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EARLY MATERNAL AND PATERNAL VOCAL INTERACTIONS FOLLOWING PRETERM BIRTH: THE ROLE OF BIRTH WEIGHT, PARENTAL ROLE AND AFFECTIVE AND STRESS SYMPTOMATOLOGY.

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Abstract

Preterm birth can be a profoundly stressful event for parents, complicating their transition to parenthood and the assumption of parental roles. Factors such as concerns regarding the infant's health and future outcomes as well as the emotional strain of early separation from the hospitalized newborn can affect parental stress and affective symptoms, negatively influencing parent-infant relationships and subsequent development. A critical element of early caregiver-infant interactions is Infant-Directed Speech (IDS), a distinctive linguistic register characterized by unique linguistic and paralinguistic features that influence and sustain infants' cognitive and emotional growth. Given its affective nature, IDS is particularly responsive to fluctuations in parents' emotional states.

The present PhD thesis includes a collection of four empirical studies that examine maternal and paternal IDS directed toward both full-term (FT) and preterm (PT) infants during the first year postpartum. The research focuses on factors influencing early interactions, including parental postnatal symptoms and the severity of prematurity, with a specific emphasis on distinguishing between extremely low birth weight (ELBW) and very low birth weight (VLBW) infants.

The first three chapters provide a comprehensive theoretical framework on premature birth and Infant-Directed Speech. The first chapter outlines the risk factors associated with preterm birth and early intervention strategies, while the second chapter discusses the challenges that parents might face in adapting to their new roles and the related mental health risks. The third chapter focuses into IDS, exploring its characteristics and how parental and infant risk factors could shape interaction patterns.

The four empirical studies reveal significant findings regarding IDS in preterm contexts, demonstrating that lower birth weight and higher maternal depression may be associated with diminished affective salience and less engaging interaction styles. Additionally, the research highlights differences and similarities in IDS characteristics between mothers and fathers, emphasizing the importance of paternal involvement in fostering positive parent-infant relationships. This research offers some insights into how preterm birth and parental emotional well-being could influence the quality of early vocal interactions, informing clinical interventions aimed at supporting positive communication with premature infants.

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Introduction

Preterm birth can be a highly unexpected and stressful event for parents, often complicating their transition into parenthood. Several factors may contribute to make the assumption of the parental role more challenging after a premature birth. On the one hand, concerns about the infant's health and future development are a major source of anxiety, while on the other hand, the early separation from the hospitalized newborn creates an emotionally complex postnatal period. As a result, many studies highlight an increased risk of affective symptoms and elevated parental stress among parents of preterm infants. These experiences can represent significant risks to the development of positive parent-infant relationships, potentially leading to less optimal interaction patterns that may impact the child's development and the instauration of secure attachment bonds.

One critical aspect of early caregiver-infant interactions is Infant-Directed Speech (IDS), a specific linguistic register that adults use when communicating with infants. IDS presents distinct characteristics that support infant development across multiple domains, including cognitive, linguistic, emotional, and social-relational ones. Due to its strong affective component, IDS may be particularly sensitive to changes in the emotional state of the parent. This PhD thesis presents a collection of four studies investigating various aspects of maternal and paternal IDS addressed towards both full-term (FT) and preterm (PT) infants during the first nine months following birth. The research focus on key factors which may influence the quality of early interactions, such as parental postnatal symptomatology and the severity of prematurity based on birth weight, specifically distinguishing between extremely low birth weight (ELBW) and very low birth weight (VLBW) infants.

The first three chapters provide a theoretical overview of the main topics addressed in the empirical studies. Specifically, the first chapter focuses on premature birth, outlining the main risk factors associated to preterm birth and its potential consequences on infants' health and development. The chapter concludes with an overview of the principal types and characteristics of early intervention methods following preterm birth.

The second chapter focuses on the transition to parenthood following preterm birth, exploring the challenges that parents of preterm infants may encounter in adapting to their parental

roles. It also investigates the mental health risks associated with preterm birth and their potential impact on the quality of early parent-infant interactions.

The third chapter centers on Infant-Directed Speech analyzing its linguistic and paralinguistic characteristics, as well as its role in supporting infant development. Additionally, the chapter explores the consequences that risk factors associated with parental variables and infant condition may have on patterns of IDS.

The fourth, fifth, sixth, and seventh chapters are respectively dedicated to the four empirical studies conducted on IDS in the context of preterm birth.

The first study examines the linguistic and pragmatic features of maternal speech directed toward ELBW, VLBW and FT infants during a free-interaction session at 3 months postpartum. The study specifically investigates how maternal depression levels and the severity of prematurity, as measured by birth weight, may influence the syntactic-lexical and functional features of maternal IDS. Findings show that high-risk conditions, such as lower birth weight and higher maternal depression, could be linked to reduced affective salience in maternal speech and a more demanding interaction style, suggesting important clinical implications.

Based on these findings, the second study explores the acoustic and prosodic characteristics of maternal speech at 3 months postpartum. Again, the study focuses on the effects of birth weight and maternal depression, this time analyzing how these factors may influence the realization of IDS prosodic patterns. Results show that both ELBW and elevated maternal depression are associated with reduced modulation in maternal speech. Since prosodic modulation is crucial for conveying emotional contents, particularly in early phases of development, these results underscore the potential impact of high-risk conditions on the emotional quality of maternal communication.

The third study adopts a longitudinal approach, analyzing maternal IDS at both 3 and 9 months postpartum to explore stability and changes in linguistic and functional components over time. It also examines the influence of parenting stress and prematurity severity on IDS patterns. Findings reveal that at 3 months, high-risk conditions, such as ELBW preterm birth and high levels of parenting stress, are linked to reduced emotional salience in speech and a greater frequency of questions. However, these associations are no longer observed at 9 months. This study emphasizes the importance of considering birth weight and parenting stress in clinical contexts to promote positive parent-infant interactions and foster infant development.

Finally, the fourth study shifts the focus to paternal involvement, comparing IDS linguistic and functional patterns among mothers and fathers of FT, VLBW and ELBW infants at 3 months postpartum. The results reveal significant differences in verbosity and lexical variability between mothers and fathers, although no differences emerged in syntactic features or pragmatic aspects related to the parental role. These findings highlight the importance of including fathers in infant care and follow-up programs, particularly in high-risk situations, as paternal involvement may serve as a protective factor for infant development and the formation of strong parent-infant bonds.

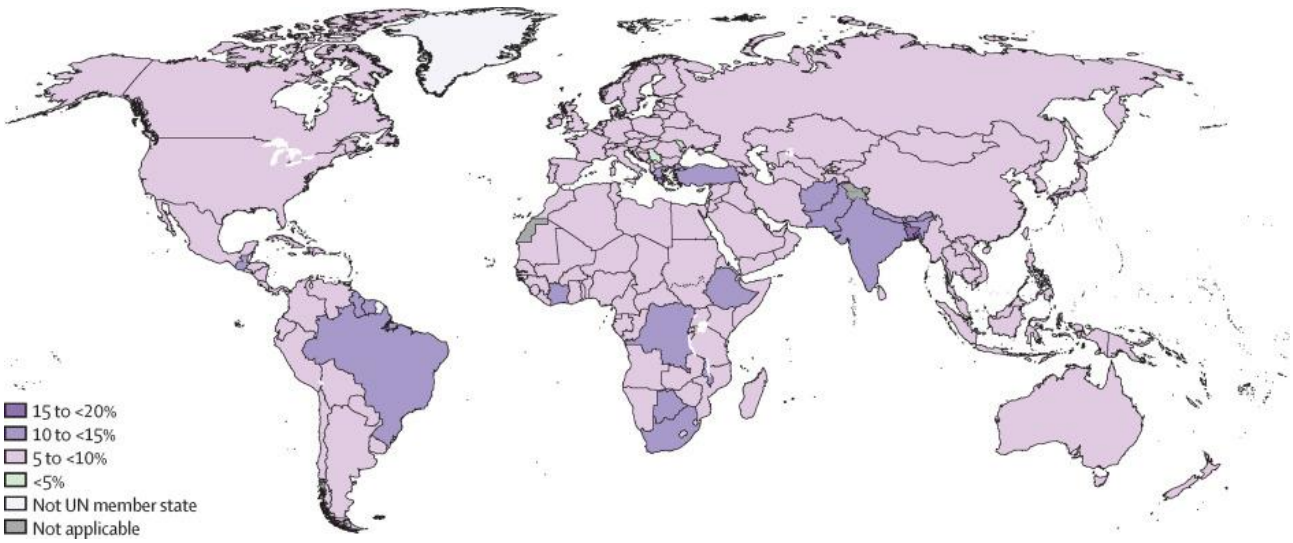
In summary, this PhD thesis aims to provide new insights into the ways in which preterm birth and parental emotional well-being may shape early parent-infant interactions. These findings could have important implications for clinical interventions designed to support both mothers and fathers in fostering positive, developmentally supportive communication with their infants.

Chapter 1 - Fragile babies at birth: the context of premature birth

1.1. Definition, epidemiology, and prevalence

Premature birth has been defined by the World Health Organization as the birth of an alive baby before the 37th week of gestation, or 259 days of gestation (WHO, 2012). The importance of focus research on prematurity is due to the fact that, still to date, it represents the first cause of neonatal death and one of the main causes of death in the first 5 years of life (Blencowe et al., 2012). Despite a greater focus on medical and public health initiatives aimed at reducing and preventing preterm birth, as well as the advancement of understanding regarding the risk factors, rates of premature birth are still high and scarcely changed in the last decade. A recent report published by the WHO (2023) reported that during 2020 the number of preterm births globally occurred was 13.4 million, with a preterm birth rate of 9.9%. The incidence of premature births is not homogeneously distributed and presents a great variability among regions. As expected, higher rates of premature births, between 10-15%, have been reported in low and middle-income contexts, such as South America, India, and South Africa, whereas in high-income countries and regions, such as Europe and North America, the rates are estimated between 5-10%, with a mean rate of 7.9%. Considering the Italian context, the rate of preterm births per 100 babies born alive is estimated to be 7.5%, and, coherently with the global trend of prematurity rate, this trend has remained quite stable since 2010.

Figure 1Estimated national preterm birth rates and numbers in 2020. UNICEF and WHO preterm estimates (Ohuma et al. 2023)



As preterm population could represent a very heterogenous group, the necessity to define different levels of the severity of prematurity led to the development of different classification systems. These systems are based on different factors according to the purpose of the classification; for example, research on preterm birth etiology, monitoring and preventing purposes, data comparison, etc. (Vogel et al., 2018). Two of the most frequently used classification systems for preterm birth are based on the weight of the infant at birth (birth weight; BW) and the number of weeks of gestation before the birth (gestational age; GA), which represent indexes of the degree of neurological and physical development (Goldenberg et al., 2008; Sansavini & Faldella, 2013).

According to the last one, GA, preterm infants are further divided into:

- Extremely preterm infants, born before the 28th completed week of gestation (5% of the overall preterm population);
- Very preterm infants, born between the 28th and the <32nd completed week of gestation (15% of the overall preterm population);
- Moderate or late preterm infants, born between the 32nd and the <37th completed week of gestation (80% of the overall preterm population).

Until 2014, GA was based on the date of the last menstrual period, as reported by the mother. However, this criterion frequently led to an overestimation of prematurity rate due mainly to imprecisions or approximations in the recall of the last menstrual cycle and to individual factors of variability (i.e., in the length of the menstrual cycle). In recent times, the estimation of GA has been enriched by the incorporation of more advanced technologies such as ultrasound scanning, which allows a more accurate estimation of the gestational age (Frey and Klebanoff, 2016). The possibility to identify the correct gestational age at the moment of birth led to the practice of monitoring and evaluating infant's growth and level of development considering his/her corrected age-based scores and not the chronological ones. Considering that a full-term pregnancy lasts at least 40 weeks of gestation (Engle, 2004), to determine the adjusted age of a premature infant, the number of weeks the infant was born prematurely is subtracted from the infant's chronological age (March of Dimes, 2007). On one hand, the use of corrected age during developmental assessments reduces the risk of underestimate preterm infant's capabilities, as it allows to consider infant's greater immaturity compared to

FT peers. On the other hand, correcting infant's age according to GA could result in an overestimation of the level of development of PT infants, since more of them would be placed in the normal or relatively high average range. This overstimation could potentially cover the presence of developmental delays and cause the delay of necessary interventions (Restiffe & Gherpelli, 2006; Wilson-Ching et al., 2014; van Veen et al., 2016; Harel-Gadassi et al., 2018). Despite these precautions, both the American Academy of Pediatrics and several authors confirm the importance of evaluate developmental trajectories of preterm infants considering their corrected age at least until the age of 24/36 months postpartum (Bernbaum et al., 2008), as in these early phases of development, infant's brain is subjected to rapid changes and modifications (Johnson, 2001; Harel-Gadassi et al., 2018).

As mentioned before, another way to classify subtypes of premature birth is according to birth weight (BW). This was one of the earlier practical criteria used to distinguish different levels of prematurity and was introduced in 1948 by the World Health Assembly (WHA), utilizing a birth weight of 2500 g or less as the threshold (Quinn et al., 2016), irrespectively to gestational age.

According to the most recently used classifications based on birth weight, it is possible to distinguish between:

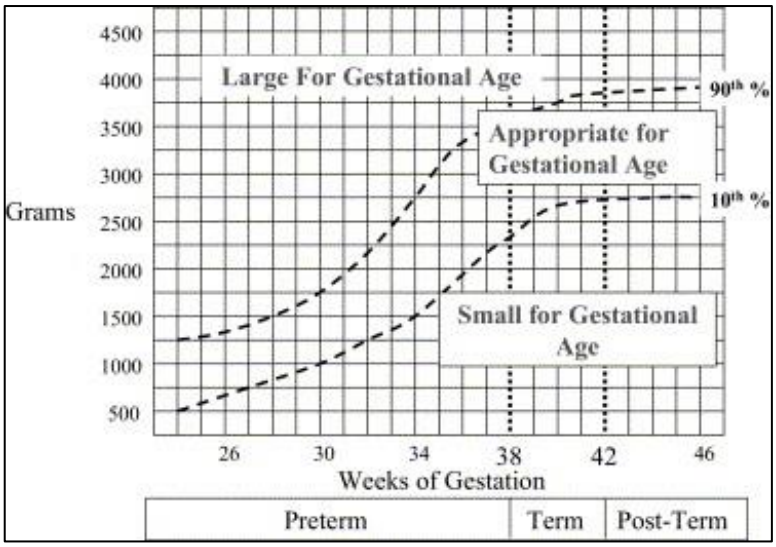
- Low Birth Weight (LBW) premature infants (BW between 1500-2500g)
- Very Low Birth Weight (VLBW) premature infants (BW between 1000 and 1500g)
- Extremely Low Birth Weight (ELBW) premature infants (BW < 1000g)

To date, this criterion has been widely used in the clinical assessment of neuropsychological profile of preterm infants and there is a branch in the literature which highlighted the importance of investigating premature outcomes by specifically taking into consideration the distinction between VLBW and ELBW preterm infants. In fact, even if both these two conditions could represent a higher risk for infant's motor and mental developmental outcomes (Buttha et al., 2002), several authors stressed the importance of separately evaluating the impact of birth weight not only on both infant's development, but also on parental psychological outcomes, as well as on the quality of early interactions. In fact, some studies reported how ELBW condition, compared to the VLBW one, could more frequently lead to higher levels of parental symptomatology in the first year postpartum, as well as to the development of atypical caregiver-infant interactive patterns (Agostini et al., 2014; Neri et al., 2015; Provera et al., 2023; 2024).

Literature on preterm and full-term birth reported how small BW at birth is not only typical of preterm birth. In fact, newborns could have a small size or weight at birth even if they born after the 37th week of gestation, mainly due to an intrauterine growth retardation or restriction. On the basis of these considerations, another way to classify both full-term and preterm birth considers both gestational age and birth weight (Battaglia & Lubchenco, 1967; see Figure 2), distinguishing among:

- Infant Appropriate for Gestational Age (APA), which present a birthweight between the 10th and 90th percentile appropriate for gestational age;
- Infant Small for Gestational Age (SGA), which present a birthweight below the 10th percentile appropriate for gestational age;
- Infant Large for Gestational Age (LGA), which present a birthweight over the 90th percentile appropriate for gestational age;

Figure 2 University of Colorado Medical Center classification of newborns by birth weight and gestational age (Battaglia & Lubchenco, 1967).



This last categorization helps identifying newborns at elevated risk because it is based on gestational ages and weights as defined by considering the standard sex-based birth weight which are appropriated for gestational age (WHO, 1995).

Both premature birth and a low birth weight represent risk factors for the infant survival and development. Infants which are born prematurely or with a lower birth weight have a higher risk of death in the first 28 days postpartum. Furthermore, compared to babies born at term (>37 weeks) and with a normal birth weight (>2500 g), preterm and LBW babies are more susceptible

to medical complications, growth failure, as well as neurodevelopmental deficits or delays (Blencowe et al., 2013; Christian et al., 2013; Gu et al., 2017). Short- and long-term developmental outcomes in preterm population, also considering the potential impact of lower birth weights, will be discussed later in this chapter (see paragraph 1.3.).

As seen at the beginning of this chapter, the presence of relatively high rates of prematurity incidence and their very small reduction in the past decade, both worldwide and in the specific Italian context, despite advantages in perinatal practices and knowledges, highlights the importance of develop preventative interventions. However, this requires a deep comprehension of the risk factors and family conditions associated with premature birth.

1.2. Risk factors contributing to preterm birth

To date, literature on premature birth has identified several factors which can increase the risk of a preterm delivery and include parental socio-demographic features, maternal and fetal medical problems, nutritional issues, multiple births and an increased used of assisted reproductive technology (Behrman & Butler, 2007; Goldenberg et al., 2008). However, there is still a certain degree of difficulty in identifying a clear etiology for PT births (Muglia & Katz, 2010; Vogel et al., 2018). In general, it could be identified different levels of risk factors which could lead to a preterm birth.

1.2.1. Sociodemographic variables and health behaviors associated with preterm birth

As regards parental socio-demographic variables which could increase the risk of a preterm birth, literature identified different factors.

The first one is related to the women's age at the moment of pregnancy according to which a lower maternal age, such as in the case of adolescent mothers, as well as an advanced maternal age (≥ 45 years) could lead to a higher risk of preterm birth (Smith & Pell, 2010; Carolan, 2013; Kozuki et al., 2013; Waldenström et al., 2014). Another important variable is related to maternal and paternal socio-economic status (SES), with evidence in the literature of a higher rate of preterm outcomes among women and men with a lower SES or educational level (Blumenshine et al., 2010; Ruiz et al., 2015; Jardine er al., 2021; Thomson et al., 2021). Ethnicity as well has been reported to influence the possibility of a preterm delivery, with literature reporting how Black race is significantly associated with higher risk of adverse pregnancy outcomes (Giurgescu et al., 2011). Other psychosocial variables which can contribute to cause preterm birth are related to the quality of the parental social environment

and partner relationship, as well as personal resources. In fact, the absence of a stable relationship with the partner, the lack of perceived partner and/or social support, as well as the presence of an adverse neighborhood could all constitutes risk factor for a premature delivery (Shah et al., 2011; Batra et al., 2020).

To date, literature agrees in recognizing some maternal health behaviors, such as the use of tobacco and alcohol or drug abuse during pregnancy, as important risk factors for adverse pregnancy outcomes (Kesmodel et al., 2000; Cnattingius, 2004; Faber et al., 2017). Specifically, both the direct and indirect exposure of mothers to smoking have negative effect on the fetal growth and development increasing the risk of PT birth, lower birth weight or SGA and, in the most serious cases, to perinatal and sudden infant death (Leonardi-Bee et al., 2008; 2011; Zhang & Wang, 2013; Faber et al., 2017). Importantly, several authors reported that the presence of at-risk maternal behaviors during pregnancy are more common among women with low-income SES or with a scarce or absent social and relational support, highlighting the importance to activate preventive programs and strategies to reduce social disparities and their effect on maternal and fetal health (Madureira et al., 2020; Roustaei et al., 2020).

1.2.2. Medical conditions and physiological factors associated with preterm birth

Taking into account the history of previous negative outcomes in pregnancies, such as abortions or other preterm birth, represents an important aspect to predict later birth outcomes. For example, literature reports that a previous preterm delivery could increase the risk of another one, and this association is even greater in case of a lower gestational period during the first pregnancy (Mercer et al., 1999; Goldenberg et al., 2008). Other widely reported causes of premature birth include multiple gestations and a short interpregnancy interval (i.e., ≤ 6 months) which could lead to adverse birth outcomes and a higher risk of premature birth (Goldenberg et al., 2008; Hanley et al., 2017).

Considering medical conditions which could increase the probability of a premature birth, literature reports the presence of intrauterine infections or inflammations, pre-eclampsia and a restricted intrauterine growth, as well as vaginal bleeding related to placenta abruption or preavia (Krupa et al., 2006). Furthermore, higher incidences of premature birth are also associated with maternal medical diseases such as diabetes, thyroid problems, asthma, chronic hypertension and nutritional status (Goldenberg et al., 2008). For example, higher rates

of preterm birth have been reported in women with obesity or too low body mass index during pregnancy (Goldenberg et al., 2008).

1.2.3. Psychological risk factors: parental variables, maternal mental health and psychological well-being

The last category of risk factors associated with premature birth is related to maternal mental health and psychological well-being. Different systematic reviews and meta-analysis reported how the presence of women's psychological distress and negative affectivity during pregnancy could constitute an important risk factor for adverse pregnancy outcomes and preterm birth (Grote et al., 2010; Staneva et al., 2015). A systematic review by Staneva and colleagues (2015) reported how psychological disorders such as depression, anxiety and stress experienced by the woman during pregnancy are both associated with an increased risk of premature birth. Interestingly, authors reported how not only the clinically diagnosed disorders were predictive of preterm birth but also their sub-clinical or symptomatological manifestation alone. Always in their systematic review, Staneva et al. (2015) identified as possible mediators between stress and affective disorders and preterm birth medical risks, smoking habits, as well as the use of antidepressants and a history of previous psychiatric disorders.

Depressive symptoms are a prevalent issue among pregnant women (Lee et al., 2007). The incidence rates of major depressive disorder can reach up to 12.7% in this population, while approximately 37% of women report experiencing depressive symptoms at some stage during pregnancy. Anxiety is also reported to be a common issue among pregnant women and frequently co-occurs with depressive symptoms (Lee et al., 2007). A review and meta-analysis by Grigoriadis et al. (2018) reported significant associations between prenatal anxiety, higher rates of PT births, as well as smaller BW and GA In their observational cohort study, Männistö and colleagues (2016) investigated the effect of several maternal psychiatric disorders, such as anxiety, depression, bipolar disorder and schizophrenia, as well as comorbid conditions on the incidence of preterm birth. Findings of this study revealed that, overall, the presence of psychiatric disorders and in particular comorbidity between disorders were significantly associated with preterm delivery. Prenatal depression has been found to be related with more adverse birth outcomes, such preterm delivery, smaller gestational age and lower birth weight (Grote et al., 2010; Grigoriadis et al., 2013). Although direct and indirect processes which underly the link between depression and preterm birth are still not clear, some authors hypothesize a mediation role of a higher use of alcohol and tobacco in depressed women which

could in turn lead to a higher risk of preterm birth (Goldenberg et al., 2008). Similarly to prenatal affective and stress symptomatology, also the presence of PTSD is associated with more adverse perinatal outcomes. Indeed, a recent review and meta-analysis by Sanjuan et al. (2021) found a significant association between PTSD and adverse gestational age and birth weight outcomes (Sanjuan et al., 2021).

1.3. Consequences of preterm birth on infant's health and development

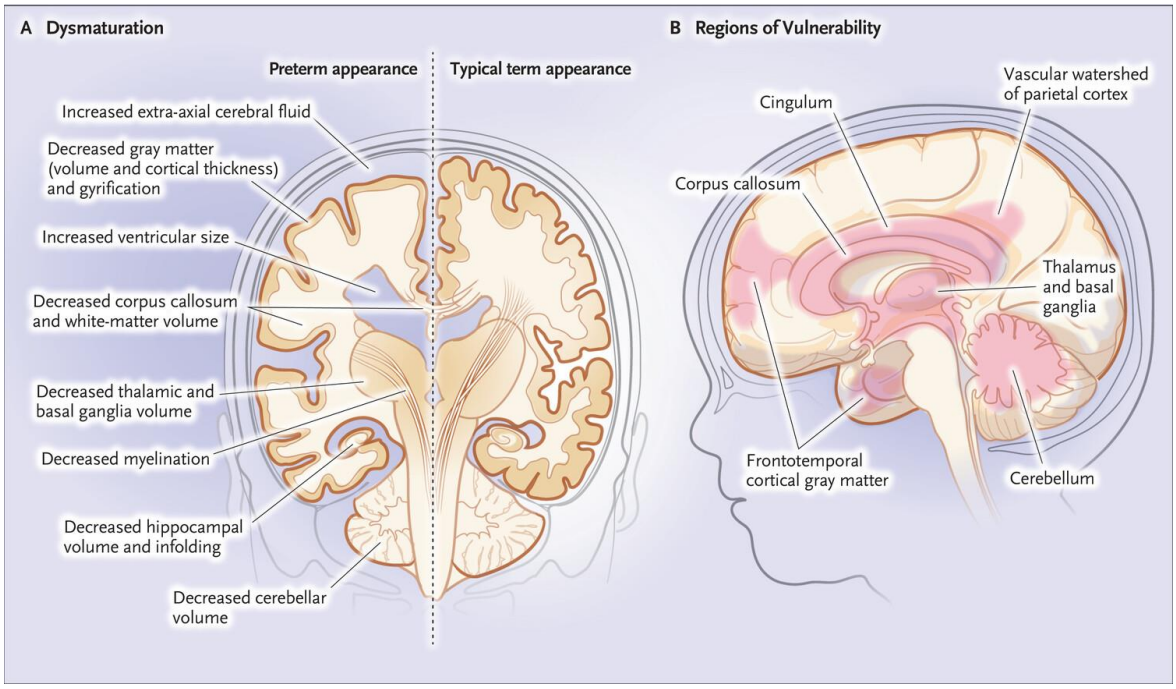
1.3.1. Medical complications and risks for brain maturation

A series of factors, such as the progressions in perinatal medicine and in neonatal intensive care, as well as the strengthening of the collaboration between obstetrics and pediatrics lead to an increase of the probability of survival of preterm infants, even in the case of more severe premature birth (i.e., in case of GA < 28 weeks and/or BW < 1000g). However, on the other hand, the occurrence of complications associated with the survival of more severe preterm infants has also progressively raised (Claas et al., 2011; Wong et al., 2019; Jeetoo et al., 2020). Overall, preterm infants are at major risk of developing medical complications, long-term morbidities, and developmental difficulties compared to full-term (FT) ones, and this risk is even higher in case of lower birth weight (Marlow et al., 2005).

As regard medical complications which could emerge in the perinatal period, preterm birth represents an important risk factor for the onset of respiratory, cardiovascular and gastrointestinal problems, especially in case of very low and extremely low birth weight and gestational age (Aylward, 2009; Saigal & Doyle, 2008). A clinical study by Wang et al. (2021) analysed a cohort of 81 premature infants with ELBW and VLBW reporting a statistically significant relations between a lower birth weight (<1000g) and the incidence of periventricular intraventricular hemorrhage and late-onset sepsis, as well as a higher risk of developing psychomotor disorders or delays during the first year postpartum. Preterm birth could have important consequences on neural system, with a higher risk of brain injuries, and impairments in brain maturation. In fact, maturation processes undergo important changes between the end of the second trimester of pregnancy and the beginning of the third one. Premature birth, especially when it occurs in earlier phases of gestation, dramatically interrupt these processes an expose the newborn to an extrauterine environment which is very different from the intrauterine one, increasing the risk of developing brain abnormalities, cerebral palsy, and negative neurological outcomes (Leam & Lehwald; 2018). To date, there is wide evidence that

early-life environment in which PT infants spend the first period after the delivery, could have important consequences on brain maturation outcomes. In this sense, a long period of hospitalization in the intensive care unit could have dramatic consequences for the infant's development. In fact, both the prolonged exposure to visual and acoustical stressors, the separation from the caregivers, as well as to repeated painful stimuli could impact on the development of brain structures and neural functions (Grunau, 2002; Grunau et al., 2006; Flacking et al., 2012; Doesburg et al., 2013; Duerden et al., 2018). Surface-based and functional MRIs studies reported frequent manifestations of brain dysmaturation in preterm infants, which include atypical development of both grey and white-matter as well as corpus callosum, lower volumes of cerebellum, thalamus, basal ganglia and other regional cerebral cortical volumes, decreased myelination, impairments in the dendritic development and a reduced connectivity (for a recent review, see Inder et al., 2024; Figure 3). The presence of cerebral and neural alterations and the early exposure to adverse environmental stimuli have been shown to have negative effects on cognitive, behavioral, and neurodevelopmental trajectories, with long-term outcomes both in infancy and in later phases of development until adulthood (Arpi et al., 2019; Sacchi et al., 2020; Burstein et al., 2021; Eves et al., 2021).

Figure 3 Dysmaturation of the Premature Brain as Seen on MRI (Inder et al., 2024)



1.3.2. Cognitive development

As mentioned before, preterm birth is associated with poorer outcomes in several developmental domains and a higher risk of neurodevelopmental disorders across all the phases of development, especially in case of lower gestational age and/or lower birth weight (De Jong et al., 2012; Sansavini et al., 2014; Li et al., 2022). However, developmental trajectories are characterized by a higher heterogeneity, due to the complex interaction between biological (brain dysmaturation processes, growth delays, medical complications), environmental (early-life environmental features), and social factors (early caregiver-infant interactions) (Sansavini & Fardella, 2013).

Overall, levels of general intellect are lower in preterm population compared to the full-tell one, with PT children showing QI scores lower by about 10 points compared to their FT peers (Bhutta et al., 2002). Differences in cognitive skills between preterm and full-term infants have been reported yet the first years after birth, with studies revealing a decrease in the general developmental quotient of preterm infants compared to full-term ones during the second year of corrected age (Sansavini et al., 2011). Coherently with this trend, other studies found a more evident and consistent gap in cognitive abilities displayed by preterm infants and full-term ones which tend to persist in later phases of development becoming more evident during preschool and school age, with the increasing of the cognitive demands (Baar van et al., 2006; Sansavini et al 2010; Johnson et al., 2011; Sansavini & Faldella, 2013). Several studies which longitudinally assessed developmental trajectories in preterm infants' cohorts using standardized instruments such as the Bayley Scales (1993) or the Griffiths Scales (1996) repeatedly reported a higher rate of developmental delays and mental disabilities, form mild to moderate and severe, compared to the full-term counterparts (Larroque et al., 2008; Johnson et al., 2009a; Sansavini et al. 2011a; 2011c). These findings have been reported from 6 months of corrected age until adolescence and affect more significantly infants with lower gestational age or birth weight. In fact, cognitive outcomes in preterm infants have repeatedly found to be inversely correlated with GA and BW, with more severe delays or impairments associated with a lower gestational age or birth weight (Bhutta et al., 2005; Marlow et al., 2005; Larroque et al., 2008). For example, considering the specific case of ELBW infants, literature reported that the incidence of mild to moderate neurocognitive disorders even in presence of normal intelligence is about 50-70% and include visuocognitive deficits verbal and non-verbal memory impairment as well as problems in attention and executive functions (Anderson et al. 2004; Marlow et al., 2007; Korkman et al., 2008; Olivieri et al., 2012).

As mentioned above, impairments in more complex cognitive abilities become more evident during school age. Indeed, academic difficulties, such as problems in reading, spelling and arithmetic tasks, have been reported to be significantly higher in preterm children compared to the full-term counterpart (Montagna & Nosarti, 2016). Difficulties in academic achievements could also in part explain the emergence, during school age, of behavioral problems as well as externalizing and internalizing disorders in the preterm population. In fact, especially more severe PT infants (for example ELBW ones), having more difficulties in addressing the increasing academic and behavioral demand could be at higher risk to undergo behavioral problems such as hyperactivity and impulse control deficits, as well as social and relational difficulties and withdrawn (Olivieri et al., 2012). One cognitive domain that is particularly vulnerable in preterm infants is attention. Impairments in both initiating joint attention and engaging in joint play have been reported in preterm infants at 6 months of corrected age. Moreover, several studies have noted a higher tendency for preterm infants to avoid adult gaze during interactions (Garner et al., 1991; Smith and Ulvund, 2003). These impairments are especially significant because these skills are important precursors to social development (Baron-Cohen, 1991; Carpenter et al., 1998), which, as we will discuss later in this chapter, is another area of increased vulnerability associated with preterm birth.

1.3.3. Motor development

Another developmental domain in which preterm infants could be particularly vulnerable is the motor one. Delays and difficulties in the acquisition of early motors skills have been reported from the first months of life and could persist also in later developmental phases until adolescence (Sansavini et al., 2011; 2014; Fuentefria et al., 2017). As repeatedly discussed before, lower gestational age and birth weight are associated with worsen outcomes also in this developmental domain (De Kieviet at al., 2009).

Differences between PT infants and their FT peers in the acquisition of milestones in gross motor development have been reported yet from the first phases of development and are frequently associated with poorer trunk control skills and inadequate flexor and extensor muscles strength. For example, by Pin et al. (2009) reported that at 4 months of corrected age, preterm infants showed poorer motor skills in prone and supine position compared to their full-term peers and, at 8 months, only half of the PT infants (GA < 28 weeks) included in their study showed a stable sitting posture without arm support. Another study by the same research

group (Pin et al., 2010) reported that, at 18 months, only 2/3 of the infants included in the PT sample demonstrated mature mobility for example being able to transfer from floor to standing or walk independently.

Atypical developmental trajectories have been reported also concerning fine motor skills. For instance, some studies reported poorer eye-hand coordination skills PT infants compared to FT peers during the first two years of life (Sansavini et al., 2011; Yaari et al., 2018), as well as overall lower fine motor scores in standardized assessments at 12, 24 and 30 months (Sansavini et al., 2014). Impaired object engagement and manipulation behaviors in preterm infants have been reported from infancy to toddlerhood. Several studies reported that, compared to FT peers, preterm infants display simpler, less varied, and shorter in duration oral and manual exploratory behaviors at both 6 and 9 months of corrected age and throughout the first 2 years of life (Lobo et al., 2015; Zuccarini et al., 2016; 2017). The detection of delays in the development of early motor skills is particularly important because these skills are crucial precursors to later linguistic development (Zuccarini et al, 2018), which is another area of weakness associated with prematurity, as we will discuss below.

1.3.4. Linguistic development

One of the most affected developmental areas associated with premature birth appears to be the linguistic one. A broad number of literature contributions reported weak language skills associated with preterm birth which could emerge from early phases of development and persist, even increasing, during childhood (Sansavini et al., 2010; Stolt et al., 2014). Deficits and delays in this domain could be explained by several factors, which include impairments in brain structure and functions (Stipdonk et al., 2018), the exposure to auditory stressors (i.e., loud sounds) and the underexposure to maternal and paternal voices during the period of hospitalization in the Neonatal Intensive Care Unit (Rand & Lahav, 2014; Best et al., 2018; Ståhlberg-Forsén et al., 2023), as well as potential challenges in establishing positive early dyadic interaction with the caregivers (Bozzette, 2007; McMahon et al., 2012). Among these risk factors, the prolonged exposition to the loud sounds of alarms, monitors, and machines which characterized the NICU's environment, as well as the deprivation of maternal voice during a fundamental developmental window for the auditory system could lead to adverse outcomes both in brain maturation processes and in later speech and language development (deRegnier et al., 2002; Vohr, 2016). Early signals of vulnerability in the precursor of language skills have

been reported at 6 months of life. For example, in their study, Imafuku and colleagues (2019) reported lower audiovisual speech perception skills in 6-month-old preterm infants compared to their full-term peers. Interestingly, this kind of skills correlated with receptive language scores at 12 and 18 months which were in fact higher in the control group compared to the PT one. A series of longitudinal studies conducted in the Italian context highlighted significant differences in the linguistic trajectories of preterm and full-term infants in the first phases of development. For example, a study by D'Odorico and colleagues (2011) found a lower degree of complexity in babbling behaviors at 12 and 18 months as well as a lower word production at 18 and 24 months in a group of Italian preterm infants compared to their full-term peers. Another study by Sansavini and colleagues (2011) longitudinally investigates trajectories of gestural and linguistic skills in a group of very preterm infants at 12, 18, and 24 months of corrected age. The study results underscored delays in both gestural production and the production and comprehension of words at each time of assessment. Furthermore, the disparity in language development between preterm and full-term infants tended to increase from 12 to 24 months.

Speech and language impairments have been recurrently reported among preterm children aged from 3 to 12 years. For example, a meta-analysis by Barre et al. (2011) and colleagues which included studies on very preterm infants and very low birth weight preterm infants aged ≥ 2 years reported overall weakness in both expressive and receptive language. Furthermore, they highlight how poorer language skills compared to full-term children are present also during primary school age. Consistently with these results, another meta-analysis, van Noort-van der Spek and colleagues (2012) analyzed the trajectories of linguistic skills in preterm infants (with gestational age < 37 weeks) from 3 to 12 years of life, highlighting overall lower scores in standardized test assessing simple and complex language functions compared to full-term peers and an increase of this gap across time. Other language weakness identified in school-aged preterm children include difficulties in more complex skills such as syntax, semantics, and prosodic processing, as well as in phonological and verbal memory (Luu et al., 2009; Vohr, 2016). As for other developmental domains, lower gestational age as well as birth weight at birth are associated with a higher rate of linguistic deficits and poorer academic outcomes in preterm children during school years (Wolke et al., 2005; Olivieri et al., 2012).

1.3.5. Emotional and social development

Socio-emotional domain appears to be an area of possible vulnerability in the preterm population. Difficulties in emotion regulation as well as in social interactions among preterm infants have been described from the first phases of development and seem to characterize the psychological profile associated to preterm birth also later in the development (Bhutta et al., 2002; Montagna & Nosarti, 2016).

In their review, Montagna & Nosarti (2016), identified three clusters of factors which contribute to atypical developmental trajectories in socio-emotional development following very preterm birth. The first one is associated to biological and neuropsychological vulnerabilities which include brain structural and functional alterations as well as early cognitive difficulties, for example in attention orienting and gaze-following, and problem multisensory processing which could impair the perception of speech. The second factor which could contribute to the onset of difficulties in socio-emotional development is related to early-life experiences of prolonged and repeated exposure to painful medical procedures which could interfere with brain maturation processes increasing the risk of alterations in later socio-emotional development. The last factor highlighted by the review of Montagna & Nosarti (2016) is related to parental stress. In fact, both preterm birth and the hospitalization of the newborn in the NICU represent very stressful experiences for parents, increasing the risk of developing postnatal symptomatology and parenting stress. The presence of maternal and paternal symptomatology and distress could negatively affect parenting functions increasing the risk of later socio-emotional difficulties. In this sense, several studies reported significant associations between higher levels of parental stress and affective symtpomatology and emotional and behavioral difficulties in VLBW preterms during childhood (Zelkowitz et al., 2011; Huhtala et al., 2011; 2012; 2014).

Moving of early socio-emotional difficulties reported in preterm infants during early phases of development, several studies reported that preterm infants, compared to their full-term peers, are less likely to be engaged in dyadic exchanges, vocalize less and tend to avoid eye contact with their caregivers. Other studies which investigate socio-emotional development in very preterm infants and/or VLBW ones during the first two years of life reported overall poorer emotional regulation skills and social engagement (Wolf et al., 2002; Janssens et al., 2009). Furthermore, understanding the needs of preterm infants is frequently more challenging for their parents due to a higher rate of disorganized behaviors and an overall difficult temperament of their infant. Difficulties in socio-emotional development have been reported also during

childhood. In fact, literature reports a higher rate of behavioral problems (about 25% among very preterm children) which include inattention, anxiety, internalizing symptomatology and socio-emotional difficulties (Johnson & Marlow, 2011; Arpi & Ferrari, 2013). Considering childhood psychiatric disorders, very preterm birth and a very low birth weight are associated with a 2/3-fold increased risk of developing attention deficit and hyperactivity disorder (ADHD), whereas extremely preterm and ELBW children display 4-fold higher risk for ADHD (Hack et al., 2009; Johnson et al., 2010), autism spectrum disorder (ASD), as well as affective disorders such as depression and anxiety during childhood (Johnson and Marlow, 2011; Treyvaud et al., 2013). A similar symptomatology has been reported to persist also during adolescence and adulthood (Walshe et al., 2008; Moster et al., 2009; Halmøyetal.,2012; for a review see Montagna & Nosarti, 2016).

1.4. The importance of early intervention following preterm birth and follow-up programs

As previously discussed, atypical trajectories in several developmental domains seem to characterize the profile associated with preterm birth. To better understand the mechanisms underlying these developmental outcomes, the literature has identified three main areas of risk contributing to the onset of adverse outcomes following preterm birth. The first area, as previously mentioned, is more related to biological factors and includes risks associated with brain immaturity, delayed growth, and the presence of medical complications. The second area is related to the early-life environment in which preterm newborns spend a prolonged period of hospitalization before the discharge. The NICU environments, in fact, lead to an overexposure of PT newborns not only to sensory stressors such as to acoustical and visual stimuli, but also to repeated procedural pain-related stress. These factors can interfere with brain maturation processes and contribute to early embodied traumas in the newborn. The third area involved in determining atypical developmental outcomes is the socio-relational one. This includes difficulties in early dyadic interactions and synchronization with the caregiver, as well as the presence of maternal or paternal postpartum symptomatology which could, in turn, affect the quality of early relationships with the baby (for an in-depth discussion see Sansavini & Fardella, 2013).

Given the complexity associated with preterm birth and the numerous factors which are involved in developmental trajectories and outcomes, there has been increasing interest in the

development of diagnostic and therapeutic programs, as well as preventive ones. These programs aim to address premature birth from a physical, neurological and psychological perspective, involving not only the infant but also the whole family. One of the most innovative aspects of these programs is the inclusion of various healthcare professionals, primarily pediatricians, psychologists, neonatologists, and child neuropsychiatrists. Based on these premises, current intervention programs aim to support not only the preterm infant but the entire family system. These programs include care interventions, follow-up programs that monitor infants' physical and neurodevelopmental trajectories during the first years after birth, and parenting support interventions that provide continuous assistance to parents from hospitalization through post-discharge.

As mentioned before, one of the main environmental risk factors for the onset of adverse neurodevelopmental outcomes following preterm birth is associated with NICU characteristics. Hospitalization in the NICU includes overstimulation from visual and acoustic stimuli, as well as painful procedures, alongside a deprivation of early interaction and contact with parents. Starting in the 1980s, Heidelise Als developed one of the most widely used early intervention programs in the NICU, the Newborn Individualized Developmental Care and Assessment Program (NIDCAP; Als, 1984), to mitigate the impact of the early-life environment and promote mid- and long-term neurodevelopmental outcomes in preterm infants. This program integrates the necessity of individualized developmental care for preterm newborns with the importance of involving parents and fostering relationships with all healthcare professionals working in the NICU. Some of the main goal of the NIDCAP program are the attenuation of the NICU environment both at a macro (light and noise) and micro-environment (the incubator), the observation of the infant behaviors during medical procedures in order to reduce stress and to promote autoregulation, the involvement of both mothers and fathers in infant’s care and the support of parenting functions in order to promote parental sensitivity and empowerment through a clear communication and sharing of information and the promotion of caring behaviors such as skin to skin contact and breastfeeding.

Recent studies have highlighted the positive impact of early interventions on infant development, particularly those that promote vocal interactions between the infant and caregivers during NICU hospitalization, such as parental speech and singing (see for example Filippa et al., 2020 for a review). These interventions are based on the premise that newborns exhibit an innate orientation and preference for the human voice (Cheng et al., 2012), especially

the mother's one, and aim to foster vocal communication between the caregiver and the newborn. The benefits of such interventions are several, including the enhancement of emotional and meaningful exchanges between the infant and caregiver, increased time for parental engagement with their newborns, and improved regulation of the infant's physiological states (Filippa et al., 2013; 2017; 2018; 2019). Additionally, these interventions have been shown to reduce parental anxiety, facilitate the development of intuitive parenting skills and promote early attachment bonds (Arnon et al., 2014; Hane et al., 2015; Filippa et al., 2020).

As mentioned before, a second type of early intervention following preterm birth involves the follow-up of the infant's physical and neurophysiological development. This intervention provides a crucial opportunity not only to monitor and track the infant's progress during the initial phases of development but also to offer parents an important point of reference after discharge from the NICU.

In terms of observing and evaluating the infant's development, various scales can be employed, such as the Griffiths Mental Development Scales (Griffiths, 1996) and the Bayley Scales (BSID-III, 2009). The Griffiths Mental Development Scales are among the most widely used instruments for assessing and monitoring an infant's development during the first two years after birth. Administered by trained professionals, this instrument evaluates the infant's general developmental quotient and tracks progress or delays in key developmental areas, such as cognitive, motor, visuo-motor, communicative-linguistic, and social domains. Longitudinally following infants' development enables early identification of areas of vulnerability and facilitates timely interventions. eventually also in collaboration with neonatologists and other health professionals, in case of delays of deficits in one or more developmental domains. From the parents' perspective, follow-up visits provide a crucial opportunity to discuss with healthcare professionals about their infant and address any concerns or questions regarding their his/her development. This ongoing support is essential for assisting families after hospital discharge, supporting parents in assuming their parenting roles during the early stages of their infant's development.

In the next chapter, we will discuss the topic of transition to parenthood in case of a premature birth, reviewing challenges associated to this clinical condition as well as potential negative effects of prematurity on parental mental health and early dyadic interactions.

Chapter 2 – The challenges of the transition to parenthood after a preterm birth: from mental representations to parental role

2.1. Transformations and reorganizations of transition to parenthood: from mental representations of the baby to the assumption of maternal and paternal role

Transition to parenthood represents a unique and challenging event for the parental couple, necessitating a profound reorganization of the individual, the couple, as well as the broader family and social systems (Di Vita & Brustia, 2008). These new adjustments involve emotional, symbolic, and social processes, both at an individual and at a joint level, and require future mothers and fathers to develop internal representations of their infant on one hand, and of themselves as parents on the other (Ammaniti, 1992; Stern & Bruschweiler-Stern, 1998). This process implies them to confront with their own attachment relationships and early childhood experiences (Slade & Cohen, 1996). In this context, the activation of the caregiving system, which occurs both at an implicit and explicit level, involves the reactivation and reorganization of early attachment bonds. This process enables new parents to reconsider their past experiences with attachment figures, in order to build new representations of themselves as mothers and fathers. (Ammaniti, 1992; Ammaniti et al., 1995; Carli, 1995; Di Vita & Brustia, 2008).

In a psychodynamic perspective, the gestational period is characterized by significant transformations in the mental representations that both mother and father start developing of their future baby. Mental representations of the imagined infant, include the expectations and desires that mothers attribute to their future child and usually become richer as the pregnancy progresses, reaching completion during the third trimester (Stern, 1995; 1998). Mothers begin to perceive the presence of their baby starting from the end of the first trimester, due to the gradual emergence of fetal movements (Stern, 1998). Simultaneously, the creation of a mental space for the future child and the formation of a mental representation of him/her allow the expectant mother to begin establishing a bond with the baby, a bond that will continue to evolve for the development of the attachment relationship (Fava Vizziello, 2003). The moment of childbirth marks an important milestone in this process, as the mental representations of the imagined baby need to integrate and adapt to the real one (Monti et al., 2008, pp. 37-39).

Although both women and men experience significant changes during the transition to parenthood, characterized by a “maturational crisis” that shifts their identities from daughters

and sons to parents (Racamier & Taccani, 1986) there may be important gender-related differences in the modalities in which they assume their parental roles (Katz-Wise et al., 2010; Kaźmierczak & Karasiewicz, 2019). Differences between women and men in experiencing parenthood start from pregnancy and continue also later after the infant's birth, determining different modalities in which mothers and fathers assume their parental role. In fact, if it allows mothers to start feeling in their body the presence of their future baby, paternal experience during pregnancy is inevitably less embodied and occurs primarily at a representational level (Audenino, 2001; Monti et al., 2008).

Traditionally, there was a clear distinction in gender and parental role between mothers and fathers. The maternal role has usually been more frequently associated with infant caring. Due to a deeply ingrained patriarchal cultural perspective, for a long time, mothers have been perceived as the primary caregivers in child-rearing, whereas fathers have traditionally assumed the role of breadwinners (Cabrera et al., 2018; Ferjan Ramírez, 2022). This culturally determined distinction between maternal and paternal roles profoundly influences the ways and extent to which mothers and fathers are involved in the care of newborns and infants during the postpartum period (Katz-Wise et al., 2010; Cabrera et al., 2018; Ferjan Ramírez, 2022). As we will discuss later, in cases of preterm birth this often results in reduced paternal involvement in follow-up programs and monitoring when the infant is at risk. Frequently, in fact, due to work-related reasons, it is not possible for both parents to attend follow-up visits for their infant, and, in these instances, it is almost always the father who renounces to be present. Fortunately, there has been a gradual increase in awareness and attention toward the importance of paternal involvement in infant's care, recognizing that the father's role is just as crucial as the mother's one. Even if the path toward achieving gender equality in the recognition of parental roles, both culturally and within social policies, is still long, research can contribute by actively involving fathers rather than excluding them and by deepening our understanding of the paternal experience both during pregnancy and the postpartum period, particularly in high-risk situations.

As widely discussed in the previous chapters, preterm birth represents an unexpected event for the parental couple, interrupting the normal processes of transition to parenthood and potentially impacting on both parental mental health and early caregiver-infant relationships (Stern & Bruschweiler-Stern, 1998).

Several factors come into play in the case of premature birth, influencing the ability of new

parents to adapt and cope with this event. First of all, preterm birth suddenly disrupts the creation of parental mental representations of their baby, forcing parents to quickly readjust their expectations and integrate actual newborn's characteristics in their internal representation (Miles & Holditch-Davis, 1997). The positive and expected representation of a healthy baby is suddenly replaced by the real infant, whose survival and development are often at risk (Tracey, 2000). Consequently, the emotional states of both mothers and fathers of preterm infants are often characterized by intense feelings of fear, anxiety and concerns about the potential loss or impaired development of their baby (Fuertes et al., 2011) which can also affect the attachment bonds with the newborn. Furthermore, after an unexpected premature birth, parents could experience confusion and difficulties in focusing on the actual condition and needs of the newborn because they often stuck on the "traumatic event", trying to find justifications and meanings for the premature delivery (Bekhechi-Mistycki and Guédeney, 2008).

Although literature presents some conflicting results, with some studies indicating overall balanced infant and attachment representations among mothers of preterm infants, other researchers have reported more negative parental representations in case of prematurity compared to full-term deliveries (for a review, see Hamon et al., 2023). For instance, Forcada-Guex et al. (2011), examining internal attachment representations at 6 months postpartum, found a higher prevalence of non-balanced representations in mothers of infants born before the 34th week of gestation compared to those with full-term infants. Conversely, Tooten et al. (2014), analysing the quality of representations considering both parental gender and the infant's birth status (full-term, very preterm, and moderately preterm), did not observe any significant association between these variables and the distribution of balanced versus non-balanced attachment representations. However, a gender effect was noted in cases of non-balanced representations: mothers more frequently exhibited distorted representations characterized by confusion and disorientation, particularly regarding roles and boundaries, while paternal non-balanced representations tended to be more disengaged and marked by higher levels of withdrawal.

In their recent review, Hamon et al. (2023) identified two primary factors that can impair the quality of parental representations: the degree and severity of prematurity and parental distress. As previously mentioned, findings associating the severity of preterm birth to the quality of parental representations are not always consistent. For example, Tooten et al. (2014)

did not find a relationship between gestational age and attachment representations. In contrast, Trumello et al. (2018), using the Clinical Interview for Parents of High-Risk Infants (CLIP; Meyer et al., 1993), reported that mothers of moderately preterm infants had a more positive perception of their infants and the dyadic relationship compared to mothers of very preterm infants, primarily because they experienced less fear of loss compared to mothers of infants at greater risk. Additionally, mothers of higher-risk preterm newborns reported to feel less prepared to assume their maternal role compared to mothers of lower-risk preterm infants (Keren et al., 2003), which also had significant implications for interactive behaviors (this aspect will be further discussed in paragraph 2.1.2.). Similar findings were reported by Gonçalves et al. (2020), who highlighted that despite the fear and increased risk associated with preterm delivery, mothers of infants born after 32 weeks of gestation felt more optimistic about their caregiving abilities compared to mothers of infants born before the 32nd week. The latter group reported more negative emotions and distress, as well as greater difficulties in caring their infants. Interestingly, some authors reported that the representation of the infant as particularly vulnerable and at risk for future difficulties changes across time, being more negative after the discharge and in the first year postpartum and improving later during toddlerhood (Hamon et al., 2023).

Even if both mothers and fathers report similar worries and fear for the infant's survival and development, literature reports the presence of differences between mothers and fathers in their reactions and coping strategies following a preterm birth. For example, Löhr et al. (2000) interviewed mothers and fathers of 20 VLBW preterm infants at 2/3 and 6/7 weeks after the birth exploring their perception of premature birth as well as their coping strategies. Both mothers and fathers reported to have experienced worries about their infant's health and survival after the delivery. Notably, fears regarding infant's death significantly decreased over time, whereas worries regarding possible handicaps tended to increase during weeks. Compared to fathers, mothers reported greater difficulties in managing early separation from the infant and experienced more negative emotions than fathers during the first contact with the newborn reporting shock and grief reactions. Gender differences emerged also with regards to coping strategies. In fact, even if both mothers and fathers reported to give great importance to social and marital support in all time of assessment, mothers reported to blame themselves and others more frequently compared to fathers in order to manage their need to give meaning to what happened.

Another important aspect to consider following a preterm birth is the prolonged hospitalization of the newborn in the neonatal intensive care unit (NICU), which exposes parents to several stressors not only including their worries for the newborn condition, but also the perception of an unfamiliar and uncomfortable environment (Cleveland, 2008). During this time, both mothers and fathers are unable to assume their caregiving roles or provide direct care for their infants. This situation can be highly stressful for parents, as they may feel restricted in their parental role and less involved in the care of their child (Feeley et al., 2013). However, parental experience during the hospitalization in the NICU may be different among mothers and fathers, in fact several studies reported how maternal experience after a premature birth is frequently characterized by feelings of guilt and failure which could also lead to the rejection of the infant (Arnold et al., 2012; Koliouli et al., 2016; Stefana et al., 2021). Mothers may experience significant emotional and physical exhaustion, and the early separation from their infant can exacerbate feelings of detachment and reduce their involvement in the infant's care (Latva et al., 2008). On the other hand, since the mother might be hospitalized too, fathers must manage work and family responsibilities on their own. At the same time, they tend to assume a more protective and supporting role both regarding their partner and the infant. However, this tendency may lead fathers to avoid and hide their own emotions, worries and needs, increasing the risk of physical and emotional distress (Arockiasamy et al., 2008; Feeley et al., 2013; Hugill et al., 2013; Stefana et al., 2021).

Due to the higher risk for newborn's health, mothers can often undergoes feeling of guilt and attribute to themselves the responsibility of the premature delivery, with an increased risk of developing depressive feelings and symptomatology in the postpartum period, as we will discuss in the following paragraphs.

2.1.1. The influence of preterm birth on maternal and paternal mental health

Preterm birth can have a negative impact not only on infant's outcomes, but also on maternal and paternal mental health, increasing the risk of adverse outcomes in parent-infant interactions and bonding with the baby (Korja et al., 2008). Premature birth exposes both mothers and fathers to a great number of stress factors as well as negative and intense emotions about infant's survival and health which can increase the risk of developing affective and stress symptomatology after birth (Vigod et al., 2010; Pace et al., 2016; Nguyen et al., 2024; Sandnes et al., 2024).

To date, a large number of studies has investigated the effects of premature birth on parental affective states and distress through a great heterogeneity of methods, such as in the clinical tools or time of assessment. Specifically, parental symptomatology has been assessed using both quantitative and qualitative methods, such as self-report questionnaires and clinical interviews, within cross-sectional and longitudinal study designs. These studies have spanned assessment periods from the early weeks postpartum to the initial years following birth. Considering the tools adopted to evaluate postnatal symptomatology, quantitative methods, such as self-report questionnaires, are generally more frequently used compared to qualitative ones. For example, a recent review and meta-analysis by Nguyen and colleagues (2024) examined the prevalence and associated factors of depression and anxiety in parents following a preterm birth. Among the 72 studies included, most assessed maternal and paternal affective disorders using self-report measures; in contrast, only four studies used qualitative methods, and one study incorporated both quantitative and qualitative approaches. This latter category includes, for example, structured clinical interviews based on the DSM or ICD-10 criteria (Nguyen et al., 2024; Sandnes et al., 2024). Considering quantitative self-report measures, depressive and anxious symptoms are usually screened through self-report measures, among which the Edinburgh Postnatal Depressive Scale (Cox et al., 1987), the State-Trait Anxiety Inventory (Spielberger et al., 1983), the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) as well as the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) seem to be the most widely reported measures. Similarly, the Parenting Stress Index (Abidin, 1990) is usually the most used tools for screening stress symptoms associated to the parental role (Sandnes et al., 2024). Compared to clinical interview, self-report questionnaires are less accurate and don't allow to detect psychiatric diagnosis; however, the lower cost in terms of time and resources makes them a valid tool for screening purposes (de Paula Eduardo et al., 2019). Findings from studies which investigate the effects of premature birth with a quantitative methodology on maternal and paternal outcomes are summarized in the following paragraphs.

2.1.1.1. Depression and anxiety

Overall, literature agrees in indicating preterm birth as an important risk factor for the occurrence of postpartum depression and anxiety in mothers and fathers (for reviews, see Vigod et al., 2010; de Paula Eduardo et al., 2019; Nguyen et al., 2024). A review and meta-

analysis by Nguyen and colleagues (2024) analyzed recent literature on parental affective disorders within the first year following preterm birth. Findings from this work indicated that the prevalence of postnatal depression and anxiety during the first year following birth was respectively 29.2% and 37.7% in mothers and 17.4% and 18.3% in fathers, confirming the results from previous reviews on the same topic (Vigod et al., 2010; de Paula Eduardo et al., 2019). Notably, differently from previous reviews, Nguyen et al. (2024) also included in their work studies on fathers, despite literature on the paternal role is relatively still scarce. Several authors reported higher incidences of affective disorders in fathers of preterm infants compared to full-term ones (Carson et al., 2015; Cameron et al., 2016; Leiferman et al., 2021), although the prevalence is usually significantly lower in fathers compared to mothers (Nguyen et al., 2024). However, this last result could be related to other confusing variables, for example the modality in which fathers express or avoid affective difficulties and gender-related biases of self-report scales employed in these studies which could be less suitable to detect specific expressions of paternal depression (Stefana et al., 2021; Nguyen et al., 2024; Sandnes et al., 2024).

Literature agrees in indicating the early postpartum period, specifically the first 3 months after birth, as the period of higher vulnerability for the onset of postnatal depression and anxiety. The prevalence of depressive and anxiety disorders is usually higher during the first trimester following birth in both mothers and fathers and tends to decrease from the second trimester, despite it may remain relatively high until the end of the first year (de Paula Eduardo et al., 2019; Sandnes et al., 2024; Nguyen et al., 2024). For instance, Garfield et al. (2021) conducted a longitudinal assessment of depressive symptom trajectories and the prevalence of a positive depression screening in a cohort of 431 parents of preterm infants during the first postpartum month. For this purpose, the Edinburgh Postnatal Depression Scale (EPDS) self-report questionnaire was administered multiple times: upon NICU admission, at discharge, and subsequently 14, and 30 days post-discharge. A cut-off ≥ of 10 points on the EPDS was used to determine a positive screening for depression. Findings indicated a decrease in both depressive symptoms and the probability of a positive screen from NICU hospitalization through one month post-discharge in both mothers and fathers; however, fathers showed comparatively less improvement than mothers. Notably, this reduction in depressive symptoms occurred irrespective of the infant's gestational age, suggesting consistent improvements regardless of the degree of prematurity. Another study by McMahon et al. (2020)

examined the trajectories of depression and anxiety in a cohort of 100 fathers of 125 very preterm infants at corrected ages of 3, 6, and 12 months. Affective disorders were assessed using two widely validated self-report instruments: the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) and the Hospital Anxiety and Depression Scale – Anxiety scale (HADS-A; Zigmond & Snaith, 1983). Considering the cut-off for positive screen (CES-D ≥ 16; HADS-A ≥ 8), results indicated a significant decline in affective disorders from the first to the second trimester. Specifically, prevalence of depression decreased from 44% at 3 months to 12% at 6 months, whereas the prevalence of anxiety decreased from 53% to 16% in the same period. Similarly, a study by Cambonie et al. (2017) conducted on a French sample of 163 mothers of VPT infants reported a significant reduction of affective disorders from the discharge to 6 months. These significant changes in parental depression and/or anxiety could be in part related to the different conditions which characterized the first months following a preterm birth. Specifically, in the early postpartum, the higher vulnerability of the newborn's health as well as his/her hospitalization and early separation from the caregivers could contribute to the onset of helplessness, exclusion and alienation feelings as well as worries and fear for the infant's future in parents of preterm infants, which, in turn, could have a negative effect on parental affective states, especially in mothers (Chertok et al., 2014). In this sense, the meta-analysis by Nguyen and colleagues (2024) reported a significant association between the duration of newborn's hospitalization and maternal anxiety. Authors hypothesized that a prolonged hospitalization could reflect the presence of greater complications in infant's health conditions, and then more intense worries and, consequently, higher levels of anxiety for the mothers.

An important aspect highlighted by several authors is the strong correlation between maternal and paternal affective states in case of premature birth. Specifically, the presence of depressive or anxious symptomatology in mothers seem to be significantly related to higher levels of depression or anxiety also in their partner, potentially leading to more adverse outcomes both in parental mental health and in infant development (Neri et al., 2020; Vriend et al., 2021). The co-occurrence of maternal and paternal postnatal symptomatology or disorders suggests the importance of including both parents in programs which aim to sustain and monitor transition to parenthood, especially in high-risk conditions, such as premature birth (Nguyen et al., 2024). In this regard, some authors have emphasized that the involvement of

fathers from the earliest stages after the child's birth is a crucial factor for both paternal well-being and the overall family system (Filippa et al., 2021).

Interestingly, birth weight rather than gestational age seems to contribute more to explain negative outcomes in parental mental health following a preterm birth. In this sense, a series of studies investigated maternal and paternal affective states and their trajectories in the first year of infant's corrected age, comparing outcomes among parents of FT, VLBW and ELBW preterm infants (Agostini et al., 2014; Neri et al., 2015; 2020; Genova et al., 2021). For example, a study by Genova and colleagues (2021) longitudinally investigated trajectories of depressive symptomatology by repeatedly administering the EPDS self-report questionnaires at 3, 9 and 12 months of infant's corrected age in mothers and fathers of 83 FT, 56 VLBW and 38 ELBW preterm infants. Results revealed that parental depressive symptoms were significantly higher in the ELBW group compared to the FT and VLBW ones at 3 months but not in later observations. Interestingly, authors highlighted how ELBW mothers, which showed higher levels of depression at 3 months, also showed a greater reduction of depressive symptomatology across time, compared to parents of VLBW and FT infants. Genova and colleagues (2022) suggest that this trend may indicate a greater emotional challenge faced by parents of more severely preterm infants – and especially mothers - in managing the transition to parenthood, mainly due to the critical condition of their babies. However, despite these initial difficulties, over the following months parents showed to gradually adjust to the situation, adapting more effectively to their parental role. Other two studies by the same research group conducted in the Italian context significantly reported higher levels of postnatal depressive symptoms in mothers of ELBW infants compared to VLBW and FT ones at 3 months of corrected age (Agostini et al., 2014; Neri et al., 2015). The impact of lower birth weight and adverse neonatal outcomes on maternal mental health appears to extend into later stages of child development. For instance, a study by Kenyhercz and Nagy (2020) in a Hungarian cohort evaluated symptoms of stress, anxiety, and depression, along with life satisfaction, in 112 mothers of preterm children born with an ELBW (N = 38), VLBW (N = 30), and LBW (N = 44) at 2 years postpartum. Findings indicated a significantly higher prevalence of maternal depression, anxiety, and psychological distress, as well as a lower quality of life, among mothers of 2-year-old ELBW children compared to mothers of VLBW and LBW children.

Overall, findings from these studies reported a higher prevalence of maternal depressive and anxious symptomatology associated to lower birth weight, especially in the first trimester

postpartum. As mentioned before, more inconsistent results related to the paternal condition could be explained by different factors, related to both cultural and gender-related differences as well as to a poorer literature which has focused on fathers' experience following a preterm birth.

2.1.1.2. Parental distress

Caring for a premature infant can be more challenging and stressful than parenting a full-term baby (Thomas et al., 2004). This difficulty arises from various factors related both to parental variables and the infant's characteristics. As previously mentioned, preterm infants are often described as less competent, active, and engaged in interactions with their caregivers. Additionally, they tend to have a more difficult temperament, which can make it harder for parents to effectively assume their parenting roles, for example positively detecting and addressing to infant's cues and needs (Goldberg & DiVitto, 1995; Halpern et al., 2001; Voegtline & Stifter, 2010). On the other hand, both the early separation due to the newborn hospitalization and the delegation of infant's care to the medical staff can exacerbate parental perception of being unable to handle the situation, potentially leading to higher levels of parenting stress (Gray et al., 2012; Monti et al., 2013). Parenting stress is in fact indicated as another frequent issue following preterm birth and several studies highlighted higher levels of parental stress in parents of preterm infants compared to full-term ones during the first postpartum years (Gray et al., 2018; for a review, see Sandnes et al., 2024). According to the recent review by Sandnes et al. (2024), the incidence of parenting stress in parents of VLBW and ELBW infants ranges between 15% and 56% in the two years following birth. Some authors suggested that both a lower gestational age and/or birth weight could have a role in predicting later parenting stress, leading to higher levels of stress in case of more severe premature birth, such as in case of VLBW or ELBW, as well as VPT infants.

However, findings are not always consistent. A study by Ionio and colleagues (2016) investigated the relation between preterm birth and parental stress and negative affect in 21 mothers and 19 fathers of preterm babies hospitalized in the NICU. All parents completed a battery of questionnaires including the Impact of Event Scale Revised (IES-R; Weiss & Marmar, 1997) for trauma-related symptoms, and the Profile of Mood States (POMS; McNair et al., 1971) for the evaluation of parents' affective states. Findings revealed worse outcomes for both parental stress and affective states in parents of newborn with poorer condition at birth, such

as lower gestational age and birth weight. A study by Kenyhercz and Nagy (2020) explored the association between birth weight and postnatal symptomatology and stress levels in mothers of preterm infants, including 44 LBW, 30 VLBW, and 38 ELBW infants at 24–28 months postpartum. Findings revealed a significant negative correlation between birth weight and maternal stress, as assessed by the Parental Stressor Scale (PSS; Berry & Jones, 1995), with lower birth weights associated to increased levels of maternal stress. This underscores the prolonged influence of neonatal health on maternal mental well-being in early childhood. However, evidence in the literature remains mixed. For instance, a study by Neri et al. (2017), which assessed maternal stress levels in mothers of 30 ELBW and 38 VLBW preterm infants at 9 months of corrected age using the Parenting Stress Index-Short Form, reported no significant group differences. These contrasting findings highlight the need for further research to clarify the relationship between neonatal birth weight and maternal stress outcomes over time.

During the first years following birth, parents of very preterm infants born before the 32nd week of gestation reported higher levels of stress related to the feeling of restriction in the parental role and to the perception of a difficult infant and difficulties in parent-infant interactions (Coletti et al., 2015; De Stasio et al., 2018; Schmöker et al. 2020). For example, a study by Coletti and colleagues (2015) investigated levels of maternal stress at 12 months in 40 mothers of very preterm infants and 39 mothers of late preterm ones, by administering the PSI-SF. Results showed higher levels of parental distress in mothers of very preterm infants compared to late preterm ones. Levels of parental stress seem to remain higher also later during infant development and are in part explained by the presence of children's behavioral problems. For example, a longitudinal study by Gray et al. (2018) administered the Parenting Stress Index-Short Form (PSI-SF) over the first two years postpartum (specifically at 4, 12 and 24 months) to a cohort of 64 mothers of full-term infants and 79 mothers of very preterm infants. Findings indicated an increase in maternal parenting stress over time within the preterm group, with significantly higher scores in total stress, parental distress, and parent-child dysfunctional interaction compared to mothers of full-term infants. Furthermore, these elevated stress levels were primarily associated, in the preterm group, with a higher prevalence of infant behavioral issues, including internalizing and externalizing problems. Another study by, Howe and colleagues (2014) assessed parenting stress in a large sample of 505 parents including 239 mothers and 58 fathers of VLBW preterm and 181 mothers and 27 fathers of full-term infants through the first 2 years postpartum, by administering the Chinese version of the Parenting

Stress Index. Although not statistically significant, findings from this study revealed overall higher levels of parenting stress in preterm families compared to full-term ones. More interestingly, authors reported gender-related differences in stress patterns among mothers and fathers of VLBW infants. Specifically, while fathers reported higher levels of general stress symptomatology, mothers exhibited greater difficulties related to social isolation, lack of marital support, as well as restrictions in their maternal role and health related problems. Gender differences in stress patterns among mothers and fathers have been reported by another study by Schmöker and colleagues (2020), which assessed parental stress in 493 mothers and 329 fathers of 547 preterm infants at 8 weeks, 6 and 12 months postpartum. For this purpose, authors used the Parenthood Stress Questionnaire (SPSQ), which is the modified Swedish version of the PSI. Similar to the findings reported by Howe et al. (2014), also Schmöker and colleagues (2020) reported that tended to perceive higher stress related to the perception of being restricted in their maternal role. Furthermore, their stress levels followed a decreasing trajectory during the first year after birth. Conversely, fathers reported higher stress associated with social isolation, and their stress levels increased in the second half of the first year, probably due to parental leave policies in Sweden according to which fathers can remain at home starting from the 6-7 months, after the end of the maternal leave. Another important finding from this study demonstrated a significant association between maternal stress and infant gestational age, with higher stress levels correlated with lower gestational ages. Specifically, mothers of very preterm infants reported greater stress compared to those with infants born at higher gestational ages.

Despite these findings, other studies have not found statistically significant differences in maternal stress between mothers of PT and FT infants. For instance, Suttora et al. (2021) compared parental stress (measured with the PSI-SF) and PTSD symptoms in 32 mothers of very preterm infants and 33 mothers of full-term infants at 6 months of corrected age, finding no significant group differences. Similarly, studies by Pisoni et al. (2019) and Spinelli et al. (2022) reported no differences in stress levels between PT and FT groups at 3 months of corrected age. These mixed results emphasize the need for further research to clarify the relationship between prematurity and maternal stress.

2.1.1.3. Post-Traumatic Stress Disorder

As extensively discussed in the previous paragraphs and chapters, preterm birth constitutes a significant risk factor affecting the infant's survival and health , as well as his/her future development. Not only, the sudden interruption of the gestational period, the circumstances surrounding delivery, and the subsequent hospitalization of the newborn in the neonatal intensive care unit (NICU) represent highly stressful and anxious experiences for new parents. These experiences, together with persistent and intense concerns and fears about the newborn's medical condition and the uncertainty regarding his/her future can make preterm birth a truly traumatic event for the parental couple, leading to the onset of post-traumatic stress symptomatology (PTSS) and, in the worst scenario, a PTS disorder (Sandnes et al., 2024). Main symptoms of post-traumatic stress disorder (PTSD) are characterized by intrusive memories, avoidance behaviors and emotional vigilance, and may affect both mothers and fathers of preterm newborns, as demonstrated by several studies. For example, Vanderbilt and colleagues (2009) assessed the prevalence of PTSD symptoms in a sample of 59 mothers one week after their infant's preterm birth. Authors found that 23% of the mothers with infants hospitalized in the NICU met the severity criteria for a diagnosis of acute posttraumatic stress. Similarly, Winter and colleagues (2018) investigated the prevalence of depression and PTS symptoms in parents (323 mothers and 237 fathers) of very preterm infants at 1-2 months postpartum, by administering the EPDS and Impact of Event Scale (IES). Incidence of moderate to high depressive symptomatology was detected in 46.7% of mothers and 16.9% of fathers, whereas the prevalence of moderate to severe PTS symptoms was 25.1% and 23.7%, respectively, with a significant correlation between depressive and PTS symptoms. Furthermore, PTSD symptomatology seems to persist also later after the discharge, affecting both mothers and fathers during the first years following birth (DeMier et al., 2000; Kersting et al., 2004; Schecter et al., 2019; Rodriguez et al., 2020). For example, a study by Schecter and colleagues (2019) explored PTSD symptoms in 91 parents of preterm infants during the first years after NICU hospitalization using the PTSD CheckList–Civilian (PCL-C; Weathers et al., 1991), a self-report questionnaire including 17 key symptoms of PTSD. Results revealed an incidence of moderate to high severe PTSD symptomatology in 17% of mothers and 9% of fathers of previously hospitalized infants. Interestingly, while exploring the effects of different gestational ages, authors did not find any statistically significant difference among parents of extremely, very, moderate and low preterm, as well as full-term infants who had been hospitalized in the NICU. Furthermore, almost 38% of parents reported at least one of the

events experienced during the NICU hospitalization as the most traumatic of their life, suggesting that the experience of NICU hospitalization itself could constitutes a traumatic event for the parents. Another study by Rodriguez and colleagues (2020) explored chronic post-traumatic stress disorder at 6 months and 3-5 years of infant's age by administering the Davidson Trauma Scale (DTS; Davidson et al., 1997) to a sample of mothers of VLBW preterm infants with a gestational age < 32 weeks. Of the 146 mothers included in the study, almost half of the sample (44%) reported chronic PTSD at 6 months. Furthermore, the incidence of PTSD was even higher among mothers of ELBW infants, suggesting that birth weight may serve as a significant predictor for chronic PTSD outcomes. Post traumatic stress symptoms persisted in 18.7% of mothers of PT children at 3-5 years postpartum, suggesting that this symptomatology can have a long-term effect on maternal mental health also during childhood, as demonstrated also by other studies (Barthel et al., 2020). Among the risk factors which seem to increase the risk of developing PTSS or PTSD following a preterm birth, literature reports complications in infant's health and medical status, factors related to the infant's birth and later hospitalization in a stressful NICU environment, as well as the presence of previous issues in maternal mental health (Greene et al., 2015; Sandness et al., 2024).

Among the risk factors associated with an increased likelihood of developing PTSS or PTSD following preterm birth, the literature identifies complications in the infant's health and medical condition, factors related to birth, and prolonged hospitalization in a stressful neonatal intensive care unit (NICU) environment, alongside a history of maternal mental health issues (Greene et al., 2015; Sandness et al., 2024).

2.1.2. Characteristics of early dyadic interactions in case of prematurity

The quality of early dyadic interactions represents a crucial mediator for shaping later infant's development. In fact, a wide branch of the literature has repeatedly demonstrated the importance of positive, sensitive, and attuned caregiver-infant interactions in influencing developmental trajectories in both the linguistic, socio-communicative, emotional and cognitive domains (Ainsworth et al., 1978; Feldman, 2007; Murray et al., 1996).

The presence of postnatal symptomatology constitutes a risk factor not only for paternal mental health and well-being, but also for the onset of positive parent-infant relationships, potentially impairing the instauration of secure attachment bonds. In this sense, literature on preterm birth has widely investigated the quality of early dyadic interactions between

premature infants and their caregivers across the first years following births, also exploring the potential effect of postnatal symptomatology on early interactive patterns. A number of factors could intervene in determining the quality of early interactive patterns and are related to both the infant's immaturity, the experience of early separation, as well as parental experiences, which are frequently characterized by emotional difficulties and stress.

As reported in the first chapter, premature infants are often described during early interactions with caregivers as more passive and less engaged and responsive compared to their full-term peers (Bozzette, 2007; Feldman & Eidelman, 2007). They frequently exhibit difficulties in social and communicative skills and tend to have a more difficult temperament (Wolf et al., 2002; Janssens et al., 2009). Infant's immaturity and greater difficulties in the socio-communicative domain can make more challenging caregiving and more difficult the development of positive and responsive interactions between the infant and the caregiver (Beckwith & Rodning, 1996; Goldberg & DiVitto, 1995). Furthermore, the greater passivity shown by preterm infants could lead to more over-stimulating parental behaviors in order to elicit the infant's response (White-Traut et al., 2013). Also, as previously seen, the experience of a traumatic premature birth can significantly increase stress levels in both parents and lead to more negative affective states. These factors can, in turn, impair the quality of early relationships and attachment bonding, both at behavioral and representational levels. In particular, mothers of premature infants may perceive themselves as less capable of effectively parenting their baby, while simultaneously perceiving their infant as more difficult and immature. As a result, they may engage in more disorganized and less functional caregiving behaviors (Forcada-Guex et al., 2011).

Both anxiety and depression have been described as potential risk factors for early dyadic interactions. A series of studies conducted on mother-infant couples explored the links between maternal postnatal symptomatology and interactive behaviors reporting a significant association between higher levels of maternal depression and poorer mother-infant interactions characterized by less emotional involvement as well as atypical behavioral patterns. For example, a study by Korja and colleagues (2008) evaluated the effects of maternal depressive symptomatology on dyadic interactions with their preterm infants at 6 and 12 months of corrected age. Results revealed that the behaviors of more depressed mothers were characterized by less positive affective involvement and communication compared to the behavior of non-depressed mothers of preterm infants, confirming the potential adverse impact that the presence of negative emotional states can have on maternal interactive

behaviors. Another study by Neri and colleagues (2015) explored the impact of maternal depressive and anxious symptomatology as well as infant's birth weight (VLBW vs. ELBW) on mother-infant dyadic interactions at 3 months of corrected age. Higher levels of depression were significantly associated with maternal remoteness and more negative affective states in interaction with the infant, whereas higher anxiety predicted lower sensitive behaviors. Furthermore, differences between birth weight groups emerged revealing more intrusive behaviors and lower remoteness in ELBW mothers, which were also the ones characterized by higher levels of postnatal depressive and anxious symptomatology. Conversely, interactions between VLBW infants and their mothers were characterized by higher maternal sensitivity and infant communication, revealing important differences related to different levels of severity of premature birth. A study by Agostini et al. (2014) reported similar results examining the impact of infant's birth weight on maternal interactive behaviors at 3 months in dyads of VLBW, ELBW preterm infants and FT ones. The findings underscored the role of birth weight as a significant moderator in the relationship between premature birth and maternal intrusive behaviors. Specifically, the study revealed that lower birth weight was associated with higher levels of maternal intrusiveness directed towards preterm infants. Authors suggested that this pattern could be attributed to two factors. First, the increased passivity observed in premature infants, particularly those with more severe conditions, may prompt mothers to adopt more stimulating and active behaviors. Second, mothers may develop more negative or distorted perceptions of their infants as extremely vulnerable and fragile, potentially leading to an increased tendency to overstimulate them during interactions. Interestingly, while considering maternal depression, differently from other studies, results from this study did not report lower levels of engagement in more depressed mothers, thus suggesting the need for further investigations.

The presence of maternal post-traumatic stress symptoms as well can lead to the instauration of atypical interactive patterns between the mother and the infant. A study by Forcada-Guex and colleagues (2011), for example, explored the potential relations between maternal post-traumatic stress, attachment representations of the infant and early dyadic interactive patterns at 6 months of corrected age in a sample of PT and FT mothers. Findings highlighted the presence of more cooperative interactive patterns in FT mothers as well as more balanced representations of their infants. Conversely, mothers of preterm infants with higher post-traumatic stress symptomatology showed more controlling interactive behaviors and more distorted attachment representations compared to FT mothers and PT ones with lower levels

of PTSS. Similarly, in their study, Muller-Nix and colleagues (2004) found that mothers of high-risk preterm infants as well as mothers which experienced higher levels of emotional stress in the perinatal period displayed more controlling and less sensitive behaviors while playing with their infants at 6 months. Interestingly, maternal stress independently predicted less functional interactive patterns even when preterm infant's interactive behaviors were similar to the ones displayed by full-term peers. This latter finding can have important implications because suggests how maternal symptomatology rather than birth status could play a fundamental role in influencing the quality of early interactive behaviors in mother-infant dyads.

As widely mentioned before, premature birth can negatively affect both parents and research in this field should consider not only the direct effect of preterm birth on one parent's mental health and behavior but also the reciprocal influence between partners. For example, Ionio et al. (2020) evaluated the impact of fathers' (N=45) levels of stress, post traumatic symptoms and negative emotions on dyadic interactive behaviors displayed by their partners (N=45) and their VLBW premature infant (GA < 32 weeks; BW < 1500 g) at 3 months of corrected age. Results revealed a significant influence of paternal mental health on mother-infant interactions at 3 months postpartum. Specifically, greater paternal stress, PTSS and negative emotions were associated with poorer and worsen mother-infant interactive behaviors and more negative outcome in infant's language development.

The quality of early dyadic interactions is recognized as a critical factor in establishing a positive caregiver-infant relationship, fostering a secure attachment bonding, and supporting the infant's later development. These early interactions between the adult and infant occur through multiple channels, such as eye contact, touch, and vocalizations. A key component of early caregiver-infant exchanges is Infant-Directed Speech (IDS), the specific register used by adults when communicating with infants and young children. In the next chapter, we will explore in detail the primary characteristics of IDS and its crucial role in promoting infant development across several domains. Furthermore, we will examine how IDS can be affected by postnatal symptoms or at-risk infant conditions, such as preterm birth.

Chapter 3 – Preterm birth and early parent-infant vocal interactions

3.1. Vocal interactions in case of preterm birth

Starting from birth, infants progressively develop the capacity to engage with caregivers in dyadic interactions marked by a turn-taking structure characterized by rhythmic timing and interpersonal synchronization between partners (Beebe et al., 1988; Delafield-Butt & Trevarthen, 2015; Gratier et al., 2015). Infant vocalizations serve not only as a means of social interaction with caregivers, providing cues for parental response, but also as important precursors to later speech and language development (Hilbrink et al., 2015; Oller et al., 2001, 2019).

Research on early interactions in the context of premature birth has identified increased challenges in interactive exchanges. On one hand, preterm infants are frequently described as more passive and less responsive and attentive during communicative exchanges (Crnic et al., 1983; Montirosso et al., 2010; Kiepura et al., 2021). Conversely, parents of preterm infants tend to show higher levels of intrusiveness and reduced attunement to their infants' cues (i.e., Agostini et al., 2015), as we discussed in the previous chapter.

Atypical interactive behaviors in preterm infants appear to emerge from the earliest developmental stages and could persist also later on (for a review, see Korja et al., 2012). For example, Minde et al. (1985) longitudinally observed mother-infant behaviors during home observations at 1, 2, and 3 months, finding that preterm infants, compared to their full-term peers, were generally less alert and focused at 1 and 2 months during interactions with their mothers. Furthermore, at each time of observation, mothers of preterm infants exhibited more distant behaviors, touching and smiling at their babies less frequently compared to full-term ones. Kiepura et al. (2021) investigated vocal behaviors in mother- and father-infant dyads at 3 months, comparing 19 full-term and 19 preterm infants. Their findings indicated that preterm infants showed shorter durations of vocalizations compared to full-term infants, irrespective of the parental role of the partner. Interestingly, the use of conversational pauses was more frequent in response to active vocal participation by the infant in both groups and regardless of parental role. Similar results were observed longitudinally by Crawford (1982), who assessed mother-infant interactions at home at 6, 8, 10, and 14 months, reporting lower levels of vocalizing and play behaviors in preterm infants compared to full-term peers.

Another longitudinal study by Crnic et al. (1983) found that preterm infants displayed less

active and responsive behaviors during free play interactions at 4, 8, and 12 months compared to full-term peers, with mothers described as being more active and stimulating. Similarly, in a study examining turn-taking processes in mother-infant dyads at 6 months, Salerni et al. (2007) found that interactions in preterm dyads were marked by higher maternal vocal responsiveness paired with lower levels of infant activity.

In early developmental stages infants' interactive behaviors are especially supported and scaffolded by parental vocal and interactive engagement, which fosters the emergence of communicative abilities and vocal participation during early interactions (Sameroff, 2010). Considering that, as outlined in the previous chapter, the increased vulnerability of preterm infants may affect both their interactive behaviors and the processes involved in the development of the parental role, representing a potential risk to sensitive and responsive parenting, the following paragraphs will review existing literature on the characteristics of parental interactive behaviors with a specific focus on patterns of Infant-Directed Speech.

3.2. The characteristics of Infant-Directed Speech (IDS)

Since the second half of the 20th century, researchers have increasingly focused on the study of peculiar linguistic register used by adults, especially caregivers, when interacting with infants and young children. This particular way of speaking, referred to by various terms over time such as "Baby Talk," "Motherese," or "Parentese," is now more commonly known as Infant-Directed Speech (IDS) or Child-Directed Speech (CDS), depending on the age of the young interlocutor (Saint-Georges et al., 2013).

In contrast to Adult-Directed Speech (ADS), which characterizes adult-to-adult conversations, IDS exhibits specific features at linguistic, acoustic, and content levels.

Among these, the most prototypical elements of IDS include structural and grammatical simplifications, lexical redundancy, specific functional and pragmatic proprieties as well as a slower tempo and an exaggerated prosodic profile (Soderstrom, 2007; Saint-Georges et al., 2013; Genovese et al., 2020). These features enhance its salience for infants, as demonstrated by the preference for this type of linguistic input shown by newborns yet from the first weeks after birth (Werker & McLeod, 1989). Moreover, IDS characteristics do not remain stable, but dynamically and interactively evolve over time to accommodate the infant's developing linguistic and communicative abilities (Kitamura et al., 2001; 2003; Soderstrom, 2007; Saint-Georges et al., 2013; Genovese et al., 2020) and to support his/her development in several

domains such as, for example, the cognitive, social, and emotional ones (Saint-Georges et al., 2013), as we will see later in this chapter.

3.2.1. Lexical features

As previously mentioned before, the lexical profile of IDS is characterized by a limited and simplified vocabulary along with a greater redundancy compared to ADS, especially during the early stages of the infant's development (Bornstein et al., 1992; Henning et al., 2005; Genovese et al., 2020).

Literature which investigated IDS verbosity reported dynamic changes in the amount of IDS over time (Bornstein et al., 1992; Henning et al., 2005). Specifically, speech input addressed to younger infants is characterized by a lower verbosity, compared to the input directed to older ones, particularly during the preverbal stage. An important study by Bornstein et al. (1992), which investigated maternal IDS in six different countries from 5 to 13 months after birth, reported a higher speech verbosity in IDS directed to older infants compared to 5-months-old ones. Similarly, a more recent study by Genovese et al. (2020) longitudinally explored maternal IDS features at 3, 6, 9 and 12 months after birth and found a general increase in speech verbosity from early stages of development to the end of the first year.

Moving on to lexical features typical of IDS, these include a higher presence of onomatopoeias, nonsense sounds, and diminutives. Onomatopoeias, particularly during the infant's preverbal stage, are often used by parents in place of the words they are referred to (Genovese et al., 2020). For example, when interacting with infants or young children, adults frequently use the sounds or noises of animals or objects to refer to them. Onomatopoeias have been found to be produced with stressed prosodic salience and are generally phonologically simpler compared to words (Laing et al., 2017). These characteristics contribute to making this type of lexical element preferred by infants in the early phases of development, as well as more suitable for language processing and early acquisition (Laing, 2014; 2019a). Furthermore, both the emphasized prosodic salience and the simple phonological structure of onomatopoeias seem to facilitate attention attraction and early interaction with caregivers, especially during preverbal stages when the infant's linguistic skills are still limited (Kauschke & Klann-Delius, 2007; Laing, 2019b).

Another element that characterizes the lexical profile of IDS is the recurrent use of diminutives (Kempe et al., 2001; 2007). Along with other lexical and functional features of adult speech

directed towards infants, the use of diminutives typically plays an affective function (Bornstein et al., 1992; Kitamura & Burnham, 2003; Genovese et al., 2020); this is particularly prominent in the early phases of development, where the affective connotation of IDS is more prevalent compared to its informative function, as we will discuss further on. Some authors also suggested that the recurrent prosodic and distributional cues typical of the diminutive form could help infants in word segmentation processes (Jusczyk, 1997; Echols et al., 1997; Kempe et al., 2005).

From a structural perspective, one of the main typical characteristics of IDS is the massive use of repetitions and reduplications. The first ones consist in the *verbatim* or partial repetition of an utterance. *Verbatim* repetitions are typical of IDS addressed to younger infants and is useful to sustain his/her attentional processes. As the infant grows, partial reiterations, which means the repetition of part of an utterance, become more frequent and serves a fundamental role also in sustaining child's vocabulary development through facilitating the segmentation of the speech flow as well as lexical processing (Segal & Newman, 2015). Reduplications consist in the repetition of one or more syllables within a word (Ferguson, 1964; Gervain & Werker, 2008). This phonological structure is frequently found in onomatopoeias, as seen before, and serves to facilitate both word segmentation and acquisition as it makes the input more salient and easier to memorize (Ota & Skarabela, 2016; 2018; Ota et al., 2018).

As previously mentioned, the lexicon of IDS is characterized by increased redundancy, contextualization, and reduced lexical variability compared to ADS. The variety of IDS lexicon, as well as the complexity of its syntactic structure which we will see later, undergoes modifications over time, becoming richer and more diversified as the infant grows (Snow, 1972; Huttenlocher et al., 2007; Genovese et al., 2020). The dynamic nature of IDS can be well explained by the concept of the Zone of Proximal Development (Vygotsky & Cole, 1978; Rowe & Snow, 2020), which suggests a reciprocal influence between the input given to the infant and his/her developmental stage. According to this theory, the optimal condition for supporting development occurs when the infant receives an input that is challenging but yet achievable and that could be adjusted in response to the infant's progress. Thus, caregivers adjust their speech according to the infant's age and skills to support and foster his/her development and in particular language acquisition processes.

3.2.2. Syntactic features

Examining the syntactic features of IDS, utterances produced by adults when speaking to infants or young children are typically syntactically simpler and shorter compared to the one displayed in adult-to-adult conversations. Similar to other IDS features, syntactic complexity and utterance length tend to increase as the infant grows, in order to adapt to his/her emerging skills (Snow, 1972; Huttenlocher et al., 2007; Poulain, T., & Brauer, 2018). One of the most reported measures of syntactic complexity in speech is represented by the Mean Length of Utterance (MLU), which indicates the average number of words or morphemes per utterance. Studies which compared MLU in speech directed to adults and to infants have found that MLU is significantly shorter in IDS, averaging around 3-4 morphemes, whereas in ADS, the utterance length averages around 8 morphemes.

Interestingly, modifications in syntactic complexity, MLU in particular, seem to follow a U-shaped trajectory across the first two years of life. In fact, several authors have observed that MLU is usually longer in the first half of the first year, undergoes significant simplification in the third trimester after birth and increases again in syntactic complexity after 12 months and throughout the second year of life (Sherrod et al., 1977; Stern et al., 1983; Genovese et al., 2020). Some authors suggested that these age-related modifications, which reflect the complexity of the interaction between speech input and infant's acquisitions, are thought to be particularly functional during the transition from the preverbal to the verbal period. More specifically, around 9 months, coinciding with the onset of babbling, caregivers tend to simplify their speech in order to facilitate vocal interactive exchanges with their infants. On the contrary, when the infant enters the verbal stage of development and begins to produce the first words, the complexity in linguistic input increases again (Genovese et al., 2020).

Other syntactic simplifications characteristic of IDS include the recurrent use of one-word utterances or word combinations, which involve the production of a single o more content words without a verb and represent linguistic forms which have been scarcely observed in ADS (Genovese et al., 2020). Even if one-word utterances are frequent in IDS, some authors argue that IDS present a certain degree of syntactic completeness, for example reporting a significant number of full clauses, including complete subject–verb combinations, and a certain degree of syntactical diversification in IDS produced by mothers in interaction with their infants (Cameron-Faulkner et al., 2003; Soderstrom et al., 2008; Genovese et al., 2020). Despite this consideration, other syntactic elements with a higher degree of complexity, such as the

production subordinate clauses as well as phrasal verbs, are rare in IDS directed to preverbal infants and emerge later as a function of age and level of development (Genovese et al., 2020).

3.2.3. Prosodic features

As mentioned at the beginning of this chapter, one of the most distinctive characteristics of IDS is its prosodic and acoustic profile. Infant-Directed Speech is in fact characterized by an exaggerated, high-pitched and overmodulated melodic profile, as well as slower tempo and longer pauses which contribute to make it more salient for the infant. This characterizes especially the earlier phases of development when dyadic communicative exchanges are mainly based on paralinguistic elements of speech (Katz et al., 1996; Saint-George et al., 2013; Spinelli et al. 2017).

The literature on IDS and prosody has identified various parameters to evaluate the acoustic properties of caregivers' speech. One of the most reported measures is the mean fundamental frequency (F0), which reflects the perceived pitch of the voice. Generally, the mean F0 of caregivers' speech during early interactive exchanges is significantly higher compared to ADS (Saint-Georges et al., 2013). This indicates that, when addressing to infants, adults tend to speak using a higher pitch of the voice. The melodic profile associated with IDS is characterized by greater F0 variation and modulation. Specifically, the F0 range — defined as the difference between the maximum and minimum pitch within an utterance — is typically wider in IDS than in adult-to-adult conversations. Additionally, variations in intonation are significantly more frequent in IDS compared to ADS, resulting in the exaggerated melodic contours that are characteristic of IDS.

A high-pitched voice as well as marked and modulated intonational boundaries play a significant role in both attentional and emotional processes and can also explain infant's preference for this kind of linguistic register compared to the adult-directed one (Fernald & Kuhl, 1987; Cooper & Aslin, 1990; Spinelli et al., 2017). Specifically, they contribute to capture and maintain infant's attention and to convey emotional information. Particularly during the pre-verbal stage of linguistic development, the prosodic features of input are more engaging and salient to the infant than the linguistic ones. Several studies reported how these prototypical IDS characteristics contribute to making it more attractive for infants contributing to capture and maintain infant's attention during dyadic exchanges (for reviews, see Saint-Georges et al., 2013; Spinelli et al., 2016). Furthermore, literature suggested how the prosodic

profile associated with IDS could contribute also to an emotional and affective function. In other words, these acoustical features of IDS could help the infant to interpret emotional contents, specifically positive emotional expressions, shared by the caregiver. In fact, as we will see in the next paragraphs, one of the main function of IDS is to facilitate conveying affective contents as well as to create emotional bonds between the caregiver and the infant (Fernald, 1992; Trainor et al., 2000; Saint-Georges et al., 2013; Spinelli et al., 2017).

Considering the rhythmicity of IDS, this speech register is generally characterized by a slower tempo, longer pauses between phrases, and more marked and exaggerated pitch contours (Stern et al., 1983; Fernald et al., 1989; Saint-Georges et a., 2013; Narayan & McDermott, 2016). The first temporal feature is usually measured in terms of speech rate, which is usually calculated as the mean number of syllables produced in one second. Several studies reported that adults tend to speak with their infant significantly more slowly than when speaking to other adults (Fernald and Simon, 1984; Tang and Maidment, 1996; Narayan & McDermott, 2016). Another characteristic of the temporal profile of IDS is the presence of longer pauses between utterances as well as more marked and exaggerated pitch contours. Pitch contours, which indicate the end of the clause, are generally marked by expanded pitch contours and a longer prepausally length, which means that the last syllable of the word usually lasts more compared to the others. Taken together these characteristics are useful to increase speech clarity and to help infants in speech segmentation processes, thus facilitating word and linguistic learning (Thiessen et al., 2005; Soderstrom, 2007; Cristia, 2013).

As happens with other features of IDS, also its prosodic profile undergoes dynamic changes based on infant's age and development. For example, the trajectories of mean F0 seems to follow an increase from birth to 6 months and then a decrease until 24 months and later on becoming then more similar to the pitch of voice of adult-to-adult conversations. Moreover, IDS is significantly influence by infant's preference and feedback. For example, a study reported that the preference of younger infants for higher IDS pitch led mothers to increase the tone of voice in order to increase infant's engagement. Moreover, infant's vocalizations in the first trimester after birth seem to influence and be influenced by maternal IDS in both pitch and melodic contours (Saint-Georges aet al., 2013).

3.2.4. Pragmatic and functional features

The pragmatic features of IDS play a crucial role in conveying the illocutionary intent of speech directed to infants. Like other aspects of IDS, these pragmatic features undergo changes and modifications, adapting to the infant's age and emerging abilities (Luksaneeyanawin et al., 1998; Saint-Georges et al., 2013). A key distinction is made between parental speech that aims to convey affective content and speech intended to share information. Based on this difference, the literature describes two main categories of IDS: affect-salient speech and information-salient speech (Penman et al., 1983; Bornstein et al., 1992; Venuti et al., 1997).

During the early stages of development, particularly in the first half of the first year, affect-salient speech constitutes nearly half of the IDS directed at infants. This category includes non-propositional or idiomatic utterances used to create affective bonds with the infant, thereby influencing their socio-affective development. The proportion of information-salient speech begins to increase from the second half of the first year, following a trajectory inversely proportional to that of affective utterances. In fact, this type of speech increases in response to the infant's emerging skills, supporting and facilitating cognitive and linguistic development (Soderstrom & Morgan, 2007; Kitamura & Burnham, 2003; Saint-Georges et al., 2013).

Similar changes in the content of IDS also pertain to the attentional focus of maternal and paternal speech over time. Some authors have reported that in the initial phases of development, the attentional focus of IDS is mainly oriented toward the infant's internal states, such as physiological or emotional conditions. As the infant grows, the attentional focus of parental speech shifts to the surrounding environment to support the infant's exploratory behaviors (Snow, 1977; Bornstein et al., 1992).

Moving on functional features of IDS, affect-salient speech usually includes greetings, exclamations, as well as comforting, approval, and loving expressions. On the other hand, information-salient speech usually includes questions, descriptives or directive utterances, which express for example orders or prohibitions. As mentioned before, this second macro-category begins to be more frequent in later phases of development as the infant starts developing more advanced motor, cognitive, and linguistic skills which allow him/her to explore the social and physical environment (Luksaneeyanawin et al., 1998).

Interrogative utterances, after affect-salient speech, represent the second most used functional category, especially during the first year of life. Among the several typologies of questions, literature further distinguishes between *Yes/No questions*, which are mostly used with younger infants to elicit his/her attention and response, and open *WH questions*, which

becomes more frequent starting from the second year of life and are usually oriented to facilitate infant's attention and interaction with the surrounding environment (Luksaneeyanawin et al., 1998; Soderstrom, 2007).

Functional and pragmatic features of IDS are strictly connected to their prosodic contours, which usually vary according to the caregiver's communicative intentions. Pitch contours, in fact, serve to discriminate between several pragmatic categories. For example, in the first semester postpartum, rising contours are produced to capture infant's attention and eye contact, or to produce yes/no questions, whereas falling contours are associated with commends or open questions. Furthermore, more complex contours, such as bell-shaped or sinusoidal ones, are used to communicate positive affect or sustain infant's attention (Stern et al., 1982; Saint-Georges et al., 2013).

During the early phases of development, when preverbal infants are not yet able to understand the meaning of words, prosodic features are fundamental in helping them to discriminate between different sentence types, such as interrogatives and declaratives. Indeed, various studies have reported an early capability in preverbal infants to distinguish between interrogative and declarative sentences only on the basis of prosodic contours (Soderstrom et al., 2011; Frota et al., 2014).

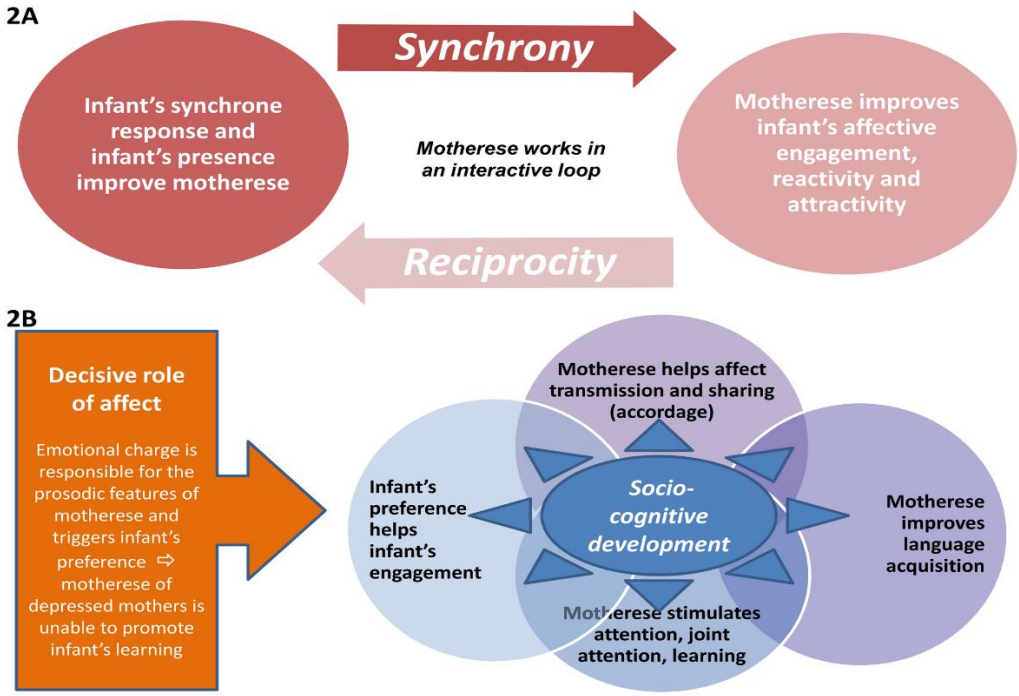
3.3. The role of Infant-Directed Speech in supporting infant development

Literature on parental speech has reported several functions associated with prototypical IDS features. Several studies demonstrated the role of IDS in influencing both the building of affective bonds between the infant and the caregiver, and the infant neuro-cognitive developmental trajectories in both the social, cognitive, and linguistic domains (Kitamura et al., 2001; Saint-Georges, 2013; Saliba et al., 2020). For example, the exposition to IDS with prototypical features plays a key role in supporting the infants' early linguistic and communicative development facilitating the infant's responsiveness during social interactions (Werker and McLeod, 1989; Goldstein and Schwade, 2008; Albert et al., 2018).

One of the main aspects which results to be particularly salient in IDS specific speech register, as we saw in paragraph 3.1.3., is its prosodic profile. According to Fernald (1984), prosodic features of IDS serve different functions during parent-infant interactions, such as engage and maintain infant's attention, modulating infant's arousal levels, conveying affective contents, and helping infants and young children in speech segmentation processes as well as language

comprehension and acquisition (see Figure 4 for a schematic summary taken from the review by Saint-Georges et al., 2013).

Figure 4 - Summary of the motherese interactive loop (2A) and its socio-cognitive implications (2B) (Saint-Georges et al., 2013, p. 13)



2A: The motherese interactive loop implies that motherese is both a vector and a reflection of mother-infant interaction. 2B: Motherese affects intersubjective construction and learning. Its implications for infants' early socio-cognitive development are evident in affect transmission and sharing, and in infants' preferences, engagement, attention, learning and language acquisition (Saint-Georges et al., 2013).

To date, a substantial number of studies have confirmed the role of IDS in facilitating early dyadic exchanges between caregivers and infants (Saint-Georges et al., 2013). One key aspect that enhances social interactions is related to the infants' preference for IDS over ADS (Fernald & Kuhl, 1987). Infants not only prefer listening to IDS, but they also exhibit a greater affective responsiveness to it, which in turn facilitates the establishment of positive interactions (Santarcangelo & Dyer, 1988). This preference appears very early in newborns and tends to decrease by the end of the first year after birth (Cooper & Aslin, 1990; Pegg et al., 1992; Newman & Hussain, 2006). Interestingly, some studies have demonstrated that, rather than a specific preference for a speech register, infants exhibit a general propensity to direct their attention towards stimuli that convey and transmit positive affective contents (Saint-Georges et al., 2013). This positive affect is more easily communicated through input with a higher mean F0 and a pronounced and modulated intonational profile. Since IDS typically conveys more affective content through its prototypical features, it results to be more attractive for younger

infants compared to ADS, which is generally less affectively emphasized (Trainor et al., 2000; Singh et al., 2002; Corbeil et al., 2013). All these characteristics of IDS play an important role in facilitating the establishment of positive interactions, promoting closeness, and building caregiver-infant affective bonds.

A second function of IDS is related to its role supporting infant's affective and emotional development. The empathized prosodic patterns typical of IDS, conveying affective contents between the caregiver and the infant, have a key role in the infant's emotional co-regulation processes (Stern et al., 1982; Spinelli et al., 2017, 2018). Regarding this last function, some authors have analyzed the prosodic patterns of maternal IDS following the Still Face Paradigm (Tronick et al., 1982). This paradigm consists in eliciting the disruption of face-to-face dyadic interactions between the infant and the caregiver and developed to be used in research to elicit infant's negative affect and evaluate the dyadic processes of reparation and mutual emotional regulation. Findings from some studies indicate that the prosodic features of IDS play a significant role in influencing an infant's biobehavioral states, thereby facilitating emotion regulation processes (Spinelli et al., 2017, 2018; Kolacz et al., 2021). For instance, Kolacz and colleagues (2021) investigated the effect of prosodic features of the maternal voice on infant's emotional and physiological regulation after the Still Face Paradigm. Their results demonstrated a bidirectional influence between the infant's states and maternal IDS; specifically, infant's heart rate, which was elevated after the social stressor, decreased with increased maternal prosody. Conversely, maternal prosody increased in response to the infant's distress behaviors and elevated heart rate. Another study by Spinelli and Mesman (2018) reported that prototypical IDS features, such as higher pitch modulation in the maternal voice, positively contributed to reducing infant's negative affect following the Still Face Paradigm. However, this association was significant only in the context of adequate maternal sensitivity, highlighting that the combination of these two maternal factors might represent the optimal condition for facilitating infant emotion regulation processes.

Another IDS function which is frequently in the literature is its role in capturing and maintaining infant attention during early interactions with the caregiver. Paralinguistic modifications of prototypical IDS, which include greater pitch modulation and exaggerated contours, in fact, seem to have a key role in eliciting attentional processes and have been associated with increased infant's visual attention towards the caregiver as well as higher cerebral activation (for a review and meta-analysis see Spinelli et al., 2017). The influence of IDS features on

infant's attention has been linked also with associative learning processes. In fact, this register provides important cues which facilitate the orientation of infant's attention towards a specific target or activity fostering joint attention processes and learning ones (Saint-Georges et al., 2013).

However, to date most studies have focused on single observation points demonstrating a significant influence between prototypical IDS and infant's attention at the same moment of the ongoing interaction. Conversely, longitudinal studies investigating the long-term outcomes of IDS on infant attention development are still rare and only one study by Roberts et colleagues (2013) reported a significant association between parental IDS at 6 months and joint attention skills at the end of the first year. Specifically, authors highlighted that the capability of caregivers to speak to the infant attributing him/her mental states and the use of wider pitch variability significantly predicted infant's joint attention abilities at 12 months.

Moving on the role of IDS in facilitating linguistic acquisition, some studies reported a significant influence of IDS on linguistic precursors during the first year of life. For example, some studies which investigate the effects of prototypical IDS on early precursors of linguistic development in preverbal infants reported a significant association between prosodic features of IDS and infant's pre-linguistic responsiveness. Specifically, it has been reported that prototypical features of parental speech, such as intonation contours, can affect infant's response increasing the number of vocalizations produced by preverbal infants at 3, 5 and 9 months after birth (Niwano & Sugai, 2002a, 2002b, 2003). Furthermore, other authors (Gratier & Devouche, 2011) found that infants as young as 3 months are able to imitate exaggerated contours which are typical of IDS but not unitonal or flat ones. As imitative skills and the rate of infant's vocalizations represent an important precursor for later linguistic development, these studies confirmed the importance of IDS for infant's language acquisition during early stages of development.

As regards later developmental outcomes in linguistic domain, literature reported a significant influence of prosodic features of IDS and vocabulary development (Saint-Georges at al., 2013 and Spinelli et al., 2017). Higher pitch and pitch variability provide important cues which help younger infants in speech segmentation and processing. In fact, IDS prosody may help infants in discriminating word and clause boundaries, thus facilitating later word comprehension and production (for a review and meta-analysis, see Saint-Georges at al., 2013 and Spinelli et al., 2017). If in the preverbal stage prosodic features of IDS seem to cover the most important role

in facilitating early linguistic acquisition, during later phases of development, linguistic features of IDS become more salient. Indeed, some studies reported a significant association between syntactic proprieties of maternal speech directed to 18-months-old children, such as MLU, and the use of simple construction and pronouns, and children linguistic development at 27 months (Furrow et al., 1979; Furrow & Nelson, 1986). Moreover, some studies hypothesize that, in later phases of development, linguistic modifications typical of IDS such as the use of diminutives and the tendency of IDS to put target word at the end of the utterance (in the final position) could play a role in facilitating segmentation, gender agreement and gender categorization processes (Kempe et al., 2003; 2005; 2007; Seva et al., 2007; Saint-Georges et al., 2013).

3.4. Factors influencing IDS patterns

3.4.1. The effects of postpartum symptomatology on Infant-Directed Speech patterns

As we discussed before in this chapter, Infant-Directed Speech represents a specific register whose features cover an important role in conveying affective and informative contents to the infant during dyadic interactions and foster infants' development in several domains.

To date, a branch of the literature on IDS has focused on the possible parental variables which could influence IDS patterns thus leading to a less optimal linguistic environment for the infant. So far, one of the most investigated areas regards the effect of maternal postnatal depression on IDS. Maternal postnatal depression is a quite common condition which can impair the quality of maternal emotional and affective states and could consequently affect different areas of parenting function, including the way in which mothers interact and speak with their infants. Findings of studies which investigated the relation between maternal depression and IDS reported speech modifications in both linguistic, prosodic and pragmatic functions related to the presence of depressive symptomatology. A recent meta-analysis by Scheiber et al. (2022) cited several studies which observed a negative association between the amount of maternal speech, evaluated in terms of total utterances (Jessee et al., 2016), word tokens (Rowe et al., 2005), or time spent vocalizing (Breznitz and Sherman, 1997), and the presence of higher levels of depressive symptomatology (see Table 1 for a brief description of the cited articles, taken from Scheiber et al., 2022). This means that, overall, depressed mothers tend to speak less and for less time with their infants compared to non-depressed ones. Interestingly, the same meta-analysis did not report statistically significant modification in IDS complexity and lexical variability, measured in terms of temporal duration and mean length of

utterances, as well as word types and maternal depression, suggesting the presence of a similar linguistic complexity in the speech input produced by depressed vs. non depressed mothers (Murray et al., 1993; Reissland et al., 2003; Hwa-Froelich et al., 2008). However, authors suggested caution in interpreting these results, as the studies considered displayed a certain degree of variability in terms of measures of IDS complexity, age of the infant (ranging from 2 to 52 months), sample size and assessment of maternal depression (Scheiber et al., 2022).

Table 1. Descriptions of cited articles which evaluated the effects of maternal depression on IDS features (from Scheiber et al., 2022, pp. 200-201)

	Authors and year	*N of dyads*	*Infant age at which maternal depressive symptoms were measured*	*Infant age at which IDS was measured*	*Measure of maternal depressive symptoms*	*Measure of IDS*	*Statistically significant results?*
Amount of IDS	Breznitz and Sherman, 1997	41	30-42 months old	30-42 m.o.	SADS (categorical; met criteria for depression vs. did not meet criteria for depression)	Sum of Vocalization	Yes
	Rowe et al., 2005	108	14, 24, and 36 m.o.	14, 24, and 36 m.o.	CES-D (continuous; self-report)	Total utterances	Yes
	Jessee et al., 2016	1114	1 and 6 m.o.	24 m.o.	CES-D (continuous; self-report)	Total word tokens	Yes
Complexity of IDS	Murray et al., 1993	59	1.5 m.o.	2-2.75 m.o.	EPDS (categorical, below a score of 13 vs. above a score of 13; self-report) Standardised Psychiatric Interview (categorical)	Mean Length of Utterance	No

	Reissland et al., 2003	64	4.5–12.75 m.o.	7.75–8 m.o.	EPDS (categorical, below a score of 9 vs. above a score of 9)	Mean Length of Utterance, Mean Duration of Utterance	No
	Hwa-Froelich et al., 2008	23	During pregnancy, 3 m.o., and 31–52 m.o.	31–52 m.o.	DIS-IV (categorical; met criteria for depression vs. did not meet	Mean Length of Utterance	No
	Rowe et al., 2005	108	14, 24, and 36 m.o.	14, 24, and 36 m.o.	CES-D (continuous; self-report)	Total Word Types	No

Note: Center for Epidemiologic Studies Depression Scale (CES-D); Diagnostic Interview Schedule, Fourth Edition; (DIS-IV); Edinburgh Postnatal Depression Scale (EPDS), Schedule for Affective Disorders and Schizophrenia (SADS).

As mentioned before, maternal emotional states could affect not only IDS form, but also its function. Herrera and colleagues (2003) investigated maternal speech directed to 6 and 10-month-old infants during free play interactions and reported different behavioral patterns in depressed mothers compared to non-depressed ones. A total of 72 mother-infant dyads were included in the study, 36 were mothers (18 depressed and 18 non-depressed) of 6-month-old infants and 36 (18 depressed and 18 non-depressed) of 10-month-old ones. Maternal depression was screened using the Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987) self-report questionnaire and a cut-off of 9/10 points to identify mother's depressed mood. Results revealed that IDS produced by depressed mothers of younger infants was characterized by a lower affective salience compared to non-depressed ones. Furthermore, IDS of mothers with higher levels of depression displayed similar proportion of affect speech both at 6 and 10 months, whereas non depressed mothers of younger infants tended to use more affect-salient speech compared to mothers without depression of older ones. Findings form this study highlighted not only that maternal depression might affect the degree of emotional and affective connotation of maternal IDS, but it could also impair the capability of adapting the verbal input according to the infant's age and developmental needs, as literature suggests that IDS tends to increase its informative salience over the affective one across time. As we saw in previous paragraphs, IDS prosody results to be one of the most salient aspects of parental speech and one of its main functions, during the preverbal stage, is to convey and share affective contents during early interactions. Several dimension of the IDS acoustic profile

seem to be particularly affected by the presence of depressive symptomatology resulting in a speech input which is less functional to engage infant's attention, as well as affective sharing and regulation (Kaplan et al., 2001). A study by Bettes (1988), for example, examined IDS produced by 10 depressed mothers and 26 non-depressed ones directed to their 3- to 4-months old infants. Maternal depression was evaluated by administering the Beck Depression Inventory (1996) self-report questionnaire and considering a cut-off of above 10 points to identify depressed mothers. Results showed flatter intonational contours in depressed mothers' speech compared to non-depressed ones. Furthermore, mothers who reported higher levels of depression tended to respond more slowly to their infants' vocalizations, indicating a greater difficulty in adapting their speech in response to their infants' cues. Another study by Kaplan and colleagues (2001) reported smaller F0 variance in IDS produced by mothers of 4- to 12-years-old infants with major depressive disorder diagnosed through the administration of the BDI questionnaire (cut off ≥ 13) and the Structured Clinical Interview for the DSM-IV Axis I diagnosis (SCID; First et al., 1997). Interestingly, the same study reported how mothers in symptomatology remission or in treatment with antidepressants showed a similar pitch and F0 variability compared to non-depressed ones. Similarly, Porritt and colleagues (2014) reported a smaller pitch variability (F0 range) in clinically diagnosed depressed mothers of 3- to 14-month-old infant compared to depressed mothers in remission, confirming the importance of early intervention to reduce the effects of maternal depression on IDS features. Similar results on the effect of depressive symptomatology on IDS were found also in the paternal population. Kaplan and colleagues (2007), for example, exploring IDS's prosody in fathers of 5- to 12.5-months-old infants, reported a significant reduced pitch modulation in IDS of fathers with higher levels of depressive symptomatology evaluated using the Beck Depression Inventory-II (BDI-II). Another study by Sethna and colleagues (2012) reported more negative and critical contents in depressed fathers' speech directed to their 3-month-old infants as well as a focus oriented on their own experience rather than on the infant's one.

As mentioned before, literature on parental symptomatology which could affect IDS's features has, so far, focused mainly on maternal postnatal depression. However, a recent study by Spinelli and colleagues (2022) explored the influence of both preterm birth and parenting stress, assessed using the Parenting Stress Index – Short Form (PSI-SF; Abidin, 1990), on IDS linguistic patterns at 3 months postpartum. Results revealed the presence of more linguistically complex IDS in mothers with higher levels of parenting stress, suggesting a

reduced capability to produce a speech input attuned to the infant's age and level of development.

3.4.2. Infant-Directed Speech addressed to preterm infants during the first year after birth

As seen in the previous chapters, premature birth could represent a traumatic event for both the newborn and the parental couple and could constitute an important risk factor for the onset of positive early interactions, also impairing the quality of communicative exchanges and IDS patterns. To date, only a few studies examined IDS features in case of prematurity, reporting small differences in linguistic and functional characteristics among PT and FT parents in the first years postpartum. For example, Suttora & Salerni (2011) longitudinally investigated maternal speech directed to their very preterm infants at 6, 12, 18 and 24 months of corrected age. Findings from this study highlighted a speech profile characterized by lexical and syntactic complexity as well as general verbosity similar to the input usually used with full-term infants. Moreover, authors also reported how maternal speech changes across time in relation to the infant's motor and vocal abilities, suggesting a certain capability of mother to dynamically adapt their speech according to the infant's developmental needs.

Salerni et al. (2007) explored at 6 months of corrected age mother-infant communicative exchanges in both PT and FT populations, specifically analysing linguistic complexity and functional features of maternal IDS, infant's prelinguistic productions and turn-taking patterns. Results revealed that PT infants were overall more passive and less involved during interactions, especially in case of lower birth weight suggesting that this variable could significantly interfere with infant's productiveness and responsiveness. On the other hand, authors did not report significant differences in the linguistic complexity as well as in the type of utterance produced by PT mothers compared to the FT ones, suggesting the presence of similar IDS patterns among the two groups.

More recently, some studies which investigated the effects of premature birth on maternal speech patterns explored the potential effect of other variables related, for example, to parental clinical or socioeconomic characteristics. Spinelli et al. (2022) investigated the impact of both premature birth and parenting stress on the linguistic and pragmatic characteristics of maternal IDS at 3 months of corrected age. Their findings revealed small differences in maternal speech between the PT and FT groups. Interestingly, in both groups, mothers who reported higher levels of parenting stress provided speech input characterized by a lower

verbosity and a greater lexical and syntactic complexity. These results suggest that perceived stress, rather than the infant's birth status, is a more significant predictor of the quality of maternal IDS. Similarly, O'Connell (2021) compared communicative patterns between FT and PT parents at 9 months postpartum, also considering the potential effect of socioeconomic deprivation. Results from this study revealed no differences in the linguistic and gestural communicative patterns between PT and FT parents in interaction with their infants. Conversely, a lower socioeconomic status was significantly related to a lower verbosity as well as a reduced complexity of the linguistic input addressed to the infant, regardless to the gestational age.

Despite this evidence, it remains a notable gap in research exploring the specific impact of different degrees of prematurity based on birth weight, as well as the combined effect of premature birth and parental symptomatology. Additionally, similar to the majority of studies on early parent-infant interactions, existing literature on IDS in preterm infants has predominantly focused on mothers. The role of fathers, by contrast, has received little to no attention.

3.5. Thesis outline and presentations of the empirical studies

As broadly discussed in this and in the previous chapters, preterm birth represents an unexpected event which could potentially negatively affect infant's development as well as parental transition to parenthood, consequently impairing the onset of positive early dyadic interactions. Even if, to date, a broad branch in the literature has analyzed different neurodevelopmental and relational dimensions connected with premature birth, still there is a lack in the literature which has explored preterm birth specifically considering the effect of birth weight and postnatal symptomatology, as well as paternal role on IDS patterns in the first year after birth. In this perspective, the aim of this doctoral project was to fulfill this gap by developing four studies which analyzed different aspects of maternal and paternal speech at 3 and 9 months postpartum, while considering the severity of prematurity and the presence of depressive symptomatology and parenting stress.

The first study compared linguistic and functional features of maternal speech directed to full-term and preterm infants at 3 months of corrected age. Specifically, both the potential influence of maternal postnatal depression and the severity of preterm birth according to birth weight on maternal infant-directed speech patterns were explored.

In order to complete the analysis of maternal speech directed towards full-term and preterm infants in the first trimester following birth (corrected age for PTs), a second study was developed to analyze prosodic and acoustical features of maternal infant-directed speech. Similarly to the first study, also in this second research the effect of potential risk factors such as maternal depression and more severe preterm birth were explored.

The third study tried to full-fill the gap in the literature regarding paternal speech directed to full-term and preterm infants in the first trimester after the birth (corrected age for PTs). Specifically, it compared syntactic, lexical, and functional characteristics of maternal and paternal infant-directed speech to 3-months-old full-term and preterm infants trying to identify differences and similarities, also considering different levels of premature birth according to birth weight.

Finally, a fourth study was developed to longitudinally investigated changes and stabilities in both the lexical, syntactic, and functional features of maternal infant-directed speech at 3 and 9 months postpartum among ELBW, VLBW, and FT mother-infant dyads. Furthermore, it analyzed the influence of the severity of prematurity and parental distress on the features of maternal infant-directed speech towards infants at 3 and 9 months following birth (corrected age for preterm infants).

Chapter 4 - Infant-Directed Speech to 3-Month-Old Severe Preterm Infants: The Influence of Birth Weight and Maternal Depressive Symptoms

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Abstract: Severe premature birth (<32 weeks) is a risk factor for the development of maternal perinatal depression, while also affecting dyadic interactions and child outcomes. Although several studies have examined the impacts of prematurity and depression on early interactions, only a few studies have investigated the features of maternal verbal input. Furthermore, no study has investigated the relationship between the effect of severity of prematurity according to birth weight and maternal input. This study aimed to explore the effects of the severity of preterm birth and postnatal depression on maternal input during early interactions. The study included 64 mother–infant dyads, classified into three groups: 17 extremely low birth weight (ELBW) preterm infants, 17 very low birth weight (VLBW) preterm infants, and 30 full-term (FT) infants. At 3 months postpartum (corrected age for preterm infants), the dyads participated in a 5-min free interaction session. Maternal input was analyzed using the CHILDES system in terms of lexical and syntactic complexity (i.e., word types, word tokens, mean length of the utterance) and functional features. Maternal postnatal depression (MPD) was assessed using the Edinburgh Postnatal Depression Scale. The results showed that in high-risk conditions (i.e., ELBW preterm birth and maternal postnatal depression), maternal input was characterized by a lower frequency of affect-salient speech and a higher proportion of information-salient speech, specifically as directives and questions, suggesting that mothers in these conditions may experience more difficulty in conveying affective content to their infants. Moreover, the more frequent use of questions may reflect an interactive style characterized by a higher level of intrusiveness. These findings provide preliminary evidence of the impacts of prematurity severity and maternal depression on maternal verbal input, highlighting the importance of assessing both factors in clinical practice. Understanding the mechanisms underlying the impacts of prematurity and depression on early interactions may inform the development of tailored interventions aimed at promoting positive parent–infant interactions and child development.

4.1. Introduction

Prematurity is a condition that occurs in cases of infants born alive before the 37th week of pregnancy (WHO, 2012), and it could represent an important risk factor for the infant's survival and development (Biasini et al., 2012; Lind et al., 2011). The risk of mortality or developmental delays is particularly evident when preterm infants are very small in terms of birth weight, as in cases of very low birth weight (VLBW; <1500 g) or extremely low birth weight (ELBW; <1000 g) conditions (Biasini et al., 2012; Blencowe et al., 2012; Mariani et al., 2018; Neri et al., 2020; Sansavini et al., 2011). Several studies that focused on the neuropsychological trajectories of preterm infants have reported the presence of deficits or delays that could affect different developmental domains (Kerstjens et al., 2012), such as the motor (Hughes et al., 2016), cognitive (Sansavini et al., 2015), and linguistic domains (Benassi et al., 2016; Guarini et al., 2016; Vandrormael et al., 2019; Pisoni et al., 2019; Forcada-Guex et al., 2011). Constituting a specific risk factor for the infant's survival, health, and development, severe prematurity can represent a stressful and traumatic event for the parents, impairing the transition to parenthood, and leading to the exacerbation of negative feelings and perceptions about themselves as parents, along with recurrent and persistent worries about the baby (Pisoni et al., 2019). Indeed, the literature underlines an increased risk of developing postnatal depressive and anxious symptomatology (Forcada-Guex et al., 2011; Monti et al., 2013; Rogers et al., 2013) in both mothers and fathers of high-risk preterm infants in the first postpartum period (Neri et al., 2015; 2020; Pace et al., 2016; Genova et al., 2022). Such symptomatology can negatively affect both parenting and infant development (Forcada-Guex et al., 2011; Neri et al., 2015), as it can impact on the mother's ability to engage in interactive exchanges with her infant and reduce the quality and quantity of input directed towards the infant, potentially leading to more negative developmental outcomes (Zelkowitzet al., 2009; Letourneau et al., 2012).

Studies that analyzed the effect of the severity of prematurity on early dyadic interactions have highlighted a significant relationship between lower birth weight and the quality of mother–infant interactions in the first postpartum period (Agostini et al., 2014; Neri et al., 2015. Specifically, a study by Neri et al. (2015) showed that ELBW preterm infants are more likely to have interactions characterized by high maternal intrusiveness and low remoteness. On the other hand, VLBW infants tend to have interactions with high levels of maternal sensitivity and infant communication. Furthermore, postnatal depression and anxiety in mothers have been

associated with negative impacts on the quality of interactions, with depression being related to maternal remoteness and a negative affective state, and anxiety being linked to low sensitivity (Neri et al., 2015).

Infant-directed speech (IDS) represents a particular spontaneous register used by parents and caregivers to interact with infants and young children (Saint-Georges et al., 2013). This form of speech is different from adult-directed speech (ADS), as it is characterized by linguistic and acoustic features such as grammatical simplification, lexical repetition, and exaggerated prosody (Soderstrom et al., 2007). These features have different important functions, such as arousing and sustaining the infant's attention, facilitating dyadic interactions, conveying affective and informative contents, and promoting linguistic development (Kitamura et al., 2003; 2009; Spinelli et al., 2017; 2018). Furthermore, IDS characteristics adjust dynamically over time, becoming more complex in order to support and shape the infant's linguistic, cognitive, and socio-affective development (Soderstrom et al., 2007; Saint-Georges et al., 2013; Genovese et al., 2020). Compared to ADS, speech's verbosity is reduced in IDS (Genovese et al., 2020). Additionally, the amount of maternal speech generally decreases when addressed to younger infants and tends to increase as they get older, adjusting to the infants' emerging skills (Bornstein et al., 1992; Henning et al., 2005).

As regards the lexical features, IDS is described as simpler, more concrete, and characterized by a lower variability in its semantic contents compared to ADS (D'Odorico & Franco, 1985; Genovese et al., 2020). Vocabulary is more limited and characterized by a higher number of repetitions. Moreover, lexical features such as onomatopoeias, nonsense sounds, and a large use of diminutives are recurrent and typical of IDS, with an important affect-salient function, conveying affective contents during caregiver–infant interactions (Kitamura et al., 2003; Bornstein et al., 1992; Genovese et al., 2020). Simplifications in IDS also include its syntactic structures, which appear to be shorter and less complex compared to ADS (Snow, 1972; Saint-Georges et al., 2013). The mean length of the utterance (MLU), which is a measure of syntactic complexity, is generally about three words in IDS and eight in ADS. Moreover, simple syntactic forms such as one-word utterances are frequent in IDS, but not in ADS (Papoušek et al., 1987; Spinelli et al., 2016).

Social–pragmatic aspects of IDS cover an important function in facilitating early dyadic interactions, because they allow infants and young children to infer the caregiver's communicative or affective intent (Saint-Georges et al., 2013). Interestingly, the literature

highlights a variation in the functional characteristics of IDS across the first two years postpartum (Genovese et al., 2020). In the early stages of development, adult speech addressed to young infants is described as more affective and characterized by a higher proportion of affect-salient utterances, such as diminutives, proper names, and onomatopoeias (Bornstein et al., 1992; Kitamura et al., 2003; Genovese et al., 2020). As the infant grows up, IDS changes in its pragmatic functions, becoming more informative, contextualized, and descriptive (Bornstein et al., 1992; Spinelli et al., 2016). The dynamic changes in the functional contents of IDS during the first year postpartum reflect the caregivers' ability to adapt and adjust their speech according to the infants' age and level of development (Rowe et al., 2012).

As mentioned above, IDS plays a key role in promoting closeness and early social interactions between the caregiver and the infant during the first years. At the same time, both formal and functional aspects of maternal speech addressed to the infant are influenced by the quality of mothers' affective states. Studies focused on depressed mothers have reported different IDS patterns and features compared to non-depressed mothers' speech (for a review, see Scheiber et al., 2022). As regards the relations between IDS verbosity and maternal postnatal depression, several studies have reported a negative association between the amount of maternal IDS (in terms of total utterances, word tokens, and number of vocalizations) and the presence of maternal depressive symptomatology, highlighting the tendency of mothers with higher levels of depression to talk less with their babies. Conversely, a few studies (Bettes, 1988; Fink et al., 2020) did not find any statistically significant differences in maternal speech's verbosity between depressed and non-depressed mothers, suggesting the need for further studies. Concerning the lexical and syntactic complexity of maternal speech, measured by analyzing the number of different word types and the mean length of the utterance, Scheiber et al. (2022) did not find in their review any statistically significant differences in IDS produced by depressed mothers compared to non-depressed ones. However, the authors warned about these results because of possible bias related to the different procedures and methods with which both depressive symptomatology and IDS were measured. An interesting finding emerged in a study by Reissland et al. (2003), showing that depressed mothers, unlike non-depressed ones, did not show adaptation of their IDS with relation to the infant's age. In fact, when talking to their infant, they did not use shorter utterances when the infant was younger (i.e., 6 months old) compared to at 10 months of age, while non-depressed mothers showed

this change. The use of shorter and syntactically simpler utterances is prototypical of IDS directed towards younger infants, because their cognitive and pre-linguistic abilities are still limited. However, the lack of this aspect in depressed mothers could suggest a lower ability of mothers with depression to adapt the complexity of their IDS according to their infants' age and abilities.

Focusing on the contents of IDS, some studies have highlighted a significant relationship between the presence of depressed mood and the functional aspects of mothers' speech addressed to the infant. Specifically, in their study, Herrera et al. (2004) reported a negative association between the amounts of affect-salient speech and information-salient speech directed to 6-month-old infants and the presence of higher levels of maternal depressive symptomatology.

As previously mentioned, previous studies have examined the characteristics of early mother–child interactions in cases of prematurity (Agostini et al., 2014; Neri et al., 2015). Of those, only a few studies examined the characteristics of communicative exchanges and infant-directed speech directed towards the population of preterm infants. For example, a study by Salerni et al. (2007), which analyzed the characteristics of maternal IDS directed towards 6-month-old premature infants, did not detect significant differences compared to the syntactic and lexical complexity of input directed towards full-term infants. However, this study did not consider the severity of prematurity as a possible influencing factor. Furthermore, to date, there are no studies in the literature that have examined the features of communicative exchanges in the very first months postpartum.

As research has shown that both prematurity and maternal postnatal depression can have significant impacts on infant development, we could hypothesize that one of the factors involved in this effect might be the quality of maternal input addressed to the infant during the first years postpartum.

In this paper, we explore the effects of the severity of prematurity (based on birth weight) and maternal postnatal depression on the lexical, syntactic, and functional features of infant-directed speech at 3 months postpartum. It is possible to hypothesize that the presence of higher-risk situations, such as severe prematurity and higher levels of maternal postnatal depression, may influence the input directed towards the infant. Specifically, these conditions might lead to the development of different interactive modalities, which could be expressed in

terms of significant differences in the syntactic, lexical, or functional features of the maternal IDS.

4.2. Materials and Methods

4.2.1. Study Design

The present pilot, prospective, exposed and non-exposed study is part of a broader research and follow-up project that aims to investigate the effects of severe prematurity on infant developmental trajectories, the presence of parental postpartum symptomatology, and the quality of early dyadic exchanges during the first year postpartum.

4.2.2. Participants

A total of 64 mother–infant dyads participated in the study. Of these, 30 mothers of full-term (FT) infants (gestational age > 36 weeks, and birth weight > 2500 g) were recruited at the antenatal classes held in Cesena during the third trimester of pregnancy, while 34 were mothers of severely preterm infants (gestational age < 32 weeks, and birth weight < 1500 g), who had been hospitalized at the Neonatal Intensive Care Unit (NICU) of the Bufalini Hospital of Cesena (Italy). Preterm dyads were differentiated into two subgroups on the basis of the infants' birth weight: 17 infants with a birth weight between 1500 and 1000 g were included in the very low birth weight (VLBW) group, and 17 infants with a birth weight less than 1000 g were included in the extremely low birth weight (ELBW) group.

The exclusion criteria were the same for all of the groups, including the presence of infant neurological disease or complications, genetic syndromes or diseases, the presence of pre-existing maternal psychiatric disorders, multiple pregnancies, and lack of fluency in the Italian language.

Before starting the study, the research project obtained approval from the Ethics Committee of the University of Bologna (Protocol Number: 0001092/2023).

4.2.3. Procedure

Data were collected at 3 months postpartum (corrected ages were considered for preterm infants) at the Laboratory of Developmental Psychodynamics "Anna Martini" (Department of Psychology, University of Bologna).

During the assessment, all participants were asked to provide a written consent form and to complete a sociodemographic questionnaire and the Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987), so as to assess their postpartum mood; furthermore, a psychologist assessed the infants' levels of mental and psychomotor development. Subsequently, all dyads were asked to participate in a free interaction session lasting about 5 min. All of the dyads were assessed in the same setting, which included the presence of puppets and toys suitable for the infants' age. Each session was video recorded and, subsequently, all of the maternal utterances addressed to the infants were fully transcribed using the Codes for the Human Analysis of Transcripts (CHAT; MacWhinney, 1996) format.

4.2.4. Measures

4.2.4.1. Sociodemographic Data

All mothers completed an ad hoc sociodemographic questionnaire, which included information about their age, years of education, type of delivery, marital status, and employment status. Perinatal data were also collected for all dyads.

4.2.4.2. Maternal Postnatal Depression (MPD)

The presence of maternal depressive symptomatology in the postpartum period was assessed by using the Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987) self-report questionnaire. This questionnaire is one of the most widely used tools in international research for assessing maternal and paternal depression in the perinatal period. The instrument is composed of 10 items, scoring from 0 to 3, which evaluate the maternal mood over the previous 7 days. Higher total EPDS scores highlight the probable presence of increased levels of depression. In this study, the EPDS questionnaire was used as a categorical variable; as suggested by the validation study for the Italian version of the instrument (Benvenuti et al., 1999), the cutoff value was set at 10 points in order to discriminate depressed mothers from non-depressed ones.

4.2.4.3. Infant Mental and Psychomotor Development

The Griffiths Mental Development Scales—Revised Version (GMDS-R for 0–2 years; Griffiths, 1996) were individually administered to evaluate the infants' levels of mental and psychomotor development. These scales are a set of developmental assessments used to evaluate the cognitive and functional abilities of infants and young children in five specific areas (locomotor,

personal and social, hearing and language, eye–hand coordination, and performance). The Griffiths scales are frequently used in clinical and research settings to aid in the diagnosis of developmental delays and to monitor progress over time in high-risk contexts such as preterm infants (Sansavini et al., 1011; 2015; Neri et al., 2015; 2020).

4.2.4.4. Infant-Directed Speech

The total amount of maternal speech addressed to the infant was analyzed considering the number of utterances produced during the free interaction session. The utterance, which is any sequence of speech separated from the following utterance by a pause longer than 1 s (D'Odorico & Jacob, 2006), was considered as the unit of analysis.
The lexical and syntactic features of maternal input were examined by analyzing the following measures:

- Word tokens, i.e., the total number of words produced;
- Word types, i.e., the total number of different words produced;
- Mean length of utterance (MLU), i.e., the ratio of words to utterance, representing a measure of syntactic complexity.

The analysis of all of these variables was conducted using the CHILDES system (Macwhinney, 1996) a specialized tool designed for the analysis of maternal and infant speech.
Functional characteristics of the maternal input were evaluated by using an ad hoc coding scheme previously used in studies on maternal speech (e.g., Venuti et al., 2012; Zampini et al., 2020). According to the scheme, each maternal utterance was attributed to one of the following mutually exclusive functional categories:

- Affect-salient speech, which includes utterances whose aim is to maintain the conversation (i.e., greeting, encouragement, singing);
- Information-salient speech, which includes utterances whose aim is to convey contents, giving or asking information. This functional category was included in the model, divided into four mutually exclusive subcategories: questions, labelling, descriptions, and directives;
- Attention getter, which includes utterances whose aim is to attract the infant's attention (i.e., the infant's name);
- Other, which includes incomplete or unintelligible utterances, or maternal speech that is not directed to the infant.

For each category and subcategory, the proportion of maternal speech in the total of maternal utterances produced during the interaction was computed.

4.2.5. Data Analysis

According to the objectives of the study, the main analysis strategy was to compare the characteristics of IDS according to the three birthweight categories, the absence/presence of depressive symptomatology, and the interaction between these two variables. Preliminarily, the presence of differences between the three groups regarding both maternal and infant demographic characteristics was investigated by running a series of analyses of variance (ANOVAs). Specifically, the groups were compared in terms of maternal age, years of education, civil status, type of delivery, employment status, infant's gender, infant's (corrected) age, infant's gestational age, and developmental quotient. The results revealed statistically significant differences between groups in terms of the mothers' years of education, the type of delivery, and the infant's gestational age.

To assess the effects of birth status and postpartum depression on the characteristics of maternal input, a multivariate analysis of covariance (MANCOVA) was run. Both birth weight (FT, VLBW, and ELBW) and maternal depression (depressed and non-depressed) were set as between-subject factors, and speech characteristics (i.e., word types and tokens, MLU, proportion of affect-salient speech, directives, questions, labelling, descriptions, attention getter, and other) were set as dependent variables. A p-value < 0.05 was considered statistically significant. Data analysis was conducted using IBM SPSS Statistics 24 software (IBM Corporation New York, NY, USA).

4.3. Results

Maternal and infant descriptive characteristics are reported in Table 1. No statistically significant differences between groups emerged regarding maternal age, infant's age, or infant developmental quotient. On the other hand, the level of education appeared to be significantly higher in FT infants' mothers compared to ELBW ones ($F(2, 61) = 4.78$, $p = 0.01$; Bonferroni *post hoc* FT vs. ELBW, $p = 0.02$). The groups showed statistically significant differences regarding the infant's gestational age at birth and the type of delivery. Specifically, in both the ELBW and VLBW groups compared to FT, cesarean delivery was more frequent than spontaneous delivery ($X^2 = 37.8$, $p = 0.00$; Bonferroni *post hoc* ELBW vs. FT, $p = 0.00$; VLBW vs. FT, $p = 0.00$). Furthermore, gestational age was significantly smaller in the ELBW group compared to the

VLBW and FT groups, and in the VLBW group compared to the FT group (F (2, 61) = 326; Bonferroni *post hoc* comparisons between all groups, $p = 0.00$). Since these two variables are strictly connected to prematurity, these results were expected.

Table 1. Participants' descriptive characteristics and differences between groups.

		FT (N = 30)	VLBW (N = 17)	ELBW (N = 17)	F/X^2	*p*
Maternal variables	Chronological age	32.7 (5.63)	33.4 (5.52)	33.4 (5.63)	0.14	0.87
	Years of education	14.6 (2.94)	12.5 (3.0)	12.0 (3.45)	4.78	0.01
	Marital status [a]				0.49	0.78
	Married	19 (63)	10 (59)	9 (53)		
	Other	11 (37)	7 (41)	8 (47)		
	Employment status [a]				0.80	0.67
	Employed	26 (87)	13 (76)	14 (82)		
	Unemployed	4 (13)	4 (24)	3 (18)		
	Type of delivery [a]				37.8	0.00
	Spontaneous delivery	27 (90.0)	6 (35.3)	4 (23.5)		
	Cesarean delivery	3 (10.0)	11 (64.7)	13 (76.5)		
Infant variables	Infant's gender [a]				4.63	0.09
	Male	10 (33.3)	11 (64.7)	9 (52.9)		
	Female	20 (66.7)	6 (35.3)	8 (47.1)		
	Infant's age (in months) [b]	2.7 (0.55)	3.01 (0.54)	2.97 (0.57)	2.23	0.11
	Gestational age at birth (in weeks)	40.17 (2.19)	29.76 (1.21)	27.05 (1.77)	326	0.00
	GMDS-R total score [c]	113 (8.63)	112 (7.07)	107 (10.9)	2.73	0.07

Data are expressed as means (with standard deviations in parentheses) for interval data. [a] Number (and % in parentheses) for categorical data. [b] Corrected age for preterm infants. [c] Calculated based on corrected age for preterm infants.

Analyzing the impacts of these three variables on IDS features, a significant effect emerged only for maternal years of education (F (9, 52) = 2.99, $p = 0.01$); therefore, this variable was included as a confounding variable in the subsequent analyses.

Sociodemographic differences between depressed and non-depressed mothers were also explored; no statistically significant differences emerged between the two groups.

As the mean years of education differed among the three groups, this variable was set as a covariate in the analysis of the variance of the features of maternal speech. Overall, multivariate analysis of covariance showed a statistically significant effect of maternal depression (Pillai's trace: F (10, 48) = 2.15, p = 0.03, partial η^2 = 0.28), but neither birth status (F (20, 98) = 1.02, p = 0.45, partial η^2 = 0.12) nor the interaction between maternal depression and birth status (F (20, 98) = 0.66, p = 0.87, partial η^2 = 0.11) was statistically significant.

In terms of univariate analyses, no significant effects of either birth status or maternal depression emerged with respect to both the syntactic and lexical complexity of maternal speech (all ps > 0.05; Table 2).

Table 2. Mean, standard deviation, and univariate analyses of syntactic and lexical features of IDS.

	Birth Weight			**Maternal Postnatal Depression**		**Birth Weight**		**Maternal Postnatal Depression**		**BW X MPD**	
	FT (N = 30)	**VLBW (N = 17)**	**ELBW (N = 17)**	**Depressed (N = 23)**	**Non-Depressed (N = 41)**	**F**	***p***	**F**	***p***	**F**	***p***
Word tokens	294.15 (19.29)	281.16 (25.55)	329.02 (23.64)	289 (20.98)	313.88 (16)	1.37	0.26	0.64	0.43	1.21	0.31
Word types	102.44 (6.06)	97.75 (8.02)	111.99 (7.42)	102.55 (6.59)	105.56 (5.02)	1.57	0.22	0.39	0.53	2.62	0.08
MLU	3.08 (0.12)	2.95 (0.16)	3.22 (0.15)	3.05 (0.13)	3.11 (0.10)	0.79	0.46	0.04	0.85	1.45	0.24

Data are expressed as estimated marginal means (with standard errors in parentheses) for interval data.

As regards the functional aspects of infant-directed speech (Table 3), data analysis highlighted the presence of statistically significant effects of both birth status and maternal depression, but not their interaction, on the proportion of affect-salient speech and questions addressed to the infant. Specifically, mothers of more severe preterm infants (i.e., ELBW) seemed to use less affect-salient speech (F (2, 49) = 3.60, p = 0.03) and more questions (F (2, 49) = 3.32, p = 0.04) when talking to their babies, compared to the mothers of VLBW and FT infants. It is interesting to note that a similar and statistically significant pattern was observed between depressed mothers and non-depressed ones (affect salient-speech: F (1, 49) = 10.83, p = 0.00; questions: F (1, 49) = 6.61, p = 0.01). Furthermore, the results showed a significant effect of maternal depression on the proportion of directives (F (1, 49) = 4.39, p = 0.04) addressed to the infant, as depressed mothers were more directive with their babies compared to non-

depressed ones (Table 3). No significant differences among groups were found regarding the other dependent variables.

Table 3. Mean, standard deviation, and univariate analyses of functional features of IDS.

	Birth Weight			Maternal Postnatal Depression		Birth Weight		Maternal Postnatal Depression		BW X MPD	
	FT (N = 30)	VLBW (N = 17)	ELBW (N = 17)	Depressed (N = 23)	Non-Depressed (N = 41)	F	*p*	F	*p*	F	*p*
Affect-salient speech	0.39 (0.03)	0.44 (0.04)	0.30 (0.04)	0.32 (0.03)	0.44 (0.02)	3.60	0.03	10.8	0.00	0.03	0.97
Labelling	0.01 (0.01)	0.01 (0.01)	0.03 (0.01)	0.02 (0.00)	0.02 (0.00)	2.37	0.10	0.06	0.81	0.24	0.80
Descriptions	0.20 (0.02)	0.16 (0.03)	0.18 (0.01)	0.20 (0.02)	0.16 (0.02)	2.29	0.11	1.29	0.26	1.08	0.35
Questions	0.28 (0.02)	0.29 (0.03)	0.37 (0.03)	0.35 (0.02)	0.28 (0.02)	3.32	0.04	6.61	0.01	0.90	0.41
Directives	0.05 (0.01)	0.05 (0.02)	0.06 (0.02)	0.06 (0.01)	0.04 (0.01)	0.59	0.56	4.39	0.04	0.09	0.91
Attention getter	0.04 (0.01)	0.03 (0.01)	0.03 (0.01)	0.03 (0.04)	0.03 (0.00)	0.10	0.90	0.01	0.93	0.62	0.54
Other	0.00 (0.00)	0.01 (0.01)	0.01 (0.01)	0.02 (0.00)	0.03 (0.00)	1.44	0.25	1.16	0.29	0.28	0.75

Data are expressed as estimated marginal means of the proportion of utterances in each category of functional speech (with standard errors in parentheses).

4.4. Discussion

The aim of the present exploratory study was to investigate the potential impacts of the severity of preterm birth and maternal postpartum depression on the features of infant-directed speech addressed to FT and PT infants.

Despite previous research having underlined how both maternal postnatal depression and the severity of prematurity could impact on the quality of early mother–infant interactions (Agostini et al., 2014; Neri et al., 2015), to the best of our knowledge, this is the first study to investigate their possible influence on IDS.

In general, the multivariate models showed significant results only regarding the effects of maternal depression on IDS characteristics. Given the exploratory nature of the research, and considering these as preliminary findings, we will discuss the significant results of the

multivariate and univariate analyses as well, as they may serve as a promising starting point for future investigations.

Overall, our results showed that neither lexical nor syntactic aspects of IDS—in terms of word types, word tokens, and MLU—nor maternal speech verbosity were affected by birth status and/or maternal postnatal depression. In line with our results, previous studies on IDS directed to PT infants compared to FT ones also found no intergroup differences in the morphosyntactic and lexical features of maternal speech (Salerni et al., 2007; Suttora & Salerni, 2011). However, these studies did not take into account the severity of prematurity, which could be an important influencing factor, as observed in studies on interactive patterns (Agostini et al., 2014; Neri et al., 2015). The present study extends these findings by showing similarities in the structural complexity of maternal inputs directed to both VLBW and ELBW infants, as well as to typically developing infants at an earlier stage of development. However, as maternal speech modifies in accordance with the infant's emerging skills, differences in IDS features may emerge later, in accordance with the infant's communicative and linguistic abilities (Zampini et al., 2020).

As emerged from the data analysis, the amounts of IDS were similar in depressed and non-depressed mothers. A recent review by Scheiber et al. (2022) on the features of child-directed speech in cases of maternal postnatal depression reported that, overall, depressed mothers tend to speak less with their babies. However, two of the six studies included in the review, which analyzed the effects of maternal depression on speech verbosity, reported no significant differences in the mean number of utterances produced by depressed and non-depressed mothers (Fink et al., 2020). The presence of conflicting results may be attributed to the multiple differences between the studies, regarding both the children's age (the range varies from 3 to 42 months), and the measures and methodologies used to assess the quantity of maternal input and maternal depressive symptoms. Therefore, the existence of inconsistent findings regarding the impact of maternal depression on speech verbosity highlights the need for further research.

No significant effects of maternal depression emerged on the lexical and morphosyntactic features of IDS. Specifically, the syntactic and lexical complexity of IDS, as measured in terms of MLU and word types, appeared to be similar in depressed and non-depressed mothers. This result is consistent with the findings of previous studies; specifically, it is in line with the study by Murray et al. (Murray et al., 1993), conducted on infants of similar age and on mothers whose depressive symptomatology was detected by using the EPDS—the same tool used in our study.

Moreover, studies on older infants showed similar results, suggesting that maternal perinatal depressive symptoms did not affect the lexical (Rowe et al., 2005) or syntactic (Hwa-Froelich et al., 2009) complexity of maternal speech directed to the infant.

Interestingly, when we explored the functional characteristics of IDS, our analyses showed a significant effect of birth status on the proportion of affect-salient speech and questions directed towards the infant. The results revealed that affect-salient speech constituted approximately half of the total utterances produced in both the FT and VLBW groups, but not in the ELBW group. Conversely, the proportion of interrogative sentences was significantly higher in the ELBW group compared to the others.

As the literature suggests, a higher proportion of affect-salient speech is expected in maternal inputs addressed to 3-month-old infants (Bornstein et al., 1992; Kitamura et al., 2003). As highlighted by several perspectives (i.e., developmental psychology and psychopathology, infant research, affective neurosciences), during this developmental stage, maternal affective speech plays a crucial role in engaging the infant in positive interactions and promoting the development of a secure attachment bonding (Stern et al., 1998; Trevarthen et al., 2001; Agostini et al., 2015). From the first weeks after childbirth, the baby is able to process emotional information during dyadic interactions and prone to recognizing maternal affective expressions, which are frequently conveyed through maternal input (Schore, 2001; Tronick et al., 2008). Research has indeed shown that younger infants are more responsive to affect-salient speech compared to information-salient speech, which becomes more relevant in later developmental stages, shaping the infant's cognitive, linguistic, and communicative development (Kitamura et al., 2009). Therefore, the maternal ability to convey emotional contents is crucial for enhancing the infant's emotional and social development, in addition to co-regulating mother–infant interactions.

Conversely, maternal speech directed to ELBW infants seemed to be more demanding and characterized by a higher proportion of questions and a lower proportion of affect-salient speech. Premature infants have been frequently described as more passive and less involved in early dyadic interactions, as compared to typically developing infants (Goldberg & Divitto, 1995; Muller-Nix et al., 2004). Due to the increased passiveness of their children, ELBW infants' mothers may use more interrogative sentences to elicit their engagement during interactive exchanges. The overstimulating communicative style adopted by ELBW mothers while speaking to their babies could also reflect a certain degree of intrusiveness in interaction. This

hypothesis is coherent with a previous study by Agostini et al. (2015), which reported more controlling and intrusive interactive behaviors in ELBW mothers compared to VLBW and FT ones. In fact, this interactive pattern would become evident when considering more severely premature infants, as a more intense maternal stimulation would emerge to enhance infant responsiveness (Muller-Nix et al., 2004). However, it is uncertain whether these outcomes remain consistent over time; thus, future studies are needed to investigate whether this trend persists in the later stages of child development.

Regarding the influence of maternal depression on the functional characteristics of IDS, data analysis revealed a significant effect with regard to the proportion of affect-salient speech, and to the number of interrogative and directive sentences. Specifically, the input of depressed mothers was found to be characterized by lower affective salience and a higher number of interrogatives and directives. This result is consistent with a previous study by Herrera et al. (2004) and may indicate a decreased ability of mothers with depressive symptoms to interact in a sensitive manner with their children, which means using more information-salient contents rather than affect-salient ones. Additionally, as higher information-salient input is more functional for sustaining the emerging linguistic and communicative skills in older children, the presence of more demanding maternal speech in depressed mothers may express a decreased ability to adapt their input to their infant's developmental level, which would, in turn, suggest a lower degree of sensitivity.

It is noteworthy that this study did not observe a significant interaction effect between severe prematurity and maternal depression, despite both being important factors that could influence maternal verbal input. This suggests that these factors may have independent impacts on the quality of maternal verbal input when considered individually. However, it is possible that other factors, which were not measured or controlled in this study (e.g., parenting stress, anxiety symptomatology, post-traumatic stress disorder symptoms), could affect the interaction between severe prematurity and maternal depressive symptoms. These findings highlight the importance of analyzing each factor separately when studying maternal verbal input in high-risk contexts, and of assessing multiple and different risk factors.

Limitations and Future Directions

As mentioned above, this was an exploratory study aiming to investigate the influence of both maternal postnatal depression and the severity of prematurity on the features of IDS. One of the main limitations of this study is the limited sample size, which restricts the generalizability

of its results and reduces the power of data analyses; therefore, future research would benefit from an increase in the number of subjects. Another limitation of this study is represented by the exclusion of fathers from the research design. The follow-up program offered by the Laboratory of Developmental Psychodynamics (Department of Psychology, University of Bologna) involves the participation of both parents but, due to the low number of fathers who agreed to participate, they were not included in the present study. Future research should consider the influence of both maternal and paternal affective states, as these might represent important risk or protective factors for child development and wellbeing, as suggested by the literature (Letourneau et al., 2012). Understanding the impact of premature birth on both parents' interactive behaviors can inform the development of targeted interventions and support programs for families in similar situations. A further limitation of our study is the collection of a limited range of sociodemographic variables; moreover, we could not collect data about the family history and obstetrics (such as corticotherapy, arterial umbilical pH, infant complications or diseases) of the participants in the study. For this reason, further studies should deepen our results by also including these variables and exploring any possible significant risk or protective effect in relation to the development of postpartum symptoms. An additional limitation of our study is represented by the use of a self-report questionnaire (EPDS) to assess the presence of maternal depressive symptoms. Future studies may benefit from complementing the use of self-report measures with diagnostic tools such as structured clinical interviews. Finally, since the literature has identified parents of severely premature children as being at higher risk of developing various forms of postpartum symptomology (e.g., anxiety, parenting stress, post-traumatic stress disorder symptoms), further studies should investigate the effects of other symptoms on IDS patterns.

4.5. Conclusions

Taken together, these results suggest that different adverse conditions during the perinatal period, such as the ones represented by maternal postnatal depression and severe premature birth, can have significant impacts on a mother's communication style. This, in turn, can affect the mother's ability to engage in developmentally appropriate and sensitive interactions with her infant. From a clinical perspective, this research highlights the relevance of providing psychological support during the perinatal period to mothers who are experiencing depressive symptomatology or who have given birth to a severely premature baby. This study also suggests

how important it is to promote awareness and provide sufficient training to the hospital staff, in order to create an environment that supports early mother–infant interactions, especially acknowledging the relevant role played by maternal vocal input during the first few weeks postpartum. In this way, it becomes possible to identify potential risk factors for the baby's and mother's mental health, and to implement early interventions to support the parenting functions and foster mother–infant bonding.

Chapter 5 – Prosody in maternal speech directed to preterm and full-term infants at 3 months postpartum: an exploratory study on the influence of infant's birth weight and postnatal depressive symptomatology

Abstract: Severe premature birth, particularly before 32 weeks of gestation, poses a significant risk not only to the infant but also to maternal mental health, potentially disrupting the quality of early mother-infant interactions. A key component of these interactions is Infant-Directed Speech (IDS), which serves essential developmental, relational and emotional functions for the infant. While several studies have examined the effects of prematurity and maternal depression on early interactions, less attention has been given to the prosodic features of maternal speech, which are crucial for conveying affective meaning. Furthermore, no studies have investigated how birth weight, as a marker of prematurity severity, relates to maternal verbal behavior. This study aimed to explore the influence of prematurity severity and postnatal depression on maternal prosody during early dyadic interactions. The research involved 66 mother-infant dyads, categorized into three groups: 21 extremely low birth weight (ELBW) preterm infants, 23 very low birth weight (VLBW) preterm infants, and 22 full-term (FT) infants. At three months postpartum (corrected for prematurity), each dyad participated in a 3-minute free interaction session. Prosodic features of maternal speech were analyzed using the PRAAT software, and maternal postnatal depression was assessed using the Edinburgh Postnatal Depression Scale. Results revealed that mothers of VLBW and ELBW infants exhibited a reduced degree of speech modulation in their IDS. Additionally, lower birth weight and higher levels of maternal depression were associated with an increased proportion of flat pitch contours. These results suggest that mothers in these high-risk conditions may face challenges in expressing emotional content through prosody, a key aspect of sensitive communication with their infants. These findings provide preliminary evidence of the impact of prematurity severity and maternal depression on maternal verbal input, highlighting the importance of considering both factors in clinical practice. Understanding the mechanisms through which prematurity and depression influence early interactions can guide the development of targeted interventions to promote positive parent-infant relationships and support optimal infant development.

5.1. Introduction

The linguistic environment surrounding an infant from the earliest stages of life plays a crucial role in shaping his/her future developmental trajectories. Adults, particularly caregivers,

typically talk with infants using a specific speech register known as Infant-Directed Speech (IDS), which differs both qualitatively and quantitatively from the language used in adult-to-adult interactions (for some reviews, see Soderstrom, 2007; Saint-Georges et al., 2013; Genovese et al., 2020). These distinctive features of IDS have been observed across numerous languages, suggesting the possibility of near-universal patterns (Fernald & Simon, 1984; Snow, 1994; Broesch & Bryant, 2014).

In addition to linguistic and grammatical simplifications and a general redundancy in the lexicon used, one of the most distinctive features of IDS is its prosodic profile (Soderstrom, 2007; Saint-Georges et al., 2013; Spinelli et al., 2016; Genovese et al., 2020). This is, in fact, characterized by specific modifications and acoustical alterations compared to the speech used in adult-directed speech. These modifications include, for example, a higher tone of the voice, wider pitch range, more exaggerated and modulated melodic contours and a slower speech rate (Stern et al., 1983; Fernald et al., 1989; Saint-George et al., 2013; Spinelli et al., 2016).

Specifically, literature agrees in reporting a higher fundamental frequency (F0) in IDS than Adult-Directed Speech (ADS), suggesting that IDS is usually perceived with a higher pitch of the voice compared to adult-directed one (Saint-George et al., 2013; Spinelli et al., 2016). Furthermore, IDS is also characterized by a greater pitch variation, which refers to changes in the tone of the voice, and an exaggerated modulation, both of which are functional to stress the communicative intent of the speaker (Sakkalou & Gattis, 2012). On the contrary, flat contours are significantly less frequent compared to ADS, as they make the input less salient for the infant (Spinelli et al., 2016). Also, in term of rhythmicity the two registers present notably differences: IDS is characterized by a slower tempo, usually measured in terms of speech rate, and longer inter-phrase pauses; furthermore, pitch contours are usually marked with greater prosodic emphasis and longer compared to ADS (Stern et al., 1983; Fernald et al., 1989; Saint-Georges et a., 2013; Narayan & McDermott, 2016). Taken together, these characteristics have been described as functional to facilitate speech segmentation, early lexical acquisition and later linguistic development (see Spinelli et al., 2016 for a review on functions of IDS prosody). Several studies in literature have demonstrated a preference in infants, and even newborns, for this linguistic register compared to the one used in adult conversations (Fernald & Kuhl, 1987; Werker & McLeod, 1989; Cooper & Aslin, 1990; Spinelli et al., 2017). This preference can be partially explained by the greater prosodic emphasis of this register, which contributes to

making it more salient, particularly in the early stages of development (Fernald & Kuhl, 1987; Cooper & Aslin, 1990; Spinelli et al., 2017). In fact, dyadic communicative exchanges with younger infants are primarily based on the paralinguistic elements of speech rather than linguistic content, as the former tend to be more engaging for infants (Saint-George et al., 2013; Spinelli et al. 2017).

From a developmental perspective, several functions have been associated to prototypical prosodic features of IDS in sustaining infant's development in several domains (for a review, see Spinelli et al., 2016). For example, IDS prosody is functional to capture, maintain and regulate infant's attentional and arousal levels during interactive exchanges (Gratier & Devouche, 2011; Roberts et al., 2013). Furthermore, prosodic cues in IDS seem to facilitate infant's pre-linguistic and linguistic development, thus facilitating speech segmentation and word acquisition (Thiessen et al., 2005; Soderstrom, 2007; Cristia, 2013). Among the various functions of IDS, one of the most important is its role in conveying affective and emotional content to the infant, aiding them in interpreting emotional cues from adult speech and, more in general, from the interaction with the caregivers (Stern et al., 1982; Fernald, 1989; Fernald, 1992; Trainor et al., 2000; Saint-Georges et al., 2013). This function is in fact particularly crucial for establishing emotional bonds between the infant and the caregiver, and to facilitate affective attunement within the dyad (Stern, 1987).

Given this relevance of linguistic environment to support infant development, some studies have begun to analyse which factors could influence prototypical IDS patterns. Among these, the quality of maternal affective states, and particularly the presence of depressive symptomatology, seems to significantly affect IDS patterns in terms of both linguistic, pragmatic and prosodic features (for a review, see Scheiber et al., 2022). For example, literature which has investigated IDS produced by depressed mothers, reported an overall reduced verbosity (Rowe et al., 2005; Jessee et al., 2016), a lower affective salience (Herrera et al., 2003; Provera et al., 2023) and modifications in IDS prosody which include a smaller pitch variability (Kaplan et al., 2001; Porrit et al., 2014) and a reduced speech modulation (Kaplan et al., 2007), as well as a higher proportion of flat utterances (Reissland et al., 2003; Reissland & Shepherd, 2006; Lam-Cassettari & Kohlhoff, 2020). This evidence is consistent with the clinical literature on adult patients with depressive disorders, which describes how affective disorders, particularly depressive symptoms, influence the production of pragmatic-affective prosody

and can thus be detected through the analysis of prosodic features of speech (Yang et al., 2012; Horwitz et al., 2013; Ding & Zhang, 2023).

Other factors that may influence maternal IDS patterns are linked to the infant's condition. In this regard, some studies have explored the characteristics of maternal speech directed towards infants in vulnerable conditions; specifically, an increasing body of research has focused on analyzing the IDS patterns produced by mothers during interactions with their preterm infants in the early years following birth (Salerni et al., 2007; Suttora & Salerni, 2011; Spinelli et al., 2022; Provera et al., 2023; 2024).

Preterm birth is defined in the literature as the birth of a live infant prior to the completion of 37 weeks of gestation (WHO, 2012). This early delivery exposes the newborn to a range of risks that can negatively impact survival, health, as well as short- and long-term development (Sansavini et al., 2011; Biasini et al., 2012). A wide number of studies have documented a higher incidence of developmental delays or impairments in several domains, including cognitive, motor, linguistic, and socio-communicative skills (Kerstjens et al., 2012; Sansavini et al., 2015; Vandormael et al., 2019). The incidence of such delays is particularly high in cases of lower gestational age and/or birth weight (Biasini et al., 2012; Zambrana et al., 2021). With respect to birth weight, a commonly used classification system categorizes preterm infants based on birth weight, distinguishing between low birth weight (LBW), very low birth weight (VLBW), and extremely low birth weight (ELBW). Recent studies have emphasized the importance of differentiating between VLBW and ELBW populations. Although both groups are considered "high-risk" due to their increased vulnerability to long-term developmental disorders (Bhutta et al., 2002), numerous studies highlighted the need to analyse the specific effects of birth weight on both infant outcomes and parental well-being, including infant development, parental mental health, and early parent-child interactions. In particular, ELBW is frequently associated with higher levels of maternal depressive symptoms and peculiar patterns of parent-infant interaction (Agostini et al., 2014; Neri et al., 2015; Provera et al., 2023; 2024).

Premature birth, while recognized as a risk factor for infants, also represents a significant source of stress for parents, potentially impairing their ability to assume the parental role and negatively affecting their parenting capacities. A range of factors, such as concerns about the infant’s survival and long-term outcomes, early separation due to neonatal hospitalization, and difficulties in managing parenting responsibilities post-discharge, often contribute to an increased risk of postnatal psychological distress in both mothers and fathers of preterm

infants (Hughes et al., 1994; Secco et al., 2006; Cardoso et al., 2015). Numerous studies have documented higher levels of depression, anxiety, and parenting stress among parents of preterm infants compared to those of full-term infants, which can also adversely affect early dyadic interactions (Forcada-Guex et al., 2011; Neri et al., 2015; 2020; Pace et al., 2016; Genova et al., 2022). Consequently, a growing body of research has focused on early caregiver-infant interactions, frequently reporting less sensitive and attuned caregiving, particularly in cases of more severe prematurity, such as lower birth weight (Agostini et al., 2014; Neri et al., 2015; Provera et al., 2023; 2024).

With regard to maternal speech characteristics addressed to preterm infants in the first year after birth, most studies to date have focused on the linguistic and functional aspects of IDS (Suttora & Salerni, 2011; Spinelli et al., 2022; Provera et al., 2023; 2024). These studies have generally found no significant differences in the lexical and syntactic complexity of IDS directed toward FT and preterm PT, even in the case of lower birth weight. However, functional aspects of IDS appear to be affected, particularly for ELBW infants. For instance, a recent study by Provera et al. (2023) identified a less affective and more demanding IDS directed toward ELBW infants compared to VLBW and FT ones. This finding aligns with earlier research linking lower birth weight to more intrusive and less sensitive caregiving behaviors at 3 months corrected age (Agostini et al., 2014; Neri et al., 2015).

Despite these findings, there is a notable gap in the literature investigating the prosodic features of IDS in the context of premature birth. This study aims to examine the influence of prematurity severity, based on infant's birth weight, and maternal postnatal depression on prosodic characteristics of IDS at 3 months postpartum. We hypothesize that high-risk conditions, such as severe prematurity and the presence of maternal postnatal depressive symptoms, may negatively affect the realization of prototypical IDS patterns, potentially resulting in a less optimal maternal speech, especially in terms of prosodic profile, towards the infant.

5.2. Materials and Methods

5.2.1. Study Design

The present explorative cross-sectional study is part of a larger research and follow-up project which aims to investigate the impact of preterm birth on infant developmental outcomes, the occurrence of parental postnatal symptomatology, and the features of maternal and paternal Infant-Directed Speech during the first year following birth. The research project has been

approved by the Ethics Committee of the University of Bologna (Protocol Number 0001092/2023).

5.2.2. Participants

Sixty-six mother-infant dyads were recruited for this study. Among them, 22 dyads consisted of mothers with FT infants, born at a gestational age of ≥36 weeks and with a birth weight ≥2500 g, who were enrolled during the last trimester of pregnancy through antenatal classes held in Cesena. The remaining 44 dyads included mothers of preterm infants (gestational age <32 weeks and birth weight <1500 g) who had been hospitalized in the Neonatal Intensive Care Unit (NICU) of the Bufalini Hospital of Cesena. These preterm dyads were further classified into two subgroups based on the infants' birth weight: 23 Very Low Birth Weight (VLBW) infants, with birth weights between 1000 and 1500 g, and 21 Extremely Low Birth Weight (ELBW) infants, with birth weights below 1000 g.

The existence of infant neurological disorders or complications, genetic syndromes or medical conditions, maternal pre-existing psychiatric conditions, and an absence of fluency in the Italian language were set as exclusion criteria for all the groups.

5.2.3. Procedure

At three months following birth (corrected age for preterm infants), each mother-infant dyad was invited to participate in a follow-up visit at the Laboratory of Developmental Psychodynamics “Anna Martini” (Department of Psychology, University of Bologna). On this occasion, after signing the informed consent, all participants completed a brief battery of questionnaires to collect socio-demographic information and to investigate the presence of maternal depressive symptoms. Additionally, a trained psychologist assessed the mental and psychomotor development of the infants included in the study using the Griffiths Mental Development Scales-Revised version (GMDS-R for 0–2 years; Griffiths, 1996). In the second part of the follow-up visit, all mothers and their infants were invited to engage in a 3-minute free-play session. These sessions took place in a quiet and standardized setting, equipped with puppets and toys appropriate for the infants’ age. Each session was video-recorded, and the maternal speech directed at the infant was fully transcribed following the Codes for the Human Analysis of Transcripts (CHAT) format (Macwhinney, 1996). This format is part of the larger Child Language Data Exchange System (CHILDES) Project and provides a standardized method for creating computerized transcriptions of face-to-face conversational interactions (Macwhinney,

2014). Subsequently, each video recording was converted into .WAV format audio files. For each mother–infant dyad, the first fifty utterances directed towards the infant were selected and extracted. Maternal sounds without a vocal content were excluded from the analysis (i.e., guttural sounds or laughs), as well as unintelligible utterances (i.e., whispers) or utterances covered by other noises, voices or infant's sounds. After the selection, a total of 2942 utterances were prosodically and acoustically analysed using the software PRAAT (Boersma & Weenink, 2005). A pitch range between 50 and 700 Hz was settled.

5.2.4. Measures

5.2.4.1. Sociodemographic Data

The sociodemographic information of the sample were examined using a specifically designed sociodemographic questionnaire which included information on maternal age, education level, marital status, employment status, parity, and relevant perinatal information.

5.2.4.2. Postnatal Depressive Symptomatology

The evaluation of maternal depressive symptoms at 3 months postpartum was conducted using the Italian validated version of the Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987). This self-administered questionnaire is widely recognized in international research for its effectiveness in detecting depression in both mothers and fathers during the perinatal phase. The EPDS consists of 10 items, each rated on a scale from 0 to 3, designed to assess maternal mood over the last 7 days. Higher overall scores indicate a greater likelihood of depressive symptoms. Based on the validation of the Italian version (Benvenuti et al., 1999), a cutoff score of 10 is usually used to distinguish between depressed and non-depressed mothers, anyway in this study the EPDS was treated as a continuous variable.

5.2.4.3. Infant Mental and Psychomotor Development

Infant cognitive and psychomotor development at 3 months was evaluated using the Griffiths Mental Development Scales-Revised (GMDS-R for 0–2 years; Griffiths, 1996), which are specifically designed for assessing infant development from birth to 2 years of age. This comprehensive tool measures overall developmental progress through a set of assessments across five distinct domains: locomotor abilities, personal-social behavior, hearing and language skills, hand-eye coordination, and general performance. The tool provides standardized scores, with an expected mean of 100 and a standard deviation of 12. For preterm

infants, age correction was applied when calculating the scores. The Griffiths scales are widely recognized in both clinical and research settings for detecting developmental delays or impairments and tracking progress, especially in high-risk populations like preterm infants (Agostini et al., 2014; Neri et al., 2015; 2017; Provera; 2023; 2024). All assessments were conducted by trained psychologists who were unaware of the infant's status and birth weight.

5.2.4.4. Prosodic features of maternal Infant-Directed Speech

According to other studies in the literature, we considered as a vocal production each sound with a vocalic content which was followed by a silent pause of at least 0.3 seconds (Stern et al., 1977; Spinelli & Mesman, 2018). In order to investigate the prosodic profile of maternal IDS, the following measures were analysed:

- *Mean Fundamental frequency* (Mean F0), measured in hertz (Hz), which is the rate at which the vocal cords vibrate within the larynx and represents the pitch levels of the voice;
- *Maximum Fundamental frequency* (F0 max) which is the highest value of F0 within the utterance, measured in Hz;
- *Minimum Fundamental frequency* (F0 min), which is the highest value of F0 within the utterance, measured in Hz;
- *F0 range measured in semitones* (St). It is and index of pitch variability and reflects the logarithmic difference between the maximum (F0 max) and minimum (F0 min) value of the fundamental frequency;
- *Proportion of flat final pitch contour*. This measure was calculated by dividing the number of utterances with a flat final pitch contour by the total number of utterances analyzed for each mother. Utterances were classified as flat if they exhibited no pitch rise or fall of at least two semitones throughout the entire duration of whole utterance (‘t Hart et al., 1990);
- *Average number of movements or speech modulation*. This measure serves as an indicative index of the degree of speech melodic modulation. As mentioned before, movements were defined as pitch oscillations, either rising or falling, of two semitones or more (‘t Hart et al., 1990). The mean number of movements was calculated by dividing the total number of movements detected within the utterance by the total number of

syllables in each utterance. The syllable count was determined using Italian parsing rules as a reference;

- *Speech rate*. This measure was calculated by dividing the number of syllables in each utterance by the utterance's duration in seconds;

To account for the potential influence of utterance length on the speech prosodic profile, we also compared the average length of utterances produced by mothers across the three groups by calculating the ratio of syllables to utterance.

5.2.5. Data Analysis

Before comparing the three groups in order to identify the presence of statistically significant predictors of maternal prosody, a series of analysis of variance (ANOVA) and Pearson's chi-square tests were conducted to evaluate the homogeneity of the 3 groups in terms of mothers' and infants' sociodemographic characteristics. Specifically, the groups were compared based on maternal age, educational level, marital status, parity, employment status, infant age (adjusted for preterm groups), and the total GMDS-R score.

Then, a series of General Linear Models were run in order to explore the potential influence of both infant birth weight, maternal postnatal depression and their interaction on prosodic features of maternal IDS, specifically F0, F0 max, F0 min, pitch range, mean number of movements, speech rate and proportion of flat utterances.

Data were analyzed using Jamovi software version 2.3.28 (The Jamovi Project, 2022). A p value < 0.05 was considered as statistically significant.

5.3. Results

5.3.1. Characteristics of the sample

Socio-demographic and descriptive characteristics of mothers-infants dyads included in the study are reported in Table 1. Statistically significant differences among groups were found in maternal age and years of education, parity condition, and infant's developmental quotient at 3 months of corrected age.

Specifically, maternal age was higher in VLBW mothers compared to FT ones (Tukey post hoc: $p = 0.008$), whereas years of education were lower in ELBW mothers compared to FT and VLBW ones (Tukey post hoc: $p = 0.037$ and $p = 0.008$, respectively); infant's gestational age at birth and birth weight were higher in the FT group compared to both the VLBW (Tukey post

hoc: $p = 0.000$ and $p = 0.001$, respectively) and ELBW ones (Tukey post hoc: $p = 0.000$ and $p = 0.001$, respectively). Infant's developmental quotient (GMDS score) was higher in the FT group compared to the ELBW (Tukey post hoc: $p = 0.001$); moreover, multiparity was more frequent in the VLBW group compared to the FT and ELBW ones. No statistically significant differences were found in the levels of maternal depression assessed by the EPDS questionnaire, suggesting a certain degree of homogeneity among groups regarding this clinical variable. Since the distribution of these variables was not homogeneous, we conducted several preliminary correlation analyses and ANOVAs to examine their relationships with the dependent variables of this study and to account for any potential influences. Because we did not observe any significant associations, these variables were excluded from the following statistical analyses.

Table 1. Participant characteristics.

		FT (N = 22)	**VLBW (N = 23)**	**ELBW (N = 21)**	**F/X²**	***p***
Maternal variables	Age	32.4 (4.77)	36.8 (4.39)	35.4 (5.10)	4.06	.010 **
	Years of education	15.0 (2.52)	15.4 (2.06)	13.0 (2.52)	5.43	.007 **
	Marital status [a]				2.15	.342
	Married/cohabit	20 (91)	23 (100)	20 (95)		
	Other	2 (9)	0 (0)	1 (5)		
	Parity [a]				7.13	.028 *
	Nulliparous	22 (100)	18 (78)	20 (95)		
	Multiparous	0 (0)	5 (22)	1 (5)		
	Working condition [a]				1.51	.470
	Employed	21 (95)	20 (87)	20 (95)		
	Unemployed	1 (5)	3 (13)	1 (5)		
	EDPS Score	4.32 (3.23)	5.96 (4.06)	5.95 (4.95)	1.15	0.322
Infant variables	Gestational age at birth (in weeks)	40.3 (2.15)	30.1 (1.96)	27.1 (1.81)	266	<.001 ***
	Birth weight (in grams)	3548 (458)	1319 (149)	880 (161)	520	<.001 ***
	Gender				0.28	.868
	Female	14 (63)	13 (57)	12 (57)		
	Male	8 (37)	10 (43)	9 (43)		
	Infant's mean age at 3 months [b]	3.07 (0.31)	3.07 (0.20)	3.09 (0.21)	0.03	.970

GMDS-R total score at 3 months [c]	113 (8.59)	108 (9.53)	103 (7.22)	7.40	<.001 ***

Data are expressed as means (and standard deviations in parentheses) for interval data. a Number (and % in parentheses) for categorical data. b Corrected age for PT infants. c GMDS-R was administered and scored considering chronological age for FT infants and corrected age for PT ones. ** p < 0.01. *** p < 0.001.

5.3.2. Prosodic features of maternal IDS at 3 months postpartum.

As previously mentioned, since the length of the utterance may impact its prosodic realization, we first analyzed the differences between groups in terms of Mean Length of Utterance (MLU). The GLM test revealed no statistically significant differences among the groups ($F(5, 60) = 1.10$; $p = .369$) (Table 2).

Table 2. Mean and standard deviation of models of MLU in syllables and prosodic features of maternal IDS.

	Birth Weight		
	FT (N=22)	VLBW (N=23)	ELBW (N=21)
MLU (syllables)	6.42 (1.78)	6.36 (1.13)	5.73 (1.37)
Mean F0 (Hz)	272 (54.4)	272 (44.8)	266 (36.8)
F0 max (Hz)	376 (83.4)	374 (73.9)	355 (52.6)
F0 min (Hz)	210 (36.6)	208 (33.2)	209 (28.1)
F0 range (St)	9.80 (2.07)	9.83 (2.24)	8.90 (2.01)
Proportion of flat utterances	6.90 (8.18)	9.74 (14.6)	13.3 (17.8)
Mean N of movements	0.35 (0.11)	0.08 (0.25)	0.07 (0.24)
Speech rate	4.75 (0.94)	4.97 (0.77)	5.09 (1.32)

Data are expressed as means (and standard deviations in parentheses) for interval data.

Moving on prosodic features, Table 2 shows the means and standard deviations of the studies variables. All GLM models which aimed to test independent variables potentially influencing prosodic features of maternal IDS at 3 months revealed no statistically significant effects of birth weight, maternal PND and their interaction on any of the pitch-related variables. Specifically, neither mean fundamental frequency ($F(5, 60) = 0.82$; $p = .540$), maximum F0 ($F(5, 60) = 0.98$; $p = .438$), minimum F0 ($F(5, 60) = 0.54$; $p = .744$), and pitch variability ($F(5, 60) = 1.01$; $p = .421$) were influenced by birth weight or maternal PND. Furthermore, in terms of duration,

neither birth weight, PND or their interaction were predictive on the speech rate of mothers with FT and PTs infants (F (5, 60) = 0.75; *p* = .592).

Conversely, GLM models for the predictors of both the mean number of movements (F (5, 60) = 4.40; *p* = .002; Table 3; Figure 1) and the proportion of flat utterances (F (5, 60) = 4.19; *p* = .002; Table 3; Figure 2) resulted to be statistically significant.

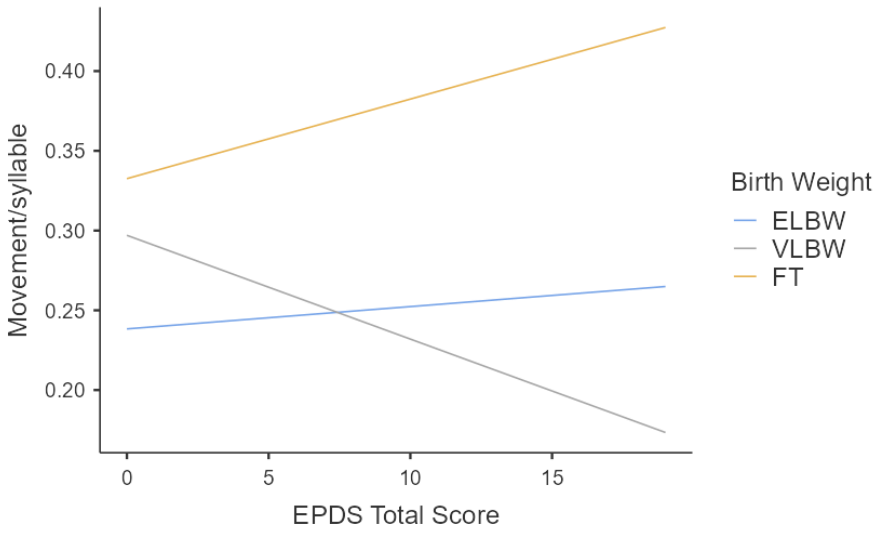
Table 3. General Linear Models for the prediction of IDS features at 3 months.

	η^2part	**F (5, 60)**	***p***	**T**	**β**	**t**	***p***
N of movements	0.26	4.40	.002 **				
Birth weight 1 [a]				0.02	0.16	0.59	.559
Birth weight 2 [b]				0.11	1.14	4.05	<.001***
EPDS_3 months				-3.99	-0.00	-0.01	.989
EPDS_3 × Birth weight 1				-0.01	-0.32	-1.28	.204
EPDS_3 × Birth weight 2				0.01	0.14	0.49	.621
Flat contours	0.27	4.19	.002 **				
Birth weight 1 [a]				-3.65	-0.32	-1.19	.240
Birth weight 2 [b]				-9.18	-0.81	-2.89	.005**
EPDS_3 months				0.93	0.34	2.86	.006**
EPDS_3 × Birth weight 1				0.71	0.26	1.01	.318
EPDS_3 × Birth weight 2				1.14	0.41	1.39	0.171

Note: [a] Birth weight 1 = ELBW vs. VLBW; [b] Birth weight 2 = ELBW vs. FT. ** p < 0.01. *** p < 0.001.

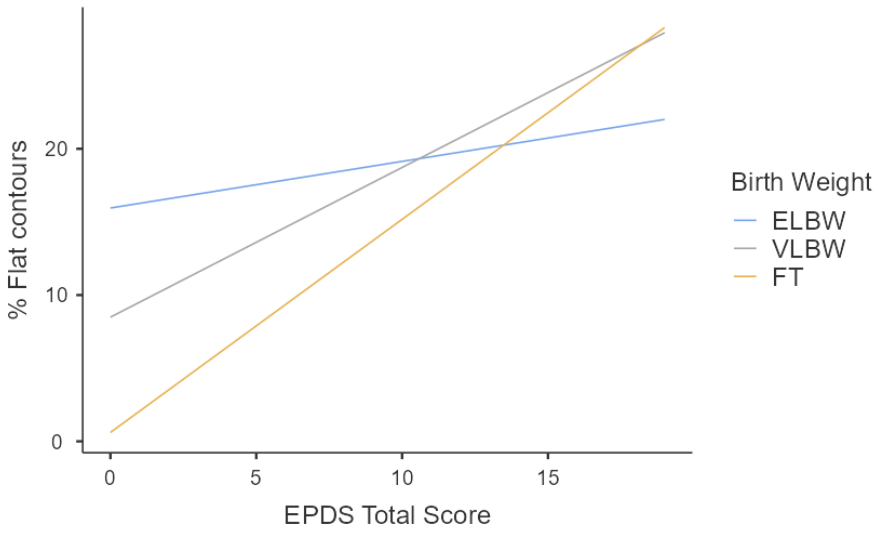
Considering the degree of speech modulation, calculated as the mean number of pitch movements within an utterance, birth weight - but not PND or their interaction - significantly influenced the number of pitch movements produced: mothers of FT infants tended to produce a more modulated speech compared to ELBW ones.

Figure 1. Plot for the effects of birth weight and maternal postnatal depression on speech modulation at 3 months.



Moving on the proportion of flat contours, both birth weight (specifically for the comparison between FT and ELBW groups) and depression, but not their interaction, significantly predicted the production of flat utterances. Specifically, mothers of ELBW infants tended to produce more monotonous utterances compared to FT ones; similarly, more depressed mothers tended to use a flatter speech style compared to non-depressed ones.

Figure 2. Plot for the effects of birth weight and maternal postnatal depression on speech modulation at 3 months.



5.4. Discussion

An increasing number of studies is starting to investigate features of Infant-Directed Speech not only addressed to typically developing infants, but also to those with atypical developmental trajectories. Among these populations, recent research has focused on both maternal and paternal speech directed towards preterm infants, particularly examining linguistic and functional characteristics (Spinelli et al., 2022; Provera et al., 2023; 2024). However, it continues to represent a significant gap in the literature concerning the prosodic profiles of IDS addressed to preterm infants at 3 months of corrected age. Furthermore, despite previous research having underlined how both maternal postnatal depression and the severity of prematurity could impact on the quality of early mother–infant interactions (Agostini et al., 2014; Neri et al., 2015; Provera et al., 2023), to the best of our knowledge, this is the first study to investigate their possible influence on the prosodic profile of IDS. Therefore, the aim of the present exploratory study was to investigate the potential impact of the severity of preterm birth and maternal postnatal depressive symptoms on the prosodic features of infant-directed speech addressed to FT and PT infants.

As previously noted, one of the linguistic factors that can significantly influence the prosodic realization of an utterance is its length. Therefore, to avoid group differences arising from variations in the syntactic complexity of maternal speech produced, the effect of both birth weight and maternal depression on MLU were preliminarily compared between the FT, ELBW, and VLBW groups. The results revealed no statistically significant differences, indicating similar syntactic complexity among the groups and between mothers with higher and lower levels of depressive symptoms. Although not the primary focus of this study, this finding aligns with previous research showing similar syntactic complexity, as measured by MLU, in the speech of mothers of FT and PT infants, and regardless from PT infants' birth weight (specifically ELBW vs. VLBW) (Suttora & Salerni, 2011; Spinelli et al., 2022; Provera et al., 2023). Additionally, our results are consistent with studies suggesting that maternal depression does not affect speech syntactic complexity (Scheiber et al., 2022).

Subsequently, a series of GLMs were run in order to explore the effects of birth weight and maternal PND on the prosodic features of mother's speech. In terms of pitch production, no statistically significant effects related to birth weight, maternal depression and their interaction emerged. The absence of birth weight effect suggested the presence of similar pitch-related values in the three groups. In fact, the mean fundamental frequency across the groups was overall similar and ranged between 266 and 272 Hz, whereas the maximum F0 was comprised

between 355-376 Hz and the minimum F0 between 208-209 Hz. In addition to being similar across groups, the mean pitch-related values in all the 3 groups were also comparable to the prototypical IDS values reported in previous studies in the literature (see for example, Gratier & Devouche, 2011; Spinelli et al., 2017). Pitch variability, represented by the F0 range, was also similar across the groups, indicating comparable pitch fluctuations in maternal speech directed to both full-term and preterm infants. This is evidenced by the F0 range falling between 8.90 and 9.80 semitones.

Taken together, these findings suggest that mothers in both the full-term and preterm groups used a higher vocal pitch and wider pitch variability when speaking to their infants. This result is in line with prototypical features of IDS described in the literature and covers an important role in getting infants' attention and in eliciting their responsiveness during dyadic interactions (Niwano & Sugai, 2003; Spinelli et al., 2016). Considering the absence of maternal PND influence on these variables, our result is in contrast with previous findings which reported a higher mean pitch and pitch range in non-depressed mothers compared to depressed ones (Porritt et al., 2013; Lam-Cassettari & Kohlhoff, 2020). However, as other studies reported higher pitch variability in depressed vs. non-depressed mothers (Reissland et al., 2003), and considering the diversity of methods used to assess maternal depressive symptoms (for example, using EPDS scores as cut-offs or as continuous variables), further investigations on the influence of maternal depression on these pitch-related variables are needed.

Regarding the proportion of flat contours, results revealed a statistically significant main effect of birth weight and maternal depression, whereas speech modulation in terms of number of movements was only predicted by infant's birth weight, but not maternal PND. Specifically, mothers of VLBW and ELBW infants tended to exhibit a reduced speech modulation, as indicated by a lower number of pitch movements and a higher proportion of flat utterances compared to mothers of FT infants. As previously noted, prototypical IDS is typically characterized by exaggerated modulation, with broader and smoother pitch contours compared to ADS (Fernald & Mazzie, 1991; Fernald & Simon, 1984; Sorianello et al., 2006; Spinelli et al., 2016). These characteristics are essential for conveying communicative intent to the infant, particularly in the early stages of development, when the infant is not yet able to fully comprehend the verbal meaning of the caregiver's speech. Furthermore, an emphasized speech modulation covers a fundamental role in facilitating emotional exchanges between the caregiver and the infant, helping this latter to interpret the emotional and affective valence of

maternal speech (Stern et al., 1982; Fernald, 1989; Fernald, 1992; Trainor et al., 2000; Saint-Georges et al., 2013).

Flatter and more monotonous speech productions are typically associated with ADS (Knoll & Costall, 2015) or situations in which mothers may encounter greater difficulties in conveying affective and emotional contents to their infants, such as in case of maternal depression (Kaplan et al., 2001; Lam-Cassettari et al., 2020). In this regard, the absence of a statistically significant effect of maternal depressive symptomatology on speech modulation represent an unexpected result and highlight the need of further investigations. Nevertheless, in our study, premature birth regardless from birth weight, was associated with a less prototypical IDS in terms of speech modulation, suggesting that mothers of infants at higher-risk condition, such as PT ones, may have more difficulties in conveying and emphasize affective contents through speech modulation compared to FT ones. Furthermore, a reduced modulation and flatter melodic contours might make it more challenging for the infant to perceive and interpret the emotional, affective and intentional content conveyed by the parent (Spinelli et al., 2016), with potential effects also in early relations and socio-emotional development. This result is in part similar to a previous study by Provera et al. (2023), which investigated functional features of maternal IDS directed to ELBW, VLBW, and FT infants at 3 months postpartum. Authors found a lower proportion of affect-salient speech, in terms of functional features, in maternal speech directed to ELBW infants compared to FT and VLBW ones. However, this study did not include a functional analysis of maternal speech, thus a potential future direction could be to examine the relationship between the functional characteristics of maternal speech and its prosodic realization, in order to assess how prosodic features vary depending on the pragmatic intent of the utterance. Furthermore, more investigations are needed to understand the specific influence of PT infant's birth weight, especially regarding the comparison between ELBW and VLBW groups.

Considering temporal features of maternal speech, no statistically significant effects of birth weight or maternal PND emerged on maternal speech rate. Furthermore, as highlighted also for pitch-related variables, the proportion of syllables produced/second was similar to prototypical values reported in previous studies on maternal IDS in the first year after birth (see for example, Provera et al., 2022). As seen before, a slower is typical of speech directed toward younger infants and may serve different functions. For example, a study by Panneton et al. (2009) suggested that a slower tempo might help younger infant to perceive vocal emotion in

caregiver's speech. Furthermore, together with other temporal and prosodic features, such as the final syllable lengthening and marked intonational contours, a slower tempo in IDS is functional, especially later in the development, to facilitate the segmentation of speech flow in single units, thus fostering later vocabulary acquisition and linguistic development.

Limitations and Future Directions

A key limitation of our study is the relatively small sample size, which may affect the generalizability of the results. Therefore, future research should aim to replicate these findings recruiting a larger number of families. A further limitation of our study is the exclusion of clinical variables beyond maternal depression in the study design. Given that preterm birth may represent a risk for the development of various forms of postnatal symptomatology, future research should investigate the impact of maternal anxiety and parenting stress on the prosodic patterns of IDS in preterm populations. Additionally, future studies should integrate screening tools, such as self-report questionnaires, with clinical interviews and other measures more sensitive to maternal depressive symptoms, enabling the differentiation within the sample between mothers diagnosed with major depression and those who are not clinically depressed

A third limitation is the exclusion of fathers from our study. Despite the follow-up program offered by the Laboratory of Developmental Psychodynamics at the University of Bologna being designed to engage both parents, the low participation of fathers prevented their inclusion in this analysis. The literature on paternal IDS, particularly concerning its prosodic features, remains very limited, despite evidence suggesting that fathers may serve as important protective factors, especially in high-risk situations, as in presence of maternal postnatal symptomatology (Letourneau et al., 2012). Therefore, a future goal of this research will be to encourage greater father participation in both the study and the follow-up program.

In sum, although the findings are promising, especially in light of the scarcity of similar studies, future research should aim to replicate these results while addressing the current study limitations.

5.5. Conclusions

Overall, the findings from this study revealed no significant differences between the PT and FT groups for most of the variables examined. This aligns with existing literature on IDS towards preterm infants, which typically reports small differences in the linguistic and functional input

provided to PT and FT infants (Suttora & Salerni, 2011; Spinelli et al., 2022; Provera et al., 2023). Our results further extend this similarity to pitch-related and temporal aspects of IDS. However, one area that appears to be particularly affected by preterm birth is the melodic modulation of IDS. Specifically, mothers of preterm infants seem to experience greater difficulty in modulating the intonational contours of their speech, regardless of the infant's birth weight. Given that melodic modulation is a key feature of the emotional and affective functions of IDS, it is essential to further investigate this aspect. Disruptions in melodic modulation might interfere with critical emotional and regulatory processes conveyed through caregivers' IDS, potentially increasing the risk of impairing the establishment of positive caregiver-infant relationships. Moreover, such disruptions could negatively impact the infant's later development, particularly in socio-emotional and affective domains.

From a clinical perspective, this study emphasizes the importance of further investigating the vocal and prosodic components of mother-child interactions, particularly in cases of increased maternal vulnerability. Previous research in the literature has already examined maternal behaviors, such as interactive patterns or tactile interaction behaviors, in populations of mothers at risk, such as mother with depressive symptoms, highlighting peculiar patterns compared to those observed in non-depressed ones (Mercuri et al., 2023; Stepakoff & Beebe, 2024). In this context, the analysis of prosodic aspects of speech could serve as a valuable index for identifying situations of greater difficulty in the affective dimension, both related to maternal symptomatology and infant vulnerable condition. Given that vocal interactions are critical for the development of caregiver-infant bonds, early identification of at-risk situations could enable more timely and effective interventions to protect and support these early relationships (see for example Neri et al., 2021 for parental book reading interventions in NICU, or Filippa et al., 2013; 2020 and Lejeune et al., 2019 for early vocal and music interventions). This highlights the importance of raising awareness and offering comprehensive training to hospital staff, fostering an environment which could facilitate the establishment of positive mother-infant interactions, particularly during the early months following birth when maternal vocalization plays a significant role. Such efforts would promote early interventions designed to enhance parenting skills and strengthen the mother-infant bond.

Chapter 6 - Infant-Directed Speech to Preterm Infants during the First Year Postpartum: The Influence of Preterm Birth Weight and Maternal Parenting Stress

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Abstract: Premature birth can increase the level of parenting stress (PS), especially in the case of parents of high-risk infants (extremely low birth weight (ELBW) and very low birth weight (VLBW)). Though published research has explored how maternal PS influences early dyadic interactions, limited research has focused on infant-directed speech (IDS), and no studies have investigated the link between prematurity severity based on birth weight and maternal IDS. This study, involving 100 mother–infant dyads, categorized into 30 ELBW premature infants, 30 VLBW premature infants, and 40 full-term (FT) ones, examined the impact of preterm birth weight and maternal parenting stress on IDS features during early interactions at 3 and 9 months postpartum. Maternal input was assessed using the CHILDES system, while parenting stress was evaluated using the Parenting Stress Index-Short Form. The results revealed that high-risk conditions (ELBW preterm birth and high parenting stress) at 3 months were associated with reduced affect-salient speech and increased questioning. IDS functional patterns, specifically the proportion of affect-salient speech and questions, were influenced by both birth weight groups and parenting stress levels at 3 months but not at 9 months. These findings highlight the need to assess, within the context of prematurity, both birth weight and parenting stress in clinical practice, offering insights for developing interventions supporting positive parent–infant interactions and facilitating infant development.

6.1. Introduction

Prematurity is defined as gestational age at birth < 37 weeks (WHO, 2012) and represents an important risk factor for the infant's health and development (Sansavini et al., 2011; Biasini et al., 2012), with an increased risk of both medical complications and the onset of deficits or delays which could affect developmental trajectories in different domains such as the cognitive, linguistic, and motor areas (Kerstjens et al., 2012; Sansavini et al., 2015; Vandormael et al., 2019). Problems in the acquisition of speech, communication, and language skills are more prevalent in the premature population compared to the full-term one (Johnson et al.,

2015). These difficulties have been documented in the early stages of development, impacting, for example, the onset of gestural abilities (Sansavini et al., 2011), the acquisition of first words (Imgrund et al., 2023), and the development of early lexical and syntactic skills (Jansson-Verkasalo et al., 2004; Imgrund et al., 2023). The risk of encountering delays or disorders in the developmental trajectories becomes more pronounced with lower gestational age (Zambrana et al., 2021) or when preterm infants are born with a very small birth weight, as in the case of very low birth weight (VLBW; BW < 1500 g) or extremely low birth weight (ELBW; BW < 1000 g) premature births (Biasini et al., 2012). Recently, a number of studies have highlighted the importance of investigating prematurity by specifically considering preterm birth weight, distinguishing between VLBW and ELBW preterm populations. In fact, although both VLBW and ELBW infants are classified as "high-risk" conditions due to their higher vulnerability to both mental and motor developmental disorders in the long term (Bhutta et al., 2002), several studies emphasize the importance of separately investigating the influence of preterm birth weight on parental outcomes, such as postpartum symptomatology, as well as early dyadic interactions. Indeed, the ELBW condition appears to be more frequently associated with higher levels of maternal depression, as well as the presence of atypical parent–infant interactive patterns (Agostini et al., 2014; Neri et al., 2015; Provera et al., 2023).

As it constitutes a risk factor for the newborn's survival and development, severe premature birth represents a stressful and even traumatic event also for parental well-being and mental health (Vigod et al., 2010; Agostini et al., 2014; Neri et al., 2015), impairing the processes of transition to parenthood (Pisoni et al., 2019) and increasing the risk of developing postpartum symptomatology (i.e., depressive, anxious, and PTSD symptoms), as well as parenting stress in both mothers and fathers during the first postpartum period (Forcada-Guex et al., 2011; Neri et al., 2015; 2020; Pace et al., 2016; Genova et al., 2022).

The adjustment to the parenting role can be particularly challenging in the case of severe prematurity because parents must cope with concerns about both the infant's health (Hughes et al., 1994) and development (Secco et al., 2006), as well as their ability to effectively care for an infant often described as more easily irritable (Hughes et al., 2002), more passive and less engaged in interactive exchanges (Beckwith et al., 1978; Davis et al., 2003; Korja et al., 2012), and less prone to express positive emotions (Coll et al., 1992). Moreover, PT infants frequently experience prolonged hospitalization in a neonatal intensive care unit (NICU). The extended exposure to a noisy and overstimulating environment, such as that found in an NICU, coupled

with the early separation from caregivers, may constitute an additional stress factor for both infants and their parents, also inhibiting early parent–infant communicative exchanges (Cardoso et al., 2015).

Consequently, parenting could represent a more stressful and demanding issue for PT infants' mothers, increasing the risk of experiencing higher levels of psychological and parenting stress (Feldman et al., 2007; Spinelli et al., 2016).

The presence of parental postpartum symptomatology and higher levels of parenting stress can adversely impact the quality of early dyadic interactions (Korja et al., 2012;Bilgin et al., 2015; Nero et al., 2017), including the quality of early dyadic exchanges between mothers and their infants, in terms of interactive behaviors (Zelkowitz et al., 2009;Forcada-Guex et al., 2011; Spinelli et al., 2013; Neri et al., 2015; Suttora et al., 2020) and verbal input directed towards the infant (Spinelli et al., 2013; Provera et al., 2023). Consequently, these difficulties have the potential to result in more negative outcomes for infant development (Zelkowitz et al., 2009; Letourneau et al., 2012).

Literature that compared early dyadic behaviors in dyads of both PT and FT infants and their mothers highlighted significant associations between birth weight and the quality of mother–infant interactions during the first months postpartum. For instance, a study by Neri et al. (2015) reported that mothers of more severe PT infants, specifically ELBW infants, were more likely to adopt intrusive behaviors during interactive exchanges, whereas VLBW mothers showed the opposite tendency, interacting with their infants in a more sensitive way. Furthermore, studies that investigated the effects of maternal parenting stress on the quality of early dyadic interactions highlighted that the more mothers were stressed, the more their interactive patterns tended to be intrusive, less attuned, and characterized by less positive interactions (Spinelli et al., 2013; Suttora et al., 2020).

When talking to infants and young children, parents spontaneously use a linguistic register known as infant-directed speech [IDS], which differs from adult-directed speech [ADS] in terms of linguistic features, pragmatic functions, and acoustic patterns (Saint-Georges et al., 2013). Verbal interactions directed towards infants are indeed characterized by a simpler lexicon and syntactic structure, frequent use of repetitions, more emphasized prosodic patterns, and specific functional and pragmatic features (Soderstrom, 2007). Infant-directed speech represents a fundamental aspect of caregiver–infant interactions, as its specific characteristics serve important functions by facilitating caregiver–infant interactions, capturing and sustaining

the infant's attention, and expressing both affective and informative contents (Kitamura et al., 2003; 2009; Spinelli et al. 2017; 2018). Moreover, the features of IDS dynamically adapt over time, increasing in complexity to foster and facilitate the linguistic, cognitive, and socio-affective development of the infant (Soderstrom, 2007; Saint-Georges et al., 2013; Genovese et al., 2020).

Overall, IDS presents a reduced verbosity and frequency of speech compared to ADS (Genovese et al., 2020). Studies that analyzed IDS towards preverbal infants of different ages reported that adults tend to talk less with younger infants and to increase their speech verbosity when interacting with older infants (Genovese et al., 2020; Bornstein et al., 1992; Henning et al., 2005). Simplifications in the syntactic structure of IDS have been widely documented, with IDS presenting shorter and more syntactically simple utterances when compared with ADS (Snow, 1972; Saint-Georges et al., 2013). Moreover, IDS addressed to preverbal infants is frequently characterized by single-word utterances and sentences without verbs (Papoušek et al., 1987; Spinelli et al., 2016). Focusing on the lexical features, the literature on IDS has highlighted the use of a limited and redundant vocabulary characterized by a frequent use of repetitions. The lexicon used by caregivers while interacting with their infants is simpler compared to ADS and characterized by a recurrent use of diminutives, onomatopoeias, and nonsense words (Bornstein et al., 1992; Kitamura & Burnham, 2003; Genovese et al., 2020). This aspect is more evident in younger infants and reflects the affect-salient function of IDS, which plays a fundamental role in facilitating affective exchanges in caregiver–infant interactions (Saint-Georges et al., 2013).

Several studies conducted on IDS have highlighted its dynamic nature, characterized by both changes and stability during the first postpartum years (Soderstrom, 2007). During the early stages of infant development, IDS is simpler in its linguistic component, and its pragmatic function is mainly affective. As the infant grows up, the verbal input becomes progressively more complex, and its pragmatic features become more informative rather than affect-salient to adapt to the child's age and developmental stage (Bornstein et al., 1992; Rowe et al., 2012). Consequently, IDS features provide the infant with a linguistic and interactive environment that significantly influences the infant's developmental trajectories across several domains, including linguistic, cognitive, and socio-affective development (Saint-Georges et al., 2013; Genovese et al., 2020).

As previously mentioned, IDS represents a fundamental aspect in caregiver–infant exchanges, promoting closeness and the development of attachment bonding, as well as supporting the infant's development in several domains. Concurrently, maternal emotional well-being and psychological stress have an influence on both formal and pragmatic aspects of maternal speech directed towards the infant (Scheiber et al., 2022; Spinelli et al., 2022; provera et al., 2023). Within this context, recent literature reported atypical IDS patterns related to both the presence of maternal postpartum symptomatology and parenting stress and the infant's birth condition, specifically premature birth (Spinelli et al., 2022; Provera et al., 2023).

Although a broad range of articles underlined the influence of maternal symptomatology in the postpartum period on the quality of early interactions (Agostini et al., 2014; Neri et al., 2015; 2020), the specific effects on the IDS pattern have not been adequately investigated. Specifically, even if the literature that focuses on mothers experiencing depressive symptoms has revealed variations in IDS patterns and characteristics when compared to non-depressed mothers' speech (Scheiber et al., 2022; Provera et al., 2023), there is a notable lack of studies that have examined the connections between the quality of maternal speech directed to the infant and the presence of parenting stress. To the best of our knowledge, only a recent study by Spinelli and colleagues (2022) investigated IDS towards 3-month-old PT and FT infants (corrected age for PT infants) while considering the levels of perceived parenting stress in mothers. The results highlighted that, although there was no main effect of prematurity on IDS characteristics, mothers who experienced higher levels of stress tended to use IDS that was more syntactically and lexically complex and thus more suitable for older infants. However, this study did not take into account the varying degrees of prematurity based on birth weight as a potential influencing factor, as well as subsequent stages of infant development.

Starting from these considerations, a longitudinal study was developed with the aim of investigating the impact of maternal parenting stress and the infant's birth condition on the functional, syntactic, and lexical characteristics of IDS at 3 and 9 months postpartum. The term "postpartum" is employed to denote the chronological age in the case of FT infants. Conversely, for PT infants, each assessment considered the corrected age, determined by deducting the number of weeks the infant was born prematurely from his/her chronological age.

The first aim of the study was to investigate the presence of differences in the level of maternal parenting stress during the first 9 months postpartum. The second aim was to explore trajectories of stability or variation in IDS's features from 3 to 9 months postpartum, also

analyzing the presence of differences related to birth weight. Finally, the third and fourth aims were to explore if birth weight and/or maternal parenting stress at 3 months could have an influence on maternal speech features at 3 months postpartum and to longitudinally investigate if birth weight as well as levels of maternal parenting stress at both 3 and 9 months postpartum could influence IDS at 9 months.

We hypothesized that the presence of high-risk scenarios, such as prematurity associated with a lower birth weight and elevated levels of maternal parenting stress, might exert an influence on the features of maternal speech directed to the infant. Specifically, these circumstances may give rise to the development of different interactive patterns, in terms of differences in the syntactic, lexical, or functional attributes of maternal IDS.

6.2. Materials and Methods

6.2.1. Study Design

The present prospective observational cohort study is part of a larger research and follow-up project designed to explore the impact of prematurity on infant development, the occurrence of maternal and paternal symptomatology in the postpartum period, and the features of early interactive exchanges in the first 12 months postpartum of corrected age. This research project obtained approval from the Ethics Committee of the University of Bologna (Protocol Number 0001092/2023).

6.2.2. Participants

A total of 100 mother–infant dyads were recruited in this research. Among these, 40 mothers with their FT infants (gestational age > 36 weeks and birth weight > 2500 g) were enrolled during the third trimester of pregnancy at antenatal classes in Cesena. Additionally, 60 mothers with their PT infants (gestational age < 32 weeks and birth weight < 1500 g) who had been hospitalized in the Neonatal Intensive Care Unit (NICU) at Bufalini Hospital (Cesena, Italy) were recruited after hospitalization. The preterm dyads were further categorized into two subgroups based on infants' birth weight: 30 preterm infants with birth weight between 1500 and 1000 g were classified into the very low birth weight (VLBW) group, and 30 preterm newborns with birth weight less than 1000 g constituted the extremely low birth weight (ELBW) group.

The exclusion criteria, which were the same for all the samples, were the existence of infant neurological disorders or complications, genetic syndromes or medical conditions, maternal pre-existing psychiatric conditions, and an absence of fluency in the Italian language.
During the study period, 137 preterm families were considered eligible for the study.
Among these, the families of 46 infants were excluded according to exclusion criteria, and 31 did not complete all study assessments, due to scheduling conflicts, leading to a final sample of 60 preterm infants.

6.2.3. Procedure

Data were collected at two different times of assessment, at 3 months (T1) and 9 months (T2) postpartum (corrected age was considered for PT infants), at the Laboratory of Developmental Psychodynamics (Department of Psychology, University of Bologna). During each visit at 3 and 9 months, all participants were asked to provide their written consent and to complete questionnaires regarding sociodemographic characteristics and the levels of stress related to parental role. A psychologist also conducted assessments of the infant's mental and psychomotor development by administering the Griffiths Mental Development Scales-Revised version (GMDS-R for 0–2 years; Griffiths, 1996). Following this, all mother–infant dyads were invited to participate in a 5 min free-interaction session. These assessments were conducted in a standardized setting which presented age-appropriate puppets and toys for the infants. Video recordings were made of each session, and subsequently, maternal speech directed towards the infant was fully transcribed in accordance with the Codes for the Human Analysis of Transcripts (CHAT) format (Macwhinney, 1996). This format is part of a broad project, the Child Language Data Exchange System (CHILDES) Project, and provides a standardized format for the generation of computerized transcription of face-to-face conversational interactive exchanges (Macwhinney, 2014).

6.2.4. Measures

6.2.4.1. Sociodemographic Data

The sociodemographic characteristics of the sample were investigated by administering an ad hoc sociodemographic questionnaire, which included information about maternal age and years of education, marital status, working condition, and parity, as well as perinatal data.

6.2.4.2. Maternal Parenting Stress

The levels of maternal stress associated with the parental role were investigated by using the Italian-validated version (Guarino et al., 2008) of the Parenting Stress Index-Short Form (PSI_SF) self-report questionnaire (Abidin, 1990). This questionnaire is widely used in international literature for the assessment of parenting stress, also in the context of preterm birth, and includes 36 items evaluated on a Likert scale of 1 to 5 points, with higher scores indicating the presence of higher levels of parenting stress. It also presents 3 subscales of 12 items investigating Parental Distress (PD), Parent-Child Dysfunctional Interaction (PCDI), and Difficult Child (DC) perception.

6.2.4.3. Infant Mental and Psychomotor Development

As mentioned above, infant mental and psychomotor development at 3 and 9 months was assessed by individually administering the Griffiths Mental Development Scales-Revised version (GMDS-R for 0–2 years; Griffiths, 1996), specifically dedicated to the evaluation of infants and children between 0 and 2 years. Through a battery of developmental assessments, these scales estimate an infant's global level of development represented by the mean score of five specific domains: locomotor skills, personal and social development, hearing and language proficiency, eye–hand coordination, and performance. The scores are standardized for an expected value of 100 with an SD of 12. For preterm groups, scoring always considered the corrected age at the time of assessment. The Griffiths scales are widely used for both clinical and research purposes to identify developmental delays and/or deficits and monitor infant's acquisitions over time in high-risk contexts such as prematurity conditions. All infants were assessed by psychologists who were trained in the use of the GMDS and blind to infant birth weight.

6.2.4.4. Infant-Directed Speech

Maternal IDS verbosity during the free-interaction session was investigated by considering the number of utterances addressed to the infant. The utterance was considered as the unit of analysis, and an "utterance" was defined as any continuous segment of speech separated from the subsequent one by a pause lasting more than 1 s (D'Odorico & Franco, 1985). To investigate the lexical and syntactic characteristics of maternal speech, the following measures were analyzed:

- Word tokens, which represent the total number of words produced.

- Word types, which represent the total number of different words produced.
- Mean Length of Utterance (MLU), a measure of syntactic complexity, calculated as the ratio of words to utterances.

Functional features of maternal IDS were analyzed through an ad hoc coding system that had been previously employed in maternal speech studies (e.g., Venuti et al., 2012; Zampini et al., 2020) and in a previous recent study on a preterm population (Provera et al., 2023). In accordance with this scheme, each maternal utterance was assigned to one of the subsequent non-overlapping functional categories:

- Affect-salient speech, including utterances intended to sustain the conversation, such as greetings, words of encouragement, or singing.
- Information-salient speech, regarding utterances aimed at conveying information, either by providing or seeking it. It includes four subcategories: questions, labeling, descriptions, and directives.
- Attention-getter utterances, including utterances designed to capture the infant's attention, such as calling the infant by their name.
- Other: incomplete or unintelligible utterances, as well as maternal speech not directed towards the infant.

We computed the proportion of maternal speech for each of these categories and subcategories by dividing the number of utterances falling into each category by the total number of maternal utterances produced during the interaction.

6.2.5. Data Analysis

Firstly, a series of analysis of variance (ANOVA) and Pearson's chi-square tests were run to assess the homogeneity between the 3 groups according to mothers' and infants' sociodemographic features. More specifically, the groups were compared with respect to mothers' age, years of education, marital status, parity, employment status, infant's age (which was corrected for PT groups), and GMDS-R total score.

According to the first aim of the study, a repeated measures ANOVA was run in order to investigate the trajectories of the levels of maternal parenting stress from 3 to 9 months according to birth weight. For the second aim, a series of repeated measures ANOVAs were also run to explore trajectories of features of IDS across the first months postpartum.

Considering the third and fourth aims of our study, two series of multivariate regressions were run to identify possible predictors for the lexical, syntactic, and functional features of IDS at both 3 and 9 months. In the first series, we selected both birth weight and maternal PSI scores as predictors for maternal speech's features at 3 months. The second series included both birth weight and maternal parenting stress at 3 and 9 months as predictors of maternal speech at 9 months. Given that birth weight presented three different conditions, we settled on ELBW as the reference group for the regression models and considered two different contrasts in our analysis: ELBW versus VLBW group (Birth weight 1) and ELBW versus FT group (Birth weight 2). This methodological step used to analyze the impact of a categorical variable with more than two levels is similar to criteria and analyses used in previously published articles (see, for example, Tufik et al., 2022; Tomaino et al., 2023).

Data were analyzed using Jamovi software version 2.3.28 (The Jamovi Project, 2022). A p value < 0.05 was considered as statistically significant.

6.3. Results

6.3.1. Sociodemographic Characteristics

Descriptive features of mothers and infants included in the study are reported in Table 1. Statistically significant differences among groups were found in maternal years of education, parity condition, days of hospitalization after birth, infant's developmental quotient at 3 months, and infant's age at 9 months. Specifically, maternal years of education were higher in FT mothers compared to ELBW ones (Tukey post hoc: $p = 0.002$); infant's gestational age at birth and birth weight were higher in the FT group compared to both the VLBW (Tukey post hoc: $p = 0.010$ and $p = 0.001$, respectively) and ELBW ones (Tukey post hoc: $p = 0.010$ and $p = 0.001$, respectively). Similarly, infant's developmental quotient and infant's age were higher in the FT group compared to the VLBW (Tukey post hoc: $p = 0.010$ and $p = 0.001$, respectively) and ELBW ones (Tukey post hoc: $p = 0.001$ and $p = 0.001$, respectively). Predictably, the hospitalization period prior to discharge was found to be longer in the ELBW group compared to the VLBW group and the term-born infant group (Tukey post hoc: $p = 0.010$ and $p = 0.001$, respectively). Moreover, multiparity was more frequent in the VLBW group compared to the FT and ELBW ones. Given that the distribution of these variables was not homogeneous, we ran a series of preliminary correlation analyses and ANOVAs to check their association with the dependent variables of the present study in order to control their possible influences. As we did not find

any significant association, these variables were not included in subsequent statistical analyses.

Table 1. Participant characteristics.

		FT (N = 40)	VLBW (N = 30)	ELBW (N = 30)	F/X²	*p*
Maternal variables	Age	33.8 (4.77)	36.2 (5.17)	34.8 (4.66)	2.09	.129
	Years of education	14.9 (2.97)	13.4 (2.50)	12.4 (3.49)	6.12	.003 **
	Marital status [a]				2.59	.274
	Married/cohabit	34 (85)	29 (96)	27 (90)		
	Other	6 (15)	1 (4)	3 (10)		
	Parity [a]				15.1	<.001 ***
	Nulliparous	39 (98)	19 (63)	26 (86)		
	Multiparous	1 (2)	11 (37)	4 (14)		
	Working condition [a]				2.13	.345
	Employed	37 (93)	25 (83)	28 (93)		
	Unemployed	3 (7)	5 (17)	2 (7)		
Infant variables	Gestational age at birth (in weeks)	40.0 (1.79)	29.2 (2.55)	26.9 (1.71)	425	<.001 ***
	Birth weight (in grams)	3445 (438)	1241 (148)	840 (150)	780	<.001 ***
	Hospitalization days	2.15 (0.36)	35.7 (11.7)	63.6 (16.1)	279	<.001 ***
	Infant's mean age at T1 [b]	3.00 (0.25)	3.05 (0.18)	3.09 (0.21)	1.65	.197
	GMDS-R total score at T1 [c]	114 (8.54)	108 (8.05)	107 (8.88)	7.80	<.001 ***
	Infant's mean age at T2 [b]	9.5 (0.25)	8.9 (0.31)	9.0 (0.23)	61.3	<.001 ***
	GMDS-R total score at T2 [c]	103 (9.27)	99 (9.11)	100 (7.58)	2.63	.077

Data are expressed as means (and standard deviations in parentheses) for interval data. a Number (and % in parentheses) for categorical data. b Corrected age for PT infants. c GMDS-R was administered and scored considering chronological age for FT infants and corrected age for PT ones. ** $p < 0.01$. *** $p < 0.001$.

6.3.2. Maternal Parenting Stress at 3 and 9 Months

Repeated measures ANOVA did not show any statistically significant effect within ($F(2, 97) = 1.19$; $p = 0.307$) or between ($F(2, 97) = 0.2$; $p = 0.819$) groups in the levels of maternal parenting stress during the first 9 months (Table 2).

Table 2. Mean and standard deviation of maternal PSI scores at 3 and 9 months.

	T1			T2			Between Effect		Within Effect		Interaction	
	FT (N=40)	**VLBW (N=30)**	**ELBW (N=30)**	**FT (N=40)**	**VLBW (N=30)**	**ELBW (N=30)**	**F (2, 97)**	***p***	**F (1, 97)**	***p***	**F (2, 97)**	***p***
PSI-SF Total Scores	61.8 (15.5)	63.5 (19.1)	62.2 (14.6)	62.3 (14.2)	61.4 (24.2)	57.9 (11.5)	0.20	.819	2.33	.130	1.19	.307

Data are expressed as means (and standard deviations in parentheses) for interval data.

6.3.3. Stability and Changes in IDS Features at 3 and 9 Months

Results of repeated measures ANOVAs (shown in Table 3) revealed an overall decrease in the number of questions ($F(1, 97) = 12.40$; $p < 0.001$) directed to the infant in all the three groups from 3 (M = 28.7; SE = 1.21) to 9 months (M = 21.4; SE = 0.89). A similar trend was found in the proportion of affective utterances, which appeared to be lower at 9 months (M = 43.0; SE = 1.47) compared to 3 months (M = 31.8; SE = 1.29) in all the groups ($F(2, 97) = 43.90$; $p < 0.001$). Nevertheless, when the effect of interaction between the birth group and the time of assessment was considered, we found significant differences that were specific only for ELBW dyads ($F(2, 97) = 6.64$; $p = 0.002$; Tukey post hoc, $p = 0.775$).

Table 3. Mean and standard deviation of lexical, syntactic, and functional features of IDS at 3 and 9 months.

	Birth Weight			Time of Assessment		T1			T2			Between Effect [b]		Within Effect [c]		Interaction	
	FT	VLBW	ELBW	T1	T2	FT (N=40)	VLBW (N=30)	ELBW (N=30)	FT (N=40)	VLBW (N=30)	ELBW (N=30)	F (2, 97)	*p*	F (1, 97)	*p*	F (2, 97)	*p*
Lexical and syntactic characteristics of maternal IDS																	
Word tokens	219 (9.47)	191 (10.9)	208 (10.9)	228 (7.44)	184 (6.23)	243 (57.1)	208 (91.8)	234 (73.4)	195 (52.5)	175 (60.2)	182 (73.6)	0.30	.739	0.55	.459	0.48	.621
Word types	88.7 (3.21)	76.6 (3.71)	77.9 (3.71)	85.8 (2.45)	76.4 (2.20)	95 (21.9)	77.4 (24.1)	85 (27.2)	82.5 (21.5)	75.9 (20.8)	70.8 (23)	0.17	.842	0.82	.369	1.71	.187
MLU	3.15 (0.08)	2.95 (0.09)	2.92 (0.09)	3.04 (0.06)	2.98 (0.05)	3.14 (0.66)	2.96 (0.59)	3.01 (0.57)	3.16 (0.51)	2.95 (0.57)	2.83 (0.64)	0.75	.389	2.40	.096	1.16	.317
Functional characteristics of maternal IDS																	
Affect-salient speech [a]	37.3 (1.76)	38.5 (2.03)	36.4 (2.03)	42.7 (1.46)	32.2 (1.29)	46.1 (13.3)	43.6 (13.9)	38.3 (16.4)	28.6 (11.9)	33.4 (12.9)	34.5 (13.7)	0.26	.769	43.90	<.001 ***	6.64	.002 **
Labeling [a]	2.29 (0.43)	2.94 (0.49)	2.54 (0.49)	1.98 (0.37)	3.20 (0.38)	0.81 (1.75)	2.64 (4.52)	2.48 (4.61)	3.77 (3.42)	3.24 (3.90)	2.59 (3.99)	0.50	.607	5.60	.020 *	3.19	.045 *
Descriptions [a]	19 (1.02)	18.7 (1.18)	16.4 (1.18)	15.5 (0.74)	20.6 (0.99)	16.7 (8.46)	15.8 (7.24)	14 (5.72)	21.3 (9.28)	21.7 (10.5)	18.8 (10)	1.17	.314	3.21	.076	0.14	.873
Questions [a]	25.9 (1.22)	22.2 (1.41)	26.9 (1.41)	28.8 (1.22)	21.2 (0.88)	26.4 (11.2)	28.6 (9.15)	31.3 (15.9)	23.2 (10.3)	17.9 (5.45)	22.6 (9.02)	2.88	.061	12.40	<.001 ***	2.00	.141
Directives [a]	6.94 (0.92)	7.69 (1.1)	8.49 (1.1)	5.38 (0.62)	10 (0.9)	3.46 (3.76)	5.8 (7.77)	6.89 (9.62)	10.4 (9.41)	9.59 (6.71)	10.1 (9.94)	0.61	.547	21.92	<.001 ***	1.51	.226
Attention-getter [a]	6.54 (0.79)	7.26 (0.92)	7.35 (0.92)	3.91 (0.52)	10.2 (0.77)	2.59 (4.41)	4.14 (4.46)	5 (6.44)	10.5 (7.36)	10.4 (6.96)	9.96 (8.58)	0.28	.755	57.59	<.001 ***	1.33	.269

[a] Data are expressed as means (and standard deviations in parentheses) for interval data. [b] The between-group effect refers to the differences among birth weight groups. [c] The within-group effect refers to the differences across the time of assessment. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

A statistically significant within effect was found for the number of both directives (3 months: M = 5.19; SE = 0.63; 9 months: M = 10.07; SE = 0.88; F(1, 97) = 21.92; $p < 0.001$) and attention-getter utterances (3 months: M = 3.78; SE = 0.52; 9 months: M = 10.21; SE = 0.75; F(1, 97) = 57.59; $p < 0.001$), which was higher at 9 months compared to 3 months in all the groups. A general increase was found also in the proportion of labels (3 months: M = 1.86; SE = 0.38; 9 months: M = 3.26; SE = 0.37; F(1, 97) = 5.60; $p < 0.020$), although the trend was statistically significant only in the FT group (Tukey post hoc: $p = 0.005$).

6.3.4. The Influence of Birth Weight and Maternal Parenting Stress on IDS Characteristics at 3 Months

Overall, all regression models aimed to test potential predictors of lexical and syntactic features of maternal speech at 3 months showed no statistically significant effect of either birth weight or parenting stress. Specifically, neither the number of word types (F(5, 94) = 2.44; $p = 0.310$), word tokens (F(5, 94) = 2.09; $p = 0.062$), nor MLU (F(5, 94) = 0.589; $p = 0.708$) was influenced by birth weight and maternal PSI scores at 3 months.
When models on functional features were investigated, regression analyses highlighted the presence of statistically significant equations only for the functional categories of affect-salient speech (F(5, 94) = 4.21; p = 0.002; Table 4, Figure 1) and questions (F(5, 94) = 4.19; p = 0.002; Table 4, Figure 2), which were both predicted by birth weight (specifically for the comparison between FT and ELBW groups), which was the main predictor according to β scores, and, to a lesser degree, by maternal parenting stress at 3 months, as well as their interactions. Specifically, maternal input directed towards ELBW infants was less affective and characterized by a higher use of questions compared to the FT group. Moreover, this trend appeared to be accentuated in mothers with higher levels of parenting stress, but only in the ELBW group (Figure 1 and Figure 2).

Figure 1. Effect of interaction between birth weight and maternal parenting stress on affect-salient speech at 3 months.

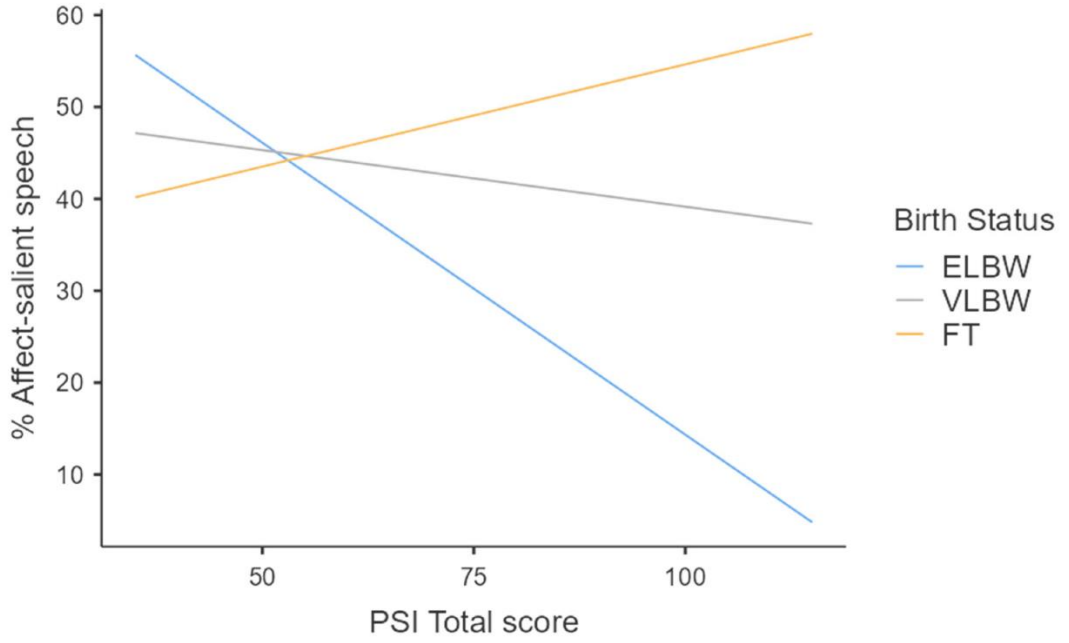

Figure 2. Effect of interaction between birth weight and maternal parenting stress on questions at 3 months.

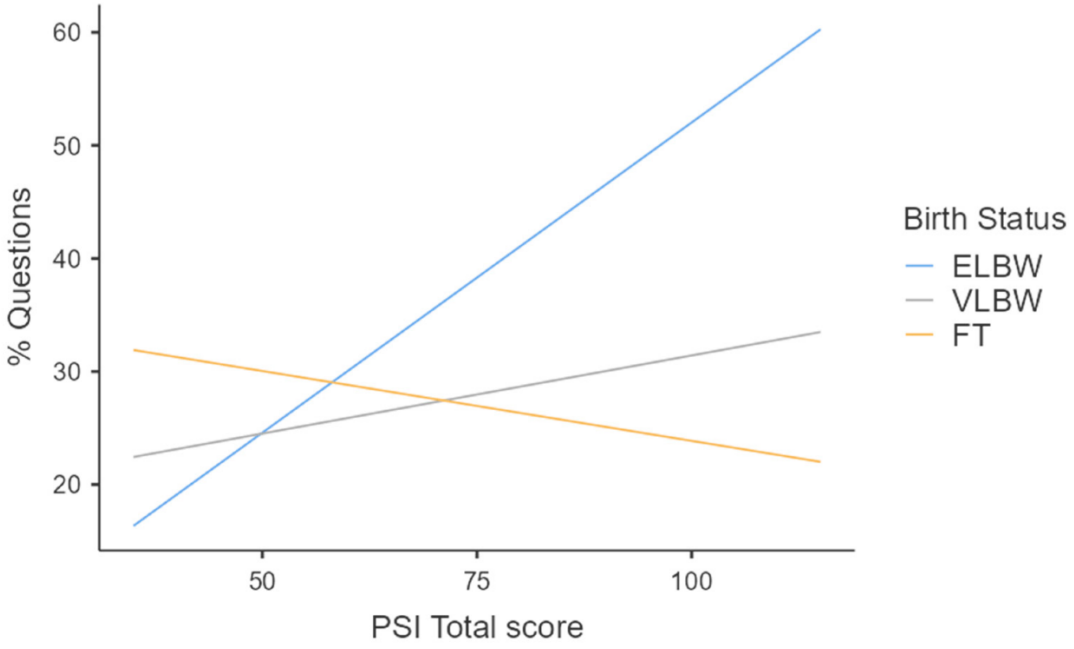

Table 4. Regression models for the prediction of IDS features at 3 months.

	R^2adj	F (5, 94)	*p*	T	β	t	*p*
Affect-Salient Speech	0.15	4.21	.002 **				
Birth weight 1 [a]				−26.43	14.09	−1.88	.064
Birth weight 2 [b]				−42.31	14.07	−3.01	.003 **
PSI_3 months				−0.64	0.17	−3.67	<.001 ***
PSI_3 × Birth weight 1				0.51	0.22	2.35	.021 *
PSI_3 × Birth weight 2				0.79	0.22	3.63	<.001 ***
Questions	0.14	4.19	.002 **				
Birth weight 1				20.45	11.76	1.74	.085
Birth weight 2				41.02	11.74	3.49	<.001 ***
PSI_3 months				0.55	0.14	3.80	<.001 ***
PSI_3 × Birth weight 1				−0.41	0.18	−2.26	.026 *
PSI_3 × Birth weight 2				−0.71	0.18	−3.87	<.001 ***

Note: [a] Birth weight 1 = ELBW vs. VLBW; [b] Birth weight 2 = ELBW vs. FT. * p < 0.05. ** p < 0.01. *** p < 0.001.

Conversely, the overall regression model did not result to be statistically significant in predicting the proportion of labels (F(5, 94) = 1.32; p = 0.263), descriptives (F(5, 94) = 1.34; p = 0.253), directives (F(5, 94) = 2.02; p = 0.083), or attention-getter utterances (F(5, 94) = 1.81; p = 0.119).

6.3.5. The Influence of Birth Weight and Maternal Parenting Stress on IDS Characteristics at 9 Months

Regarding the analysis of the predictors of lexical and syntactic features of maternal speech at 9 months, the number of word types (F(8, 91) = 0.97; p = 0.461), word tokens (F(8, 91) = 0.91; p = 0.509), and MLU (F(8, 91) = 1.15; p = 0.340) were influenced by birth weight and/or the levels of maternal parenting stress at 3 and 9 months.

Similarly, overall regression models on functional features assessing the proportion of directives (F(8, 91) = 0.62; p = 0.759), labels (F(8, 91) = 1.24; p = 0.284), descriptives (F(8, 91) = 1.51; p = 0.166), and attention-getter utterances (F(8, 91) = 0.62; p = 0.757) did not show statistically significant results.

In contrast, regression analyses focused on predicting affect-salient speech ($F(8, 91) = 2.63$; $p = 0.012$) and questions ($F(8, 91) = 3.67$; $p < 0.001$; Figure 3) produced statistically significant findings. Specifically, a lower proportion of affect-salient speech at 9 months appeared to be significantly predicted by higher levels of maternal parenting stress at 3 months; while the proportion of questions addressed to the infant was influenced by birth weight (being a mother of ELBW vs. FT infant), parenting stress at 3 months, and their interaction (higher levels of parenting stress were associated with a lower proportion of questions in FT and ELBW groups but not in the VLBW one; Figure 3). Among these, the predictor with higher β scores was birth weight, followed by the interaction between parenting stress at 3 months and the preterm birth weight, followed by PSI-SF scores at 3 months (Table 5).

Figure 3. Effect of interaction between birth weight and maternal parenting stress at 3 months on questions at 9 months.

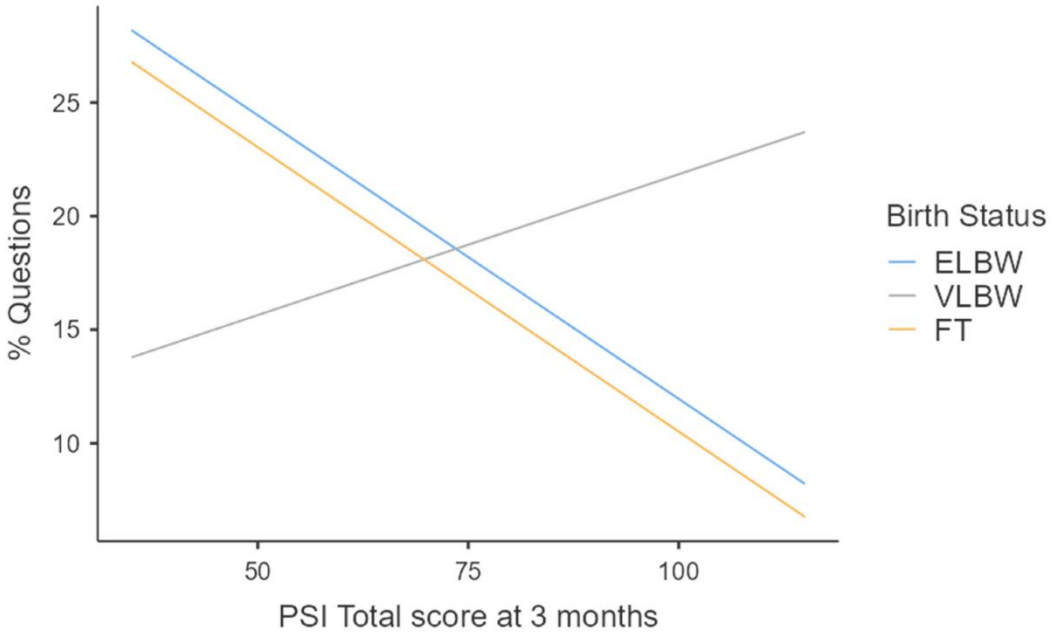

Table 5. Regression models for the prediction of IDS features at 9 months.

	R^2adj	F(8, 91)	*p*	T	β	t	*p*
Affect-Salient Speech	0.12	2.63	.012 *				
Birth weight 1				−1.02	14.56	−0.07	.944
Birth weight 2				−18.81	15.21	−1.24	.219
PSI_3 months				−0.53	0.18	−2.88	.005 **
PSI_3 × Birth weight 1				0.26	0.26	1.02	.310

PSI_3 × Birth weight 2				0.44	0.27	1.65	.102
PSI_9 months				0.23	0.23	1.00	.319
PSI_9 × Birth weight 1				−0.28	0.28	−1.02	.311
PSI_9 × Birth weight 2				−0.25	0.31	−0.80	.428
Questions	0.20	3.67	<.001 ***				
Birth weight 1				−12.40	9.658	−1.294	.202
Birth weight 2				−21.32	10.04	−2.122	.037 *
PSI_3 months				−0.250	0.121	−2.063	.042 *
PSI_3 × Birth weight 1				0.374	0.171	2.190	.031 *
PSI_3 × Birth weight 2				−0.708	0.176	−0.004	.997
PSI_9 months				0.202	0.153	1.319	.190
PSI_9 × Birth weight 1				−0.248	0.180	−1.377	.172
PSI_9 × Birth weight 2				0.329	0.207	1.590	.115

Note: Birth weight 1 = ELBW vs. VLBW; Birth weight 2 = ELBW vs. FT. * p < 0.05. ** p < 0.01. *** p < 0.001.

6.4. Discussion

The general aim of this study was to investigate the potential influence of both preterm birth weight and levels of maternal parenting stress on infant-directed speech patterns during the first 9 months after childbirth.

6.4.1. Maternal Parenting Stress at 3 and 9 Months

Focusing on the first aim of our study, the results revealed the absence of statistically significant differences among groups in the maternal PSI scores at both 3 and 9 months. The literature on the impact of prematurity on parental stress levels has reported conflicting results to date. Indeed, while some studies indicated a significant impact of prematurity on maternal stress (Feldman & Eidelman, 2007; Bilgin & Wolke, 2015), others did not highlight differences between PT and FT populations (Gray et al., 2012; Neri et al., 2017; Suttora et al., 2020; Spinelli et al., 2022). Our finding aligned with this latter series of studies suggesting that, although premature birth could represent a stressful event for parents, PT infants' mothers in our sample did not experience higher levels of parenting stress at both 3 and 9 months compared to FT ones. Moreover, previous studies have examined the potential relationship between maternal parenting stress and prematurity in the first trimester postpartum, finding no statistically significant differences associated with parenting stress levels. However, none of these studies

employed a longitudinal design, and these studies did not explore the comparison between different levels of prematurity. Our study confirms and extends these findings also to the third trimester postpartum, further comparing ELBW and VLBW infants.

6.4.2. Stability and Changes in IDS Features at 3 and 9 Months

Overall, our findings revealed that the linguistic and structural aspects of maternal speech, specifically related to word types and tokens, as well as MLU, were not influenced by the birth condition at both 3 and 9 months. This outcome aligns with existing literature, which similarly observed no significant differences in lexical and syntactic features of maternal speech directed towards PT and FT infants (Salerni et al., 2007; Suttora & Salerni, 2011; Provera et al., 2023). Furthermore, our results confirmed findings from a previous study by Provera et al. (2023), which, comparing the linguistic complexity of the maternal input directed to 3-month-old FT and PT infants and considering preterm birth weight, did not find any statistically significant difference between mothers of ELBW and VLBW infants, and extended this similarity also to later stages of development. The absence of significant differences in IDS complexity between 3 and 9 months may reflect a U-shaped trend in the trajectories of the linguistic characteristics of IDS during the first year. As suggested by several authors (Sherrod et al., 1977; Stern et al., 1983; Genovese et al., 2020), there appears to be an initial increase in syntactic complexity during the first six months postpartum, followed by a subsequent decrease towards the end of that year and then by an increase during the second year postpartum. As mentioned above, this pattern reflects the dynamic nature of IDS which is deliberately adjusted by caregivers according to the emerging language abilities of the infant. In the early months, the heightened complexity of IDS may serve to stimulate the infant, while the observed decline in complexity towards the end of the first year may facilitate linguistic assimilation, thereby guiding and shaping linguistic development in a manner reflective of the infant's growing capabilities (Genovese et al., 2020).

The pragmatic features of IDS also appeared to be influenced by the infant's age. At 3 months postpartum, maternal speech directed towards infants was predominantly characterized by affect-salient utterances, constituting more than half of the overall input directed to the infants; conversely, at 9 months, the proportion of affect-salient speech tended to decrease, and simultaneously, the number of labels, directives, and attention-getter utterances tended to increase. This IDS pattern is consistent with the existing literature which suggests that mother–

infant communicative vocal exchanges during the first six months after birth are mainly affective and that a tendency to become more informative, descriptive, and contextualized (Bornstein et al., 1992; D'Odorico et al., 1999; Rowe et al., 2012) appears at later stages of development, when the infant starts to explore the surrounding environment and expresses a higher level of intersubjectivity (Stren et al., 1983). The shift in the maternal communicative style is functional in supporting the infant's emerging skills across the communicative, linguistic, and socio-cognitive domains (Saint-Georges et al., 2013). In the present study, this trend seems to occur independently from the preterm status. Interestingly, the only exception regards IDS functional features directed to ELBW infants, specifically the proportion of affect-salient speech and labels, which appeared to be less influenced by the infant's age. In fact, although maternal speech towards ELBW infants showed a little decrease in its affective features and an increase in the number of labels, this trend was not statistically significant, differently from what happens for FT infants. It could be hypothesized that mothers of PT infants with a lower birth weight may encounter challenges in adjusting their communicative style according to the infant's age and developmental level, persisting in using an interactive style more suitable for younger infants. This result confirms the importance of exploring the effects of prematurity while also considering preterm birth weight, as highlighted by previous studies (Agostini et al., 2014; Neri et al., 2015; Provera et al., 2023). The way ELBW and VLBW mothers interact with their infants may be related to distinct representations of their infants and their capabilities. For example, preterm infants' mothers may hold a stereotyped perception of their infant as more vulnerable, less mature, and less competent irrespective of the infant's actual abilities or developmental level reached (Stern et al., 2006; Patruno et al., 2015; Salvatori et al., 2016). This representation, which could be more persistent in mothers of more vulnerable PT infants, like ELBW ones, may lead to the adoption of less suitable and functional interactive modalities for supporting the infants in their development.

6.4.3. The Influence of Birth Weight and Maternal Parenting Stress on IDS at 3 Months

In an exploration of the impact of parenting stress and birth weight on maternal input at 3 months, no significant effects were observed in relation to both syntactic and lexical features of maternal IDS. The lack of significant differences between groups in both lexical and syntactic complexity of IDS is consistent with previous results presented in a study by Spinelli et al. (2022) which did not find differences in the linguistic complexity of maternal input directed

towards PT and FT infants. Interestingly, in contrast to our findings, this study reported a significant influence of maternal parenting stress on these linguistic aspects of IDS (specifically in terms of MLU and the types/tokens ratio) at 3 months, reporting higher complexity of IDS associated with higher levels of maternal stress and thus suggesting the presence of less adequate interactive modalities. Again, this study compared FT and PT dyads, without taking into account preterm birth weight. Nevertheless, the differences in these findings underscore the necessity for further investigations keeping in mind the differentiation of preterm samples according to the levels of prematurity.

On the contrary, both the independent variables appeared to be significant predictors of IDS functional features at 3 months. Mothers of both ELBW and VLBW infants exhibited a tendency to talk with their infants in a more demanding way, using less affect-salient speech and using more questions compared to the FT group's mothers. As mentioned above, maternal speech towards younger infants is expected to be more affective compared to IDS addressed to older ones. Various theoretical perspectives, including developmental psychology, psychopathology, infant research, and affective neurosciences, underscore the significant role of maternal affective speech in this early phase because it plays a crucial part in fostering positive interactions with the infant and facilitating the establishment of secure attachment bonding (Stern et al. 1998; Trevarthen et al., 2001; Agostini et al., 2014). The tendency that emerged in our PT samples of addressing less affect-salient speech to younger infants became more pronounced with higher levels of parenting stress only for ELBW infants, suggesting that mothers in high-risk scenarios could experience more difficulties in establishing sensitive and attuned interactions with their infants. Literature on prematurity has frequently described PT infants as more passive and less engaged in dyadic interactions (Goldberg & Divitto, 1995; Muller-Nix et al., 2004). This characteristic could lead ELBW mothers to elicit the attention and engagement of their infants by addressing them with more questions during interactive exchanges. However, this interactive modality could also suggest a certain degree of intrusiveness in mother–infant interactions that is exacerbated in cases of mothers experiencing higher levels of parenting stress. Our hypotheses are consistent with a previous study by Muller-Nix et al. (2004), which reported a higher frequency of intrusive behaviors and lower levels of sensitivity associated with more stressed mothers of preterm infants compared to FT and non-stressed ones. Moreover, our findings are also in line with previous studies which

highlighted the presence of more controlling and intrusive behaviors in interactive exchanges with PT infants with a lower birth weight (Agostini et al., 2014).

6.4.4. The Influence of Birth Weight and Maternal Parenting Stress on IDS at 9 Months

Consistent with our findings at 3 months, our findings indicated that neither birth weight nor parenting stress significantly influenced the lexical and syntactic characteristics of IDS at 9 months. This result could suggest a certain similarity in the structural and lexical complexity of maternal speech, which does not differ between FT and PT groups, aligning with previous findings from the literature (Suttora & Salerni, 2011). Moreover, maternal parenting stress levels at both 3 and 9 months did not emerge as predictors of speech complexity at 9 months, therefore reinforcing the trend observed at 3 months also for later developmental stages. Concerning pragmatic features, our findings revealed that the proportion of affect-salient speech directed to the infants was significantly influenced by levels of maternal parenting stress at 3 months, but not at 9 months. Specifically, in all three groups, mothers experiencing higher stress at 9 months tended to engage with their infant using a less affective input.
Regarding the proportion of questions addressed to the infant, the results revealed that PT mothers compared to FT ones exhibited a less interrogative style while talking with their infants. Interestingly, the presence of parenting stress at 3 months appeared to influence the interactive style of ELBW and VLBW mothers differently. Similar to what happened with FT mothers, higher PSI scores at 3 months were associated with a lower number of questions directed to ELBW infants; conversely, VLBW mothers displayed the opposite pattern.

Limitations and Future Directions

While there is still a scarcity of literature examining IDS in the context of premature birth, and the available studies share comparable sample sizes with ours, one of the main limitations in our research is the restricted number of participants, which could limit the generalizability of our findings. Consequently, future studies should replicate this research with an increased number of participants involved. Our study focused on prematurely born infants with a gestational age < 32 weeks, categorizing them into two subgroups based on birth weight to evaluate potential significant differences between the ELBW and VLBW groups. While our primary emphasis was on birth weight, it is important to note that the exclusion of preterm infants with a gestational age > 32 weeks and a birth weight small for gestational age (SGA) represents a limitation in our study. This limitation restricts the generalizability of our results to

this specific subgroup of preterm infants. Furthermore, it is essential to acknowledge that our study did not take into account other crucial variables affecting infants, such as prenatal steroids and various postnatal morbidities (e.g., intraventricular hemorrhage, bronchopulmonary dysplasia, and sepsis). These factors could significantly impact infant outcomes and contribute to increased parental stress during the postpartum period. A further limitation is related to the exclusion of fathers from this research design. Although the follow-up program provided by the Laboratory of Developmental Psychodynamics of the University of Bologna is addressed to both parents, the low participation rate of fathers precluded their inclusion in the present study. Subsequent studies should consider levels of parenting stress in both mothers and fathers, recognizing their potential role as significant risk or protective factors for child development and well-being (Letourneau et al., 2012). Examining the influence of premature birth on the interactive behaviors of both parents can provide insights for tailoring interventions and support programs for families facing similar stressful circumstances. Lastly, in this study, we only considered the influence of parenting stress as a possible predictor for the characteristics of IDS patterns. However, given that existing literature indicates that parents of severely premature infants are at a heightened risk of experiencing various postpartum symptoms (e.g., depression, anxiety, PTSD symptoms), subsequent studies should explore the impact of different symptoms on maternal (and paternal) speech. Although promising, given the lack of other similar studies in the literature, our results should be replicated in further studies taking into account all these limitations.

6.5. Conclusions

Overall, the findings from this study support a potential connection between maternal psychological well-being and mental health in the first months postpartum and the quality of the interactive behaviors across the first year. Specifically, a significant relationship between maternal distress and linguistic interactive style has been explored and suggested.

The first period following childbirth represents a sensitive moment for parents, particularly in the case of prematurity. As mentioned above, the circumstances of preterm births, especially in more severe cases of prematurity, may increase the risk of developing postnatal psychopathology as well as parenting stress, which could negatively impact the quality of early dyadic exchanges. As the quality of the linguistic input serves important roles not only in facilitating the infant's linguistic acquisition but also in supporting the development in several

domains, including the socio-affective one, it is important to monitor the presence of typical or atypical IDS patterns during the first year, especially when they are associated with high levels of parenting stress or other risk factors. Considering the clinical implications of the findings, this study contributes to supporting the importance of implementing adequate psychological support for mothers during the early postpartum period, when needed, in the case of preterm infants with lower birth weight or high parenting stress. In fact, the possibility of perceiving a supportive and adequate environment, both at the hospital and after the discharge of the infant, may facilitate the co-construction of sensitive dyadic interactions, support parenting functions, and foster the development of mother–infant bonding, with improvement in infant development (Milgrom et al., 2013; Harding et al., 2019).

Chapter 7 - Paternal and maternal speech at 3 months postpartum: an exploratory study on the effect of parental role and birth weight

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Abstract: Recent research highlights a growing interest for early interactions between fathers and their infants, acknowledging the significant influence these interactions have on developmental out-comes. However, there is a limited understanding of the specific characteristics of paternal Infant-Directed Speech (IDS), especially in the context of premature birth. This study aimed to analyse the functional and morpho-syntactic features of paternal IDS to full-term (FT) and preterm (PT) infants at 3 months, comparing it with maternal communicative style. Additionally, the study explored the influence of the severity of preterm birth according to birth weight, further distinguishing between Extremely Low Birth Weight (ELBW) and Very Low Birth Weight (VLBW) infants. Seventy-one father-infant and mother-infant dyads (24 FT, 22 ELBW, 25 VLBW) were recruited at 3 months (corrected age for PTs). Parent-infant interactions were video-recorded to assess lexical, syntactic, and functional aspects of paternal and maternal speech. Results revealed lower verbosity and lexical variability in paternal IDS compared to maternal one. No differences were found between parents of PTs and FT groups. Overall, these findings could contribute to better understand patterns of parent-infant communications in both FT and PT dyads, confirming the importance of involving both mothers and fathers from the early stages of development.

7.1. Introduction

The quality of early parent-infant interactions is widely recognized as fundamental for the co-construction of the relationship among the baby and his/her parents, scaffolding the child's development and promoting the areas of self-regulation, socialization, cognitive and emotional functioning (Stern et al., 1998; Trevarthen & Aitken, 2001; Feldman, 2007).

While most of the literature focused on parental interactive patterns as sensitivity and responsivity, since the 1960s, an increasing literature has studied the characteristics of linguistic input which adults use to talk with infants and young children. This speech style, widely known as Infant-Directed Speech (Saint-Georges et al., 2013; ManyBabies Consortium,

2020), differs from Adult-Directed Speech in various linguistic and suprasegmental adaptations, including simplified lex-icon and syntax, increased use of repetition, exaggerated high-pitched prosody, longer pauses, and slower speech rate (Ferguson, 1977; Snow, 1977; Soderstrom, 2007; Saint-Georges et al., 2013; Spinelli et al., 2017; Genovese et al., 2020). Interestingly, studies analysing patterns of maternal IDS across different cultures have found similar characteristics, particularly in the acoustic and prosodic aspects of this speech register. Cross-linguistic research, in particular, has highlighted the presence of certain universal features in IDS that serve important functions and contribute to its distinctive emotional and attention-getter qualities (Kitamura et al., 2001; Broesch & Bryant, 2015; Parlato-Oliveira et al., 2020)

Research examining IDS has underscored a fundamental role in supporting infant development among several domains, such as the social, emotional, linguistic, ones. More specifically, it has been repetitively found that IDS covers a key function in facilitating the onset of social interactions, conveying of affective contents, capturing, and maintaining infant's attention, and fostering his/her linguistic development (Stern et al., 1977; Stern et al., 1983; Saint-Georges et al., 2013; Spinelli et al., 2017; Spinelli & Mesman 2018). In this regard, one significant aspect of IDS is represented by its functional features, which provide fundamental information into the purpose and pragmatics of speech. Research on parental speech has identified two main functional categories of IDS that reflect the communicative intent of the speaker: affect-salient and information-salient speech (Penman et al., 1983; Bornstein et al., 1992; Broerse et al., 1994). Affect-salient speech is primarily used to convey affective contents from the parent to the infant, thereby facilitating emotional and interactive exchanges. On the other hand, information-salient speech, which includes questions, descriptions, and directives, is used to convey information about the infant, the dyad, and the surrounding environment. Like other features of IDS, these functional aspects dynamically change over time according to the infant's age and developmental stage.

These characteristics undergo dynamic changes over time, progressively becoming more complex as the infant grows up adapting to and supporting his/her emerging skills (Stern et al., 1983; Bornstein et al., 1992; Kitamura & Burnham, 2003; Kitamura & Lam, 2009; Saint-Georges et al., 2013; Genovese et al., 2020). Specifically, during the first months postpartum, IDS is typically more affectively connotated and characterized by a higher number of questions, whereas the proportion of information-salient speech, such as descriptives and directives,

increases as the infant grows up, acquires new developmental skills and becomes able to explore the surrounding environment.

To date, the literature on IDS during the first year postpartum has predominantly focused on mother-infant dyads, with relatively less attention given to the role of pa-ternal speech. Research involving fathers has not only been less numerous but also more discontinuous over time. The first studies which compared maternal and paternal IDS to preverbal infants have highlighted overall similar speech features. For example, Papousek et al. (1987) investigated maternal and paternal speech addressed to 3-month-old infants reporting similar speech registers characterized by a simplified syntactic structure, redundancy, and slower speech tempo. Similar results were also found by Kruper and Uzgiris (1987), which reported similarities in the frequent use of repetitions and questions in both maternal and paternal IDS addressed to 3-and 9-months old infants.

Conversely, more recent studies reported little differences between the two speech styles, which regard mainly the amount of speech addressed to the infant (for a narrative review see Ferjan Ramírez, 2022). For example, a study by Johnson et al. (2014) which investigate verbal interactive patterns among mother-infant and father-infant dyads from birth through the first 7 months postpartum, reported a higher amount of maternal speech compared to paternal one during dyadic interactions. Moreover, authors found that mothers showed a higher responsiveness to infant's vocalizations compared to fathers, and infants tended to respond more frequently to maternal speech compared to the paternal one.

Another study by Kokkinaki (2019) systematically compared different aspects of maternal and paternal IDS produced in natural interactions with their infants, from 2 to 6 months after birth. Significant differences between mothers and fathers were found in terms of structural variations, quantitative differences, and similarities. Specifically, paternal IDS structure was described as shortened and characterized by a higher rate of productions, revealing a more active and reactive speech style. Considering the amount of IDS, mothers were found to be more talkative during dyadic interactions and their speech was described as more infant- and dyad-focused compared to the paternal one. Conversely, similarities were found as regards the content of maternal and paternal IDS, such as the production of open and close-ended questions, the use of "we" as an ex-pression of sharing between the caregiver and the infant (emotions, physiological states, etc.) as well as the capability to respond to infant's emotional expressions.

Apart from the evidence provided by these studies conducted on full-term infant populations, there is still a gap in the literature regarding the differences and similarities in maternal and paternal IDS in cases of high-risk conditions related to infant birth.

Among these, preterm birth, which means that the childbirth is anticipated before the 37th week of gestation (WHO, 2012), represents a complex risk factor not only for the infant (Sansavini et al., 2011; Biasini et al. 2012) but also for parents, potentially affecting the establishment of positive early dyadic interactions. This risk is even more accentuated in case of lower gestational age (Zambrana et al., 2021) or when the infant is born with a very low birth weight (VLBW; BW<1500g) or extremely low birth weight (ELBW; BW<1000g) (Biasini et al., 2012). According to this latter criterion, recent studies highlighted the importance of examining prematurity by specifically differentiating VLBW and ELBW populations, as they could lead to different infant developmental outcomes but also differently impact on parental mental health and early dyadic interactions. For example, studied reported a higher incidence of maternal depression in case of ELBW condition as well as atypical parent–infant interaction patterns (Agostini et al., 2014; Neri et al., 2015; Provera et al., 2023, 2024).

Preterm condition poses significant risks to an infant's survival and health and can lead to vulnerabilities in various developmental domains, including linguistic, motor, and cognitive areas (Kerstjens et al., 2012; Sansavini et al., 2015; Vandormael et al., 2019). Consequently, preterm infants' parents could face higher challenges in the transition to parenthood and are at major risk of developing negative psychological reactions (i.e., depression, anxiety, parental distress) in the postpartum period, which also constitutes an important risk factor for the onset of interactions and the relation with the infant (Forcada-Guex et al., 2011; Pace et al., 2016; Neri et al., 2020; Agostini et al., 2022; Genova et al., 2022).

Considering the effects of prematurity on early dyadic interactions, the presence of atypical interactive patterns seems to be related to both infant and parental variables. On one hand, due to their neuropsychological immaturity, preterm (PT) infants are described as more passive, less attentive and involved, as well as more difficult during early exchanges (Montirosso et al., 2010; Fuertes et al., 2024), making more difficult to create positive interactions. On the other hand, preterm infants' mothers have been described as more stimulating and active, as well as less synchronized compared to full term (FT) ones (Agostini et al., 2014). The few studies which investigated father-infant interactions in the context of prematurity reported overall similar levels of sensitivity among mothers and fathers.

Interestingly, when non-sensitive behaviors were found, they tended to be more controlling for mothers whereas fathers were described as more verbally unresponsive (Neri et al., 2017).

In the context of prematurity, studies on verbal interactive patterns focused mainly on maternal speech reporting overall few differences in lexical and syntactic, as well as functional IDS features at 3 and 6 months postpartum (Salerni et al., 2007; Suttora & Salerni, 2011; Spinelli et al., 2022). However, when considering different levels of PT severity, mothers of more severe PT infants (i.e., ELBW ones) seem to adopt a more demanding, directive and less affective speech style compared to FT mothers and the ones of VLBW preterm infants at 3 months (Provera et al., 2023).

To the best of our knowledge, only one study so far investigated IDS among fathers and mothers addressed to PT and FT infants. Specifically, Kiepura and colleagues (2022) compared vocal behaviors among mothers and fathers of PT and FT infants at 3 months, analyzing frequencies and durations of vocalizations and pauses. Results showed that maternal vocalizations were more frequent and longer compared to paternal ones, regardless of birth condition.

Given these premises and considering the lack of studies which analyzed paternal IDS patterns addressed to PT infants, the aim of our study was to contribute to fulfill this gap in the literature, describing linguistic and pragmatic features of IDS at 3 months postpartum (corrected age for PT infants). The main aim of the study was to investigate the characteristics of the speech style related to parental role, by the comparison of paternal and maternal IDS in terms of syntactic, lexical, and functional features. Given the scarcity of studies on the differences between maternal and paternal IDS, and considering the sometimes-contradictory results, two possible outcomes can be hypothesized: one confirming and one disconfirming the differences found in the literature, which would provide greater consistency to previous studies. The second aim was to compare the characteristics of IDS directed towards preterm and full-term infants, taking into account the potential influence of PT birth weight (VLBW vs. ELBW). Concerning this topic and based on a previous study on maternal IDS directed to FT, VLBW, and ELBW infants (Provera et al., 2023), we hypothesized to find a more demanding and less affective linguistic input directed towards more severe PT infants (ELBW ones). Lastly, the effect of the interaction between parental role and birth weight was explored.

7.2. Materials and Methods

7.2.1. Study Design

The present exploratory study has been developed in the context of a broader research and follow-up project which aims to investigate the impact of premature birth on infant development, maternal and paternal mental health, as well as the quality of caregiver-infant interactions during the first year postpartum.

7.2.2. Participants

For this study, a total of 142 parents (71 mothers and 71 fathers) were recruited. Of these, 25 couples were parents of infants born full-term (FT) after the 36th week of gestation and with a birth weight > 2500 g. Families of FT infants were recruited for the study through a network established in collaboration with antenatal classes provided by the Health Services of Cesena. This network aimed to facilitate the recruitment of pregnant mothers for research projects and follow-up studies promoted by the Developmental Psychodynamic Laboratory of the Department of Psychology (University of Bologna), as already done in previous publications (Provera et al., 2023; 2024). The remaining 46 couples were parents of PT infants born before the 32nd week of gestation and with a birth weight < 1500 g, which had been hospitalized at the Neonatal Intensive Care Unit (NICU) of Bufalini Hospital (Cesena, Italy). The PT group was then divided into two subgroups according to the infants' birth weight: 24 couples were included in the VLBW group (birth weight between 1000 and 1500 g) and 22 couples in the ELBW group (birth weight < 1000g).

Exclusion criteria were the same for all the participants and included the presence of infant neurological disorders, genetic syndromes or other medical conditions or complications, the presence of previous or present psychiatric conditions in mothers and/or fathers, and a lack of fluency in the Italian language.

The research project was approved by the Ethical Committee of the Department of Psychology of University of Bologna (Protocol Number: 0001092/2023).

7.2.3. Procedure

The assessment and data collection were conducted at 3 months postpartum (for PT infants, corrected age was considered) at the Developmental Psychodynamic Laboratory (Department of Psychology, University of Bologna, Cesena). At the beginning of the follow-up visit and assessment, which usually lasted 45 minutes, a psychologist asked all parents to read and sign the written informed consent. Parents were then asked to complete a short battery of questionnaires which included a sociodemographic form and two specific and validated

questionnaires - the Edinburgh Postnatal Depression Scale (Cox et al., 1987) and the Parenting Stress Index-Short Form (Abidin, 1990) - on levels of maternal and paternal postpartum depression and parental distress in order to control the homogeneity of the groups. Once the questionnaires had been completed, which typically took five-ten minutes, a trained psychologist assessed the level of infant's mental and psychomotor development by administering the Griffiths Mental Development Scales – Revised version (Griffiths, 1996). The assessment took place in a room equipped for child evaluation and video recording, in the presence of the parents. After this first part of the assessment, both mothers and fathers were asked to individually participate in a 5 min session of free interactions with their infant. All the dyads were observed in the same standardized setting which included the presence of age-appropriate toys and puppets for the infants and each free-interactive session was video-recorded. All materials, including administered questionnaires and video recording materials, have been stored using a unique alphanumeric code in order to pseudonymize per-sonal data. Only in a second moment, after the assessment, maternal and paternal speech directed to the infant were *verbatim* transcribed by a blinded trained psychologist and researcher following the Codes for the Human Analysis of Transcripts (CHAT) format (Macwhinney, 1996).

7.2.4. Measures and Materials

7.2.4.1. Sociodemographic Data

The sociodemographic characteristics of the sample were examined using an ad hoc questionnaire, which included information about parental age and education level, marital status, employment condition, and number of children. Perinatal data related to the type of delivery, the gestational period, and infant's characteristics at birth were also collected.

7.2.4.2. Maternal and paternal postnatal depressive symptomatology and parenting stress

Mothers' and fathers' levels of depressive symptoms were investigated using the Edinburgh Post-natal Depression Scale (Cox et al., 1987) questionnaire, the most widely used self-report tool for the screening of postnatal depressive symptomatology in both women and men (Kennedy & Munyan, 2021). It consists of 10 items assessing the presence of perinatal depressive symptoms over the past 7 days. Each item is scored from 0 to 3 points, and the total EPDS score ranges from 0 to 30. Higher scores indicate higher levels of depressive symptoms. A validated Italian version of the EPDS questionnaire is available for both mothers (Benvenuti et al., 1999) and fathers (Loscalzo et al., 2015).

To investigate symptoms of parenting-related stress, all the participants were asked to complete the Italian validated version (Guarino et al., 2008) of the Parenting Stress Index-Short Form (PSI-SF; Abidin, 1990). This self-report tool is a 36-item questionnaire scored on a 5-point Likert scale. It generates a total score and 3 subscale scores which reflect three different dimensions: parental distress (PD), parent–child dysfunctional interaction (PCDI), and the perception of a difficult child (DC). Subscale scores range from 12 to 60, while the total score, which sums the subscale scores, ranges from 36 to 180, with higher scores indicating greater parenting stress levels.

7.2.4.3. Infant Mental and Psychomotor Development

Levels of infant mental and psychomotor development at 3 months were evaluated using the Griffiths Mental Development Scales-Revised version (GMDS-R for 0-2 years; Griffiths, 1996). These scales have been designed for assessing infants and children from birth to 2 years. The GMDS-R provides a comprehensive evaluation through a series of developmental tests, measuring overall development across five specific domains: locomotor skills, personal and social development, hearing and language abilities, eye-hand coordination, and general performance. Scores are standardized, with an expected value of 100 and a standard deviation of 12. For preterm infants, the corrected age was used for scoring during assessments. The Griffiths scales are extensively used in both clinical and research settings to detect developmental delays or deficits and to track developmental progress in high-risk situations such as prematurity (Agostini et al., 2014; Neri et al., 2015; 2017; Fontana et al., 2023). All assessments were conducted by psychologists trained in the GMDS-R and unaware of the infants' birth weight.

7.2.4.4. Maternal and paternal Infant-Directed Speech

The total amount of maternal and paternal speech directed to the infant was analysed by counting the number of utterances made during the free interaction session. An utterance, defined as any sequence of speech separated from the next by a pause longer than 1 second (D'Odorico & Franco, 1985), served as the unit of analysis.

The lexical and syntactic features of the parental IDS were examined through the following measures:

- Word tokens: the totality of words produced;

- Word types: the totality of different words produced;
- Mean length of utterance (MLU): the average number of words per utterance, which provides an index of syntactic complexity.

All these variables were analyzed according to the CHILDES system using the CLAN software (MacWhinney, 2014), a specialized tool for examining caregiver's and infant speech.

The functional characteristics of maternal speech were analyzed using a specific coding scheme previously utilized in studies on maternal speech (Venuti et al., 2012; Zampini et al., 2020; Provera et al., 2023; 2024). Each maternal utterance was classified into one of the following exclusive functional categories:

- Affect-salient speech: utterances aimed at sharing affective contents and maintaining the conversation (e.g., greetings, encouragement, use of onomatopoeias, singing);
- Information-salient speech: utterances intended to convey content, including giving or asking for information. This category was further divided into four exclusive subcategories: questions, labeling, descriptions, and directives;
- Attention getters: utterances intended to attract the infant's attention (e.g., calling the infant's name);
- Other: incomplete or unintelligible utterances or speech not directed at the infant.

The proportion of maternal and paternal speech in the total number of utterances produced during the interaction was considered for each category and subcategory.

7.2.5. Data Analysis

Primarily, the homogeneity of the three groups in both sociodemographic characteristics (maternal and paternal age, education level, marital status, employment condition, parity, infant's corrected age) was evaluated. Perinatal data related to the type of delivery, number of gestational weeks, infant's weight at birth, days of hospitalization before the discharge and GMDS-R total score were also compared among groups. These analyses were run by a series of ANOVAs, for continuous dependent variables, and Pearson's chi-square tests for categorical dependent variables. Furthermore, in order to assess the homogeneity between groups in parental clinical variables, specifically parental depression and level of parenting stress, a series of ANOVAs were run setting EPDS total score and PSI total scores as dependent variables and birth group and parental role as independent ones.

In order to address the aims of the study, linguistic and functional features of IDS were compared according to the parental role, the three birth groups defined on the basis of birth

weight, and the interaction between parental role and birth groups. Specifically, two multivariate analyses of covariance (MANCOVA) were run. In the first MANCOVA, both parental role (mothers vs. fathers) and birth weight (FT, VLBW, and ELBW), as their interaction, were set as between-subject factors, whereas speech linguistic features (specifically, word types and tokens, MLU) were set as dependent variables. Due to the non-homogeneous distribution of certain variables (specifically gestational age and developmental quotient, as shown in the following paragraph) and their potential influence on linguistic features, these variables were included as covariates in the statistical model. In the second model, functional categories of IDS (specifically, the proportion of affect-salient speech, labels, descriptives, questions, directives, and attention-getter) were set as dependent variables, whereas parental role, birth weight and their interaction were identified as between-subject factors. In this second model, developmental quotient was set as covariate.

Data analysis was conducted using IBM SPSS Statistics 24 software (IBM Corporation New York, NY, USA) and statistically significance was defined with a p-value < 0.05.

7.3. Results

Parental sociodemographic variables are displayed in Table 1. As mentioned before, a series of ANOVA 2x3 (parental role x birth weight) were run to investigate homogeneity among groups. Statistically significant differences were found for parental age [$F(5,136) = 3.4$; $p = .006$] and years of education [$F(5,136) = 2.95$; $p = .014$]. Specifically, for parental age, a significant effect of gender [$F(1,136) = 6.67$; $p = .011$] and birth group ($F(2,136) = 5.09$; $p = .007$) emerged indicating that mothers were overall younger than fathers, and FT parents were overall younger compared to parents of the VLBW group (Tukey post hoc: $p = .006$). A gender effect emerged [$F(1,136) = 9.40$; $p = .003$)] regarding years of education, indicating a higher level of education in mothers compared to fathers independently from birth groups. No significant differences among parents and groups were found in the marital status, working condition, and parity condition.

Considering maternal and paternal levels of depressive symptoms and parental distress, no significant differences emerged in the EPDS and PSI scores among groups. The two models did not reach the statistical significance (EPDS scores: $F(5,136) = 1.70$; $p = .137$; PSI scores: $F(5,136) = 0.33$; $p = .894$), suggesting a certain degree of homogeneity among parents.

Table 1. Parents' sociodemographic and clinical characteristics and differences among groups.

	Mothers (N=71)			Fathers (N=71)			F	
	FT (N=24)	VLBW (N=25)	ELBW (N=22)	FT (N=24)	VLBW (N=25)	ELBW (N=22)	(5, 136)	*p*
Age[a]	33.4(5.05)	36.8(6.18)	36.1(5.02)	36(5.85)	39.4(6.01)	38(4.33)	3.41	.006**
Years of education[a]	14.9(2.84)	15.1(2.04)	14.1(2.95)	12.4(2.99)	13.6(2.04)	13.8(2.84)	2.95	.014*
Working condition[b]							6.31	.177
Employed	23(96)	25(100)	21(95)	24(100)	25(0)	21(95)		
Unemployed	1(4)	0(0)	1(5)	0(0)	0(0)	1(5)		
Marital status [b]							1.99	.370
Married/cohabit	23(96)	25(100)	22(100)	23(96)	25(100)	22(100)		
Other	1(4)	0(0)	0(0)	1(4)	0(0)	0(0)		
Parity [b]							3.85	.146
Nulliparous	23(96)	19(76)	18(82)	23(96)	19(76)	18(82)		
Multiparous	1(4)	6(24)	4(18)	1(4)	6(24)	4(18)		
EPDS score[a]	4.83(3.14)	6.76(3.52)	5.82(5.17)	4.58(2.69)	4.44(3.07)	4.32(3.88)	1.70	.137
PSI total score[a]	59.9(13.3)	59.3(13.5)	61.3(15.6)	56.3(11.2)	57.9(13.9)	59.1(18.8)	0.33	.894

[a] Interval data are expressed as means (with standard deviations in parentheses).

[b] Categorical data are expressed as frequency (and % in parentheses).

* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

As regards infant's variables, displayed in Table 2, the three groups significantly differed according to gestational age, birth weight, hospitalization period before the discharge, and infant's developmental quotient. Specifically, infant's gestational age and birth weight were higher in the FT group compared to both the LBW (Tukey post hoc: $p = 0.010$ and $p = 0.001$, respectively) and ELBW conditions (Tukey post hoc: $p = 0.010$ and $p = 0.001$, respectively), and in the VLBW group compared to the ELBW one (Tukey post hoc: $p = 0.031$ and $p = 0.001$, respectively). Similarly, FT infants showed higher developmental quotient scores compared to VLBW (Tukey post hoc: $p = 0.028$) and ELBW ones (Tukey post hoc: $p = 0.001$), and VLBW infants reported higher scores compared to ELBW ones (Tukey post hoc: $p = 0.025$).

Given the non-homogeneous distribution of some parental and infant variables, a series of correlations were first run in order to check their possible association with parental speech measures and to identify the presence of covariates.

No significant associations emerged among sociodemographic variables (parental age, and years of education), while infant developmental quotient and gestational age at birth were positively correlated with all the lexical and syntactic measures: MLU (Pearson's $r = 0.168$; $p = .046$; Pearson's $r = 0.200$; $p = .019$, respectively), Types (Pearson's $r = 0.248$; $p = .003$; Pearson's

r = 0.171; p = .045, respectively), and Tokens (Pearson's r = 0.251; p = .003; Pearson's r = 0.161; p = .050, respectively). As regards the relation between functional features and socio-demographic variables, a positive correlation was found only between labels and developmental quotient (Pearson's r = -0.197; p = .018). Consequently, only gestational age and developmental quotient were included as covariates in the following analyses.

Table 2. Infants' characteristics and differences among groups.

	FT (N=24)	**VLBW (N=25)**	**ELBW (N=22)**	**F (2,68)**	***p***
Infant's mean age (in months) [a]	2.97 (0.21)	3.07 (0.19)	3.06 (0.19)	1.98	.145
Gestational age at birth (in weeks)	37.4 (5.50)	29.7 (1.95)	27 (1.74)	52.5	<.001***
Birth weight (in grams)	3607 (422)	1301 (136)	870 (153)	659	<.001***
GMDS-R total score [a]	114 (7.96)	109 (7.07)	103 (7.58)	12.2	<.001***

Data are expressed as means (with standard deviations in parentheses).

[a] Calculated based on corrected age for preterm infants.

* p < 0.05. ** p < 0.01. *** p < 0.001.

7.3.1. Lexical and syntactic features of maternal and paternal IDS at 3 months.

For investigating the first research question of our study, two series of Multivariate Analysis of Covariance (MANCOVA) were run. The first MANCOVA included parental role and birth group as independent variables and MLU, Word Types and Tokens as dependent variables. Birth weight, gestational age at birth and infant's developmental quotient were added as covariates. Results are displayed in Table 3.

Multivariate analysis of covariance highlighted a statistically significant effect of parental role [F (3, 129) = 2.72, p = .047, partial η2 = 0.06] and of the interaction parental role*birth weight [F (6, 260) = 2.14, p = .049, partial η2 = 0.05], but not a main effect of birth weight [Pillai's trace: F (6, 260) = 2.10, p = .054, partial η2 = 0.05].

Univariate analysis showed a statistically significant parental role effect on the indexes of word types [F (1, 133) = 6.03; p=.015; partial η2 = 0.05] and tokens [F (1, 133) = 8.24; p=.005; partial η2 = 0.06] which resulted to be higher in mothers compared to fathers, whereas no statistically significant effects were found for the MLU index. Despite the multivariate model for the interaction effect resulted to be statistically significant, no statistically significant effects emerged from univariate analyses (alle ps > .05).

Table 3. Means, standard deviations, and univariate analyses of syntactic and lexical features of IDS.

	Birth Weight			Parental Role		FT		VLBW		ELBW		Birth Weight			Parental Role			BW x PR		
	FT (N=48)	**VLBW (N=50)**	**ELBW (N=44)**	**Fathers (N=71)**	**Mothers (N=71)**	**Fathers (N=24)**	**Mothers (N=24)**	**Fathers (N=25)**	**Mothers (N=25)**	**Fathers (N=22)**	**Mothers (N=22)**	**F**	***p***	**part η^2**	**F**	***p***	**part η^2**	**F**	***p***	**part η^2**
Word tokens	221 (43.1)	197 (17.1)	172 (26.9)	179 (8.93)	215 (8.93)	189 (62.5)	245 (49.6)	198 (87.2)	201 (88.5)	151 (67.4)	191 (69.1)	0.85	.426	0.01	**8.24**	**.005 ****	**0.06**	2.01	.128	0.03
Word types	75.9 (15.6)	73.0 (6.20)	73.6 (9.63)	68.7 (3.22)	79.8 (3.22)	67.5 (16.1)	84.4 (16.1)	70.5 (7.23)	75.6 (7.23)	68.1 (10.4)	79.2 (10.4)	0.02	.976	0.01	**6.03**	**.015 ***	**0.05**	0.57	.565	0.01
MLU	2.33 (0.39)	3.34 (0.15)	3.41 (0.24)	2.93 (0.08)	3.12 (0.08)	2.21 (0.40)	2.45 (0.40)	2.89 (0.18)	3.28 (0.18)	3.45 (0.26)	3.37 (0.26)	2.03	.135	0.03	2.68	.104	0.02	1.54	.217	0.02

Data are expressed as estimated marginal means (with standard errors in parentheses) for interval data.

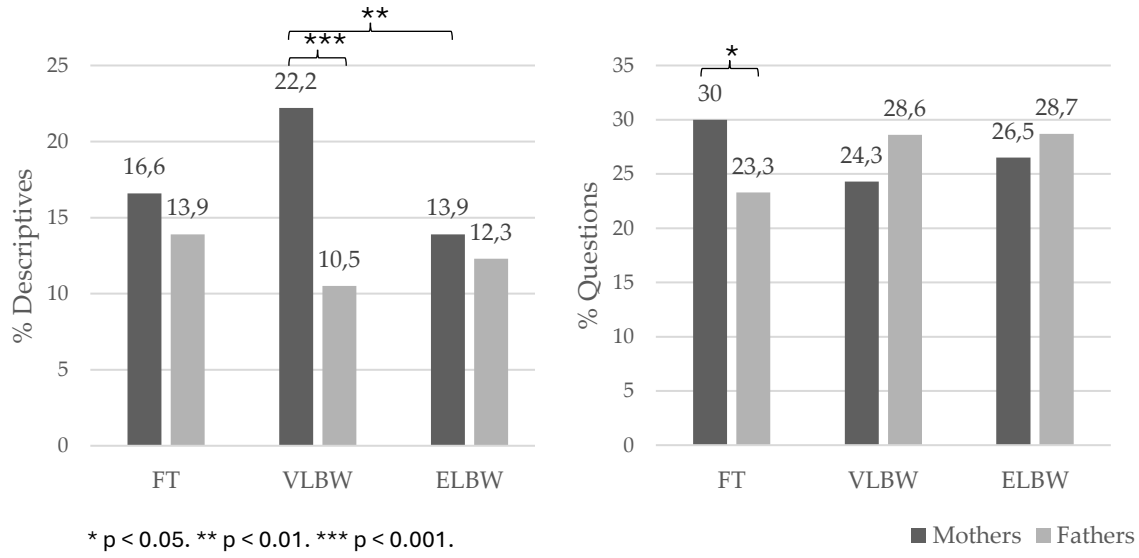
* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

7.3.2. Functional features of maternal and paternal IDS at 3 months.

Secondly, a MANCOVA model including parental role and birth group as independent variables and functional categories of IDS (affect-salient speech, labels, descriptives, questions, directives, attention-getter) as dependent variables was run. As preliminary correlations showed significant associations between the proportion of labels and developmental quotient (Pearson's r = -0.200; p = 0.017), this last was included as covariate in the analysis.

Results are displayed in Table 4. Multivariate analysis of covariance highlighted a statistically significant effect of parental role [F (6, 129) = 2.73, p = .016, partial η^2 = 0.12] and of the interaction parental role*birth group [F (12, 260) = 2.12, p = .016, partial η^2 = 0.09], while the main effect birth group did not result to be statistically significant [Pillai's trace: F (12, 260) = 1.21, p = .271, partial η^2 = 0.05]. A statistically significant effect of parental role emerged for the proportion of descriptive utterances produced, which was higher in mothers compared to fathers regardless to the birth weight of the infant [F (1, 135) = 12.8; p <.001; partial η^2 = 0.10]. Two statistically significant interaction effects emerged in both the functional categories of descriptives [F (2, 135) = 5.57; p<.005; partial η^2 = 0.08] and questions [F (2, 135) = 3.34; p =.038; partial η^2 = 0.05] [Figure 1]. Specifically, mothers of VLBW infants tended to produce more descriptive utterances compared to fathers of the same group (Bonferroni post hoc: p < .001) and mothers of ELBW infants (Bonferroni post hoc: p =. 002), whereas mothers of FT infants produced more questions compared to fathers of the same group (Bonferroni post hoc: p =. 039).

Figure 1. Percentages for Descriptives and Questions related to parental roles and birth weight.



* p < 0.05. ** p < 0.01. *** p < 0.001.

Table 4. Means, standard deviations, and univariate analyses of functional features of IDS.

	Birth Weight			Parental Role		FT		VLBW		ELBW		Birth Weight			Parental Role			BW x PR		
	FT (N=48)	**VLBW (N=50)**	**ELBW (N=44)**	**Fathers (N=71)**	**Mothers (N=71)**	**Fathers (N=24)**	**Mothers (N=24)**	**Fathers (N=25)**	**Mothers (N=25)**	**Fathers (N=22)**	**Mothers (N=22)**	**F**	***p***	**part η^2**	**F**	***p***	**part η^2**	**F**	***p***	**part η^2**
Affect-salient speech	48.2 (2.61)	44.36 (2.35)	45.3 (2.73)	47.95 (1.97)	44.2 (1.97)	50.5 (3.54)	46 (3.54)	45.7 (3.33)	43 (3.33)	47.6 (3.7)	43.6 (3.71)	0.62	.536	0.01	1.76	.186	0.03	0.04	.961	0.01
Labels	1.07 (0.48)	2.08 (0.43)	1.50 (0.50)	1.57 (0.36)	1.53 (0.36)	1.08 (0.66)	1.07 (0.66)	2.30 (0.62)	1.86 (0.62)	1.34 (0.68)	1.65 (0.68)	1.26	.287	0.02	0.01	.926	0.00	0.17	.843	0.01
Descriptives	15.3 (1.36)	16.5 (1.23)	12.8 (1.42)	12.28 (1.03)	17.50 (1.03)	13.92 (1.85)	16.61 (1.85)	10.5 (1.74)	22.5 (1.74)	12.3 (1.94)	13.9 (1.94)	1.86	.159	0.03	**12.8**	**<.001 *****	**0.10**	**5.57**	**.005 ****	**0.08**
Directives	3.10 (1.03)	4.86 (0.93)	3.96 (1.08)	4.26 (0.78)	3.68 (0.78)	4.72 (1.40)	1.48 (1.40)	5.47 (1.32)	4.24 (1.32)	2.6 (1.46)	5.33 (1.46)	0.86	.444	0.01	0.27	.603	0.01	2.42	.093	0.04
Questions	26.7 (1.73)	26.4 (1.56)	27.6 (1.81)	26.91 (1.31)	26.95 (1.31)	23.3 (2.35)	30.0 (2.35)	28.6 (2.21)	24.3 (2.21)	28.7 (2.46)	26.5 (2.46)	0.12	.884	0.02	0.01	.984	0.01	**3.34**	**.038***	**0.05**
Attention-getter	4.95 (1.22)	4.78 (1.10)	6.65 (1.28)	5.58 (0.93)	5.31 (0.93)	5.27 (1.66)	4.64 (1.66)	5.74 (1.56)	3.71 (1.56)	5.72 (1.73)	7.59 (1.73)	0.69	.502	0.01	0.04	.840	0.00	0.74	.478	0.01

Data are expressed as estimated marginal means (with standard errors in parentheses) for interval data.

* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

7.4. Discussion

Early caregiver-infant interactions play a key role for the infant's development and psychological health. One important aspect of dyadic interactions is represented by Infant-Directed Speech, which covers several developmental and affective functions, influencing infant's growth in several developmental trajectories and facilitating the establishment of positive relations between the infant and the caregiver.

Given the lack of studies on IDS in literature, the aim of this study was to contribute to enrich the literature on early father-infant interactions, exploring the characteristics of paternal language directed to the infant at the end of the first trimester postpartum in the case of full-term (FT) and preterm (PT) birth. Specifically, our purpose was to compare maternal and paternal speech in interaction with their infants, taking into consideration the possible impact of different levels of prematurity according to birth weight.

7.4.1. Lexical and syntactic features of maternal and paternal IDS at 3 months.

Considering lexical and syntactic features of IDS, a significant main effect of pa-rental role emerged for the number of word types and tokens produced, whereas no main effect of parental role was observed for the mean length of the utterance (MLU). Specifically, both word types and tokens, which reflect the number of different words produced and the speech amount addressed to the infant respectively, resulted to be significantly lower in fathers compared to mothers, regardless of the birth weight of their infants. These results highlight how, in our sample, paternal IDS was overall characterized by a lower lexical variability and verbosity compared to maternal one, suggesting that mothers tend to be more talkative than fathers during dyadic interactions. Conversely, the MLU was not different between mothers and fathers, suggesting similar degree of syntactic complexity in maternal and paternal speech. These findings are coherent with previous literature on parental IDS, which reported a higher amount of linguistic input produced by mothers compared to fathers in interactions with their babies as well as similar syntactic properties of maternal and paternal speech (i.e., Johnson et al., 2014; Kokkinaki et al., 2019).

Conversely, the main effect of birth weight did not seem to influence lexical and syntactic features of parental speech, as shown by the absence of statistically significant differences among groups in both the number of word types and tokens, as well as MLU. This finding is in line with previous studies which reported overall no or small differences in maternal IDS

addressed to their FT and PT infants in the first semester after birth (Suttora & Salerni, 2011; Spinelli et al., 2022; Provera et al., 2023). However, none of these studies explored the role of fathers and only one (Provera et al., 2023) investigated different levels of prematurity. Thus, our study confirms and extends these findings also to paternal speech, further comparing ELBW and VLBW infants.

Taken together, these results seem to suggest a certain degree of gender specificity lexical and syntactic registers directed to infant independently from birth weight, as emerged by the absence of a significant interaction effect between parental role and birth weight.

7.4.2. Functional features of maternal and paternal IDS at 3 months

Moving on functional features of IDS, we found a lower amount of descriptive utterances in paternal speech compared to maternal one. This result is coherent with previous studies.

Specifically, a study by Kokkinaki (2019) which investigated parental IDS from 2 to 6 months after birth, reported a higher amount of declarative utterances in mothers compared to fathers. Furthermore, another study by Venuti and colleagues (2012) found the same results in mothers and fathers of older children (2 to 4 years old) of typical and atypical development. We might hypothesize that this pattern could reflect a higher predisposition in mothers to describe to their infants the context in which the interaction is taking part. This tendency could reflect an aspect of parenting which is already present from early stages of development and that transcends infant's birth weight, as suggested by the absence of a significant main effect of birth weight. Interestingly, the significant interaction effect for which mothers of ELBW infants produced less descriptives compared to VLBW ones could reflect an adaptation of their speech which could be related to the birth condition of their infant. Indeed, severe preterm infants tend to produce less vocalizations compared to FT ones (Wolf et al., 2002; Janssens et al., 2009). It could be hypothesized that the perception of a higher immaturity of their infants, and probably also their greater passiveness during interactions, could lead mothers of more severe PT infants to recall more frequently their attention, rather than describing the surrounding environment, with the aim of eliciting their response. This hypothesis is somehow sup-ported by the higher, despite not significantly, proportion of attention getter produced by mothers of ELBW compared to VLBW ones.

A further significant effect emerged for the proportion of questions. In general, questions are a prominent type of utterance in both maternal and paternal IDS, especially in the first months

after birth. Consistent with existing literature, our sample showed also that questions were the second most common functional category used by parents, following affect-salient speech. In the present study we found a significant difference only in the comparison between FT mothers and FT fathers, where the first showed a higher number of questions than the latter. Since previous studies, differently to our findings, have found a similar number of questions produced by fathers and mothers of FT infants (Kokkinaki et al., 2019), our findings need further investigation.

Considering all the other functional features of IDS, our results revealed similar patterns in all dyads. In fact, both the proportion of affective contents, labels, directives, and attention-getter utterances did not significantly differ either according to parental role, birth weight, or their interaction. This homogeneous trend in the functional contents of IDS produced by mothers and fathers aligns with previous findings in the literature, which reported overall similar speech styles in both parents of FT infants (see for example Kokkinaki et al., 2019), extending these results also to the case of prematurity.

As previous mentioned, one of the most important aspects of IDS during the first phases of development is its affective connotation, which is crucial to convey and share affective contents with the infant, establish positive interactions and build secure attachment bonding (Stern et al., 1998; Trevarthen & Aitken, 2001). In our sample, almost half of the speech input produced by both mothers and fathers of the three groups was affect-salient speech, suggesting a similar tendency of both mothers and fathers to engage their infant in sensitive and attuned interactions, regardless of the infants' status. Conversely, the proportion of directive utterances was small and similar among parents of all the groups, suggesting the presence of low levels of intrusiveness in the speech style of both mothers and fathers, independently from the birth condition. Furthermore, the use of labels, which represents a subcategory of information-salient speech, usually becomes more frequent starting from the second year as the infant grows up and starts exploring and orienting his/her attention to the surrounding environment (for example, pointing or looking at the objects). In this sense, labelling objects becomes functional to scaffold infant's linguistic and vocabulary acquisition later in the development, whereas during the first half of the first year this category is usually less salient for the infant and less functional for the development of early relations (Bornstein et al., 1992). The absence of differences among parents and groups in the proportion of this functional category could suggest a certain capability to adapt the contents of speech

according to infant's age and level of development, which would express a sensitive approach towards infant's needs and capacities.

Taken together, the present study could suggest an overall adequate quality of the vocal interaction of all parents with their infants, regardless to parental role and birth weight.

In general, our study seemed to align with previous findings in the literature on maternal and paternal IDS, thus extending the knowledge on gender-related differences and similarities also to the PT population. Despite preliminary, these results should encourage to continue orienting research also on fathers and on the importance of their involvement in infant's caregiving as they play an important protective role to support early dyadic interactions.

Conversely, the absence of significant effect of preterm status, especially in case of severe prematurity, is not consistent with literature on maternal interactive behaviors and IDS at 3 months after the birth reported a significant effect of more severe premature birth, according to birth weight. Specifically, mothers of ELBW seemed to interact with their infants displaying more intrusive behaviors (Agostini et al., 2014; Neri et al., 2015) and less prototypical IDS patterns (Provera et al., 2023; 2024). However, when studies on interactive patterns considered both infant birth weight and parental role, other researchers did not find any significant effect of birth status on early interactive behaviors (Harrison & Magill-Evans, 1996; Hall et al., 2015; Neri et al., 2017) suggesting that the effect of prematurity could be less significant when parent gender is also considered. This finding underscores the importance of evaluating the parental dyad rather than focusing solely on the individual contributions of the mother or father.

Limitations and future directions

Some limitations should be discussed. First, the small sample size of our research makes difficult to generalize our results to the FT and PT populations. Even if recruiting parental dyads of both mothers and fathers could be challenging, further studies should enlarge the number of participants involved in order to possibly confirm the results of this study. Furthermore, our study is constrained by its focus on a single age point. Longitudinal studies are needed to explore the developmental trajectories of maternal and paternal IDS patterns directed to PT and FT infants.

Secondly, we controlled homogeneity for parental symptomatology among groups, but a specific effect on our dependent variables was not investigated, despite previous studies reported significant effects of maternal symptomatology on mothers' IDS (Provera et al., 2023;

2024). Related to this issue, the use of self-report could be not entirely suitable for identifying gender-related differences in the manifestation of postnatal depressive symptoms (Martin et al., 2013), especially for fathers' population.

Finally, our study is constrained by its focus on a single age point. Longitudinal studies are needed to explore the developmental trajectories of maternal and paternal IDS patterns directed to PT and FT infants.

Another important limitation to the generalization of our results is that they are referred only to the Italian linguistic and cultural context. However, since the cultural context of origin may influence how parental roles are expressed and, consequently, affect maternal and paternal interactive behaviors, it would be desirable in the future to conduct cross-cultural studies to explore the presence of similarities and differences related to both native language and cultural background. With regard to this last point, we would also highlight that the sole representation of the mother-father couple is not sufficient to describe the plurality of parental roles that exist in modern society. Today, there is an increasing variety of family structures, including, among others, single-parent and same-sex parent families. Although our study focused on moth-er-father parental couples, we believe it is becoming more important to extend research to these other family forms, in order to foster a deeper understanding of both the specificities and similarities that characterize the plurality of parenting experiences.

7.5. Conclusions

This study aimed to give a contribution in deepening the knowledge on the differences and similarities between maternal and paternal speech both in case of FT birth and PT one.

As previously discussed, results revealed overall small differences between mothers and fathers and among groups of PT and FT infants, also in case of more severe premature birth. Even if promising, we consider that our findings could be partially explained by considering the characteristics of data collection and recruitment of this research. In the case of PT groups, parents were both involved in a research and follow-up project which supports families of PT infants from birth to 24 months of corrected age, following and monitoring infant's development as well as parental well-being. We might hypothesize that the parents of preterm infants who agreed to participate in the study are inherently driven by a strong motivation, which could, in turn, reflect greater pa-rental sensitivity, as well as a higher attentiveness to the developmental needs of their children. All these aspects could constitute protective factors for the

establishment of positive dyadic interactions which in fact resulted to be, in our sample, similar to the ones found in FT dyads.

Besides these considerations, we hope that this study may contribute to underline two main aspects. The first one is the importance of including fathers in assessment programs and interventions, as they play a fundamental role in supporting infant's development and psychological health. To date, literature on IDS has mainly focused on maternal input, because mothers have historically been considered as "primary caregivers", whereas fathers have been for a long time considered as less involved in infant caretaking and thus less crucial in affecting infant's development. Consequently, the idea that mothers are more involved in infant's caring and fathers in working duties has been predominant, leading fathers to become less involved also in follow-up and research appointments both for working reasons and cultural ones (Cabrera et al., 2018; Ferjan Ramírez, 2022). Luckily, the spread of a more egalitarian perception of parental roles as well as scientific evidence of similar levels of sensitivity among mothers and fathers (Tamis-LeMonda et al., 2013) has contributed to orient the literature also on the paternal role and its importance for infant's development and well-being.

The second aspect is related to the importance of raising awareness and providing adequate training for hospital staff to foster an environment that supports early mother- and father-infant interactions. It is particularly crucial to recognize the significant role of maternal and paternal vocal input during the first period postpartum in order to develop programs of early interventions oriented in sustaining parenting roles and the development of a positive caregiver-infant bonding.

Conclusion

This study aimed to explore various dimensions of maternal and paternal speech input directed towards the infant in the context of preterm birth, in order to improve the understanding of the parents' interactive vocal behaviors.

The work began with three theoretical chapters that provided a framework for the topics under consideration. The first two chapters focused on preterm birth and its impact on infant development, as well as challenges which may characterize the transition to parenthood following a preterm birth, highlighting the potential consequences on maternal and paternal well-being, particularly regarding their affective states and levels of parenting stress, and the quality of early dyadic interactions between the infant and the caregiver. The third chapter introduced the central theme of the study, providing a comprehensive overview of Infant-Directed Speech and its distinctive features. It examined the linguistic and paralinguistic characteristics of this speech style and their role in fostering both infant's development and the instauration of positive early caregiver-infant relationships.

Subsequently, four empirical studies were conducted to investigate, from different perspectives, the effects of preterm birth, along with the presence of parental depressive symptoms and parenting stress, on the linguistic, functional, and prosodic characteristics of Infant-Directed Speech during the first months following birth. The first two studies explored the effects of maternal depressive symptoms and lower birth weight on the characteristics of Infant-Directed Speech towards full-term and preterm infants at 3 months postpartum. Both the two studies highlighted that in higher-risk conditions, such as when more negative maternal affective states are present or in cases of more severe prematurity, there may be greater difficulty in conveying affective contents to the infant during interactions. In contrast, a reduced affective salience in these interactions was associated with a more demanding interactive style, suggesting that these circumstances may impair the mother's ability to engage in sensitive interactions with the infant. The third study longitudinally examined the relationship between parenting stress and maternal Infant-Directed Speech during the first nine months postpartum. Findings revealed a similar effect of parenting stress symptoms and lower birth weight on mother-infant interactive patterns. Even more interestingly, a significant relationship emerged between parenting stress at three months and the quality of speech input at nine months. Various authors identify the first trimester postpartum as a critical period for the establishment of early forms of primary intersubjectivity between the caregiver and the infant.

Paying close attention to the quality of interactive exchanges during this time, as well as to emotional or stress-related difficulties in caregivers, may represent an important protective and preventive factor, helping to avoid the development of interaction patterns that might be less functional to foster the infant's development. Finally, the fourth study aimed to deepen the understanding of paternal Infant-Directed Speech, a topic that has been inconsistently addressed in the literature and, in our view, has not yet received sufficient attention. This study aimed to identify differences and similarities between maternal and paternal Infant-Directed Speech at three months postpartum, further considering the potential effect of premature severity on the base of birth weight. The results showed no substantial differences, except in verbosity and lexical variability. On the contrary, paternal Infant-Directed Speech was found to be emotionally similar to maternal speech, regardless of the infant's birth weight. This study underscores the need to further explore the paternal role in both developmental and relational terms. Particularly in the case of preterm birth, it highlights the importance of adopting monitoring and support approaches to parenthood that also include fathers as primary, rather than secondary, figures alongside mothers.

The present PhD project was developed in the context of the follow-up program developed by the Developmental Psychodynamic Laboratory of the Department of Psychology (University of Bologna) in collaboration with the Bufalini Hospital of Cesena (Italy). Consequently, the studies conducted within this project are subject to limitations in sample size, related to the number of infants who have accessed hospital services in recent years. Thus, one of the limitations of the studies included in this thesis is the relatively small sample size of participants recruited. In fact, although consistent with much of the recent literature on this topic, it limited our capacity to employ more complex research designs and data analysis that could incorporate a broader range of predictive variables. To address this limitation, the next phase of the research and follow-up project will focus on expanding the sample size, which will facilitate a more detailed examination of underexplored areas, such as, for example, the reciprocal influences between maternal and paternal interactive styles. Additionally, an increase in sample size will facilitate the analysis of longitudinal models to evaluate trajectories in parent-infant interaction patterns over the early years of life and to examine their relationship with developmental outcomes in later stages.

A second important limitation of these studies is represented by its exclusive focus on parental input, overlooking the dynamic interplay between caregiver and infant. As discussed in the third

chapter of this thesis, parent-infant interactive exchanges involve a co-construction of communication, in which each partner both influences and is influenced by the responses and cues provided by the other. While Infant-Directed Speech and its peculiar characteristics were central to the proposed studies, this focus might limit our understanding of the interaction as a bidirectional process. Future research should therefore consider the active contributions of the infant, such as vocalizations, gaze, and other responsive behaviors, as well as the complex dynamics of turn-taking that emerge during dyadic interactions. Incorporating these elements could allow for a more holistic description and perspective on caregiver-infant communication, clarifying how each partner's behaviors shape and are shaped by those of the other.

Another important limitation is represented by the use of self-report questionnaires as the only measure for screening postpartum symptoms. Although using these tools within a follow-up program reduces time and resource demands, we believe this approach may limit the instrument sensitivity and the depth and complexity of symptomatology captured. To address this limitation, future studies should consider integrating clinical and qualitative interviews into monitoring and follow-up protocols. This would enable a richer and deeper understanding of parental experiences, capturing subtleties and dimensions of symptoms that standardized tools alone might not detect. Moreover, although the tools employed during the follow-up program allowed for the detection of depressive symptoms and parenting stress only, the experience of parents of preterm infants may also be marked by elevated anxiety symptoms and, in some cases, even post-traumatic stress ones. Future studies aim to enrich the existing screening tools with additional instruments capable of identifying other symptom forms and manifestations of difficulty in adapting to the parental role. Such approach would provide a more comprehensive and detailed view of parental challenges, potentially improving support strategies and intervention outcomes.

As already reported in the limitations of the fourth study presented, an additional limitation of our research project is represented by the sole focus on mother-father parental couples. We would like to emphasize that this limited representation does not fully capture the diversity of parental roles in contemporary society. Family structures are increasingly varied and include single-parent, same-sex parent families, and other configurations. While our study focused on traditional mother-father couples, we recognize the growing need to extend research to these diverse family forms. Such an approach would allow us to gain a richer understanding of both the unique and shared aspects that shape the pluralism of parenting experiences across

different family structures.

Despite these limitations, the strengths of this work are considered to be threefold. First, it provided a multifaceted analysis of parental speech. Infant-Directed Speech is a simplified, yet complex register, characterized by specific modifications at both the linguistic and paralinguistic levels. This collection of studies aimed to capture part of this complexity by examining not only the linguistic dimension, but also the pragmatic functions, as well as the prosodic and acoustic profile of parental speech addressed to the infant. This comprehensive approach aimed to deeply investigate patterns of Infant-Directed Speech from multiple perspectives. A second strength consisted in the emphasis on the importance of differentiating between different levels of severity of prematurity when studying the population of preterm infants, in line with more recent literature developed by scientific research groups. By distinguishing between ELBW and VLBW infants, this work highlighted the different impacts that lower birth weight can have, both at the individual level and in relational dynamics. This differentiation is crucial for gaining a better understanding of the needs, vulnerabilities, and strengths of families with preterm infants. Furthermore, a deeper understanding of these specificities can contribute to the development of more tailored and effective support interventions for each unique situation.

Lastly, although it was the focus of only one study, another strength of this project could be represented by the contribution made to literature on fathers. As mentioned earlier, the follow-up service for families of preterm infants, promoted by the Psychodynamic Development Laboratory at the University of Bologna, attributed significant emphasis on the importance of involving both members of the parental dyad, when present. Our study may serve as a starting point for further research that could explore this topic more in depth, including later developmental stages and in relation to the presence or absence of emotional challenges in fathers. Thus, the goal of the present work, as well as future ones, is to develop an increasingly comprehensive and nuanced understanding of the dynamic which characterized infant-caregiver dyads, especially following a preterm birth, capturing the complexities of these early relationships and their implications over time.

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Appendix A – Edinburgh Postnatal Depression Scale

Cox et al., 1987; Italian validated version by Benvenuti et al., 1999.

Le chiediamo gentilmente di rispondere a questo questionario, barrando la risposta che meglio descrive come si è sentita durante questi ultimi 7 giorni e non solo oggi.

Durante questi ultimi sette giorni:

1. Sono stata capace di ridere e di vedere il lato buffo delle cose

- ☐ Come facevo sempre
- ☐ Adesso, non proprio come al solito
- ☐ Adesso, decisamente un po' meno del solito
- ☐ Per niente

2. Ho guardato con gioia alle cose future

- ☐ Come ho sempre fatto
- ☐ Un po' meno di quanto ero abituata a fare
- ☐ Decisamente meno di quanto ero abituata a fare
- ☐ Quasi per nulla

3. Mi sono incolpata senza motivo quando le cose andavano male

- ☐ Sì, il più delle volte
- ☐ Sì, qualche volta
- ☐ Non molto spesso
- ☐ No, mai

4. Sono stata preoccupata o in ansia senza un valido motivo

- ☐ No, per niente
- ☐ Quasi mai
- ☐ Sì, qualche volta
- ☐ Sì, molto spesso

5.Ho avuto momenti di paura o di panico senza un valido motivo

- ☐ Sì, moltissimi
- ☐ Sì, qualche volta
- ☐ No, non molti
- ☐ No, per niente

6. Mi sentivo sommersa dalle cose

- ☐ Sì, il più delle volte non sono stata affatto capace di far fronte alle cose
- ☐ Sì, qualche volta non sono stata capace di far fronte alle cose bene come al solito
- ☐ No, il più delle volte ho fatto fronte alle cose bene
- ☐ No, sono riuscita a fronteggiare le situazioni bene come sempre

7. Sono stata così infelice che ho avuto difficoltà a dormire

- ☐ Sì, il più delle volte
- ☐ Sì, qualche volta
- ☐ Non molto spesso
- ☐ No, per nulla

8. Mi sono sentita triste o infelice

- ☐ Sì, il più delle volte
- ☐ Sì, abbastanza spesso
- ☐ Non molto spesso
- ☐ No, per nulla

9. Sono stata così infelice che ho perfino pianto

- ☐ Sì, il più delle volte
- ☐ Si, abbastanza spesso
- ☐ Solo di quando in quando
- ☐ No, mai

10. Il pensiero di farmi male mi è passato per la mente

- ☐ Sì, molto spesso
- ☐ Qualche volta
- ☐ Quasi mai
- ☐ Mai

Appendix B – Parenting Stress Index - Short Form

Abidin,1995; Italian validated version by Guarino et al., 2005

1. Spesso ho la sensazione di non riuscire a far fronte molto bene alle situazioni	FA	A	I	D	FD
2. Per venire incontro ai bisogni di mio/a figlio/a mi accorgo di sacrificare la mia vita più di quanto mi aspettassi	FA	A	I	D	FD
3. Mi sento intrappolato/a dalle mie responsabilità di genitore	FA	A	I	D	FD
4. Da quando ho avuto questo/a figlio/a non riesco a fare cose nuove e diverse	FA	A	I	D	FD
5. Da quando ho avuto questo/a figlio/a mi rendo conto che quasi mai riesco a fare le cose che mi piacciono	FA	A	I	D	FD
6. Non sono soddisfatto/a dell'ultimo acquisto di abbigliamento che ho fatto per me	FA	A	I	D	FD
7. Ci sono un bel po' di cose della mia vita che mi disturbano	FA	A	I	D	FD
8. Aver avuto un/a figlio/a ha causato, nel rapporto con mio/a marito/moglie (o con il partner), più problemi di quanto mi aspettassi	FA	A	I	D	FD
9. Mi sento solo/a e senza amici	FA	A	I	D	FD
10. Quando vado ad una festa di solito mi aspetto di non divertirmi	FA	A	I	D	FD
11. Non sono così interessato/a alla gente come lo ero una volta	FA	A	I	D	FD
12. Non mi diverto più come una volta	FA	A	I	D	FD
13. Mio/a figlio/a raramente fa per me cose che mi gratificano	FA	A	I	D	FD
14. A volte sento di non piacere a mio/a figlio/a e che lui/lei non vuole stare vicino a me	FA	A	I	D	FD
15. Mio/a figlio/a mi sorride molto meno di quanto mi aspettassi	FA	A	I	D	FD
16. Quando faccio le cose per mio/a figlio/a ho la sensazione che i miei sforzi non siano molto apprezzati	FA	A	I	D	FD
17. Quando mi/a figlio/a gioca non ride né mostra di divertirsi spesso	FA	A	I	D	FD
18. Mio/a figlio/a non sembra imparare così velocemente come la maggioranza dei bambini	FA	A	I	D	FD
19. Mio/a figlio/a non sorride tanto quanto la maggioranza dei bambini	FA	A	I	D	FD
20. Mio/a figlio/a non riesce a fare tanto quanto mi aspettavo	FA	A	I	D	FD
21. Ci vuole molto tempo ed è molto difficile per mio/a figlio/a abituarsi alle novità	FA	A	I	D	FD

In relazione alla prossima affermazione, scelga una sola risposta tra le alternative da "1" a "5" qui di seguito indicate. 22. **Sento di essere** 1. non molto bravo/a come genitore 2. una persona che ha qualche problema ad essere genitore 3. un genitore medio 4. un genitore al di sopra della media 5. un genitore molto bravo	1	2	3	4	5
23. Mi aspettavo di provare per mio/a figlio/a sentimenti di maggior calore e vicinanza di quelli che provo e questo mi dispiace	FA	A	I	D	FD
24. Talvolta mio/a figlio/a fa cose che mi disturbano, solo per farmi dispetto	FA	A	I	D	FD
25. Mio/a figlio/a sembra che pianga o si agiti molto più di della maggioranza dei bambini	FA	A	I	D	FD
26. Mio/a figlio/a di solito si sveglia di cattivo umore	FA	A	I	D	FD
27. Ritengo che mio/a figlio/a sia facilmente irritabile e di umore variabile (lunatico/a)	FA	A	I	D	FD
28. Mio/a figlio/a fa alcune cose che mi infastidiscono molto	FA	A	I	D	FD
29. Mio/a figlio/a reagisce duramente quando succede qualcosa che non gli/le piace	FA	A	I	D	FD
30. Mio/a figlio/a rimane facilmente male per le più piccole cose	FA	A	I	D	FD
31. I ritmi del sonno e dell'alimentazione di mio/a figlio/a sono stati molto più difficili da regolare di quanto mi aspettassi	FA	A	I	D	FD
In relazione alla prossima affermazione, scelga una sola risposta tra le alternative da "1" a "5" qui di seguito indicate. **32. Mi sono reso/a conto che convincere mi/a figlio/a a fare qualcosa o a smettere di fare qualcosa è:** 1. molto più difficile di quanto mi aspettassi *2. un po' più difficile di quanto mi aspettassi* *3. all'incirca difficile come mi aspettavo* *4. un po' più facile di quanto mi aspettassi* *5. molto più facile di quanto mi aspettassi*	1	2	3	4	5
In relazione alla prossima affermazione, scelga la risposta tra le alternative da "+ 10" a "1-3". **33. Pensi con attenzione e conti il numero di cose che Suo/a figlio/a fa e che La infastidiscono (ad esempio: perde tempo, si rifiuta di ascoltare, è troppo attivo/a, piange, interrompe, fa le lotte, fa a pugni, piagnucola, ecc.)**	+10	8-9	6-7	4-5	1-3
34. Alcune cose che fa mio/a figlio/a mi infastidiscono veramente molto	FA	A	I	D	FD
35. Mio/a figlio/a si è dimostrato/a un problema più grande di quanto mi aspettassi	FA	A	I	D	FD

36. Mio/a figlio/a mi chiede di più della maggior parte dei bambini	FA	A	I	D	FD

FA = Fortemente d’accordo

A = D’accordo

I = Nè d’accordo nè in disaccordo

D = In disaccordo

FD = Fortemente in disaccordo