita et al., 2020). We chose questions regarding presence of support during delivery (e.g. partner or family), family and friends visits after delivery, mother-newborn separation during long period after delivery, mother and infant's diagnosis of COVID-19, COVID-19-related perinatal distress and worry about infant's health due to COVID-19. To explore the particular impact of COVID-19 on the early tactile experiences, two questions were created based on the formulation and answer scales of the COPE-IS, namely: "After delivery and during hospitalization, how much your experiences of touch with your baby (e.g. stroking, kissing) were a cause of concern to you?" (1 = no concern; 5 = highly concern); and "To what extent do you think COVID-19 had a positive or negative impact on your experiences of touch with your baby (e.g. stroking, kissing) during hospitalization?" (1 = very positive; 7 = very negative). We also asked if mother-newborn skin-to-skin contact was experienced (0 = No; 1 = Yes).

Infant's Development

The Caregiver-Reported Early Development Instruments (CREDI) Long Form (0 – 36 months old) was administrated to assess infant's motor, cognitive, language, socio-emotional and overall development. The CREDI is an internationally developed, population-level measure, and it is freely available in its website (https://credi.gse.harvard.edu/). The caregivers are asked to report whether their children exhibit a range of skills and behaviors through a response scale of "yes" = 1 and "no" = 0. The option "I don't know" is also available, but answers in this option are treated as missing values. The instrument comprises a total of 108 items, using start rules based on children's age. In its turn, completion ends based on children's ability (i.e. after five consecutive "no" answers). A scoring application (https://credi.shinyapps.io/Scoring_App/) is also available, which uses a multidimensional item response theory (IRT) approach and provides norm-referenced standardized scores, which can be interpreted as z-scores. The reference group was selected from the cross-country CREDI database to

capture children with advantageous home environments (Seiden et al., 2021). Studies using the CREDI's long form revealed evidence of internal consistency and construct and discriminant validity (McCoy et al., 2021; Waldman et al., 2021). The reliability and validity have also been explored in China (Li et al., 2020) and India (Alderman et al., 2021). The CREDI is characterized to be accessible for caregivers with lower educational level and it is "culturally neutral", which enables cross-context comparison (McCoy et al., 2017). Based on the evidence of its reliability and validity, as well as on its accessibility, the CREDI has received the highest score in a recent systematic review regarding early child development measures (Boggs et al., 2019). The validation study of the CREDI for the Portuguese population is currently being carried out (https://prochildcolab.pt/avaliacao-do-desenvolvimento-na-primeira-infancia/).

Infant's Temperament

The Infant Behavior Questionnaire–Revised Very Short Form (IBQ-Rvsf) (Putnam et al., 2014) is a caregiver-report measure of infant's temperament, composed of 37 items. Through a 7-point Likert scale (1 = "Never"; 7 = "Always"), parents are asked to report the observation of specific behaviors involving their children in common situations during the past week. A "Does not apply" option is also provided for each item. The IBQ-Rvsf provides three temperamental dimensions: positive affectivity/surgency (i.e. infant's activity and pleasure), negative emotionality (i.e. distress, sadness, and fear), and orienting/regulatory capacity (i.e. soothability, cuddliness, and orienting). The total scores on each dimension range from 0 to 7, with higher scores suggesting stronger evidence for the presentation of each dimension. The IBQ-Rvsf has its origin in the Infant Behavior Questionnaire–Revised (IBQ-R) (Gartstein & Rothbart, 2003), which has been widely used in childhood literature, revealing strong psychometric properties. For the present study, we used the items available on the Portuguese version of the IBQ-R (Costa & Figueiredo, 2018). Only mothers of children with at least 3 months old had access to the questionanire, following the procedure of Putnam et al. (2014).

Maternal Psychopathological Symptomatology

The Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987; Portuguese version: Augusto et al., 1996) is composed of 10 items and provides a measure of depressive symptomatology. Total scores range from 0 to 30, with higher scores suggesting greater severity. The EPDS has been widely used for the identification of perinatal depression (Cox, 2019). In the present study, we used a

threshold of 13 or more as an indicator of clinically significant depressive symptomatology (Levis et al., 2020).

The General Anxiety Disorder-7 (GAD-7; Spitzer et al., 2006; Portuguese version: Sousa et al., 2015) provides a measure of anxiety symptomatology following the criteria from the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV and DSM-IV-TR (American Psychiatric Association, 2013). Composed of 7 items, total scores can range from 0 to 21, with higher scores evidencing greater severity. Reliability and construct validity has been evidenced in the perinatal period (Simpson et al., 2014). A threshold of 10 or more was adopted in the present study to consider clinically significant symptomatology (Spitzer et al., 2006).

Maternal experiences and attitudes towards touch

To explore mothers' own experiences and attitudes towards affective and social touch, we used the Touch Experiences and Attitudes Questionnaire (TEAQ) (Trotter et al., 2018; Portuguese version: Pereira et al., 2021). Composed by 57 items, the TEAQ has a validated six-factor structure, namely Friends and Family Touch (FFT), Current Intimate Touch, Childhood Touch (ChT), Attitude to Self-Care, Attitude to Intimate Touch, and Attitude to Unfamiliar Touch. Through a 5-point Likert scale, participants were asked to classify the level of agreement with statements about the experience of touch in diverse situations. The mean score was calculated for each subscale, with higher scores reflecting greater positive attitude or higher frequency of touch experiences. For the present study, we only explored the FFT dimension, as a measure of mothers' amount and enjoyment of affectionate touch experiences with their family and friends, and the ChT dimension, which provides a retrospective report of the amount of touch in mothers' childhood experiences.

Analytic procedures

Statistical analyses were conducted using IBM Statistical Package for Social Sciences (SPSS), version 28.

Normality was assessed, with Skewness (SK) and Kurtosis (Ku) values revealing no significant biases in relation to the means (Kline, 2016). Descriptive statistics were conducted for all variables, namely frequencies and measures of central tendency and variability.

To analyse gender-related differences on infant's outcomes, independent samples t-test were used. It was considered a significant statistical difference when $p \leq .05$ (Pallant, 2016). To analyze the

effect size, we used the Cohen's d, considering the following values: .2 = small effect; .5=medium effect; and .8 = large effect (Cohen, 1988).

Bivariate Pearson's correlations and Spearman's Rank Order Correlation were computed to explore possible significant relationships between infants' age and infants' developmental and temperamental outcomes, maternal psychopathological symptomatology, and COVID-19-related perinatal distress. The strength of the relationship was classified based on Cohen's (1988) criteria: .10 = weak or small association; .30 = moderate correlation; and .50 = strong or large correlation.

To control the effect of infant's age, partial correlations were conducted when exploring the possible association between variables of interest.

A moderating effect can be observed when a variable has an impact on the direction and/or strength of the relationship between two other variables (Baron & Kenny, 1986). To explore the possible moderating effect of early tactile experiences on the relationship between COVID-19-related perinatal distress and infants' outcomes, moderation analyses were conducted for the variables of interest which revealed significant correlations between them. Due to its ordinal nature, the moderator and predictor variables were first recoded to dummy variables. For the COVID-19-related perinatal distress, whose original response scale ranged from 0 to 7, a value of 0 concerns no or low distress levels, while a value of 1 corresponds to moderate to high distress levels. In the case of maternal worry about mother-newborn early tactile experiences, a value of 0 indicates no or low levels of worry and a value of 1 corresponds to moderate or high levels of worry. In terms of the perceived impact of COVID-19 on the early tactile experiences, no or low negative impact corresponds to a value of 0 and moderate to high negative impact matches a value of 1. The effect of infants' age was also controlled in each analysis. Preliminary analyses were conducted to verify compliance with the assumptions for carrying out the analysis, namely inexistence of multicollinearity problems, which is indicative of the absence of problems in the estimation of β, and inexistence of problems regarding distribution normality, linearity, homoscedasticity, and independence of residues (Pallant, 2016). The interaction term was created through the multiplication of the moderator and predictor variables. The criterion variable introduced in the hierarchical multiple regressions corresponded to the infants' developmental or temperamental outcome. The existence of a moderation effect was verified when the interaction term proved to be significant ($p \leq .05$).

Results

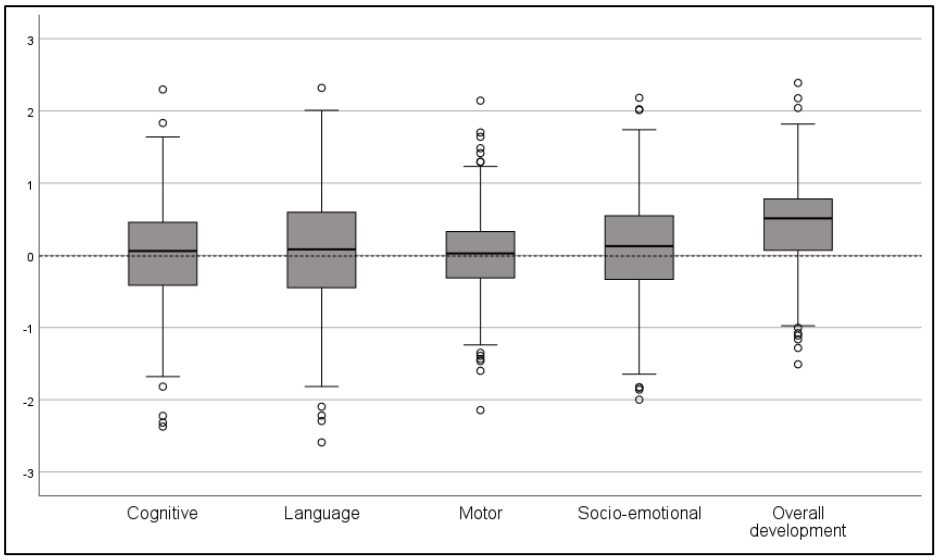
Mothers of 265 (50.6%) male and 259 (49.4%) female infants participated in the present study, with infants' age ranging from 0 to 12 months old (*M* = 5.42; *SD* = 3.094). Descriptive statistics for sociodemographic variables, newborn characteristics, infants' developmental and temperamental outcomes, perinatal and early tactile experiences, maternal mental health and maternal experiences and attitudes towards touch, are reported in Appendix A.

Infants' developmental and temperamental outcomes

A similar developmental pattern was observed for infants in the present study compared to the average children from the CREDI reference sample, which was assessed previously to the COVID-19 pandemic (cf. Figure 1). For all developmental domains, more than 50% of infants revealed scores inside the reference-group standard deviation. In fact, the mean and standard deviation of each developmental domain in the present sample were inside the reference-group standard deviation. In terms of specific developmental domains, the social-emotional domain revealed the higher mean (*M* = .107; *SD* = .684), and the motor domain the lowest mean (*M* = .010; *SD* = .545). Only 5% of infants presented a z-score bellow -.534 in the overall development, with more than 50% of the sample positioning itself at a level equivalent to the upper mean of the reference sample. No gender-related significant differences emerged for all developmental domains (cf. Table A3).

Figure 1

Norm-referenced standardized scores of developmental domains assessed through CREDI



Note 1. A z-score of 0 represents a similar developmental status as the average child in the CREDI reference sample of the same age. A z-score of 1 and a z-score of -1 represents the reference-group standard deviation (Seiden et al., 2021).

In terms of temperament, the IBQ-Rvsf was completed for 353 infants with at least 3 months of age. The orienting/regulatory capacity revealed the higher mean score (M = 5.388; SD = .714), followed by positive affectivity (M = 4.507; SD = 1.047) and negative emotionality (M = 4.003; SD = 1.109). No gender-related significant differences emerged for all temperamental domains (cf. Table A3).

Age-related outcomes

Age was significantly and negatively associated to all domains of development and to regulatory capacity. Mothers of older infants reported a tendency for their children to exhibit a lower range of motor (r = -.297, p = .000), cognitive (r = -.126, p =.004), language (r = -.416, p = .000), and socio-emotional (r = -.093, p = .033) abilities that were expected comparing to the age-standardized reference population, translating into lower scores for the overall development (r = -.304, p = .000). They also perceived their children as having a lower orienting/regulatory capacity (r = -.120, p = .024). However, the strength of the relationship was low for all variables, except for the language and overall domains, which revealed moderate correlations. In its turn, a significant positive association was found between age and temperamental dimensions of positive affectivity (r = .606, p = .000) and negative emotionality (r = .119; p = .025). It should be noted that the temperament measure was only available for children aged at least 3 months old. Mothers of older infants perceived their children as more emotionally expressive regardless of its valence. The correlation was particularly strong for the positive affectivity, but a small effect size was found for the negative emotionality. In terms of perinatal distress related to COVID-19, even though its lower effect size, mothers of older infants tended to reveal higher levels of distress (rho = .117, p = .007) and to report higher scores of anxiety (r = .114; p = .015) and depressive (r = .154, p = .001) symptomatology.

After controlling for the effect of infants' age, all developmental domains were significantly and positively associated with each other and with the temperamental domain of surgency/positive affectivity, which particularly revealed a moderate partial correlation with the overall development (r = .313, p = .000) (cf. Appendix B for correlations between variables of interest, while controlling the effect of infant's age). No significant association emerged between developmental domains and the two temperamental domains of negative emotionality and orienting/regulatory capacity. In its turn, mothers who perceived their children with higher orienting/regulatory capacity also reported higher positive affectivity (r = .281, p = .000) and lower negative emotionality (r = -.208, p = .000), although the effect size was low.

The role of COVID-19-related perinatal distress on infants' outcomes

Mothers who reported higher levels of COVID-19-related perinatal distress tended to perceive their children as revealing a lower socio-emotional ability (*rho* = -.094, *p* = .031) and express higher negative emotionality (*rho* = .187, *p* = .000), after controlling for infants' age. No significant partial correlation emerged for the remaining developmental and temperamental domains.

Higher levels of distress related to the COVID-19 were also significantly associated with total scores of maternal anxiety (*rho* = .307, *p* = .000) and depressive (*rho* = .356, *p* = .000) symptomatology. In the present sample, 20.2% of mothers who completed the GAD-7 were above the clinical cut-off for anxiety symptomology, and 18.5% of mothers scored higher than the clinical cut-off for depressive symptomatology in the EDPS. There was no significant association between developmental domains and the total scores of GAD-7 and EPDS, after controlling for infants' age. In its turn, mothers with higher total scores of anxiety and depressive symptomatology tended to perceive their children as expressing more negative emotionality and revealing lower regulatory capacity, but the strength of the relationship was low. A strong association was found between the total scores of GAD and EPDS (*r* = .779; *p* = .000).

The role of early tactile experiences on infants' outcomes

Skin-to-skin contact after birth was not implemented for 17.7% of our sample. No skin-to-skin contact was significantly associated with maternal worry about early tactile experiences (*rho* = -.180, *p* = .000) and perceived as worst the impact of COVID-19 on those experiences (*rho* = -.142, *p* = .001). No skin-to-skin contact was also associated to higher levels of COVID-19-related perinatal distress (*rho* = -.129, *p* = .003). However, no significant correlation emerged between skin-to-skin contact and infants' developmental and temperamental outcomes.

In the present sample, 20 mothers (3.8%) reported to have been separated from their newborn during a long period after delivery. The reasons for separation were the following: delivery-related procedures or complications (n = 12); infant's neonatal support (n = 2); mother's COVID-19 diagnosis (n = 2); wait for the COVID-19 test result (n = 2); COVID-19-related preventive measures (n = 1); and unknown (n = 1). During the separation period, only five newborns had contact with a significant person, which was the infant's father in all cases. Mothers who were separated from their newborns during a long period after delivery perceived the impact of COVID-19 on early tactile experiences as worst (*rho* = .243, *p* = .000). They also tended to experience significantly higher levels of COVID-19-related perinatal distress

(*rho* = .156, *p* = .000) and to perceive their children as revealing a lower socio-emotional ability (*rho* = -.100, *p* = .022).

Worry about early tactile experiences was significantly and positively partly correlated with the temperamental dimension of negative emotionality (*rho* = .192, *p* = .000). Mothers who reported a worst impact of COVID-19 on their earlier tactile experiences during hospitalization tended to perceive their children as expressing higher negative emotionality (*rho* = .219, *p* = .000) and revealing lower orienting/regulatory capacity (*rho* = -.153, *p* = .004). After controlling for infants' age effect, worry about early tactile experiences, impact of COVID-19 on early tactile experiences, COVID-19-related perinatal distress, and maternal anxiety and depression symptomatology were significantly and positively associated with each other.

When exploring the potential association between mother's own experiences and attitudes towards touch and the variables of interest, also controlling for infants' age, significant positive associations emerged between the Family and Friends Touch (FFT) dimension of TEAQ and infants' language (*r* = .129, *p* = .023) and overall development (*r* = .146, *p* = .010), suggesting that mothers who experience and enjoy more giving and receiving affectionate touch in their closer relationships also reported that their children exhibit a higher range of overall developmental abilities, particularly in the language domain. Those mothers also perceived their children as expressing more positive affectivity (*r* =.285, *p* = .000) and revealing higher regulatory capacity (*r* = .131, *p* = .047). However, the effect size was low for all variables. The FFT dimension was not associated with infant's negative emotionality, neither with maternal psychopathological symptomatology.

No significant associations emerged between maternal childhood experiences (ChT) and infants' developmental and temperamental outcomes. However, mothers who reported having experienced less amount of affectionate touch in childhood (ChT), revealed significantly higher total scores of anxiety (*r* = -.227, *p* = .000) and depressive (*r* = -.233, *p* = .000) symptomatology. In its turn, mothers with fewer affective touch experiences during their childhood also revealed higher levels of worry about the early tactile experiences with their children during hospitalization (*rho* = -.134, *p* = .017). No relationship emerged between COVID-19-related perinatal distress and maternal experiences and attitudes towards touch, as assessed by FFT and ChT dimensions of TEAQ.

The role of COVID-19 diagnosis on infants' outcomes

In the present sample, 33 mothers and 8 infants received a diagnosis of COVID-19. However, no information was reported for 56 mother-infant dyads. From the 33 infected mothers, 19 were

diagnosed during the post-partum period, 5 at the delivery moment, 6 at the third trimester of pregnancy and 3 at the second trimester of pregnancy. All infected infants were diagnosed during the postpartum period, with the age of diagnosis ranging from 1 month to 8 months of age. At the time of participation in the present study, children of mothers who received a diagnosis tended to be younger (r = -,118, p = .011). After controlling for infant's age, no significant association emerged between mother or infant diagnosis of COVID-19 and infants' developmental and temperamental outcomes, neither with COVID-19 related perinatal distress. However, mother diagnosis of COVID-19 was significantly associated to the experience of a worst impact of COVID-19 on early tactile experiences (*rho* = .097, p = .037).

The moderating effect of early tactile experiences on the relationship between COVID-19-related perinatal distress and infants' developmental and temperamental outcomes

Based on the previously reported significant associations, the potential moderating effects of maternal worry about mother-newborn early tactile experiences and the perceived impact of COVID-19 on those experiences were explored on the relationship between COVID-19-related perinatal distress and infants' negative emotionality (cf. Appendix C).

No moderator effect was observed for the maternal worry about mother-newborn early tactile experiences (β = .090, p = .317) (cf. Table C1), neither for the impact of COVID-19 on those experiences (β = .056, p = .612) in the relationship between COVID-19-related perinatal distress and infant's negative emotionality, after controlling for infant's age and (cf. Table C2). However, when analyzed separately, COVID-19-related perinatal distress (β = ,141 p = .008), maternal worry about mother-newborn early tactile experiences (β = .156, p = .003) and perceived impact of COVID-19 on mother-newborn early tactile experiences (β = .121, p = .025) were positive predictors of infant's temperamental dimension of negative emotionality.

A group of mothers also reported having experienced separation from their children during a long period after deliver, which prevented any mother-newborn tactile experiences. In this sense, the potential moderator effect of mother-newborn separation on the relationship between COVID-19 related perinatal distress and infants' socio-emotional development was also explored, controlling infant's age effect.

Mother-newborn separation during long period was a significant moderator (β = .199, p = .022) on the relationship between COVID-19 related perinatal distress and infants' socio-emotional development (cf. Table C3). When analyzed separately, mother-newborn separation (β = -.089, p =

.003) was a negative predictor of infants' socio-emotional development. Significant models were originated in all four steps of the Hierarchical Multiple Regression. The final model, which included the interaction term, was statistically significant [R^2 = .038, $F_{(4, 519)}$ = 5.147, p = <.001], suggesting that the slope that predicted the change in infants' socio-emotional development according to the level of COVID-19-related perinatal distress differs significantly depending on whether the mother-newborn separation occurred or not. Nevertheless, this final model only explained 3.8% of the variance of socio-emotional development. A graphic representation of the moderation effect is presented in Figure C1, which suggests that when mothers experienced lower levels of COVID-19 distress, the experience of mother-newborn separation led to children's lower socio-emotional ability, compared to when separation did not occur.

Study 2

Methods

Participants and procedures

The sample of study 2 is composed by a clinical group of 29 infant-mother dyads, in which mothers tested positive for SARS-CoV-2 at delivery, and a control group of 36 infant-mother dyads, in which delivery also occurred during the pandemic but without uterine exposure to SARS-CoV-2. Mother-infant dyad was included if the mother was at least 18-years-old, resident in Portugal, and a Portuguese fluent speaker. In case of premature delivery (i.e. less than 37 weeks of gestation), delivery in non-hospital context, genetic or neurological disorder or sensory deficits diagnosed in the infant, the dyad was excluded. The present study was conducted under the research project "Early experiences of affective touch during the COVID-19 pandemic: Assessment of the impact on infants' developmental trajectories" (n.º 411/20), approved by the Ethics Committee of the University Hospital Centre of São João/Faculty of Medicine of the University of Porto, and following the Declaration of Helsinki.

Infants of the clinical group were born in the University Hospital Centre of São João (UHCSJ) from mothers who were positive for SARS-CoV-2 at delivery or were transferred to there after birth due to their mothers' diagnosis, since the UHCSJ was considered a reference hospital in the northern region of Portugal for positive cases to COVID-19, particularly at the beginning of the pandemic. Those infants were followed in the primary infancy psychological consultation of the UHCSJ at 6-months-old or 12-months-old, depending on their date of birth. As part of the consultation, a developmental assessment

was conducted by a psychologist. A total of 39 mothers who attended the first consultation with their children were invited to participate in a face-to-face study and 38 mothers provided consent for participation. After providing consent, the research team had access to the developmental assessment results and clinical processes. Following the psychological consultation, infant-mother dyads were enrolled in an assessment session that also took place in the UHCSJ, where the remaining protocol assessment was administered by a member of the research team. Whenever necessary, a new session was scheduled to complete the assessment, accordingly to the availability of the family. This final session took place in one of the assessment sites of the control group. Considering the exclusion criteria for the present study, 4 infants were excluded due to premature delivery and 5 infants who received a diagnosis of genetic/neurological disorder or sensory deficits were also excluded, thus composing the clinical group with 29 infant-mother dyads.

For recruiting the control group, 201 mothers, residents in the districts of Porto or Braga, who provided their contacts after completing the MothersDuringCOVID or the BabiesDuringCOVID online surveys, were invited to participate in the face-to-face study. Consent was given for 35 mother-infant dyads to participate. Additionally, 5 mothers enrolled in the present study with their children, by invitation of other participants. Two assessment sessions were scheduled accordingly to family availability and residence zone, aiming to assess those infants for the first time at 6-months-old or 12-months-old. All the protocol assessment was administered by a research member of the project team. The face-to-face assessment sessions took place in one of four possible locations: Psychological Neuroscience Laboratory, School of Psychology, University of Minho, Braga (n = 18); Psychology Association of the University of Minho, Guimarães (n = 5); IND – Institute of Neurodevelopment, Porto (n = 11); Faculty of Psychology and Education Sciences, University of Porto, Porto (n = 6). Considering the exclusion criteria for the present study, one infant was excluded due to a premature delivery, two infants were excluded due to non-hospital delivery, and one infant whose mother did not share the necessary information to verify exclusion criteria was also excluded, thus composing the control group with 36 infant-mother dyads.

Data from study 2 was collected from February to October 2021. After the face-to-face assessment session, each mother received a link to complete at home the BabiesDuringCOVID online survey, previously described on study 1.

Measures

Sociodemographic information, newborn characterization, perinatal experiences, and early tactile experiences

Through the BabiesDuringCOVID online survey, we extracted information about mother, father and infant's age; mother and father's educational level; household monthly income; sibling position; cesarean delivery; gestational age; birth weight; birth length; and Apgar score at 5th minute. We also explored the questions originally from the COPE-IS about presence of support during delivery, family and friends visits after delivery, mother and infant diagnosis of COVID-19 during the pos-partum period, COVID-19-related perinatal distress and worry about infant's health due to COVID-19. To explore the worry about mother-newborn early tactile experiences during hospitalization and the impact of COVID-19 on those experiences, we also included in the present study the two questions created and previously described on study 1.

Additionally, we extracted data from the clinical processes to characterize the COVID-19 symptomatology severity, the experience of mother-newborn separation protocol when mothers were positive, and to examine if infants were being breastfed at the time of hospital discharge.

Infants' development and temperament

The Griffiths Mental Development Scales from 0 to 2 years old (revised version; Huntley, 1996; translated to Portuguese by Ferreira et al.) were administered face-to-face by an examiner to assess infant's development. The Griffiths provides a strengths and needs profile defined on 5 domains: 1) Locomotor; 2) Personal-Social; 3) Language and Hearing; 4) Eye-hand Coordination; and 5) Performance. A general development score is also provided. Higher scores reflect the acquisition of a higher range of abilities expected for infant's age. In the case of the clinical group, the administration and quotation follow a procedure adapted in hospital context. To enable the comparison between groups, the domains and general scores were standardized.

The CREDI, composed by motor, cognitive, language, socio-emotional, and overall development domains, was also administered through the BabiesDuringCOVID online survey, following the procedures previously described in study 1. In this way, it was possible to assess infant's development through caregiver report and by examiner's observation.

The IBQ-Rvsf was also administered as part of the BabiesDuringCOVID online survey, following the described procedures and providing three temperamental domains: positive affectivity/surgency; negative emotionality; and orienting/regulatory capacity.

Infants' sensory profile

The Sensory Profile 2 (Dunn, 2014; translated to Portuguese by the research team in collaboration with Escola Superior de Saúde de Alcoitão), was presentially administered to mothers. The Infant version questionnaire (25 items) was applied to 6-months-old or younger children and the Toddler version questionnaire (54 items) was applied to 7-months-old or older children. The questionnaires provide information about sensory processing in general, but also in specific sensory domains, namely auditory, visual, touch, movement, body position and oral. A 5-point Likert scale is used to classify the frequency of sensory experiences in daily life (5 = "Almost Always"; 1 = "Almost Never"). A "Does Not Apply" = 0 option is also available. For the present study, we will focus only on the touch sensory domain. In order to compare between groups regardless of questionnaire version, total scores were normalized (i.e. considering the ratio between total scores and the maximum score for each group), with scores ranging between 0 and 1. A higher score on the touch sensory domain reveals higher distress or difficulty in experiences involving tactile processing.

Infant's brain electroencephalographic activity

Infant's brain electroencephalographic activity (EEG) during the resting-state was recorded using the Mentalab Explore portable device (https://mentalab.com/). With a size of 4x4x2 cm, the Mentalab Explore device is placed on the back of the EEG cap and data is recorded via livestream through Bluetooth, using the Mentalab ExplorePy software. A set of 8 AgAg/Cl wet ring electrodes and one unipolar reference were applied in a neoprene EEG cap with one of two possible sizes: XS (36 – 42 cm) and S (42 – 48 cm). The electrodes were placed according to the international 10–20 system on the Fz, F3, Cz, C3, C4, Pz, P3, and Oz positions. The locations were chosen having in mind the implementation of a tactile EEG paradigm, which was performed after the resting-state EEG. Recorded data from the tactile paradigm will not be an object of study in the present thesis. To record the EEG, infants were seated on their mothers' laps in an ergonomic seat. Mothers were instructed to try to avoid interacting or communicating with their children no more than necessary during data collection. During the resting-state EEG recording, infants watched a silent movie (Czech cartoon Krtecek, as in Fairhurst et al., 2014).

Maternal psychopathological symptomatology

Through the BabiesDuringCOVID online survey, we also collected data regarding mother's anxiety and depressive symptomatology by administering the GAD-7 and the EPDS, respectively. We followed the scoring procedures described on study 1.

Analytic procedures

Statistical analyses were conducted in SPSS, version 28. Descriptive statistics were used to characterize all variables, namely frequencies and measures of central tendency and variability.

To compare the clinical group against the control group, we used non-parametrical statistics, given the small sample size. For categorial variables, we conducted the Chi-Square test for independence and analyzed the effect size through the phi coefficient. Fisher's exact test was used as an alternative when the expected frequency in a cell was less than 5. Mann-Whitney U test were used for continuous and ordinal variables, and an approximate value of r was calculated to examine the effect size. The criteria of Cohen (1988) were once more adopted in the analysis of effect size.

Data from the baseline EEG recordings were pre-processed using MATLAB R2021a, through the EEGLAB toolbox (https://eeglab.org/; version 2021.1). First, a 1 – 30 Hz band-pass filter was applied to reduce noisy electrical activity. Data from poorly recording channels were replaced by spherical-spline interpolation. Additionally, large ocular or other artifacts were rejected manually by inspection of the recording. We also performed an exploratory Independent Component Analyses (ICAs) to reject artifacts. Nevertheless, due to the limited number of electrodes, this method was not advantageous compared to the manual artifact rejection and this ICAs correction was ultimately discarded. Following previous literature with similar populations, an offline re-reference to Cz was also performed (Hardin et al., 2021; Perone & Gartstein, 2019).

The Power Spectral Density (PSD) for the 6 – 9 Hz alpha band was analyzed. Power in the 6 – 9 Hz band is the most commonly reported measure in infant baseline EEG literature (Perone & Gartstein, 2019), with changes in power in this frequency band being associated with development and emotional regulation (Norton et al., 2021). Additionally, we also explored the SPD for the 3 – 6 Hz theta band, which has been associated with social stimulation and affective state (Orekhova et al., 2006). To ensure consistent and reliable results, only the participants that had more than 120 seconds of usable EEG data, after the pre-processing procedures, were retained for the following steps (Noreika et al., 2020). The PSD is commonly measured in continuous EEG (Cohen, 2014) and corresponds to the squared amplitude of the neural signal integrated over a range of signal frequencies (Noreika et al.,

2020). For this purpose, we used a Fast Fourier Transformation that produces the spectral power expressed in mean square microvolts for each electrode site (DeBoer et al., 2013; Norton et al., 2021). Comparisons between clinical and control groups regarding the PSD for each electrode and each frequency band were conducted on SPSS through Mann-Whitney U test. Spearman's correlations were also conducted to explore the relationship between the PSD and infant's outcomes.

Results

A total of 65 mother-infant dyads participated in study 2, with infant's age ranging from 5 to 13 months old. Descriptive statistics and differences between clinical and control groups regarding sociodemographic variables, newborn characteristics, infants' developmental/temperamental outcomes and touch sensory processing, perinatal and early tactile experiences, and maternal mental health, are reported in Appendix D.

In the clinical group (n = 29), with 12 male and 17 female infants, all mothers were infected with SARS-CoV-2 at delivery, but none of the children were positive to COVID-19 after birth and during hospitalization. In terms of the severity of the disease, 16 (55.2%) mothers were asymptomatic and 13 (44.8%) were symptomatic. No mother received a second COVID-19 diagnosis after discharge, but one infant was diagnosed with COVID-19 at 1 month of age. However, no information about COVID-19 diagnosis after discharge was available for 9 mother-infant dyads.

In the control group (n = 36), mothers and their children (18 male and 18 female infants) were not diagnosed with COVID-19 at delivery or during hospitalization. However, 5 mothers and 2 infants were infected during the post-partum period. The two infants were infected together with their mother when they were 1.5-months-old and 5-months-old, respectively. No information was available for 4 infant-mother dyads regarding COVID-19 diagnosis after hospital discharge.

Compared to the control group, mothers (X^2 (1, n = 59) = 14.140, p < .001, *phi* = .529) and fathers (X^2 (1, n = 59) = 5.507, p = .019, *phi* = .341) of infants from the clinical group had a lower educational level. The household monthly income was also lower in the clinical group compared to the control group (X^2 (1, n = 59) = 7.694, p = .006, *phi* =.396). No differences emerged for mother's age, fathers' age, infant's gender, to be the first child, gestational age, birth weight, APGAR at 5th minute, and maternal history of mood and/or anxiety disorder. The control group revealed lower birth length, since one infant presented 35.50 cm, compared to the minimum length of 47.00 cm in the clinical group.

When comparing infants' outcomes, no significant differences emerged regarding infant's development as assessed by Griffiths for all developmental domains, as well as for the general development. No differences were also observed regarding the domains of CREDI, which is completed through mother's report of infant's developmental acquisitions. In terms of temperament, although closer to the significance threshold, a significant difference emerged for positive affectivity/surgency (U = 426.000, z = 1.995, p = .046, r = .277), with mothers of the control group reporting to perceive their children as expressing more positive affectivity compared to the clinical group. No difference emerged for negative affectivity and orienting/regulatory capacity. In addition, infants' touch sensory processing did not differ between groups, revealing the same median score (Mdn = .267).

With regard to early tactile experiences, mother-newborn skin-to-skin contact was more frequent in the control group (X^2 (1, n = 58) = 6.519, p = .011, phi = .372). A separation protocol was implemented for 10 (34.5%) mother-infant dyads of the clinical group. Mothers of the clinical group not only reported significantly higher levels of worry about mother-newborn early tactile experiences during hospitalization (U = 160.500, z = -3.576, p <.001, r = .482) but they also perceived a worst impact of COVID-19 on those early tactile experiences (U = 88.000, z = -4.938, p <.001, r = .666). In its turn, no differences emerged between clinical and control groups in terms of COVID-19 related perinatal distress, neither with worry about infant's health due to COVID-19. It should be noted, however, that not all mothers provided data regarding these variables.

Finally, there were no significant differences in the total scores of GAD-7 and EPDS. Nevertheless, not all mothers completed the maternal psychopathological symptomatology measures. In terms of clinical thresholds, 6 in 20 mothers of the clinical group and 5 in 32 mothers of the control group revealed clinically significant anxiety symptomatology. Clinically significant depressive symptomatology was observed in 2 out of 19 mothers of the clinical group and 6 out of 31 mothers of the control group.

Infants' brain electroencephalographic activity

Despite the more restricted recommendations (DeBoer et al., 2013), we considered the suggestion for not combining more than 1 – 2 months intervals in averages of group EEG when conducting infant studies (Picton et al., 2000; Taylor & Baldweg, 2002). In this way, the clinical group was divided based on infant's age into 6-months-old age group (n = 21; M_{weeks} = 26.095; SD = 1.729) and 12-months-old age group (n = 8; M_{weeks} = 53; SD = 2.449). The same was done for the control

group, splitting it into 6-months-old age group (n = 17; M_{weeks} = 27.882; SD = 2.288) and 12-months-old age group (n = 19; M_{weeks} = 53.632; SD = 2.087).

Due to placement procedure problems (e.g. cap and/or electrodes placement), baseline EEG was not collected for four infants from the clinical group. One infant from the control group and another one from the clinical group were also excluded from the analyses due to problems in data recording (i.e. no data available in the recorded files). The baseline EEG was not recorded for two infants from the control group since mother-infant dyads missed the recording session and was not possible to reschedule. Three infants from the control group were also excluded from EEG analysis due to behavior during the recording (e.g. mother-infant interaction during most of the recording). After the pre-processing procedures, 9 infants from the clinical group and 13 infants from the control group were excluded from analyses since they presented less than 120 seconds of usable data.

After the exclusion procedures, 11 infants from the control group and 12 infants from the clinical group were available for PSD analyses for the 6-months-old age group. In terms of the 12-months-old age group, 6 infants from the control group were available, but only 3 infants from the clinical group presented usable data. In this way, we only carried out the PSD analyzes for the 6-months-old age group.

No significant difference between clinical and control group emerged for the PSD analysis in any electrode in the 6 – 9 Hz alpha band, neither in the 3 – 6 Hz theta band (cf. Appendix E). To explore the relationship between the PSD and measures of infant's development, temperament and touch sensory profile, Spearman's correlations were conducted without discriminating the group (cf. Appendix F). No significant correlation emerged between PSD in the different electrodes and frequency bands with general development, as assessed by Griffiths, overall development, as assessed by CREDI, IBQ-Rvsf temperamental dimensions, and tactile sensory profile.

Discussion

The present dissertation aimed to explore the possible impact of being born during the COVID-19 pandemic. Our findings suggest that infants exposed to the pandemic environment, regardless of the infection, presented a similar developmental pattern compared to a cross-cultural reference sample assessed previously to the COVID-19 pandemic (Seiden et al., 2021). This is in line with the findings of Imboden et al. (2021), that also did not observe significant differences when they compared the ASQ-3 scores of children with ages ranging from 6 to 36 months old with children assessed prior to the pandemic.

When comparing infants exposed in utero to SARS-CoV-2 against unexposed infants, we did not observe significant differences in terms of development, as assessed through an examiner or by mother's report. Shuffrey et al. (2021) also did not observe differences in infants' development when comparing infants who were exposed in utero to the infection against unexposed infants. Additionally, we did not observe differences regarding the temperamental domains of negative emotionality and orienting/regulatory capacity, as well as touch sensory processing. The only significant difference that emerged between groups regarding the infant's outcomes was related to positive affectivity, suggesting that unexposed infants were perceived by their mothers as experiencing higher activity and pleasure, although it was closer to the significance threshold. In study 1, even though the lower number of infected mothers and infants, no significant association emerged between mother or infant diagnosis and infant's outcomes. These findings support the suggestion to explore the impact of the pandemic environment per se, even without mothers contracting the infection. However, it should be acknowledged that infants exposed in utero to other infections, such as HIV, might only reveal changes later throughout their development (Boivin et al., 2019; Wedderburn et al., 2019). Considering that study 2 only included children aged between 5 and 13 months and we did not explore differences between age in this study, we should not rule out the possibility that observable changes may appear later in life. In light of this, it is important to keep monitoring the developmental trajectories of those children, to better understand the possible impact and intervene as early as possible if necessary.

Following what was previously reported, it should be noted that age-related outcomes were observed on study 1. In fact, mothers of older infants reported that their children exhibited a lower range of motor, cognitive, language, socio-emotional and overall development, compared to the cross-cultural, age-standardized reference population. Studies about the reliability and validity of CREDI have neglected the inclusion of younger children (McCoy et al., 2021), which could translate into greater

fragility of the instrument to assess earlier outcomes, leading to unpredictable differences as children progress in age group. However, mothers of older infants also perceived their children as having a lower orienting/regulatory capacity, which was assessed through IBQ-Rvsf. They also perceived their children as more emotionally expressive, regardless of the positive or negative valence. Additionally, mothers of older infants reported to have experienced higher levels of COVID-19-related perinatal distress and higher maternal psychopathological symptomatology. The already available literature suggests that COVID-19-related perinatal distress could be a potential underlying mechanism for worst infant's outcomes (Buthmann & Gotlib, 2021; Shuffrey et al., 2021; Provenzi,et al., 2021a; Provenzi et al., 2021b). In conclusion, although some precaution must be considered when interpretating age-related findings, worst outcomes might in fact be observable over time but, at least in part, be associated with worst maternal experiences related to the COVID-19 pandemic.

In terms of the electroencephalographic activity assessed through resting-state EEG, we did not find significant differences between infants exposed in utero to SARS-CoV-2 and unexposed infants regarding the PSD in any electrode in the 6 – 9 Hz alpha band, neither in the 3 – 6 Hz theta band. To the best of our knowledge, this was the first study to explore the use of the Mentalab Explore Device in infants. The 6 – 9 Hz alpha band is the dominant frequency band in EEG studies in infancy (Norton et al., 2021) and it has been associated with basic cognitive processes (MacNeill et al., 2018). In its turn, the activity in the 3 – 6 Hz theta band has been linked to the expression of emotions (Saby & Marshall, 2012) and regulatory processes during infancy (Perone & Gartstein, 2019). These two frequency bands have been particularly explored in cases of childhood maltreatment and children raised in aversive environments, revealing lower levels of frequency power in the alpha band and higher levels in the theta band (Bick & Nelson, 2017; Zeanah et al., 2003; Marshall et al., 2004). In study 2, after EEG pre-processing procedures, we were only able to conduct the PSD analysis of 12 infants from the clinical group and of 11 infants from the control group. EEG studies with infants are always subject to high data loss due to artifacts and other variables, such as difficulties in behavioral regulation or reactivity to the EEG cap placement, leading to a small sample size (Azhari et al., 2020; DeBoer et al., 2013; Noreika et al., 2020; Perone & Gartstein, 2019), which was the case of our study. In its turn, a small sample size might lead to non-observable differences between groups (DeBoer et al., 2013).

Based on the already available literature on the impact of COVID-19 on perinatal distress, we hypothesized that children whose mothers reported higher levels of distress would present worst outcomes. In fact, we observed a tendency in study 1 for mothers with higher levels of distress to perceive their children as revealing lower socio-emotional ability (i.e. the ability to regulate behaviors

and emotions and to get along with others) and express higher negative emotionality (i.e. distress, sadness, and fear). COVID-19-related perinatal distress was also associated with higher levels of maternal anxiety and depressive symptomatology. Due to the transversal nature of the present study, we cannot attribute causality to these relationships. Nevertheless, these findings are in line with the previously reported literature. Particularly, Buthmann and Gotlib (2021) described that, during the COVID-19 pandemic, postnatal maternal depression was a mediator between prenatal somatization symptoms and infants' negative emotionality. In this way, the association between poor infant's outcomes and COVID-19-related perinatal distress, as observed in study 1, might be in part explained by maternal psychopathological symptomatology. In fact, previous studies had already linked maternal depressive symptomatology to the report of worst infants' temperamental outcomes (Erickson et al., 2017), which agrees with study 1, with mothers with higher total scores of anxiety and depressive symptomatology perceiving their children as expressing more negative emotionality and revealing lower regulatory capacity.

Our findings suggest that COVID-19 harmed the early tactile experiences between mother-newborn during hospitalization, with possible impairments in infants' outcomes. In fact, study 2 highlights that infected mother not only reported significantly higher levels of worry about their experiences, but they also perceived a worst impact of COVID-19 on those experiences, and skin-to-skin contact was more frequent when mothers were not infected. In its turn, study 1 revealed that the perception of a worst impact of COVID-19 on the mother-newborn early tactile experiences during hospitalization was associated with infant's higher negative emotionality and lower orienting/regulatory capacity, as well as with higher COVID-19-related perinatal distress. Farroni et al. (2022) proposed a conceptual framework where early tactile experiences, mediated through the C-tactile system (McGlone et al., 2014), might shape socio-emotional and cognitive developmental trajectories by supporting the physiological regulation and the development of the bodily self, and ultimately enabling the emergence of higher mechanisms of self-regulation, such as executive functions. The hindering effect of COVID-19 on early tactile experiences might then prevent the optimal functioning of this wellness-promoting system. The moderating role of mother-newborn separation found in study 1, also supports the previously reported findings about how the prevention of early tactile experiences can lead to severe and cascading developmental consequences (Cascio et al., 2019). Even considering that only 3.8% of mother-newborn dyads experienced separation in our sample, it was possible to observe an impact on socio-emotional development. In addition, findings from study 1 also suggest that less affectionate touch in mothers' childhood was related to maternal psychopathological symptomatology, which is

consistent with the results of Narvaez et al. (2019), who described a link between retrospective reports of childhood touch and psychopathology. In its turn, depressed mothers tend to interact less with their children (Peltola et al., 2014) and to resort less to positive touch (Herrera et al., 2004). Those findings highlight the impact that mothers' own experiences might have on the caregiver touch orientations. In fact, mothers who experienced less affective touch during their childhood were also more worried about the early tactile experiences with their children during hospitalization. On contrary, mothers who experience and enjoy more giving and receiving affectionate touch in their closer relationships perceived their children as exhibiting a higher range of overall development, particularly language ability. In this way, we suggest that the previously described model (Farroni et al., 2022) might benefit from the inclusion of the possible role that mother's own tactile experiences can play in the early tactile experiences with their children and in their neurodevelopmental trajectory.

One of the goals of the present dissertation was to explore the possible moderator effect of early tactile experiences in the relationship between COVID-19-related perinatal distress and infants' outcomes, particularly the role of skin-to-skin contact. Although the absence of skin-to-skin contact was associated with higher levels of COVID-19-related perinatal distress, maternal worry about early tactile experiences during hospitalization and to perceive as worst the impact of COVID-19 on those experiences, skin-to-skin contact was not associated with infants' outcomes. In the BabiesDuringCOVID online survey, we asked if mother-newborn skin-to-skin contact was experienced after delivery, but we did not specify the characteristics of this experience as defined by the World Health Organization (2017). In this way, we do not know at which time after delivery the skin-to-skin contact began and its duration, as we also did not ask about the reasons for not experiencing skin-to-skin contact. Based on the previously reported benefits of skin-to-skin contact on infants' physiological regulation (Carozza & Leong, 2021; Feldman et al., 2010), particularly on stress regulation (Hardin et al., 2020; Takahashi et al., 2011), and since the results suggest that skin-to-skin contact might be a potential buffer for COVID-19-related perinatal distress, a more specific definition of the skin-to-skin contact experience should be explored in future studies, making it possible to better capture its true impact.

Some limitations in the two studies should be acknowledged. First, infant's development, temperament and touch sensory processing was assessed through instruments whose validation for the Portuguese population is still ongoing. The unprecedent nature of the pandemic demanded an adaptation of the research context, and other advocated the development and use of ad-hoc instruments (e.g., Provenzi et al., 2021b). In the present dissertation, it was clear the absence of validated measures for the Portuguese population that would allow to determine the COVID-19

pandemic impact on infancy, especially through online reporting. For the same reason, there was also the absence of a Portuguese pre-pandemic normative sample, which made it impossible to compare our sample with Portuguese children born prior to the pandemic. Nevertheless, the research team was careful to find alternatives to assess infants using measures with internationally verified validity and reliability. This was the case of CREDI, that not only gave the opportunity to assess infant's development through maternal report online through a "culturally neutral" measure (Mc Coy et al., 2017), but also to provide a pre-pandemic cross-country reference sample (Seiden et al., 2021). Second, to control for other variables that may be associated with triggering higher levels of distress as well as infants' developmental changes, we considered exclusion criteria that can limit the generalization of our results to children with clinical conditions, such as prematurity. It should be noted that other studies that explored the impact of the pandemic on infancy used similar exclusion criteria (Deoni et al., 2021; Provenzi et al., 2020). Additionally, the analysis of the resting-state EEG was also conditioned by the electrodes' placement, which was chosen having in mind the implementation of a tactile EEG paradigm. Due to the limited number of electrodes and the location chosen, we could not explore possible right frontal asymmetry, which is one of the main markers studied in case of care deprivation and maternal psychopathology (Field et al., 1995); Hardin et al., 2021), and is associated with negative affect and emotional dysregulation (Grossmann, 2013; Hecht, 2010; Peltola et al., 2014). Finally, when conducting study 2, we experienced difficulties in recruiting participants (i.e. mother-baby dyad) during the pandemic and to be able to perform data collection with the imposed preventive measures, especially during the state of emergency. In the case of the clinical group, although we tried to expand our partnership network to another hospital, in order to include more mothers who tested positive at the time of delivery, we ended up not being able to proceed with the recruitment, thus being limited to the cases of only one hospital. However, the sample from study 1 revealed that the number of mothers diagnosed at the time of delivery was low (only 5 in 468). This suggests that the number of potential participants for the clinical group would still be limited, even resorting to other forms of recruitment. In the case of the control group, we had an after-invitation acceptance rate of 17.41% to participate in the face-to-face study. Despite having followed the previously defined inclusion and exclusion criteria, we ended up noticing that some mothers in the control group also experienced a diagnosis of COVID-19, albeit during the postpartum period. They also revealed high COVID-19-related perinatal distress, concern for their children's health due to COVID-19, and some mothers presented clinically significant psychopathological symptoms. It is then possible that mothers from the control group who agreed to participate in the face-to-face study might have been motivated to participate due to a greater concern

for their children as well as due to the distress they experienced. In this sense, although the two groups may end up being more homogeneous than planned, but at the same time revealing high heterogeneity within each group, due to the difficulties reported above, we could not recruit more participants to increase our sample and to solve these vulnerabilities. In this way, it should be considered that the non-observable differences between groups might not only be due to the small sample size, but also due to the characteristics of the sample itself.

To the best of our knowledge, this dissertation presents the first overview of the impact of COVID-19 pandemic on infants' neurodevelopmental outcomes in Portugal, and it is also one of the few to explore this impact worldwide, with a particular focus on the role of early tactile experiences. The relevance of the findings is linked to the emergency to understand the impact that COVID-19 may have on infancy and to provide guidance for the definition of intervention strategies. It is urgent to identify protective factors with potential to mitigate the adverse outcomes (Venta et al., 2021). In addition to highlighting the suggested "hidden pandemic" that might result from the COVID-19-related perinatal distress, our findings also stressed how early tactile experiences might also suffered from the pandemic context and, in turn, contribute to the infants' trajectory. Affective touch is a powerful force in human development (Cascio et al., 2019) and it is essential to mobilize all efforts for its promotion as early as possible. No children should be left behind on this demand, especially in such vulnerable times as during the COVID-19 pandemic.

References

Ackerley, R., Wasling, H. B., Liljencrantz, J., Olausson, H., Johnson, R. D., & Wessberg, J. (2014). Human C-Tactile Afferents Are Tuned to the Temperature of a Skin-Stroking Caress. *The Journal of Neuroscience, 34*(8), 2879–2883. https://doi.org/10.1523/JNEUROSCI.2847-13.2014

Alderman, H., Friedman, J., Ganga, P., Kak, M., & Rubio-Codina, M. (2021). Assessing the performance of the Caregiver Reported Early Development Instruments (CREDI) in rural India. *Annals of the New York Academy of Sciences*, *1492*(1), 58–72. https://doi.org/10.1111/nyas.14543

Almond, D. (2006). Is the 1918 Influenza Pandemic Over? Long-Term Effects of In Utero Influenza Exposure in the Post-1940 U.S. Population. *Journal of Political Economy*, *114*(4). 672-712. https://doi.org/10.1086/507154

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders: Fifth Edition*. American Psychiatric Association.

Araújo, L. A., Veloso, C. F., Souza, M. C., Azevedo, J. M. C., & Tarro, G. (2021). The potential impact of the COVID-19 pandemic on child growth and development: a systematic review. *Jornal de Pediatria*, 97 (4), 369-377. https://doi.org/10.1016/j.jped.2020.08.008

Augusto, A., Kumar, R., Calheiros, J. M., Matos, E., & Figueiredo, E. (1996). Post-natal depression in an urban area of Portugal: comparison of childbearing women and matched controls. *Psychological Medicine*, *26*(1), 135-141. https://doi.org/10.1017/s0033291700033778

Azhari, A., Truzzi, A., Neoh, M. J. Y., Balagtas, J. P. M., Tan, H. A. H., Goh, P. L. P., Ang, X. H. A., Setoh, P., Rigo, P., Bornstein, M. H., & Esposito, G. (2020). A decade of infant neuroimaging research: What have we learned and where are we going? *Infant Behavior and Development, 58*, 101389. https://doi.org/10.1016/j.infbeh.2019.101389

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of personality and social psychology*, *51*(6), 1173.

Bick, J., & Nelson, C. A. (2017). Early experience and brain development. *Wiley interdisciplinary reviews. Cognitive science*, *8*(1-2), 10.1002/wcs.1387. https://doi.org/10.1002/wcs.1387

Boggs, D., Milner, K. M., Chandna, J., Black, M., Cavallera, V., Dua, T., Fink, G., KC, A., Grantham-McGregor, S., Hamadani, H., Hughes, R., Manji, K., McCoy, D. C., Tann, C., & Lawn, J. E. (2019). Rating early child development outcome measurement tools for routine health programme use. *Archives of disease in childhood, 104(Suppl 1)*, S22-S33. https://doi.org/10.1136/archdischild-2018-315431

Boivin, M. J., Maliwichi-Senganimalunje, L., Ogwang, L. W., Kawalazira, R., Sikorskii, A., Familiar-Lopez, I., Kuteesa, A., Nyakato, M., Mutebe, A., Namukooli, J. L., Mallewa, M., Ruiseñor-Escudero, H., Aizire, J., Taha, T. E., & Fowler, M. G. (2019). Neurodevelopmental effects of ante-partum and post-partum antiretroviral exposure in HIV-exposed and uninfected children versus HIV-unexposed and uninfected children in Uganda and Malawi: a prospective cohort study. *The Lancet HIV*, *6*(8), e518–e530. https://doi.org/10.1016/S2352-3018(19)30083-9

Bremner, A. J., & Spence, C. (2017). The development of tactile perception. *Advances in Child Development and Behavior, 52*, 227–268. https://doi.org/10.1016/bs.acdb.2016.12.002

Buekens, P., Alger, J., Bréart, G., Cafferata, M. L., Harville, E., & Tomasso, G. (2020). A call for action for COVID-19 surveillance and research during pregnancy. *The Lancet Global Health, 8*(7), e877-e878. https://doi.org/10.1016/S2214-109X(20)30206-0

Buthmann, J., Finik, J., Ventura, G., Zhang, W., Shereen, A. D., & Nomura, Y. (2019). The children of Superstorm Sandy: Maternal prenatal depression blunts offspring electrodermal activity. *Biological Psychology*, *146*, 107716. https://doi.org/10.1016/j.biopsycho.2019.107716

Buthmann, J. L., & Gotlib, I. H. (2021). *Maternal Prenatal Somatization, Postnatal Depression, and Offspring Temperament During the COVID-19 Pandemic*. PsyArXiv. https://doi.org/10.31234/osf.io/sryx8

Carozza, S., & Leong, V. (2021). The Role of Affectionate Caregiver Touch in Early Neurodevelopment and Parent–Infant Interactional Synchrony. *Frontiers in Neuroscience, 14*. https://doi.org/10.3389/fnins.2020.613378

Cascio, C. J., Lorenzi, J., & Baranek, G. T. (2016). Self-reported pleasantness ratings and examiner-coded defensiveness in response to touch in children with ASD: effects of stimulus material and bodily location. *Journal of Autism and Developmental Disorders, 46*(5), 1528–1537. https://doi.org/10.1007/s10803-013-1961-1

Cascio, C. J., Moore, D., & McGlone, F. (2019). Social touch and human development. *Developmental Cognitive Neuroscience, 35*, 5-11. https://doi.org/10.1016/j.dcn.2018.04.009

Cohen, J.W. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Cohen, M. X. (2014). *Analyzing neural time series data: Theory and practice*. MIT press.

Costa, R. & Figueiredo, B. (2018). Infant behaviour questionnaire – revised version: a psychometric study in a Portuguese sample*. Journal of Reproductive and Infant Psychology, 36*(2), 207-218, DOI: 10.1080/02646838.2018.1436752

Cox, J. (2019). Thirty years with the Edinburgh postnatal depression scale: voices from the past and recommendations for the future. *The British Journal of Psychiatry, 214*(3), 127-129. https://doi.org/10.1192/bjp.2018.245.

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, R. J. (2000). Affective style, psychopathology, and resilience: Brain mechanisms and plasticity. *American Psychologist, 55*, 1196-1214. https://doi.org/10.1037/0003-066x.55.1196.

DeBoer, T., Scott, L. S., & Nelson, C. A. (2013). Methods for acquiring and analyzing infant event-related potentials. In M. de Haan (Ed.), *Infant EEG and Event-Related Potentials* (pp. 5 – 38). Psychology Press.

Deoni, S. C., Beauchemin, J., Volpe, A., Sa, V., & RESONANCE Consortium. (2021). *Impact of the COVID-19 Pandemic on Early Child Cognitive Development: Initial Findings in a Longitudinal Observational Study of Child Health*. MedRxiv: The Preprint Server for Health Sciences. https://doi.org/10.1101/2021.08.10.21261846

Direção Geral da Saúde [DGS]. (2020). *Orientação nº018/2020 de 30/03/2020: COVID-19: Fase De Mitigação: Gravidez e Parto*. https://www.apsei.org.pt/media/apsei/COVID-19/Orienta__es/18.pdf

Duhn, L. (2010). The importance of touch in the development of attachment. *Advances in Neonatal Care, 10*(6), 294–300. https://doi.org/10.1097/ANC.0b013e3181fd2263

Dunn, W. (2014). Sensory Profile 2: User's Manual. Pearson.

Easterlin, M. C., Crimmins, E. M., & Finch, C. E. (2021). Will prenatal exposure to SARS-CoV-2 define a birth cohort with accelerated aging in the century ahead? *Journal of Developmental Origins of Health and Disease*, *12*(5), 683–687. https://doi.org/10.1017/S204017442000104X

Erickson, N. L., Gartstein, M. A., & Dotson, J. A. W. (2017). Review of prenatal maternal mental health and the development of infant temperament. *Journal of Obstetric, Gynecologic, & Neonatal*

Nursing: Clinical Scholarship for the Care of Women, Childbearing Families, & Newborns, 46(4), 588–600. https://doi.org/10.1016/j.jogn.2017.03.008

Fairhurst, M. T., Loken, L., & Grossmann, T. (2014). Physiological and behavioral responses reveal 9-month-old infants' sensitivity to pleasant touch. *Psychol Sci, 25*(5), 1124-1131. https://doi.org/10.1177/0956797614527114

Fan, Y., Wang, H., Wu, Q., Zhou, X., Zhou, Y., Wang, B., Han, Y., Xue, T., & Zhu, T. (2021). SARS pandemic exposure impaired early childhood development in China. *Scientific Reports*, *11*(1). https://doi.org/10.1038/s41598-021-87875-8

Farroni, T., Longa, L. D., & Valori, I. (2022). The self-regulatory affective touch: a speculative framework for the development of executive functioning. *Current Opinion in Behavioral Sciences, 43*, 167-173. https://doi.org/10.1016/j.cobeha.2021.10.007

Feldman, R., Singer, M., & Zagoory, O. (2010). Touch attenuates infants' physiological reactivity to stress. *Developmental Science*, *13*(2), 271–278. https://doi.org/10.1111/j.1467-7687.2009.00890.x

Field, T., Fox, N. A., Pickens, J., & Nawrocki, T. (1995). Relative right frontal EEG activation in 3- to 6-month-old infants of "depressed" mothers. *Developmental Psychology, 31*(3), 358–363. https://doi.org/10.1037/0012-1649.31.3.358

Filippetti, M. L., Clarke, A. D. F., Dr, & Rigato, S. (2021). *The mental health crisis of expectant women in the UK: effects of the COVID-19 pandemic on prenatal mental health, antenatal attachment and social support*. PsyArXiv. https://doi.org/10.31234/osf.io/4328p

Foss-Feig, J. H., Heacock, J., & Cascio, C. J. (2012). Tactile responsiveness patterns and their association with core features in autism spectrum disorders. *Research in Autism Spectrum Disorders, 6*, 337–344. https://doi.org/10.1016/j.rasd.2011.06.007

Gartstein, M. A., & Rothbart, M. K. (2003). Studying infant temperament via the Revised Infant Behavior Questionnaire. *Infant Behavior and Development, 26*(1), 64-86. https://doi.org/10.1016/S0163-6383(02)00169-8

Giesbrecht, G. F., Bagshawe, M., van Sloten, M., MacKinnon, A. L., Dhillon, A., van de Wouw, M., Vaghef-Mehrabany, E., Rojas, L., Cattani, D., Lebel, C., & Tomfohr-Madsen, L. (2021). Protocol for the pregnancy during the covid-19 pandemic (pdp) study: A longitudinal cohort study of mental health among pregnant canadians during the covid-19 pandemic and developmental outcomes in their children. *JMIR Research Protocols*, *10*(4). https://doi.org/10.2196/25407

Gordon, I., Voos, A. C., Bennett, R. H., Bolling, D. Z., Pelphrey, K. A., Kaiser, M. D. (2013). Brain mechanisms for processing affective touch. *Human Brain Mapping, 34*(4), 914-922. https://doi.org/10.1002/hbm.21480

Green, J., Staff, L., Bromley, P., Jones, L., & Petty, J. (2021). The implications of face masks for babies and families during the COVID-19 pandemic: A discussion paper. *Journal of Neonatal Nursing*, 27 (1), 21-25. https://doi.org/10.1016/j.jnn.2020.10.005

Greenough, W. T., Black, J. E., Wallace, C. S. (1987). Experience and brain development. *Child Development, 58*, 539–559. https://doi.org/10.2307/1130197

Grossmann, T. (2013), Mapping Prefrontal Cortex Functions in Human Infancy. *Infancy, 18*, 303-324. https://doi.org/10.1111/infa.12016

Guo, C., Chen, G., He, P., Zhang, L., & Zheng, X. (2020). Risk of cognitive impairment in children after maternal exposure to the 1998 Yangtze River flood during pregnancy: analysis of data from China's second National Sample Survey on Disability. *The Lancet Planetary Health*, *4*(11), e522–e529. https://doi.org/10.1016/S2542-5196(20)30198-4

Hardin, J. S., Jones, N. A., Mize, K. D., & Platt, M. (2020). Parent-Training with Kangaroo Care Impacts Infant Neurophysiological Development & Mother-Infant Neuroendocrine Activity. *Infant Behavior and Development*, *58*. https://doi.org/10.1016/j.infbeh.2019.101416

Hardin, J. S., Jones, N. A., Mize, K. D., & Platt, M. (2021). Affectionate touch in the context of breastfeeding and maternal depression influences infant neurodevelopmental and temperamental substrates. *Neuropsychobiology, 80*(2), 158–175. https://doi.org/10.1159/000511604

Hecht D. (2010). Depression and the hyperactive right-hemisphere. *Neuroscience research*, *68*(2), 77–87. https://doi.org/10.1016/j.neures.2010.06.013

Herrera, E., Reissland, N., Shepherd, J. (2004). Maternal touch and maternal child-directed speech: effects of depressed mood in the postnatal period. *J. Affect. Disord. 81*, 29–39. http://dx.doi.org/10.1016/j.jad.2003.07.001.

Howland, M. A., Sandman, C. A., Davis, E. P., & Glynn, L. M. (2020). Prenatal maternal psychological distress and fetal developmental trajectories: Associations with infant temperament. *Development and Psychopathology*, *32*(5), 1685–1695. https://doi.org/10.1017/S095457942000142X

Huntley, B. J. F., Huntley, E. S., di Mascio, D., Chen, T., Berghella, V., & Chauhan, S. P. (2020). Rates of maternal and perinatal mortality and vertical transmission in pregnancies complicated by severe acute respiratory syndrome coronavirus 2 (SARS-Co-V-2) infection: A systematic review. *Obstetrics and Gynecology, 136*(2), 303–312. https://doi.org/10.1097/AOG.0000000000004010

Huntley, M. (1996). The Griffiths Mental Development Scales – from birth to 2 years (The 1996 Revision) (Portuguese translation by C. R. Ferreira, I. N. Carvalhão, I. C. Gil, M. M. Ulrich, & S. F. Fernandes). CEGOC-TEA.

Hyman, S. L., Levy, S. E., Myers, S. M., Council On Children With Disabilities, Section On Developmental And Behavioral Pediatrics (2020). Identification, Evaluation, and Management of Children With Autism Spectrum Disorder. *Pediatrics, 145*(1): e20193447. https://doi.org/10.1542/peds.2019-3447

Imboden, A., Sobczak, B. K., & Griffin, V. (2021). The impact of the COVID-19 pandemic on infant and toddler development. *Journal of the American Association of Nurse Practitioners*. https://doi.org/10.1097/JXX.0000000000000653

Ionio, C., Ciuffo, G., & Landoni, M. (2021). Parent–infant skin-to-skin contact and stress regulation: A systematic review of the literature. *International Journal of Environmental Research and Public Health, 18*(9). https://doi.org/10.3390/ijerph18094695

Jardine, J., Relph, S., Magee, L. A., von Dadelszen, P., Morris, E., Ross-Davie, M., Draycott, T., & Khalil, A. (2021). Maternity services in the UK during the coronavirus disease 2019 pandemic: a national survey of modifications to standard care. *BJOG: An International Journal of Obstetrics and Gynaecology*, *128*(5), 880-889. https://doi.org/10.1111/1471-0528.16547

Kaiser, M. D., Yang, D. Y. -J., Voos, A. C., Bennett, R. H., Gordon, I., Pretzsch, C., Beam, D., Keifer, C., Eilbott, J., McGlone, F., & Pelphrey, K.A. (2016). Brain mechanisms for processing affective (and nonaffective) touch are atypical in autism. *Cerebral Cortex, 26*(6), 2705-2714. https://doi.org/10.1093/cercor/bhv125

King, L. S., Feddoes, D. E., Kirshenbaum, J. S., Humphreys, K. L., & Gotlib, I. H. (2021). Pregnancy during the pandemic: The impact of COVID-19-related stress on risk for prenatal depression. *Psychological Medicine*, 1–11. https://doi.org/10.1017/S003329172100132X

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). The Guilford Press.

Kyle, M. H., & Dumitriu, D. (2021). The effect of coronavirus disease 2019 on newborns. *Current Opinion in Pediatrics*, *33*(6), 618-624. https://doi.org/10.1097/mop.0000000000001063

Laplante, D. P., Brunet, A., Schmitz, N., Ciampi, A., & King, S. (2008). Project ice storm: Prenatal maternal stress affects cognitive and linguistic functioning in 51/2-year-old children. *Journal of*

the American Academy of Child and Adolescent Psychiatry, *47*(9), 1063–1072. https://doi.org/10.1097/CHI.0b013e31817eec80

Levis, B., Negeri, Z., Sun, Y., Benedetti, A., Thombs, B. D. (2020). Accuracy of the Edinburgh postnatal depression scale (EPDS) for screening to detect major depression among pregnant and postpartum women: systematic review and meta-analysis of individual participant data. *BMJ*, 371:m4022. https://doi.org/10.1136/bmj.m4022

Li, Y., Tang, L., Bai, Y., Zhao, S., & Shi, Y. (2020). Reliability and validity of the Caregiver Reported Early Development Instruments (CREDI) in impoverished regions of China. *BMC Pediatrics*, *20*(1), 1-16. https://doi.org/10.1186/s12887-020-02367-4

Lin, S. H., Cermak, S., Coster, W. J., & Miller, L. (2005). The relation between length of institutionalization and sensory integration in children adopted from Eastern Europe. *American Journal of Occupational Therapy, 59*(2), 139–147. https://10.5014/ajot.59.2.139

MacNeill, L. A., Ram, N., Bell, M. A., Fox, N. A., & Pérez-Edgar, K. (2018). Trajectories of infants' biobehavioral development: Timing and rate of A-Not-B performance gains and EEG maturation. *Child Development, 89*(3), 711–724. https://doi.org/10.1111/cdev.13022

Maitre, N. L., Key, A. P., Chorna, O. D., Slaughter, J. C., Matusz, P. J., Wallace, M. T., & Murray, M. M. (2017). The dual nature of early-life experience on somatosensory processing in the human infant brain. *Current Biology, 27*(7), 1048-1054. https://doi.org/10.1016/j.cub.2017.02.036

Marshall, P. J., Fox, N. A., & the BEIP Core Group. (2004). A comparison of the electroencephalogram between institutionalized and community children in Romania. *Journal of Cognitive Neuroscience,16*, 1327–1338. https://doi.org/10.1162/0898929042304723

McCoy, D. C., Sudfeld, C. R., Bellinger, D. C., Muhihi, A., Ashery, G., Weary, T. E., Fawzi, W., & Fink, G. (2017). Development and validation of an early childhood development scale for use in low-resourced settings. *Population health metrics*, *15*, 1-18. https://doi.org/10.1186/s12963-017-0122-8

McCoy, D. C., Seiden, J., Waldman, M., & Fink, G. (2021). Measuring early childhood development: considerations and evidence regarding the Caregiver Reported Early Development Instruments. *Annals of the New York Academy of Sciences, 1492*(1), 3-10. https://doi.org/10.1111/nyas.14598

McGlone, F., Olausson, H., Boyle, J.A., Jones-Gotman, M., Dancer, C., Guest, S., Essick, G. (2012). Touching and feeling: Differences in pleasant touch processing between glabrous and hairy skin in humans. *European Journal of Neuroscience, 35*(11), 1782-1788. https://doi.org/10.1111/j.1460-9568.2012.08092.x

McGlone, F., Wessberg, J., & Olausson, H. (2014). Discriminative and affective touch: sensing and feeling. *Neuron, 82*, 737–755. https://doi.org/10.1016/j.neuron.2014.05.001

Mesquita, A. R., Antunes, J., Pereira, R., Martins, S., Soares, I., & Sampaio, A. (2020). *Escala de Impacto do Coronavírus nas Experiências Perinatais (EICEP - II)*. https://mfr.osf.io/render?url=https://osf.io/kwqxe/?direct%26mode=render%26action=download%26mode=render

Mesquita, A., Costa, R., Bina, R., Cadarso-Suárez, C., Gude, F., Díaz-Louzao, C., Dikmen-Yildiz, P, Osorio, A., Mateus, V., Domínguez-Salas, S., Vousoura, E., Levy, D., Alfayumi-Zeadna, S., Wilson, C. A., Contreras-García, Y., Saldivia, S., Christoforou, A., Hadjigeorgiou, E., Felice, E., (...) & Riseup-PPD-COVID-19 Group (2021). *Impact of Governmental responses to the COVID-19 pandemic on perinatal mental health: Evidence from 12 countries.* [Manuscript submitted for publication].

Miguel, H. O., Gonçalves, Ó. F, Cruz, S., & Sampaio, A. (2019a). Infant brain response to affective and discriminative touch: A longitudinal study using fNIRS. *Social Neuroscience, 14*(5), 571-582. https://doi.org/10.1080/17470919.2018.1536000

Miguel, H. O., Gonçalves, Ó. F, & Sampaio, A. (2020). Behavioral response to tactile stimuli relates to brain response to affective touch in 12-month-old infants. *Developmental Psychobiology, 62*(1), 107-115. doi: 10.1002/dev.21891

Miguel, H. O., Lisboa, I. C., Gonçalves, Ó. F., & Sampaio, A. (2019b). Brain mechanisms for processing discriminative and affective touch in 7-month-old infants. *Developmental Cognitive Neuroscience, 35*, 20-27. 10.1016/j.dcn.2017.10.008

Montagu, A. (1986). Touching: *The Human Significance of the Skin*. New York: Perennial Library.

Moore, E. R., Bergman, N., Anderson, G. C., & Medley, N. (2016). Early skin-to-skin contact for mothers and their healthy newborn infants. *Cochrane Database of Systematic Reviews* (11). https://doi.org/10.1002/14651858.CD003519.pub4

Morrison, I., Löken, L. S., & Olausson, H. (2010). The skin as a social organ. *Experimental Brain Research, 204*, 305–314. https://10.1007/s00221-009-2007-y

Motrico, E., Bina, R., Domínguez-Salas, S., Mateus, V., Contreras-García, Y., Carrasco-Portiño, M., Ajaz, E., Apter, G., Christoforou, A., Dikmen-Yildiz, P., Felice, E., Hancheva, C., Vousoura, E., Wilson, C. A., Buhagiar, R., Cadarso-Suárez, C., Costa, R., Devouche, E., Ganho-Ávila, A., Gómez-Baya, D., ... Riseup-PPD-COVID-19 Group (2021). Impact of the Covid-19 pandemic on perinatal mental health (Riseup-PPD-COVID-19): protocol for an international prospective cohort study. *BMC public health*, *21*(1), 368. https://doi.org/10.1186/s12889-021-10330-w

Narvaez, D., Wang, L., Cheng, A., Gleason, T. R., Woodbury, R., Kurth, A., & Lefever, J. B. (2019). The importance of early life touch for psychosocial and moral development. *Psicologia: Reflexão e Crítica*, *32*(16), https://doi.org/10.1186/s41155-019-0129-0

Nomura, Y., Davey, K., Pehme, P. M., Finik, J., Glover, V., Zhang, W., Huang, Y., Buthmann, J., Dana, K., Yoshida, S., Tsuchiya, K. J., Li, X. B., & Ham, J. (2019). Influence of in utero exposure to maternal depression and natural disaster-related stress on infant temperament at 6 months: The children of Superstorm Sandy. *Infant Mental Health Journal*, *40*(2), 204–216. https://doi.org/10.1002/imhj.21766

Noreika, V., Georgieva, S., Wass, S., & Leong, V. (2020). 14 challenges and their solutions for conducting social neuroscience and longitudinal EEG research with infants. *Infant Behavior and Development, 58*, 1013933. https://doi.org/10.1016/j.infbeh.2019.101393

Norman, M., Navér, L., Söderling, J., Ahlberg, M., Hervius Askling, H., Aronsson, B., Byström, E., Jonsson, J., Sengpiel, V., Ludvigsson, J. F., Håkansson, S., & Stephansson, O. (2021). Association of Maternal SARS-CoV-2 Infection in Pregnancy with Neonatal Outcomes. *JAMA - Journal of the American Medical Association*, *325*(20), 2076-2086. https://doi.org/10.1001/jama.2021.5775

Norton, E. S., MacNeill, L. A., Harriott, E. M., Allen, N., Krogh-Jespersen, S., Smyser, C. D., Rogers, C. E., Smyser, T. A., Luby, J., & Wakschlag, L. (2021). EEG/ERP as a pragmatic method to expand the reach of infant-toddler neuroimaging in HBCD: Promises and challenges. Developmental Cognitive Neuroscience, 51, 100988. https://doi.org/10.1016/j.dcn.2021.100988

Olausson, H., Wessberg, J., Morrison, I., McGlone, F., & Vallbo, A., (2010). The neurophysiology of unmyelinated tactile afferents. *Neuroscience & Biobehavioral Reviews, 34*(2), 185– 191. https://doi.org/10.1016/j.neubiorev.2008.09.011

Orekhova, E. V., Stroganova, T. A., Posikera, I. N., & Elam, M. (2006). EEG theta rhythm in infants and preschool children. *Clinical Neurophysiology, 117*(5),1047–1062. https://doi.org/10.1016/j.clinph.2005.12.027

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

Pallant, J. (2016). SPSS survival manual: A step by step guide to data analysis using IBM SPSS (6th ed.). McGraw-Hill Education.

Peltola, M. J., Bakermans-Kranenburg, M. J., Alink, L. R., Huffmeijer, R., Biro, S., & van IJzendoorn, M. H. (2014). Resting frontal EEG asymmetry in children: meta-analyses of the effects of psychosocial risk factors and associations with internalizing and externalizing behavior. *Developmental psychobiology*, *56*(6), 1377–1389. https://doi.org/10.1002/dev.21223

Pereira, A. R., Antunes, J., Trotter, P. D., McGlone, F., González-Villar, A. J., & Sampaio, A. (2021). Translation and validation of the European Portuguese version of the Touch Experiences and Attitudes Questionnaire (TEAQ) [Manuscript submitted for publication]. University of Minho and Liverpool John Moores University.

Perone, S., & Gartstein, M. A. (2019). Relations between dynamics of parent-infant interactions and baseline EEG functional connectivity. *Infant Behavior and Development*, *57*, 101344. https://doi.org/10.1016/j.infbeh.2019.101344

Picton, T. W., Bentin, S., Berg, P., Donchin, E., Hillyard, S. A., Johnson, R., Jr, Miller, G. A., Ritter, W., Ruchkin, D. S., Rugg, M. D., & Taylor, M. J. (2000). Guidelines for using human event-related potentials to study cognition: recording standards and publication criteria. *Psychophysiology, 37*(2), 127–152.

Poon, L. C., Yang, H., Lee, J. C. S., Copel, J. A., Leung, T. Y., Zhang, Y., Chen, D., Prefumo, F. (2020). ISUOG Interim Guidance on 2019 novel coronavirus infection during pregnancy and puerperium: information for healthcare professionals. *Ultrasound in Obstetrics & Gynecology, 55*, 700 – 708. https://doi.org/10.1002/uog.22013

Pope, J., Olander, E. K., Leitao, S., Meaney, S., & Matvienko-Sikar, K. (in press). Prenatal stress, health, and health behaviours during the COVID-19 pandemic: An international survey. *Women and Birth*. https://doi.org/10.1016/j.wombi.2021.03.007

Provenzi, L., & Grumi, S. (2021). The Need to Study Developmental Outcomes of Children Born During the COVID-19 Pandemic. *JAMA Pediatrics*. https://doi.org/10.1001/jamapediatrics.2021.4342

Provenzi, L., Grumi, S., Altieri, L., Bensi, G., Bertazzoli, E., Biasucci, G., Cavallini, A., Decembrino, L., Falcone, R., Freddi, A., Gardella, B., Giacchero, R., Giorda, R., Grossi, E., Guerini, P., Magnani, M. L., Martelli, P., Motta, M., Nacinovich, R., … Borgatti, R. (2021a). Prenatal maternal stress during the COVID-19 pandemic and infant regulatory capacity at 3 months: A longitudinal study. *Development and Psychopathology*, 1–9. https://doi.org/10.1017/S0954579421000766

Provenzi, L., Mambretti, F., Villa, M., Grumi, S., Citterio, A., Bertazzoli, E., Biasucci, G., Decembrino, L., Falcone, R., Gardella, B., Longo, M. R., Nacinovich, R., Pisoni, C., Prefumo, F., Orcesi, S., Scelsa, B., Giorda, R., & Borgatti, R. (2021b). Hidden pandemic: COVID-19-related stress, SLC6A4 methylation, and infants' temperament at 3 months. *Scientific Reports*, *11*(1). https://doi.org/10.1038/s41598-021-95053-z

Puopolo, K. M., Hudak, M. L., Kimberlin, D. W., Cummings, J. (2020). *Initial Guidance: Management of Infants Born to Mothers with COVID-19*. American Academy of Pediatrics Committee on Fetus

and Newborn, Section on Neonatal Perinatal Medicine, and Committee on Infectious Diseases. https://downloads.aap.org/AAP/PDF/COVID%2019%20Initial%20Newborn%20Guidance.pdf

Putnam, S. P., Helbig, A., Gartstein, M.A., Rothbart, M.K. & Leerkes, E. M. (2014). Development and assessment of short and very short forms of the Infant Behavior Questionnaire-Revised. *Journal of Personality Assessment, 96,* 445-458. https://doi.org/10.1080/00223891.2013.841171

Rao, S. P. N., Minckas, N., Medvedev, M. M., Gathara, D., Y N, P., Estifanos, A. S., Silitonga, A. C., Jadaun, A. S., Adejuyigbe, E. A., Brotherton, H., Arya, S., Gera, R., Ezeaka, C. v., Gai, A., Gobezayehu, A. G., Dube, Q., Kumar, A., Naburi, H., Chiume, M., ... Lawn, J. E. (2021). Small and sick newborn care during the COVID-19 pandemic: Global survey and thematic analysis of healthcare providers' voices and experiences. *BMJ Global Health*, *6*(3). https://doi.org/10.1136/bmjgh-2020-004347

Royal College of Obstetricians and Gynaecologists. (2021). Coronavirus (COVID-19) Infection in Pregnancy 2021 [Version 14.1: updated November 2 2021]. https://www.rcog.org.uk/globalassets/documents/guidelines/2021-11-02-coronavirus-covid-19-infection-in-pregnancy-v14.1.pdf.

Saby, J. N., & Marshall, P. J. (2012). The utility of EEG band power analysis in the study of infancy and early childhood. *Developmental Neuropsychology*, 37(3), 253-273). https://doi.org/10.1080/87565641.2011.614663

Sánchez-Luna, M., Colomer, B. F., Romero, C. A., Allen, A. A., Souto, A. B., Longueira, F. C., Badía, M. C., Pradell, Z. G., López, M. G., Cruz, M., Herrera, L., Bautista, C. R., García, L. S., Flores, E. Z., & SENEO COVID-19 Registry Study Group. (2021). Neonates Born to Mothers With COVID-19: Data From the Spanish Society of Neonatology Registry. *Pediatrics*, *147*(2): e2020015065. https://doi.org/10.1542/peds.2020-015065

Seiden, J., Waldman, M., McCoy, D. C., & Fink, G. (2021). *Caregiver-Reported Early Development Instruments: Data Management & Scoring Manual*. https://credi.gse.harvard.edu/files/credi/files/credi_scoring_manual_15-october-2021.pdf

Shuffrey, L. C., Firestein, M. R., Kyle, M., Fields, A., Alcántara, C., Amso, D., Austin, J., Bain, J. M., Barbosa, J., Bence, M., Bianco, C., Fernández, C., Goldman, S., Gyamfi-Bannerman, C., Hott, V., Hu, Y., Hussain, M., Factor-Litvak, P., Lucchini, M., ... Dumitriu, D. (2021). *Birth during the COVID-19 pandemic, but not maternal SARS-CoV-2 infection during pregnancy, is associated with lower neurodevelopmental scores at 6-months*. MedRxiv: The Preprint Server for Health Sciences. https://doi.org/10.1101/2021.07.12.21260365

Simpson, W., Glazer, M., Michalski, N., Steiner, M., Frey, B. N. (2014). Comparative efficacy of the generalized anxiety disorder 7-item scale and the Edinburgh postnatal depression scale as screening tools for generalized anxiety disorder in pregnancy and the postpartum period. *The Canadian Journal of Psychiatry,59*, 434–40. https://doi.org/10.1177/070674371405900806

Smirni, D., Smirni, P., Carotenuto, M., Parisi, L., Quatrosi, G., & Roccella, M. (2019). Noli Me Tangere: Social Touch, Tactile Defensiveness, and Communication in Neurodevelopmental Disorders. *Brain Sciences, 9*(12), 368. https://doi.org/10.3390/brainsci9120368

Sousa, T. V., Viveiros, V., Chai, M. V., Vicente, F. L., Jesus, G., Carnot, M. J., Gordo, A. C. & Ferreira, P. L. (2015). Reliability and validity of the Portuguese version of the Generalized Anxiety Disorder (GAD-7) scale. *Health and Quality of Life Outcomes*, *13*(1), 1-8. https://doi.org/10.1186/s12955-015-0244-2

Spitzer, R. L., Kroenke, K., Williams, J. B. W., Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med, 166*(10), 1092-1097. https://doi.org/10.1001/archinte.166.10.1092

Stein, A., Pearson, R. M., Goodman, S. H., Rapa, E., Rahman, A., McCallum, M., Howard, L. M., & Pariante, C. M. (2014). Effects of perinatal mental disorders on the fetus and child. *The Lancet*, 384 (9956), 1800-1819. https://doi.org/10.1016/S0140-6736(14)61277-0

Takahashi, Y., Tamakoshi, K., Matsushima, M., & Kawabe, T. (2011). Comparison of salivary cortisol, heart rate, and oxygen saturation between early skin-to-skin contact with different initiation and duration times in healthy, full-term infants. *Early Human Development*, *87*(3), 151–157. https://doi.org/10.1016/j.earlhumdev.2010.11.012

Taylor, M. J., & Baldeweg, T. (2002). Application of EEG, ERP and intracranial recordings to the investigation of cognitive functions in children. Developmental Science, 5, 318–334. https://doi.org/10.1111/1467-7687.00372

Thomason, M. E., Graham, A., & VanTieghem, M. R. (2020). *COPE: Coronavirus Perinatal Experiences - Impact Survey (COPE-IS).* https://www.nlm.nih.gov/dr2/COPE-Impact_Survey_Perinatal_Pandemic_Survey.pdf

Trocado, V., Silvestre-Machado, J., Azevedo, L., Miranda, A., & Nogueira-Silva, C. (2020). Pregnancy and COVID-19: a systematic review of maternal, obstetric and neonatal outcomes. *Journal of Maternal-Fetal and Neonatal Medicine*, 1-13. https://doi.org/10.1080/14767058.2020.1781809

Trotter, P. D., McGlone, F., Reniers, R. L. E. P., & Deakin, J. F. W. (2018). Construction and validation of the touch experiences and attitudes questionnaire (TEAQ): a self-report measure to determine attitudes toward and experiences of positive touch. *Journal of nonverbal behavior*, *42*(4), 379-416. https://doi.org/10.1007/s10919-018-0281-8

United Nations Development Programme. (2020). *Brief#2: Putting The Un Framework For Socio-Economic Response To Covid-19 Into Action: Insights*. https://www.undp.org/content/dam/undp/library/covid19/Brief2-COVID-19-final-June2020.pdf

Van den Bergh, B. R. H., Dahnke, R., & Mennes, M. (2018). Prenatal stress and the developing brain: Risks for neurodevelopmental disorders. *Development and Psychopathology*, *30*(3), 743–762. https://doi.org/10.1017/S0954579418000342

Van den Bergh, B. R. H., van den Heuvel, M. I., Lahti, M., Braeken, M., de Rooij, S. R., Entringer, S., Hoyer, D., Roseboom, T., Räikkönen, K., King, S., & Schwab, M. (2020). Prenatal developmental origins of behavior and mental health: The influence of maternal stress in pregnancy. *Neuroscience and Biobehavioral Reviews*, 117, 26-64. https://doi.org/10.1016/j.neubiorev.2017.07.003

Vasung, L., Abaci Turk, E., Ferradal, S. L., Sutin, J., Stout, J. N., Ahtam, B., Lin, P. Y., & Grant, P. E. (2019). Exploring early human brain development with structural and physiological neuroimaging. *NeuroImage, 187*, 226–254. https://doi.org/10.1016/j.neuroimage.2018.07.041

Venta, A., Bick, J., & Bechelli, J. (2021). COVID-19 threatens maternal mental health and infant development: possible paths from stress and isolation to adverse outcomes and a call for research and practice. *Child Psychiatry and Human Development, 52*(2), 200-204. https://doi.org/10.1007/s10578-021-01140-7

Walder, D. J., Laplante, D. P., Sousa-Pires, A., Veru, F., Brunet, A., & King, S. (2014). Prenatal maternal stress predicts autism traits in 61/2 year-old children: Project Ice Storm. *Psychiatry Research*, *219*(2), 353–360. https://doi.org/10.1016/j.psychres.2014.04.034

Waldman, M., McCoy, D. C., Seiden, J., Cuartas, J., CREID Field Team, & Fink, G. (2021). Validation of motor, cognitive, language, and socio-emotional subscales using the Caregiver Reported Early Development Instruments: An application of multidimensional item factor analysis.

International Journal of Behavioral Development, *45*(4), 368–377. https://doi.org/10.1177/01650254211005560

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S., & Ho, R. C. (2020). Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *International Journal of Environmental Research and Public Health*, *17*(5). https://doi.org/10.3390/ijerph17051729

Wang, L., Shi, Y., Xiao, T., Fu, J., Feng, X., Mu, D., Feng, Q., Hei, M., Hu, X., Li, Z., Lu, G., Tang, Z., Wang, Y., Wang, C., Xia, S., Xu, J., Yang, Y., Yang, J., Zeng, M., ... on behalf of the Working Committee on Perinatal and Neonatal Management for the Prevention and Control of the 2019 Novel Coronavirus Infection (2020). Chinese expert consensus on the perinatal and neonatal management for the prevention and control of the 2019 novel coronavirus infection. *Annals of Translational Medicine*, *8*(3), 47–54. https://doi.org/10.21037/atm.2020.02.20

Wedderburn, C. J., Yeung, S., Rehman, A. M., Stadler, J. A. M., Nhapi, R. T., Barnett, W., Myer, L., Gibb, D. M., Zar, H. J., Stein, D. J., & Donald, K. A. (2019). Neurodevelopment of HIV-exposed uninfected children in South Africa: outcomes from an observational birth cohort study. *The Lancet Child and Adolescent Health*, *3*(11), 803–813. https://doi.org/10.1016/S2352-4642(19)30250-0

Wilbarger, J., Gunnar, M., Schneider, M., & Pollak, S. (2010). Sensory processing in internationally adopted, post-institutionalized children. *Journal of Child Psychology and Psychiatry, 51*(10), 1105–1114. https://doi.org/10.1111/j.1469-7610.2010.02255.x

World Health Organization. (2017). *Protecting, Promoting and Supporting Breastfeeding in Facilities Providing Maternity and Newborn Services.* http://apps.who.int/iris/bitstream/handle/10665/259386/9789241550086-eng.pdf?sequence=1

World Health Organization. (2020a, March). *WHO Director-General's opening remarks at the media briefing on COVID-19 – 11 March 2020*. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—11-march-2020

World Health Organization. (2020b, April). *Interim recommendations on obligatory hand hygiene against transmission of COVID-19.* https://cdn.who.int/media/docs/default-source/inaugural-who-partners-forum/who-interim-recommendation-on-obligatory-hand-hygiene-against-transmission-of-covid-199df7efde-8250-4502-8e4e-7259cf45b020.pdf?sfvrsn=b88e44a5_1&download=true

World Health Organization. (2021). *Weekly operational update on COVID-19 - 30 November 2021*. https://www.who.int/docs/default-source/coronaviruse/weekly-updates/20211129_wou_82_rev.pdf?sfvrsn=4da20e6a_5&download=true

Xie, M., Wang, X., Zhang, J., & Wang, Y. (2021). Alteration in the psychologic status and family environment of pregnant women before and during the COVID-19 pandemic. *International Journal of Gynecology and Obstetrics*, *153*(1), 71–75. https://doi.org/10.1002/ijgo.13575

Appendix A

Descriptive statistics and gender-related differences [Study 1]

Table A1

Descriptive statistics for sociodemographic variables [Study 1]

Variables	*n* (%)
Mother's birth country	
1 = Portugal	505 (96.4)
2 = Other	19 (3.6)
Mother's Educational Level	
0 = Secondary Education or lower	95 (18.1)
1 = Higher Education	428 (81.7)
Missing	1 (.2)
Father's Educational Level	
0 = Secondary Education or lower	224 (42.7)
1 = Higher Education	297 (56.7)
Missing	3 (.6)
Mother Living with partner	
0 = No or not applied	11 (2.1)
1 = Yes	513 (97.9)
Household Income	
0 = 1745€ or less	253 (48.3)
1 = More than 1745€	271 (51.7)

Variables	*n*	Range	*M*	*SD*
Mother's age (years)	524	20 - 46	32.94	4.400
Father's age (years)	520	23 - 61	35.09	5.596
Infant's age (months)	524	0 - 12	5.42	3.094

Table A2

Descriptive statistics for newborn characteristics [Study 1]

Variables	*n* (%)
1st child (Sibling Position)	
0 = No	190 (36.3)
1 = Yes	334 (63.7)
1st pregnancy	
0 = No	222 (42.4)
1 = Yes	302 (57.6)
Planned pregnancy	
0 = No	92 (17.6)
1 = Yes	432 (82.4)
High-Risk pregnancy	
0 = No	352 (67.2)
1 = Yes	172 (32.8)
Cesarean delivery	
0 = No	358 (68.3)
1 = Yes	166 (31.7)
NICU care	
0 = No	503 (96.0)
1 = Yes	21 (4.0)

Variables	*n*	Range	*M*	*SD*
Gestational Age (weeks)	524	37 - 42	39.21	1.119
Birth weight (Kg)	524	1.860 - 5.350	3.238	.439
Birth length (cm)	523	38.50 - 60.00	48.815	2.171
APGAR 5th minute	524	8 - 10	9.87	.371

Table A3

Descriptive statistics and gender-related differences for infants' developmental and temperamental outcomes [Study 1]

	n	Range	*Mdn*	*IQR*	*M*	*SD*	Gender-related differences				
							Male *M (SD)*	Female *M (SD)*	*t*	*p*	Cohen's d
COG	524	-2.372 - 2.297	.061	.872	.024	.660	.004 (.660)	.045 (.661)	-.700	.484	-.061
LAN	524	-2.591 - 2.319	.082	1.045	.040	.741	.006 (.733)	.075 (.749)	-1.065	.288	-.093
MOT	524	-2.144 - 2.143	.026	.644	.010	.545	.015 (.553)	.004 (.537)	.232	.817	.020
SEM	524	-1.999 - 2.182	.129	.883	.107	.684	.090 (.699)	.124 (.669)	-.574	.566	-.050
OVL	524	-1.509 - 2.388	.512	.714	.438	.553	.434 (.562)	.441 (.546)	-.151	.880	-.013
PAS	353	1.500 - 6.636	4.727	1.511	4.507	1.047	4.506 (1.044)	4.508 (1.053)	-.015	.988	-.002
NEG	353	1.38 - 6.57	4.000	1.784	4.003	1.109	3.976 (1.085)	4.030 (1.135)	-.460	.646	-.049
ORC	353	2.83 - 6.88	5.417	.961	5.388	.714	5.440 (.686)	5.334 (.740)	1.389	.166	.148

Note 1. Norm-referenced standardized z-scores of CREDI domains: COG = Cognitive; LAN = Language; MOT = Motor; SEM = Socio-Emotional; OVL = Overall.

Note 2. IBQ-Rvsf domains: PAS = Positive Affectivity/Surgency; NEG = Negative Emotionality; ORC = Orienting/Regulatory Capacity.

Table A4

Descriptive statistics for perinatal and early tactile experiences *[Study 1]*

Variables	*n* (%)
No presence of support (e.g. partner, family) at delivery	
0 = Presence	325 (62.0)
1 = No presence	199 (38.0)
No Family and friends visits after delivery due to COVID-19	
0 = Visits	29 (5.5)
1 = No visits	495 (94.5)
Mother-newborn separation during long period after delivery	
0 = No separation	504 (96.2)
1 = Separation	20 (3.8)
Mother-newborn Skin-to-skin contact	
0 = No	93 (17.7)
1 = Yes	431 (82.3)
Mother's diagnosis of COVID-19	
0 = No	435 (83.0)
1 = Yes	33 (6.3)
Missing	56 (10.7)
Infant's diagnosis of COVID-19	
0 = No	460 (87.8)
1 = Yes	8 (1.5)
Missing	56 (10.7)

Variables	*n*	Range	*Mdn*	*IQR*
Worry about mother-newborn tactile experiences during hospitalization	524	1 - 5	1.00	2
Impact of COVID-19 on mother-newborn tactile experiences during hospitalization	524	1 - 7	4.00	0
Worry about infant's health due to COVID-19	467	1 - 7	5.00	2
COVID-19-related perinatal distress	524	1 - 7	4.00	2

Table A5

Descriptive statistics for maternal mental health and maternal experiences and attitudes towards touch [Study 1]

Variables	***n* (%)**
Mother's history of mood and/or anxiety disorder	
0 = No	382 (72.9)
1 = Yes	79 (15.1)
Missing	63 (12.0)
History of maternal mental health treatment	
0 = No	354 (67.6)
1 = Yes	107 (20.4)
Missing	63 (12.0)
Current maternal mental health treatment	
0 = No	424 (80.9)
1 = Yes	36 (6.9)
Missing	64 (12.2)

Variables	***n***	**Range**	***Mdn***	***IQR***	***M***	***SD***
GAD	458	0 - 21	6.00	6.000	6.788	4.904
EPDS	454	0 - 29	8.000	8.000	8.555	5.320
FFT	313	1.36 – 5.00	3.545	1.32	3.480	.871
ChT	313	1.22 – 5.00	4.222	1.44	3.999	.902

Note 1. GAD = General Anxiety Disorder-7 total score; EPDS = Edinburgh Postnatal Depression Scale total score

Note 2. TEAQ domains: FFT = Friends and Family Touch; ChT = Childhood Touch

Appendix B

Correlations between variables of interest while controlling the effect of infant's age [Study 1]

Table B1

Pearson's Correlations between infants' outcomes, maternal psychopathological symptomatology, and maternal attitudes and experiences towards touch, while controlling the effect of infant's age [Study 1]

Variables	COG	LAN	MOT	SEM	OVL	PAS	NEG	ORC	GAD	EPDS	FFT	ChT
COG	–											
LAN	.705***	–										
MOT	.726***	.534***	–									
SEM	.946***	.658***	.636***	–								
OVL	837***	.672***	.862***	.780***	–							
PAS	.253***	.112*	.420***	.170***	.313***	–						
NEG	-.044	-.071	-.010	-.063	-.082	.063	–					
ORC	.057	.070	.034	.029	.075	.281***	-.208***	–				
GAD	-.032	-.050	.019	-.048	-.062	.012	.271***	-.111***	–			
EPDS	-.018	-.040	-.013	-.028	-.081	-.032	.232***	-.134*	.779***	–		
FFT	.094	.129*	.069	.087	.146**	.285***	-.028	.131*	-.098	-.091	–	
ChT	.026	.109	-.032	.053	.055	.128	-.076	.092	-.227***	-.233***	.522***	–

Note 1. CREDI: COG = Cognitive; LAN = Language; MOT = Motor; SEM = Socio-Emotional; OVL = Overall.

Note 2. IBQ-Rvsf: PAS = Positive Affectivity/Surgency; NEG = Negative Emotionality; ORC = Orienting/Regulatory Capacity.

Note 3. GAD = General Anxiety Disorder-7 total score; EPDS = Edinburgh Postnatal Depression Scale total score

Note 4. TEAQ: FFT = Friends and Family Touch; ChT = Childhood Touch

*p≤.05 ** p ≤.01; *** p ≤ .001

Table B2

Spearman's Correlations between perinatal experiences and infants' outcomes, while controlling the effect of infant's age [Study 1]

Variables	COG	LAN	MOT	SEM	OVL	PAS	NEG	ORC	1	2	3
COVID-19-related perinatal distress (1)	-.059	.019	-.004	-.094*	-.032	.029	.187***	-.017	—		
Worry about early tactile experiences (2)	.070	.042	.013	.055	.028	-.034	.192***	-.041	.200***	–	
Impact of COVID-19 on early tactile experiences (3)	-.011	-.046	-.037	-.011	-.032	-.011	.219***	-.153**	.270***	.398***	—
Skin-to-skin contact	.062	.044	.031	.058	.056	.072	-.047	.100	-.129**	-.180***	-.142***
Mother-newborn separation	-.080	-.052	-.046	-.100*	-.065	-.032	.074	-.077	.156***	.079	.243***
Mother COVID-19 diagnosis	-.045	-.076	-.052	-.031	-.086	-.069	.025	-.097	-.018	.066	.097*
Infant COVID-19 diagnosis	.023	.027	-.008	.047	-.011	-.035	.014	-.060	-.008	.006	.081

Note 1. CREDI: COG = Cognitive; LAN = Language; MOT = Motor; SEM = Socio-Emotional; OVL = Overall.

Note 2. IBQ-Rvsf: PAS = Positive Affectivity/Surgency; NEG = Negative Emotionality; ORC = Orienting/Regulatory Capacity.

*p≤.05 ** p ≤.01; *** p ≤ .001

Table B3

Spearman's Correlations between perinatal experiences and maternal psychopathological symptomatology and maternal attitudes and experiences towards touch, while controlling the effect of infant's age [Study 1]

Variables	GAD	EPDS	FFT	ChT
COVID-19-related perinatal distress	.307***	.356***	-.043	-.075
Worry about early tactile experiences	.104*	.105*	-.063	-.134*
Impact of COVID-19 on early tactile experiences	.195***	.223***	-.080	-.054

Note 1. GAD = General Anxiety Disorder-7 total score; EPDS = Edinburgh Postnatal Depression Scale total score

Note 2. TEAQ: FFT = Friends and Family Touch; ChT = Childhood Touch

*p≤.05 ** p ≤.01; *** p ≤ .001

Appendix C

Moderating effect of early tactile experiences on the relationship between COVID-19-related perinatal distress and infant's developmental and temperamental outcomes [Study 1]

Table C1

Regression coefficients obtained through Hierarchical Multiple Regression, with COVID-19-related perinatal distress, maternal worry about mother-newborn early tactile experiences and the interaction term in the prediction of infant's negative emotionality, controlling infant's age effect (n = 353) [Study 1]

Model	Predictors	R^2	*F*	*β*	*t*	*p*
1	Infant's age	.014	5,037*	.119	2.244	.025
2	Infant's age	.034	6,121**	.104	1.965	.050
	COVID-19-related perinatal distress			.141	2.668	.008
3	Infant's age	.057	7,067***	.113	2.153	.032
	COVID-19-related perinatal distress			.114	2.147	.032
	Maternal worry about early tactile experiences			.156	2.948	.003
4	Infant's age	.060	5,552***	.112	2.147	.032
	COVID-19-related perinatal distress			.088	1.485	.138
	Maternal worry about early tactile experiences			.091	1.085	.279
	Interaction term (Distress * Worry)			.090	1.003	.317

* p ≤.05; **≤.01 *** p ≤ .001

Table C2

Regression coefficients obtained through Hierarchical Multiple Regression, with COVID-19-related perinatal distress, impact of COVID-19 on mother-newborn early tactile experiences and the interaction term in the prediction of infant's negative emotionality, controlling infant's age effect (n = 353) [Study 1]

Model	Predictors	R^2	*F*	β	*t*	*p*
1	Infant's age	.014	5.037*	.119	2.244	.025
2	Infant's age	.034	6.121**	.104	1.965	.050
	COVID-19-related perinatal distress			.141	2.668	.008
3	Infant's age	.048	5.811***	.118	2.233	.026
	COVID-19-related perinatal distress			.116	2.156	.032
	Impact of COVID-19 on early tactile experiences			.121	2.247	.025
4	Infant's age	.048	4.413**	.118	2.218	.027
	COVID-19-related perinatal distress			.109	1.952	.052
	Impact of COVID-19 on early tactile experiences			.073	.669	.504
	Interaction term (Distress * Impact)			.056	.508	.612

* p ≤.05; **≤.01 *** p ≤ .001

Table C3

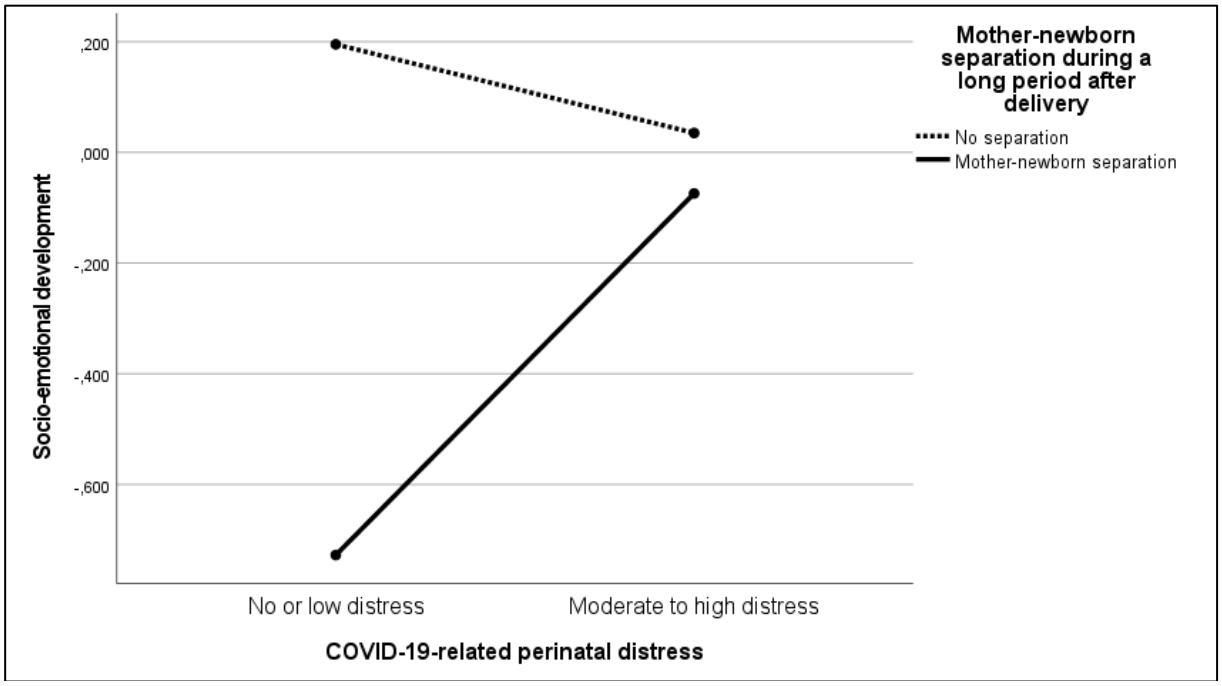
Regression coefficients obtained through Hierarchical Multiple Regression, with COVID-19-related perinatal distress, mother-newborn separation during a long period after delivery and the interaction term in the prediction of infant's socio-emotional development, controlling the age effect (n = 524) [Study 1]

Model	Predictors	R^2	*F*	β	*t*	*p*
1	Infant's age	.009	4.585*	-.093	-2.141	.033
2	Infant's age	.020	5.431**	-.082	-1.873	.062
	COVID-19-related perinatal distress			-.109	-2.496	.013
3	Infant's age	.028	5.052**	-.079	-1.817	.070
	COVID-19-related perinatal distress			-.099	-2.276	.023
	Mother-newborn separation during long period			-.089	-2.056	.040
4	Infant's age	.038	5.147***	-.076	-1.752	.080
	COVID-19-related perinatal distress			-.117	-2.649	.008
	Mother-newborn separation during long period			-.259	-3.033	.003
	Interaction term (Distress * Separation)			.199	2.304	.022

* p ≤.05; **≤.01 *** p ≤ .001

Figure C1

Graphic representation of the moderating effect of mother-newborn separation during a long period after delivery on the relationship between COVID-19-related perinatal distress and infants' socio-emotional development, controlling the effect of infants' age



Appendix D

Descriptive statistics and differences between clinical and control groups [Study 2]

Table D1

Descriptive statistics and differences between clinical and control groups for sociodemographic variables [Study 2]

Variables	Clinical Group (n = 29)		Control Group (n = 36)		Differences between groups		
	n	%	*n*	%	χ^2	*p*	Phi coefficient
Mother's Educational Level							
0 = Secondary Education or lower	13	44.8	3	8.3	14,140	<.001	.529
1 = Higher Education	10	34.5	33	91.7			
Missing = No information	6	20.7	0	0			
Father's Educational Level							
0 = Secondary Education or lower	15	51.7	11	30.6	5,507	.019	.341
1 = Higher Education	8	27.6	25	69.4			
Missing = No information	6	20.7	0	0			
Household Income							
0 = 1745€ or less	17	58.6	12	33.3	7,694	.006	.396
1 = More than 1745€	6	20.7	24	66.7			
Missing = No information	6	20.7	0	0			
Infant's Age Group							
0 = 6-months-old	21	72.4	17	47.2	3,224	.073	.254
1 = 12-months-old	8	27.6	19	52.8			

Variables	Clinical Group (n = 29)				Control Group (n = 36)				Differences between groups	
	n	Range	*M*	*SD*	*n*	Range	*M*	*SD*	Mann-Whitney U test	*r*
Mother's Age (years)	29	20 - 41	32.76	5.416	36	28 - 46	32.76	5.416	U = 586.000 z = .847 p = .397	.105
Father's Age (years)	23	22 - 41	34.52	4.511	36	23 - 46	35.19	4.833	U = 436.000 z = .343 p = .731	.045

Table D2

Descriptive statistics and differences between clinical and control groups for newborn characteristics and perinatal and early tactile experiences [Study 2]

	Clinical Group (n = 29)		Control Group (n = 36)		Differences between groups		
	n	***%***	***n***	***%***	χ^2	***p***	**Phi coefficient**
Gender							
0 = Male	12	41.4	18	50.0	.196	.658	-.086
1 = Female	17	58.6	18	50.0			
1st child (Sibling Position)							
0 = No	17	58.6	13	36.1	2.431	.119	.224
1 = Yes	12	41.4	23	63.9			
Cesarean delivery							
0 = No	13	44.8	28	77.8	6.140	.013	-.339
1 = Yes	16	55.2	8	22.2			
Breastfeeding at the time of hospital discharge							
0 = Non-breast milk	10	34.5	2	5.6	11.771	.003	.447 [Cramer's V]
1 = Breast milk	9	31.0	22	61.1			
2 = Mixed	10	34.5	6	16.7			
Missing	-	-	6	16.7			
No presence of support (e.g. partner, family) at delivery							
0 = Presence	8	27.6	24	66.7	4.377	.036	-.320
1 = No presence	13	44.8	10	27.8			
Missing	8	27.6	2	5.6			
No Family and friends visits after delivery due to COVID-19					1.851 [Fisher's Exact Test:]	.144	-.249
0 = Visits	0	0	5	13.9			
1 = No visits	21	72.4	29	80.6			
Missing	8	27.6	2	5.6			
Mother-newborn Skin-to-skin contact							
0 = No	13	44.8	8	22.2	6.519	.011	.372
1 = Yes	9	31.0	28	77.8			
Missing	7	24.1	-	-			

Variables	Clinical Group (n = 29)				Control Group (n = 36)				Differences between groups	
	n	Range	M	SD	n	Range	M	SD	Mann-Whitney U test	r
Gestational Age (weeks)	29	37 - 41	38.97	1.180	36	37 - 41	39.17	1.000	U = 577.500 z = .762 p = .446	.095
Birth weight (g)	29	2250 - 3870	3186.90	381.064	36	2070 - 4512	3141.19	458.026	U = 454.500 z = -.891 p = .373	.111
Birth length (cm)	29	47.00 - 53.00	49.845	1.587	36	35.50 - 52.90	48.186	3.079	U = 329.000 z = -2.560 p = .010	.318
APGAR 5th minute	29	9 - 10	9.79	.415	36	9 - 10	9.92	.280	U = 586.500 z = 1.423 p = .155	.177

	Clinical Group (n = 29)				Control Group (n = 36)				Differences between groups	
	n	Range	Mdn	IQR	n	Range	Mdn	IQR	Mann-Whitney U test	r
Worry about mother-newborn tactile experiences during hospitalization	21	1– 5	5.00	1	34	1 - 5	1.50	3	U = 160.500 z = -3.576 p <.001	.482
Impact of COVID-19 on mother-newborn tactile experiences during hospitalization	21	4 – 7	6.00	2	34	1 - 7	4.00	0	U = 88.000 z = -4.938 p <.001	.666
Worry about infant's health due to COVID-19	20	1 - 7	5.50	6	32	1 - 7	5.00	3	U = 268.500 z = -.983 p = .325	.136
COVID-19-related perinatal distress	21	1 - 7	5.00	3	34	1 - 7	5.00	2	U = 286.000 z = -1.250 p = .211	.169

Table D3

Descriptive statistics and differences between clinical and control groups for infants' developmental and temperamental outcomes [Study 2]

	Clinical Group (n = 29)					Control Group (n = 36)					Differences between groups	
	N	**Range**	**Mdn**	**M**	**SD**	**N**	**Range**	**Mdn**	**M**	**SD**	**Mann-Whitney U test**	**r**
G.LOC	29	-1.464 - 1.838	.060	.073	.912	36	-1.663 - 2.485	-.267	-.001	.972	U= 475.0 z = -.621 p =.535	.077
G.PS	29	-1.068 - 1.717	.126	.201	.623	36	-2.075 - 2.320	-.258	-.082	1.017	U = 400.0 z = -1.614 p = .107	.200
G.LH	29	-.744 - 1.924	.145	.151	.571	36	-1.944 - 1.552	.394	.006	1.020	U = 544.0 z = .291 p = .771	.036
G.EHC	29	-1.221 - 2.199	.000	.160	.725	36	-1.701 - 1.903	-.071	.041	.983	U = 466.0 z = -.741 p = .459	.092
G.PRF	29	-1.181 - 2.272	.052	.111	.700	36	-1.791 - 1.689	.077	.047	.961	U = 496.0 z = -.344 p = .731	.043
G.GEN	29	-1.116 - 1.461	.172	.173	.584	36	-1.855 - 2.067	-.016	.009	.998	U = 456.0 z = -.871 p = .383	.108
CREDI COG	21	-1.953 - 3.162	.488	.219	1.124	34	-1.491 - 1.443	-.129	-.055	.656	U = 312.0 z = -.780 p = .436	.105
CREDI LAN	21	-1.918 - 3.008	.221	.083	1.003	34	-1.697 - 1.473	-.228	-.273	.719	U = 259.0 z = -1.698 p = .090	.229
CREDI MOT	21	-1.393 - 4.192	.270	.206	1.298	34	-1.287 - .945	-.160	-.139	.671	U = 311.0 z = -.797 p = .426	.107
CREDI SEM	21	-1.862 - 2.858	.595	.285	1.080	34	-1.410 - 1.783	.103	.097	.722	U = 307.0 z =-.866 p =.386	.117
CREDI OVL	21	-1.310 - 4.238	.636	.625	1.236	34	-.845 - 1.587	.233	.305	.705	U = 303.0 z = -.935 p = .350	.126
PAS	20	1.69 - 6.38	4.760	4.496	1.169	32	3.00 - 6.46	5.252	5.126	.837	U = 426.0 z = 1.995 p = .046	.277
NEG	20	1.45 - 5.09	3.505	3.351	1.028	32	1.50 - 5.82	4.042	3.862	1.338	U = 401.0 z = 1.524 p = .128	.211
ORC	20	3.17 - 6.25	4.958	4.875	.671	32	4.18 - 6.83	5.092	5.179	.716	U = 380.0 z = 1.129 p =.259	.157
PS2 touch	27	.000 - .733	.267	.312	.173	35	.067 - .533	.267	.288	.116	U = 471.5 z = -.014 p = .989	.002

Note 1. Norm-referenced standardized z-scores of CREDI domains: COG = Cognitive; LAN = Language; MOT = Motor; SEM = Socio-Emotional; OVL = Overall.

Note 2. Standardized z-scores of Griffiths domains: G.LOC = Locomotor; G.PS = Personal-Social; G.LH = Language and Haring; G.EHC = Eye-Hand Coordination; G.PRF = Performance; G.GEN = General Development.

Note 3. IBQ-Rvsf domains: PAS = Positive Affectivity/Surgency; NEG = Negative Emotionality; ORC = Orienting/Regulatory Capacity.

Note 4. PS2 touch = Standardized z-scores of touch processing domain of Sensory Profile 2.

Table D4

Descriptive statistics and differences between clinical and control groups for maternal mental health [Study 2]

Variables	Clinical Group (n = 29)					Control Group (n = 36)					Differences between groups	
	n	Range	Mdn	M	SD	n	Range	Mdn	M	SD	Mann-Whitney U test	r
GAD	20	0 - 21	7.000	7.300	5.172	32	0 - 18	5.000	6.000	4.752	U = 267.000 z = -1.001 p = .317	.139
EPDS	19	1 - 25	7.000	8.316	5.598	31	0 - 26	8.000	8.355	5.742	U = 301.000 z = .130 p = .896	.018

Note 1. GAD = General Anxiety Disorder-7 total score; EPDS = Edinburgh Postnatal Depression Scale total score

Appendix E

Differences between clinical and control groups regarding Power Spectrum Density [Study 2]

Table E1

Power Spectrum Density (expressed in mean square microvolts) in 6-9 Hz alpha band for each electrode and differences between clinical and control group [Study 2]

	Clinical Group (n = 29)					Control Group (n = 36)					Differences between groups	
	N	**Range**	**Mdn**	**M**	**SD**	**N**	**Range**	**Mdn**	**M**	**SD**	**Mann-Whitney U test**	**r**
Fz	12	1.620 - 11.515	6.751	6.516	2.660	11	3.393 - 10.136	5.456	6.086	2.415	U = 55.000 z = -.677 p = .525	-.141
F3	12	2.406 - 12.072	7.693	7.794	2.594	11	4.612 - 10.370	6.107	7.056	2.108	U = 52.000 z = -.862 p = .413	-.180
C3	12	1.448 - 12.231	7.433	7.272	2.855	11	3.654 - 10.922	6.012	6.335	2.301	U = 48.000 z = -1.108 p = .288	-.231
C4	12	2.142 - 11.916	7.159	7.278	2.836	11	4.311 - 11.568	5.961	6.498	2.375	U = 47.000 z = -1.169 p = .260	-.244
Pz	12	3.520 - 12.144	7.555	7.999	2.344	11	4.128 - 10.111	7.380	7.109	2.200	U = 52.000 z = -.862 p = .413	-.180
P3	12	5.725 - 11.497	8.941	8.810	1.909	11	5.766 - 11.148	8.000	8.355	1.712	U = 56.000 z = -.615 p = .566	-.128
Oz	12	8.393 - 14.096	11.834	11.557	1.778	11	10.222 - 14.392	11.163	11.538	1.301	U = 61.000 z = -.308 p = .786	-.064

Table E2

Power Spectrum Density (expressed in mean square microvolts) in 3 – 6 Hz theta band for each electrode and differences between clinical and control group [Study 2]

	Clinical Group (n = 29)					Control Group (n = 36)					Differences between groups	
	n	**Range**	**Mdn**	**M**	**SD**	**n**	**Range**	**Mdn**	**M**	**SD**	**Mann-Whitney U test**	**r**
Fz	12	7.760 - 13.884	11.501	10.901	1.963	11	8.368 - 13.462	10.883	10.992	1.843	U = 68.000 z = .123 p = .928	.026
F3	12	8.615 - 14.351	12.060	11.979	1.968	11	9.929 - 14.067	10.583	11.383	1.501	U = 53.000 z = -.800 p = .449	-.167
C3	12	7.853 - 16.297	11.871	11.480	2.465	11	8.794 - 13.395	10.345	10.811	1.518	U = 54.000 z = -.739 p = .487	-.154
C4	12	7.461 - 14.298	11.869	11.547	2.005	11	9.041 - 15.651	11.466	11.387	1.848	U = 56.000 z = -.615 p = .566	-.128
Pz	12	8.338 - 15.972	13.071	12.796	2.109	11	9.062 - 15.557	12.856	11.950	2.038	U = 49.000 z = -1.046 p = .316	-.218
P3	12	10.907 - 16.441	14.309	13.811	1.780	11	10.727 - 16.598	13.322	13.244	1.613	U = 50.000 z = -.985 p = .347	-.205
Oz	12	14.085 - 18.381	16.181	16.214	1.447	11	14.308 - 18.269	16.112	16.091	1.188	U = 63.000 z = -.185 p = .880	-.039

Appendix F

Spearman's correlations between Power Spectrum Density in theta and alpha bands for each electrode and infant's outcomes [Study 2]

Variables	GEN (n = 23)	OVL (n = 19)	PAS (n = 19)	NEG (n = 19)	ORC (n = 19)	PS2 touch (n = 23)
PSD Alpha Band						
Fz	-0,137	0,135	-0,067	0,204	0,243	-0,156
F3	-0,134	0,286	0,051	0,212	0,224	-0,096
C3	-0,253	0,051	-0,125	0,157	-0,019	-0,045
C4	-0,144	0,158	-0,026	0,123	0,230	-0,129
Pz	0,015	0,279	0,096	0,356	-0,053	-0,043
P3	-0,093	0,295	0,086	0,268	0,051	-0,044
Oz	-0,038	-0,163	-0,075	0,104	-0,046	0,050
PSD Theta Band						
Fz	-0,157	0,428	0,165	0,377	0,169	-0,079
F3	-0,206	0,432	0,226	0,425	0,128	0,006
C3	-0,218	0,309	0,035	0,160	0,104	0,018
C4	-0,162	0,265	0,077	-0,059	0,292	-0,031
Pz	-0,004	0,346	0,151	0,367	-0,178	-0,003
P3	-0,058	0,416	0,140	0,293	0,007	0,043
Oz	-0,012	0,098	0,339	-0,004	0,109	-0,004

Note 1. GEN = Griffiths General Development; OVL = CREDI Overall Development

Note 2. IBQ-Rvsf domains: PAS = Positive Affectivity/Surgency; NEG = Negative Emotionality; ORC = Orienting/Regulatory Capacity

Note 3. PS2 touch = touch processing domain of Sensory Profile 2

Appendix G

Ethics Committee Approval for Study 1

Universidade do Minho

Conselho de Ética

Comissão de Ética para a Investigação em Ciências da Vida e da Saúde (CEICVS)

Identificação do documento: CEICVS 045/2020

Título do projeto: As experiências perinatais durante a pandemia COVID-19: Avaliação do impacto na saúde mental das mulheres e nas trajectórias desenvolvimentais das crianças

Equipa de investigação: Ana Mesquita, Doutorada em Ciências Biológicas e Biomédicas, Laboratório de Neurociências Psicológicas, Escola de Psicologia da Universidade do Minho; **Isabel Soares** (Professora Catedrática) e **Bárbara Figueiredo** (Professora Associada), Unidade de Investigação de Psicopatologia do Desenvolvimento, Centro de Investigação em Psicologia da Universidade do Minho; **Adriana Sampaio** (Professora Auxiliar), Diretora do Laboratório de Neurociências Psicológicas, Centro de Investigação em Psicologia da Universidade do Minho; **Sara Girão**, Psicóloga Clínica no Hospital de S. João – Serviço de Neonatologia; **Cristina Nogueira-Silva**, Assistente Hospitalar de Ginecologia e Obstetrícia do Hospital de Braga e Professora Auxiliar da Escola de Medicina, Universidade do Minho; **Ana Ganho**, Faculdade de Psicologia e Ciências da Educação da Universidade de Coimbra; **Berta Rodrigues Maia**, Professora Auxiliar convidada, Universidade Católica Portuguesa, Centro de Estudos Filosóficos e Humanísticos; **Mariana Vaz Pires Marques**, Técnica Superior (Psicologia Clínica) e Doutorada, Centro Hospitalar e Universitário de Coimbra, Serviço de Psicologia Médica, Centro de Investigação do Núcleo de Estudos e Intervenção Cognitivo-Comportamental; **Raquel Costa,** Investigadora Pós Doc da Unidade de Investigação em Epidemiologia (EPIunit) do Instituto de Saúde Pública**; Angel Carracedo** (Doutorada em Psicologia) e **Montse Fernández Prieto** (Professor Catedrático), Fundación Pública Galega de Medicina Xenómica, Santiago de Compostela

Unidade Orgânica Promotora: Centro de Investigação em Psicologia da Universidade do Minho

Outras Unidades: Fundacion Publica Galega de Medicina Xenómica

PARECER

De acordo com a documentação apresentada, o projeto insere-se no âmbito de um projeto de investigação da iniciativa dos investigadores, promovido pelo Centro de Investigação em Psicologia da Universidade do Minho. Trata-se de um estudo prospetivo, observacional, descritivo e analítico, realizado em Portugal, através de inquéritos administrados online, que tem como objetivo principal explorar prospectivamente o impacto das experiências perinatais durante a pandemia de COVID-19 na saúde mental das grávidas e mães recentes, e no desenvolvimento dos seus filhos durante o primeiro ano de vida (alterações epigenéticas, cerebrais, perfil sensorial), com o apoio institucional da Escola de Psicologia da Universidade do Minho.

Após verificação e análise dos documentos associados ao processo de pedido de emissão de parecer ético sobre o projeto em apreço, a que reporta sumariamente a respetiva "Grelha de verificação e avaliação ética", considera-se que (i) o processo está devidamente instruído, (ii) a análise dos documentos apresentados sobre o estudo a realizar obedecem às regras de conduta ética e requisitos exigidos para as boas práticas na experimentação com humanos e (iii) estão em conformidade com o Guião para submissão de processos a pedido de Parecer Ético na UMinho.

Face ao exposto, a Comissão de Ética para a Investigação em Ciências da Vida e da Saúde (CEICVS) nada tem a opor à realização do projeto, emitindo o seu parecer favorável, que foi aprovado por unanimidade dos seus membros.

Braga, 19 de junho de 2020.

A Presidente da CEICVS

(Maria Cecília Lemos Pinto Estrela Leão)

Appendix H

Ethics Committee Approval for Study 2

Unidade de Investigação
Tomei conhecimento. Nada a opor. À DC.
18 de Janeiro de 2021
A Coordenadora da Unidade de Investigação
(Prof.ª Doutora Ana Azevedo)

n.º 411/2020

DIRECÇÃO CLÍNICA
2021/1/19

SÃO JOÃO

PEDIDO DE AUTORIZAÇÃO

Realização de Investigação

Exmo. Senhor Presidente do Conselho de Administração do Centro Hospitalar de São João

CONSELHO DE ADMINISTRAÇÃO - REUNIÃO DE
Presidente do Conselho de Administração
21/01/21
(Prof. Doutor Fernando Araújo)

Nome do Investigador Principal:
Ana Raquel Marcelino Mesquita

Título da Investigação:
As experiências precoces de toque afetivo durante a pandemia de COVID-19: Avaliação do impacto nas trajetórias desenvolvimentais dos bebés

Pretendendo realizar no(s) Serviço(s) de:
no âmbito do Serviço de Neonatologia, com recolha dos dados nas consultas externas de Neonatologia e de Psicologia da Primeira Infância
a investigação em epígrafe, solicito a V. Exa., na qualidade de Investigador/Promotor, autorização para a sua efetivação.

Para o efeito, anexo toda a documentação referida no dossier da Comissão de Ética do Centro Hospitalar de São João/ Faculdade de Medicina da Universidade do Porto respeitante à investigação, à qual enderecei pedido de apreciação e parecer.

Com os melhores cumprimentos.

O Investigador/ Promotor

Porto, 27 *de* outubro *de* 2020 .

Assinado por : ANA RAQUEL MARCELINO MESQUITA
Num. de Identificação Civil: 1860148
Data: 2020.10.27 16:27:09 +0000
CHAVE MÓVEL

Centro Hospitalar São João
Centro de Epidemiologia Hospitalar
5/1/2021

CES-IM005-0

Comissão de Ética Centro Hospitalar São João / / Faculdade de Medicina da Universidade do Porto n.º_____/_____

SÃO JOÃO

U.PORTO FMUP FACULDADE DE MEDICINA UNIVERSIDADE DO PORTO

Questionário para submissão de Investigação

Exmo. Sr. Presidente da Comissão de Ética do Centro Hospitalar de São João/ Faculdade de Medicina da Universidade do Porto,

Pretendendo realizar a investigação infracitada, solicito a V. Exa., na qualidade de Investigador, a sua apreciação e a elaboração do respetivo parecer. Para o efeito, anexo toda a documentação requerida.

IDENTIFICAÇÃO DO ESTUDO

Título da investigação: As experiências precoces de toque afetivo durante a pandemia de COVID-19: Avaliação do impacto nas trajetó

Nome do investigador: Ana Raquel Marcelino Mesquita

Endereço eletrónico: ana.mesquita@psi.uminho.pt **Contacto telefónico:** 253604613

Caracterização da investigação:

☐ Estudo retrospetivo ☐ Estudo observacional ☒ Estudo prospetivo

☐ Inquérito ☐ Outro. Qual? _____

Tipo de investigação:

☐ Com intervenção ☒ Sem intervenção

Formação do investigador em boas práticas clínicas (GCP): ☐ Sim ☒ Não

Promotor *(se aplicável)*: Centro de Investigação em Psicologia (CIPsi), Universidade do Minho

Nome do orientador de dissertação/tese *(se aplicável)*: _____

Endereço eletrónico: _____

Local/locais onde se realiza a investigação: Serviço de Neonatologia - CHUSJ; Universidade do Minho; Fundacion Publica Galega

Data prevista para início: 01 / 12 / 2020 Data prevista para o término: 31 / 12 / 2022

PROTOCOLO DO ESTUDO

Síntese dos objetivos:

O presente projeto pretende explorar prospectivamente o impacto da COVID-19 nas trajectórias desenvolvimentais de bebés durante o primeiro ano de vida, avaliando particularmente o impacto das experiências precoces, nomeadamente da privação de toque afetivo em dois grupos distintos: um grupo de bebés cujas mães testaram positivo para o SARS-CoV-2 durante o parto, e um grupo de comparação de bebés cujas mães revelaram teste negativo para o SARS-CoV-2. Avaliaremos a resposta neurofisiológica dos bebés perante a estimulação tátil afetiva e discriminativa. Será igualmente abordado o papel das modificações epigenéticas, do stress crónico e a qualidade das experiências de toque afetivo nas interações materno-infantis. Também será realizada uma avaliação global do desenvolvimento dos bebés, bem como do seu perfil sensorial e temperamento. Os possíveis efeitos associados às experiências parentais

Fundamentação ética (ganhos em conhecimento/inovação; ponderação benefícios/riscos):

Nenhum dos procedimentos a implementar é invasivo ou provoca dor física. Não será dado nenhum benefício aos participantes pela sua participação, esta será voluntária e sem recompensas. Os participantes poderão recusar ou interromper a qualquer momento a sua participação no estudo, sem nenhum tipo de prejuízo por esse facto e sem que tal comprometa o relacionamento com o(s) prestador(es) de cuidados de saúde nem o respeito pelos direitos à assistência que lhe é devida.

Pretendemos com o presente projeto contribuir para um maior conhecimento sobre os mecanismos moleculares e neurais envolvidos no processamento de toque afetivo, bem como identificar fatores de proteção e de risco para o bem-estar e desenvolvimento ótimo dos bebés. Este conhecimento será crucial para informar políticas públicas para o desenho de intervenções baseadas na evidência científica a serem adotadas nas atuais circunstâncias de pandemia de COVID-19 ou em situações futuras semelhantes, particularmente no que respeita aos bebés que se encontram em situações de alto risco.

DES-IM007-0

CONFIDENCIALIDADE

De que forma é garantida a anonimização dos dados recolhidos de toda a informação?

Para garantir a confidencialidade dos dados obtidos, será atribuído um código que passará a identificar os participante nos questionários a usar, dados biológicos, restantes instrumentos de avaliação e base de dados. As gravações audiovisuais serão observadas

O investigador necessita ter acesso a dados do processo clínico? ☒ Sim ☐ Não

Está previsto o registo de imagem ou som dos participantes? ☒ Sim ☐ Não

Se sim, está prevista a destruição deste registo após o sua utilização? ☒ Sim ☐ Não

CONSENTI MENTO

O estudo implica recrutamento de:

Doentes: ☐ Sim ☒ Não Voluntários saudáveis: ☒ Sim ☐ Não

Menores de 18 anos: ☒ Sim ☐ Não

Outras pessoas sem capacidade do exercício de autonomia. ☐ Sim ☒ Não

A investigação prevê a obtenção de Consentimento Informado: ☒ Sim ☐ Não

Se não, referir qual o fundamento para a isenção:

Existe informação escrita aos participantes: ☒ Sim ☐ Não

PROPRIEDADE DOS DADOS

A investigação e os seus resultados são propriedade intelectual de:

☒ Investigador ☒ Promotor ☐ Ambos ☒ Serviço onde é realizado

☐ Não aplicável Outro: _____

BENEFÍCIOS, RISCOS E CONTRAPARTIDAS PARA OS PARTICIPANTES

Benefícios previsíveis:

Compreender o impacto da pandemia de COVID-19 nas trajetórias desenvolvimentais dos bebés permitirá desenvolver intervenções que promovam melhorias e a adequação das melhores práticas nas circunstâncias atuais e em situações semelhantes no futuro. Permitirá igualmente um melhor conhecimento sobre a resposta neurofisiológica associada ao toque afetivo na infância. Temos como objetivo

Riscos/incómodos previsíveis:

Não se antecipam riscos, apenas possível desconforto relacionado com a colocação de touca fNIRS nos bebés ou a recolha de saliva e das unhas. No entanto, sempre que o desconforto for manifestado, o procedimento será de imediato interrompido. Também a gravação das interacções entre a mãe e o bebé pode gerar algum desconforto que tentará ser minimizado pelo esclarecimento adequado por parte dos

São dadas contrapartidas aos participantes:

- ***pela participação*** ☐ Sim ☒ Não ☐ Não aplicável
- ***pelas deslocações*** ☐ Sim ☐ Não ☒ Não aplicável
- ***pelas faltas ao emprego*** ☐ Sim ☐ Não ☒ Não aplicável
- ***por outras perdas e danos*** ☐ Sim ☐ Não ☒ Não aplicável

CUSTOS / PLANO FINANCEIRO

Os custos da investigação são suportados por:

☒ Investigador ☐ Promotor ☐ Serviço onde é realizado

☐ Não aplicável Outro: _____

Existe protocolo financeiro? ☐ Sim ☒ Não

LISTA DE DOCUMENTOS ANEXOS

- [x] Pedido de autorização ao Presidente do Conselho de Administração do Centro Hospitalar de São João *(se aplicável)*
- [ ] Pedido de autorização à Diretora da Faculdade de Medicina da Universidade do Porto *(se aplicável)*
- [x] Protocolo do estudo
- [x] Declaração do Diretor de Serviço onde decorre o estudo
  (sendo um estudo na área de enfermagem deve anexar também a concordância do chefia de enfermagem)
- [x] Profissional de ligação
- [ ] Informação dos orientadores
- [x] Informação ao participante
- [x] Modelo de consentimento
- [x] Instrumentos a utilizar *(inquéritos, questionários, escalas, p.ex.)*: _____
- [x] Curriculum Vitae abreviado *(máx. 3 páginas)*
- [ ] Protocolo financeiro
- [ ] Outros:

COMPROMISSO DE HONRA E DECLARAÇÃO DE INTERESSES

Declaro por minha honra que as informações prestadas neste questionário são verdadeiras. Mais declaro que, durante o estudo, serão respeitadas as recomendações constantes da Declaração de Helsínquia (1960 e respetivas emendas), e da Organização Mundial da Saúde, Convenção de Oviedo e das "Boas Práticas Clínicas" (GCP/ICH) no que se refere à experimentação que envolve seres humanos. Aceito, também, a recomendação da CES de que o recrutamento para este estudo se fará junto de doentes que não tenham participado em outro estudo, nos últimos três meses. Comprometo-me a entregar à CES o relatório final da investigação [illegible]

Assinado por: ANA RAQUEL MARCELINO MESQUITA
Num. de Identificação Civil: BI11860148
Data: 2020.10.27 16:20:03 +0000

Porto, 27 de outubro de 2020

Nome legível: Ana Raquel Marcelino Mesquita

CHAVE MÓVEL

Parecer da Comissão de Ética do Centro Hospitalar de São João/FMUP Emitido na reunião plenária da CE de 23 / 11 / 20

Aguarda esclarecimentos.

Prof. Doutor Filipe Almeida
Presidente da Comissão de Ética

Centro Hospitalar São João

CONSIDERADOS QUE FORAM COMO SATISFATÓRIOS OS ESCLARECIMENTOS PRESTADOS PELO(A) INVESTIGADOR(A), A CES APROVA POR UNANIMIDADE O PARECER DO RELATOR, PELO QUE NADA TEM A OPOR À REALIZAÇÃO DESTE PROJETO DE INVESTIGAÇÃO.

23/12/2020

Prof. Doutor Filipe Almeida
Presidente da Comissão de Ética

3/3