The influence of gestational age on social attention and language in the second year of life

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Summary

Premature birth is common worldwide and does not show signs of decreasing. In rich countries, assisted reproductive techniques contribute to maintain the rate high. Infants born prematurely are more at risk for a series of complications that could affect their cognitive and emotional performances well into teenage years and adulthood.

Research on premature delivery is complicated by a series of methodological difficulties and is still largely based on data collected decades ago, when medical procedures in the neonatal units were different. Moreover, the development of socio-cognitive abilities in infants born preterm, in particular concerning moderate to late prematurity, is still understudied.

The Special Delivery study was set up to address these gaps in the literature, through a short-term longitudinal study. A multi-method approach provided tools to explore different cognitive and social abilities from birth up to 24 months of age. Infants born at extremely low gestational ages and with complicated medical situations were excluded, in order to better explore the influence of prematurity alone.

This thesis focuses on social attention and language between 13 and 24 months. Infants born preterm showed a delay in language abilities at 18 and 24 months and gestational age correlated positively with both receptive and expressive vocabulary size at both ages. Also some social attention behaviours were affected by prematurity. In particular, responding to joint attention and initiating behavioural request had lower scores in the preterm born sample, while initiating joint attention had no relation with the participants' birth status. With regard to the relation between social attention and language, the effect of gestational age on receptive vocabulary at 24 months was completely mediated by responding to joint attention skills at 13 months. It was concluded that prematurity in a healthy sample affects mainly responding to joint attention, which in return has a negative impact on subsequent language development.

DECLARATION

This work has not been submitted in substance for any other degree or award at this or any other university or place of learning, nor is being submitted concurrently in candidature for any degree or other award.

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This thesis is being submitted in partial fulfilment of the requirements for the degree of …………………………(insert MCh, MD, MPhil, PhD etc, as appropriate)

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STATEMENT 2

This thesis is the result of my own independent work/investigation, except where otherwise stated.
Other sources are acknowledged by explicit references. The views expressed are my own.

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Man is by nature a social animal;
an individual who is unsocial naturally and not accidentally
is either beneath our notice or more than human.
Society is something that precedes the individual.
Anyone who either cannot lead the common life or is so self-sufficient as not to need to,
and therefore does not partake of society,
is either a beast or a god.

– Aristotle, Politics

Truly wonderful the mind of a child is.

– Yoda

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The project came from the initial interest and efforts of another person, PhD student at the time I joined the Cardiff lab. I thank Alice Winstanley for conveying to me the importance of our study and inspiring me to always do better through her passion, dedication and precision. I truly thank her for the thousands of hours of shared work, for her support in my first months of life abroad and also later. My thesis would have surely not been possible without her constant help and her statistical wisdom. I thank my dear office mate Sita Deeg, for infinite interesting conversations on languages, cultures, statistics and crafts. Difficult days became lighter with her company. It would have not been the same without Kate Ellis-Davies and Katherine Scott, whose active presence would always shake the quiet lab. Their tirelessness was only matched by their cheerfulness.

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Thanks to Antonio for most of the reasons already listed here, everything else, and more.

List of content

Preface[1]

Infants born prematurely show developmental delays and differences in multiple cognitive domains when compared with infants born at term (Aylward, 2005; Teune et al., 2011). The degree of prematurity contributes to influence which domains are compromised, as well as the severity of the delay, with infants born at earlier gestational ages (i.e., before 32 weeks of gestation) showing worse outcomes (Aylward, 2005; Larroque et al., 2008; Luciana, 2003; Saigal & Doyle, 2008; Sansavini, Savini, et al., 2011; Zeitlin et al., 2008). Research showed that these infants' cognitive, motor and emotional development often presented a collection of issues (Aylward, 2002a, 2005) that could persist until later on in life (Bhutta, Cleves, Casey, Cradock, & Anand, 2002; Larroque et al., 2008; Lee, Yeatman, Luna, & Feldman, 2011; Lind et al., 2011), even until adulthood (Saigal & Doyle, 2008; Zwicker & Harris, 2008). In particular, premature infants born at earlier gestational ages show a higher than normal incidence of visual attention difficulties (Harel, Gordon, Geva, & Feldman, 2011; Reuner, Weinschenk, Pauen, & Pietz, 2014), language problems (Foster-Cohen, Edgin, Champion, & Woodward, 2007; Guarini et al., 2009; Kern & Gayraud, 2007; Luoma, Herrgård, Martikainen, & Ahonen, 1998; Sansavini et al., 2010; Sansavini, Guarini, et al., 2011), disorders belonging to the autism spectrum (Gray, Edwards, O'Callaghan, & Gibbons, 2015; Samantha Johnson & Marlow, 2011; Kuzniewicz et al., 2014), social-emotional and behavioural problems (Clark, Woodward, Horwood, & Moor, 2008; Delobel-Ayoub et al., 2006; Spittle et al., 2009) as well as disruptions in visual engagement during social interactions (De Groote, Roeyers, & Warreyn, 2006; De Schuymer, De Groote, Desoete, & Roeyers, 2012; Harel et al., 2011; Imafuku et al., 2016).

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[1] The literature searches for this thesis have been carried out on multiple search engines (i.e., Web of Science, PubMed, Google Scholar). The keywords 'preterm' or 'premature' were accompanied by keywords specific to the topic discussed in each section. To ensure that the included literature was up to date, each search was repeated twice: once including papers from all years and once including only

Taken all together, these adverse outcomes could point towards an atypical functioning of social cognition skills. In fact, visual attention, social engagement and language have been shown to depend on each other for optimal development in the typically developing population (Brooks & Meltzoff, 2005; Carpenter, Nagell, Tomasello, Butterworth, & Moore, 1998; Charman et al., 2000; Daum, Ulber, & Gredeback, 2013; Delgado et al., 2002; Gliga & Csibra, 2009; Morales et al., 2000; Mundy & Gomes, 1998; Mundy & Jarrold, 2010), as well as in subjects on the autistic spectrum (Charman, 2003; Mundy, 2003; Mundy, Sullivan, & Mastergeorge, 2009). Instead of considering each adverse outcome in isolation, investigating their mutual interdependence could help reinterpreting the problems typically shown by these infants (i.e., visual attention, social engagement and language development). A few studies begun to explore these links in infants born preterm, reporting relations across skills similar to those in the term population (De Schuymer, De Groote, Beyers, Striano, & Roeyers, 2011; Olafsen et al., 2006). Looking at the various negative outcomes as related and based on skills potentially dependent on each other for development could help understanding the roots of developmental delays in the preterm population. Moreover, if the same type of relation across these skills is present in the preterm population as it is in the normal and autistic populations, the discovery could help easing the families' approach to these issues, as well as help designing more specific interventions and support activities. In fact, if negative outcomes are related, by working on one or a small subset of skills, one could improve performance also on the others. For example, interventions could focus on improving early socio-cognitive behaviours (i.e., gaze following) in order to improve more complex behaviours and skills down the road (i.e., vocabulary size).

Moreover, detailing the relations between early gaze following, joint attention, imitation and language development in an atypical population, would deepen the current knowledge on how these skills interact and influence each other during typical development. By comparing the present results with research on both typically and other atypically developing infants, one could find shared and unshared features of socio-cognitive skills' emergence and characteristics. How prematurity could affect social cognitive abilities is still unclear, but there are results showing that different brain structures are often affected by prematurity (Inder, Warfield, Wang, Hüppi, & Volpe, 2005; Lowe et al., 2011; Mewes et al., 2006; Smyser et al., 2010). One could hypothesise that these structural differences are amongst the causes for the developmental differences between the preterm and the term populations. Alternatively - or additionally - one could consider the environmental elements surrounding premature birth as more relevant for the atypical development of these infants' socio-cognitive skills. The Special Delivery project, as well as this dissertation, focuses on the environmental elements and their role as either a risk or protective factor.

However, when studying this population, it is difficult to disentangle the outcomes due to the medical sequelae of prematurity to the ones due to prematurity itself. Brain lesions, sensory impairments, higher sensitivity to infections, respiratory problems and internal organs deficiencies that require potentially long hospital stays post birth are very common in the preterm population born at early gestational ages (Aylward, 2005; Luciana, 2003; Saigal & Doyle, 2008; Zeitlin et al., 2008). This highlights the need for investigating social cognition in preterm infants born after 32 weeks of gestation. The medical situation characterising infants born at later rather than earlier gestational ages is often less problematic (Engle, 2011; Engle, Tomashek, & Wallman, 2007; Escobar, McCormick, et al., 2006; Escobar, Clark, & Greene, 2006; Saigal & Doyle, 2008; Teune et al., 2011). Therefore, a limited number of confounding factors would impact the assessment of prematurity's effect on socio-cognitive skills' development. However, even showing fewer negative outcomes compared to infants born at earlier gestational ages, premature infants born after 32 weeks do show language difficulties (Cusson, 2003; De Schuymer et al., 2011; Guarini et al., 2009). It is therefore relevant to investigate these infants' socio-cognitive skills. Additionally, even if premature infants born at earlier gestational ages have been the focus of more research in the past decades because of their higher risk of mortality and serious morbidity (Engle et al., 2007; Escobar, McCormick, et al., 2006), premature births after 32 weeks of gestation are more common (Davidoff et al., 2006; Goldenberg, Culhane, Iams, & Romero, 2008; Kramer et al., 2000). Research on premature infants born at later gestational ages is therefore very relevant for health care, families, education and society in general (Engle et al., 2007; Escobar, McCormick, et al., 2006; Wang, Dorer, Fleming, & Catlin, 2004). Lastly, as it has been recently shown, infants born in the first weeks after term can present some adverse outcomes compared to infants born later (Engle, 2011; Jean-Bernard Gouyon et al., 2010; Madar, Richmond, & Hey, 1999). Expanding the research on the whole spectrum of gestational ages, instead of focusing it at the extremes can help providing a more detailed and clear picture of the relation between length of gestation and features of the subsequent development of socio-cognitive skills.

All these considerations constitute the theoretical rationale on which this dissertation is based. Social cognition skills, as shown by studies on both typically and atypically developing populations, depend on each other to properly develop. Since infants born prematurely show difficulties in some of these skills, it is important to systematically investigate all of them, while considering them as related. This could help us to better understand the causes and consequences of impaired performances in one or more of these skills and how they affect each other. In particular, exploring these topics on premature infants born at later gestational ages, could help disentangling the issues due to problems usually attached to prematurity from those due to prematurity itself. Additionally, by testing infants born at all gestational ages higher than 32 weeks -instead of dichotomising the preterm and term born groups by excluding infants born across the 37 weeks mark - the degree of prematurity's impact on the performance is investigated more clearly.

Methodologically, the study posed an issue that has theoretical ramifications. The difference between the expected end of the pregnancy and the earlier actual date of birth of a preterm infant, gives researchers the opportunity to make a fundamental choice between two options, each one with its own strengths and weaknesses. In order to schedule the timing of testing sessions, the age of infants born preterm could be calculated based either on the actual date of birth (chronological age), or on the expected date of birth (corrected age). Therefore, when testing a skill, one could focus more on the role of time and experience in mastering the skill, or on the role of biological development. In the first case, infants born preterm can be compared to infants born at term based on their actual date of birth (i.e., they have been born around the same time): the two groups have benefited from the same amount of time to develop a skill and eventual differences cannot be attributed to differences in amount of experience. In the second case, infants born preterm can be compared to infants born at term based on their expected date of birth (i.e., they have been conceived around the same time): the two groups are composed by infants with a similar degree of biological development and eventual differences cannot be attributed to biological immaturity. Of course both approaches lend themselves to criticisms and have intrinsic limitations, but at the same time they each have strengths that contribute to build a more thorough picture of premature, as well as typical, development (Lems, Hopkins, & Samsom, 1993; Wilson & Cradock, 2004). In fact, by being able to separate two of the major elements that constitute development itself - experience and biological maturation - research on prematurely born infants can better investigate their respective contribution. In the

Special Delivery study, all participants were tested based on their chronological age, therefore stressing the role of experience over biological maturation in the acquisition and mastering of socio-cognitive skills. Since this set of skills is intrinsically relational, the importance of the amount of time spent outside of the womb, directly experiencing those relations, was deemed as more relevant. This choice stands in contrast to what has been the most common standard in research in the past decades. In fact, most studies chose to compare preterm and term born infants based on their expected date of birth (corrected age), focusing more on the importance of biological maturation - due also to the higher number of studies on preterm infants born at earlier rather than later gestational ages.

Another main theoretical theme of this dissertation is the way in which socio-cognitive skills' develop and become available to infants. There are different views on the role of the experience that infants accumulate in the first months of life with regard to the flourishing of social communication happening around their first birthday. Some think that the skills demonstrated by infants before the 9 months mark are the necessary basis for the development of a more sophisticated view of the underlying cognitive processes embedded in every social interaction, therefore contributing to the emerging of the view that other people are intentional beings (Mundy, 2003; Mundy, Card, & Fox, 2000; Mundy & Jarrold, 2010; Striano & Rochat, 1999). Others think that, although related, the social communication behaviours that infants master before the 9 months mark are only a primitive version of the ones available after the understanding that others are intentional beings (Carpenter et al., 1998; Tomasello, 1995, 1999; Tomasello & Carpenter, 2007; Tomasello, Carpenter, Call, Behne, & Moll, 2005; Tomasello & Rakoczy, 2003). The theoretical background on which this dissertation was built follows the idea that infants begin building their socio-cognitive skills well before they are 9 months old, by acting and reacting to the world and people around them.

Moreover, by exploring how these abilities emerge in a population whose experience and biological maturation interact differently compared to a normally developing population, this theoretical issue was explored from a particular point of view.

In conclusion, this dissertation reports part of the findings from the Special Delivery project, which had broader aims than the ones described here. This dissertation focuses on the investigation of a particular set of skills and their development during the second year of life in infants born both prematurely and at term. The ability of these infants to follow gaze, to share attention and to develop language skills was explored through different experimental tasks and questionnaires administered longitudinally over a period of 11 months (from 13 to 24 months of age). The two groups of participants were compared in order to find any discrepancies in their developmental pathways and to assess how the emerging of the different socio-cognitive skills was related to prematurity.

Summary of the dissertation

This dissertation includes a subset of the data collected during the Special Delivery project, in order to explore the theoretical issues discussed above. In particular, this dissertation focuses on joint attention abilities during the second year of age and covers the relation between the development of joint attention and language between 13 and 24 months.

The dissertation begins with a general introduction covering a range of theoretical and methodological themes related to the Special Delivery project in general and the tasks here included in particular. The first section of the introduction defines prematurity, its epidemiology, morbidity and mortality. The reader is presented with details on how frequent a premature birth is and in particular how many of these births happen towards the later gestational weeks of prematurity. Additionally, a picture of the consequences of preterm birth, especially with regard to the negative outcomes in cognition, language and social cognition, stresses the relevance of this research project. The second section defines a series of fundamental behaviours and related cognitive processes involved in social attention, and how these behaviours become available to infants during their first and second year of life. Two different and contrasting theoretical frameworks are described, introducing one of the main aims of this dissertation. By exploring how social cognition and language emerge, in fact, the present work aimed to add some new findings to the debate.

The second chapter focuses on methodology and is divided into four sections. The first one describes the Special Delivery study and gives an overview of its different aims, with details on some methodological choices made for achieving them. The second section specifies which parts of the general study have been carried out by me and which parts are included in this dissertation. The third section reports all the methodological details on participants' recruitment and data collection. Here is also explained one of the main choices that characterised the study: the choice of calculating the participants' age based on their actual date of birth both for infants born preterm and at term. Finally, the last section of this chapter presents the participants' samples, including some demographical and medical data.

The following three chapters report data from the study: chapter three focuses on joint attention skills, chapter four on language skills and chapter five on the relations between participants' performance in joint attention and language abilities. Each chapter provides an introduction on the previous literature reporting on premature infants' performance in these skills, while the background on normally developing infants' performance was provided in the first chapter.

Finally, the sixth chapter summarises all the conclusions from the results presented in this dissertation and brings them together to describe the general findings. Moreover, limitations and problems with the tasks here included are discussed. Possible additions to the studies and future directions are also reported.

Chapter 1 - General introduction

1.1 Introduction

This chapter introduces the reader to the main topics of this thesis by posing two questions: “what is preterm birth?”, “what is social attention?”. These themes are defined and described through the work of other researchers. Given the nature of these topics, contributions from different approaches (i.e., developmental, cognitive and neurocognitive psychology, as well as neonatology) are included in order to better understand the features of the questions and their implications.

1.2 What is preterm birth?

1.2.1 Defining prematurity

Since mortality and morbidity factors depend also on fetal and neonatal maturation, having an accurate way of assessing prematurity is important to provide better care for pregnant women, make better decisions regarding the delivery, as well as to offer more help to new mothers and infants (Engle, 2006). Defining prematurity is therefore not only an exercise for researchers, but has a direct impact on the population.

The first definitions of prematurity from the 19th century, as well as the one from 1948 by the first World Health Assembly, relied on birthweight: an infant was considered “premature” or “immature” if born with a birthweight of 2,500 grams (5 pounds, 8 ounces) or less (Zegers-Hochschild et al., 2009). The use of birthweight as a proxy measure for prematurity, however, has always been too sensitive and not specific enough: it identifies a very heterogeneous group and misses many preterm infants. For example, it can include infants who had abnormal fetal umbilical arterial blood flow patterns (fetal growth restriction), but who do not share the same risks as infants who have a low weight because born preterm (Engle, 2006). Moreover, birthweight seems to be more an associated risk factor, rather than a primary risk factor when considering preterm birth: being born early, an infant is exposed to an extrauterine life for which he is not fully prepared, while being born with a small size, within the range of normality, does not pose physiological obstacles to a typical development (A. J. Wilcox, Weinberg, & Basso, 2011).

The Committee on the Fetus and Newborn of the American Academy of Pediatrics (2004) defines gestational age (or menstrual age) as the time between the first day of the last normal menstrual period and the delivery day. Often the labels gestational age and conceptional age are used interchangeably, however they usually vary by 2 weeks (Engle, 2006).

Unfortunately, given the easiness of recording birthweight compared to gestational age, due to the possible lack of precision regarding the date of the mother's last menstrual period and other factors (see section 2.4.2), this measure has been largely used for decades and is still present today, even though not as frequently as in the past. Stressing the benefits of using gestational age to classify infants to better identify possible medical problems, Battaglia and Lubchenco (1967) designed a system which included both factors. Infants were therefore classified in 9 different groups: 3 gestational age groups (Pre-Term, Term and Post-Term) with each one having 3 birthweight subgroups (Large, Appropriate and Small for Gestational Age).

Gestational age is conventionally expressed in completed weeks[2] (i.e., an infant born at 34 weeks - 34^{+0} - is defined as "born at 34 completed weeks"; also, an infant born at 34 weeks plus 3 days - 34^{+3} - is considered a 34 weeks infant) (Committe on Fetus and Newborn, 2004).

Thirty-seven completed weeks of gestation is the boundary between Term and Pre-Term birth established by the Committee on the Fetus and Newborn of the

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[2] The literature sometimes lacks clarity as to what the authors of a single paper define as *completed weeks*, as the expression is at times interpreted as +6 days and so 34 completed weeks is wrongly interpreted as 34^{+6}, while in reality it refers to 34^{+0} (Chabra, 2012). Due to this confusion, and not knowing what other researchers were exactly referring to, throughout this thesis gestational ages are described as they were in the original papers, using either the number of weeks and days (i.e., 38^{+5}) or the expression "completed weeks". Referring to the new data presented here, the number of weeks and days is always specified.

American Academy of Pediatrics (i.e., birth at 36 weeks and 6 days - 36^{+6} - would be considered Pre-Term; birth at 37 weeks and 0 days - 37^{+0} - would be considered Term), which considered 2 weeks as a reasonable error in estimating gestation. In the same way, the Post-Term birth label is used for infants born after 42 completed weeks of gestation ($\geq 42^{+0}$) (Committee on Fetus and Newborn American Academy of Pediatrics, 2004). This classification is still used today and has been further refined. Unfortunately there are very frequent variations that contribute to the methodological confusion and inconsistency present in the field. The International Committee for Monitoring Assisted Reproductive Technology (ICMART) and the World Health Organization (WHO) revised the glossary (see Table 1.1) of assisted reproductive technology (ART) in 2009, hoping to standardise some definitions and create more consensus across studies and interventions worldwide (Zegers-Hochschild et al., 2009).

Table 1.1
Definitions from the International Committee for Monitoring Assisted Reproductive Technology (ICMART) and the World Health Organization (WHO) (Zegers-Hochschild et al., 2009).

Label	Definition
Extremely low birthweight	birthweight less than 1000 g
Very low birthweight	birthweight less than 1500 g
Low birthweight	birthweight less than 2500 g
Small for gestational age	birthweight less than 2 standard deviations below the mean or less than the 10th percentile according to local intrauterine growth charts
Extremely preterm birth	a live birth or stillbirth that takes place after 20 but before 28 completed weeks of gestational age
Very preterm birth	a live birth or stillbirth that takes place after 20 but before 32 completed weeks of gestational age
Preterm birth	a live birth or stillbirth that takes place after at least 20 but before 37 completed weeks of gestational age
Full-term birth	a live birth or stillbirth that takes place between 37 and 42 completed weeks of gestational age
Post-term birth	a live birth or stillbirth that takes place after 42 completed weeks of gestational age

Engle (2006) strongly advocated the use of standardised definitions, especially when referring to infants born “late preterm”. A higher level of agreement is present for the major categories of gestational age (i.e., extremely preterm, preterm, term, post-term), but a range of labels has been used to refer to infants born between 32 and 37 weeks of gestation: late preterm, marginally preterm, moderately preterm, minimally preterm, mildly preterm, near term, early term. Engle (2006) considers the last two particularly misleading for care practice decisions, since they attribute a healthy-sounding name to a population with higher risks.

The classification that overlaps with the majority of the recent literature, and which guided the present thesis, is shown in Figure 1.1.

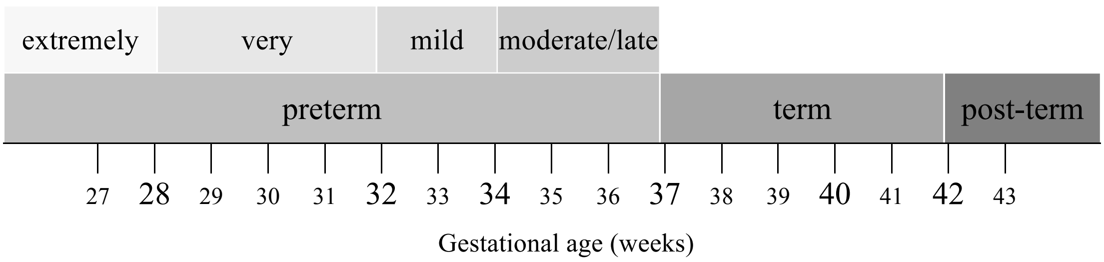

Figure 1.1. Common classification based on gestational age (GA) at birth, focusing on preterm births. The expected date of birth is at 40^{+0} weeks.

Since research has identified that neonatal outcomes, especially respiratory morbidity, vary depending on the timing of delivery also within the term weeks range (Engle, 2011; Jean-Bernard Gouyon et al., 2010; Madar et al., 1999), the need to characterize the 5-weeks term range ($37^{+0} \leq GA \leq 41^{+6}$) more in detail has also emerged. A work group recommended to replace the label Term with three different ones: Early term, 37^{+0} through 38^{+6} weeks; Full term, 39^{+0} through 40^{+6} weeks; and Late term, 41^{+0} through 41^{+6} weeks. The label Post term remains to indicate births at 42^{+0} weeks and beyond (The American College of Obstetricians and Gynecologists Committee on Obstetric Practice, 2013).

Although it does not directly relate to the scope of this thesis, it seems worthwhile noting that the other end of the gestational age spectrum – as opposed to post term birth – has an undefined cut-off. In fact, the distinction between preterm birth and spontaneous abortion varies depending on the country (Goldenberg et al., 2008). A review comparing international practices in 2008 concluded that the threshold of viability is generally set at ≥25 weeks, compassionate care is employed at ≤22 weeks, and different variables influence a more individual approach between 23 and 24 weeks of gestation (Pignotti & Donzelli, 2008).

1.2.2 Epidemiology

Estimates from a systematic review showed that 9.6% of all births worldwide were preterm in 2005, meaning 12.9 million preterm births, with the majority (85%) concentrated in Africa and Asia. Africa had the highest rate (11.9% of births were preterm), followed by North America (10.6%), while Europe had the lowest rate (6.2%) (Beck et al., 2010).

In England and Wales, in 2012, 7.1% of births were premature (*Gestation-specific infant mortality, 2012*, 2014). In England, between 2013 and 2014, 7.4% of all live births, therefore ~51,700 per year, suffered from complications relating to short gestation and low birth weight (*NHS Maternity Statistics – England, 2013-14*, 2015). In Europe, between 1996 and 2008, preterm birth rate increased in most countries, although trends were highly heterogeneous across countries and were influenced by type of pregnancy (i.e., singleton vs. multiple), gestational age group and type of labour onset (i.e., spontaneous vs. non-spontaneous) (Zeitlin et al., 2013). In the USA, the rate of preterm birth has been increasing by more than one third from 1981 to 2006, but since then has been declining for five straight years, being 11.71% of all USA births in 2011 (B. E. Hamilton, Hoyert, Martin, Strobino, & Guyer, 2013).

Looking at the frequency of occurrence according to gestational age, from an analysis of American and Canadian birth cohorts around 1985 and 1995, Kramer and colleagues (Kramer et al., 2000) reported that mild and moderate prematurity (between

32 and 36 weeks of gestation) accounted for ~80% of all premature births. A similar result was found looking at singleton birth rates in the USA in 1992 and then in 2002: preterm infants born after 34 weeks were the fastest-growing group, accounting for 74% of all singleton preterm births (Davidoff et al., 2006). Research published in 2008, which investigated preterm birth in developed countries, showed that about 5% of preterm births occur at less than 28 weeks, about 15% at 28–31 weeks, about 20% at 32–33 weeks, and 60–70% at 34–36 weeks of gestation (Goldenberg et al., 2008), therefore maintaining the same trend as North America a decade earlier.

Multiple conditions and mechanisms usually initiate preterm labour and in most cases a single cause cannot be established (for reviews see Goldenberg et al., 2008; A. J. Wilcox et al., 2011). Causes of preterm delivery include: maternal complications (i.e., severe maternal hypertension, maternal diabetes), endangered fetal wellbeing leading to an induced birth (i.e., intrauterine growth restriction) and placental abruption (i.e., due to infection or cervical anomalies) (for reviews see Engle, 2011; Goldenberg et al., 2008; Moutquin, 2003; A. J. Wilcox et al., 2011). Spontaneous preterm birth is more common if the pregnancy arises with a short interval from a previous pregnancy (Conde-Agudelo, Rosas-Bermúdez, & Kafury-Goeta, 2006), if the mother previously had another preterm baby (Ananth, Getahun, Peltier, Salihu, & Vintzileos, 2006; Mercer et al., 1999), has a low pre-pregnancy body mass index (Hendler et al., 2005; Neggers & Goldenberg, 2003; Nohr et al., 2007), has a lower rate of weight gain during pregnancy (Carmichael & Abrams, 1997; Nohr et al., 2007), is experiencing a strenuous physical workload and/or stress, or is abusing cigarettes or drugs (for reviews see Engle, 2011; Goldenberg et al., 2008; Luciana, 2003; Moutquin, 2003). The relation between high pre-pregnancy body mass index and spontaneous preterm birth is less clear. Recent research seems to indicate that obese women might have an increased risk of spontaneous preterm delivery due to high body mass alone (Nohr et al., 2007), but the higher risk for this population is mainly mediated by other complications associated with obesity (i.e., gestational diabetes, pre-eclampsia and hypertension) often requiring elective preterm delivery (Aly et al., 2010; Madan et al., 2009; Nohr et al., 2007; Torloni et al., 2009). Finally, multiple gestations account for a good number of all preterm births (15-20% according to Goldenberg et al., 2008; 10% according to Moutquin, 2003). From a study looking at data collected in 2000 from countries in the European Union emerged that about half of the infants from multiple births were born preterm, accounting for between 18% and 25% of preterm births in each country (Blondel, Macfarlane, Gissler, Breart, & Zeitlin, 2006). However, twins usually have better outcomes than singletons when born between 28 and 37 weeks of gestation, although the exact reasons have yet to be found (for a review see A. J. Wilcox et al., 2011). A high number of preterm multiple deliveries is associated with assisted reproductive technologies (Goldenberg et al., 2008). This is true also in the European Union, as shown by research on multiple births in 2000 reporting that both the medical management of subfertility and rising maternal age at childbirth were factors contributing in the high rates of multiple births (Blondel et al., 2006).

Certain maternal demographic characteristics play a risk factor role, although the mechanisms by which they are related to preterm birth are unknown (Goldenberg et al., 2008). Ethnicity, low socio-economic and educational status, low and high maternal age, and single marital status are all risk factors for premature delivery (Peacock, Bland, & Anderson, 1995; Santos et al., 2008; L. K. Smith, Draper, Manktelow, Dorling, & Field, 2007; Thompson, Irgens, Rasmussen, & Daltveit, 2006). Peacock, Bland and Anderson (1995) found also that trouble with "nerves" and depression, help from professional agencies, and little contact with neighbours were all significantly associated with an increased risk of preterm birth, while smoking was associated only with delivery before 32 weeks, but had no effects on the total length of gestation.

Specifically for ethnicity, black, African-American and African-Caribbean women had a higher risk, while East Asian and Hispanic women had a lower risk of preterm delivery in both in the UK and USA (Goldenberg et al., 2008). Also, the mother's ethnic group influenced the feature of the obstetric precursors of preterm labour: a preterm labour with intact membranes was more common in white women, while a premature rupture of the membranes was more frequent in black women (Ananth, Ananth, & Vintzileos, 2006).

In some cases, unfortunately, a preterm delivery is the best solution to more complicated medical problems that might occur continuing the pregnancy (Spong et al., 2011). Along with looking for ways to avoid preterm birth when this can be done, researchers and medical staff should therefore continue working on ways to diminish the negative impacts of preterm birth on the child's development.

1.2.3 Morbidity and mortality

In 2010, worldwide, 40.3% of deaths in children under 5 years of age occurred in neonates, for whom preterm birth complications (14.1%) was the leading cause of death (Liu et al., 2012). In general, mortality rates depend on a numerous list of factors, not last the country of birth and its attitude towards intensive care of both pregnant women and newborns (Saigal & Doyle, 2008). In almost all high- and middle-income countries of the world, preterm birth is the biggest cause of child death (Liu et al., 2012). In fact, in high-income countries, between 65% and 75% of neonatal deaths occur in preterm-born infants (see Zeitlin et al., 2013). In the USA, preterm birth accounted for ~34% of all infant deaths in 2002 (Callaghan, MacDorman, Rasmussen, Qin, & Lackritz, 2006). Despite the low absolute risks, the relative risks of post neonatal death and adverse outcomes are quite elevated in preterm infants born after 32 weeks, compared to a term population. Since preterm births after 32 weeks of gestation are more common than preterm births before 32 weeks of gestation, these relative risks translate into a substantial impact at the population level (Escobar, Clark, et al., 2006; Kramer et al., 2000).

Gestational age at birth influences greatly the impact of prematurity on developmental outcomes, with infants born at lower gestational ages having to face higher risks. A study looking at 10 regions in 9 European countries in 2003 (Zeitlin et al., 2008) found that 14.2% of infants who were born alive between 22^{+0} and 31^{+6} weeks of gestation died before discharge from the hospital, although the standardised mortality rate varied across regions (from a high rate of 18%– 20% to a low rate of 7%–9%).

Since the 1970s, technological advantages and improved medical practices (i.e., the widespread use of assisted ventilation), as well as a different attitude towards intensive care (i.e., allowing parents in the unit) in developed countries increased the survival rates for preterm infants in general, and for the ones on the border of viability (GA < 28 weeks) in particular (Feldman, Eidelman, Sirota, & Weller, 2002; Goldenberg, Culhane, Iams, & Romero, 2007; Gultom, Doyle, Davis, Dharmalingam, & Bowman, 1997; Saigal & Doyle, 2008). Unfortunately, improved survival rates have not coincided with improved developmental outcomes or quality of life for these infants (Hintz et al., 2005; Zwicker & Harris, 2008).

Premature birth can cause different physical and cognitive conditions from infancy to adulthood. The complex picture regarding circumstances leading to preterm birth is further complicated by risk and protective factors after birth (see Figure 1.2). Again, gestational age at birth plays a big role in the rate and type of morbidity accompanying prematurity, with infants born before 32 weeks of gestation having higher risks of adverse outcomes. Brain injuries and disruption of cortical development could arise from an immunological response of the mother to intrauterine infections,

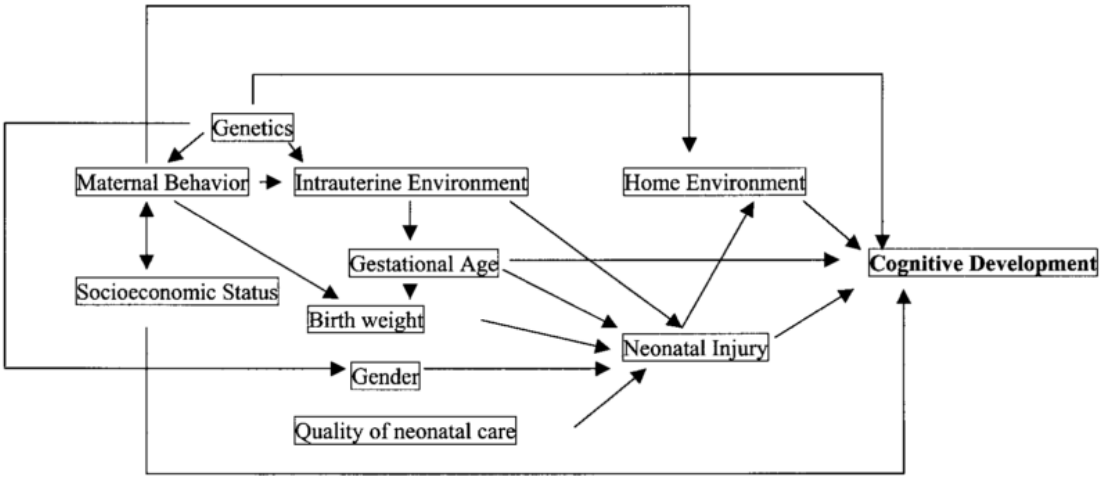

Figure 1.2. Sources of influence on cognitive development for infants born preterm (Luciana, 2003).

perinatal insults (i.e., hypoxia or ischemia) or as a consequence of prematurity per se (i.e., high susceptibility to drops in cerebral pressure or other alterations in cerebral blood flow) (for reviews see Aylward, 2005; Luciana, 2003). Common neurodevelopmental sequelae in the early years are cerebral palsy, developmental delay, motor deficits and sensory impairments (i.e., visual and auditory deficits); cognitively, this population has higher risks for difficulties with attention, visual processing and executive function as well as emotion regulation, showing, for example, higher incidence of attention deficit hyperactivity disorder (ADHD) (for reviews see Aylward, 2005; Engle, 2011; Saigal & Doyle, 2008). In the study mentioned earlier, looking at 10 regions in 9 European countries in 2003 (Zeitlin et al., 2008), researchers found that in infants born between 22^{+0} and 31^{+6} weeks of gestation morbidity varied significantly across regions; the combined prevalence of brain injury (i.e., intraventricular haemorrhage, IVH, grades III and IV and cystic periventricular leukomalacia, PVL) ranged from 2.6% to 10.0% and respiratory disorders (i.e., bronchopulmonary dysplasia, BPD) from 10.5% to 21.5%. An Italian study looked at infants born before 32 weeks of gestation between 2003 and 2006 without any major cerebral damage or important medical problem. Participants were followed for 2 years and regularly tested, at age corrected for prematurity, with the revised Griffiths Mental Development Scales

0–2 years (Griffiths, 1996), showing significantly lower scores for infants born before 29 weeks, but also mild cognitive impairments for infants born between 29 and 32 weeks, compared to infants born at term. In particular, the study showed that the preterm samples increased their difficulties between the first and the second year of life, differently from the term sample (Sansavini, Savini, et al., 2011). A research including all live births between 22 and 32 completed weeks of gestation from nine French regions in 1997, carried out a cognitive assessment at 5 years of age (recruiting children born at 39 and 40 weeks of gestation for the comparison group), finding that cerebral palsy was diagnosed in 9% of children born preterm. Different degrees of disability were present in the preterm sample, with special health-care resources used by 42% of children born at 24–28 weeks and 31% born at 29–32 weeks, compared with only 16% of those born at 39–40 weeks (Larroque et al., 2008).

Also infants born after 32 weeks of gestation have a greater risk of poor outcomes compared to infants born at term, and in recent years the literature is more frequently addressing this population. Compared with infants born at term, preterm infants born after 32 weeks have higher rates of temperature instability, respiratory distress, apnea, hypoglycaemia, seizures, jaundice, feeding difficulties, infections, intraventricular haemorrhage (IVH grades I and II), and re-hospitalisations (Boyle et al., 2015; Engle, 2011; Engle et al., 2007; Escobar, Clark, et al., 2006; J.-B. Gouyon, Iacobelli, Ferdynus, & Bonsante, 2012; Harijan & Boyle, 2012; Saigal & Doyle, 2008; Shapiro-Mendoza & Lackritz, 2012; Teune et al., 2011). However, many studies do not differentiate between causes of premature delivery, therefore grouping together premature births due to pregnancy complications, spontaneous premature labour, elective premature delivery and other reasons (Teune et al., 2011). In fact, severe adverse outcomes are usually rare in infants born after 34 weeks (i.e., IVH grades III and IV, culture proven sepsis or necrotizing enterocolitis), while the most common adverse outcomes are respiratory distress, sepsis work-ups, and phototherapy for hyperbilirubinemia (i.e., jaundice) (McIntire & Leveno, 2008). A study including singleton live births between 34^{+0} and 41^{+6} weeks of gestation in the French region of Burgundy between 2000 and 2008 showed that the rate of severe respiratory diseases approximately doubled for each week of shorter gestation from 39 to 34 weeks. Results also indicated that the risk of poor prognosis was higher for early term compared to full term infants (Jean-Bernard Gouyon et al., 2010). A cohort study carried out in Brazil in 2004 found that preterm infants born after 34 weeks were at higher risk (10%) of not receiving breast milk within the first hours after birth and of not being exclusively breast fed at 3 months, compared to infants born at term (Santos et al., 2008). A systematic review of studies comparing infants born after 34 weeks with infants born at term, reported results showing that the infants born preterm were more likely to suffer from cerebral palsy and mental retardation than their term peers, although there was also a study showing no differences between the two populations (see Teune et al., 2011).

Worse cognitive and developmental outcomes are more common in the mild and moderate preterm population (born ≥32 weeks) also after infancy, compared to the term population. Low-risk infants born in Italy after 33 weeks (who were not presenting complicated medical situations) were tested with the Mental Scale (MDI) of the Bayley Scales of Infant Development second edition (BSID-II, Bayley, 1993) at 12 and 18 months, age corrected for prematurity. Scores were similar to the ones achieved by their term peers; however, they were lower if considering the scores relative to the participants' uncorrected age (see section 2.4.2; Romeo et al., 2010). Toddlers born after 34 weeks of gestation were tested at 24 months with the Bayley Scales of Infant Development Short Form-Research Edition (BSF-R, derived from the BSID-II, Bayley, 1993) were found to have higher odds of more severe (52%) and milder (43%) mental developmental delay, as well as severe (56%) and milder (58%) psychomotor developmental delay, compared to term toddlers. The authors found male gender to be the most important single contributor to severe mental developmental delay, and late prematurity to be the most significant contributor to severe psychomotor developmental delay (Woythaler, McCormick, & Smith, 2011). The authors concluded that the reasons for these difficulties were probably not related to brain immaturity and vulnerability to injury, as their results pointed to modifiable social factors (i.e., socio-economic factors) as the ones most associable with mental delays (Woythaler et al., 2011). The same sample was evaluated at 5 to 6 years old for school readiness, finding that the late preterm sample had worse scores on reading, math and expressive language than their term born peers (Woythaler, McCormick, Mao, & Smith, 2015).

Research on cognitive functioning in preterm subjects born after 32 weeks showed inconsistent results (de Jong, Verhoeven, & van Baar, 2012). In infancy, the majority of studies reported no delay when age was corrected for prematurity (Cheatham, Bauer, & Georgieff, 2006; Reuner et al., 2014; Romeo, Guzzardi, et al., 2012; Shah, Robbins, Coelho, & Poehlmann, 2013), or they reported a delay present in the first year of life disappearing after 24 months of age (Hillemeier, Farkas, Morgan, Martin, & Maczuga, 2009). However, some studies showed a poorer performance from the preterm born subjects (Voigt, Pietz, Pauen, Kliegel, & Reuner, 2012). In the same way, studies investigating cognitive functioning in childhood and adolescence reported contrasting results, with some showing no differences with term born subjects (Gurka, LoCasale-Crouch, & Blackman, 2010; Odd, Emond, & Whitelaw, 2012) and others showing lower scores from the preterm samples (Talge et al., 2010). Moreover, there are indications that late prematurity is a risk factor for cognitive impairment in late adulthood (Heinonen et al., 2015). As discussed more in detail in Chapter 2, the preterm population is not an homogeneous one, and differences across studies regarding subjects' cause of premature birth, medical sequelae (in particular regarding brain injury), as well as the definition used to describe prematurity (Aylward, 2002b; Fernell & Gillberg, 2012; Myatt et al., 2012), together with other methodological factors like the chosen tests and measures (Reuner, Fields, Wittke, Löpprich, & Pietz, 2013), are often at the base of contrasting results across studies involving prematurely born subjects.

Even if some studies found good cognitive developmental outcomes for late-preterm infants, it is often the case that these children require more help within the school system, but also at younger ages. Given the high number of late-preterm births within the total of preterm births, this often results in a substantial effort from organisations, schools, and the society in general. Kalia et al. (Kalia, Visintainer, Brumberg, Pici, & Kase, 2009) explored the need of interventional therapies (i.e., physical therapy, occupational therapy, speech therapy) in infants born after 32 weeks. They found that at 12 months (corrected for prematurity) preterm infants born after 32 weeks require the same amount of interventional therapies than infants born before 32 weeks, when adjusting for comorbidities of prematurity. Studies investigating performance in school-aged children born after 32 weeks found increased risks of problems. Preterm infants showed more often learning difficulties, lower scores on reading, spelling and arithmetic and higher risks of attending special education and of repeating grades compared with term born samples (Chan & Quigley, 2014; Chyi, Lee, Hintz, Gould, & Sutcliffe, 2008; de Jong et al., 2012; Huddy, Johnson, & Hope, 2001; Teune et al., 2011). Moreover, the preterm samples showed a lower likelihood of finishing high school and university than the term samples (Teune et al., 2011).

With regard to emotional and behavioural problems, research shows that preterm infants born after 32 weeks have an increased risk of problems compared to their term born peers (Samantha Johnson et al., 2015; Potijk, de Winter, Bos, Kerstjens, &

Reijneveld, 2012; Talge et al., 2010) and also compared to preterm infants born before 32 weeks (Shah et al., 2013). These are usually defined as externalising (i.e., attention problems, aggressive behaviour) and internalising (i.e., emotionally reactive behaviour, anxious/depressed behaviour, somatic complaints, withdrawn behaviour) problems. Potijk et al. (Potijk, de Winter, Bos, Kerstjens, & Reijneveld, 2015) also found that these infants had higher than normal rates of co-occurrence of developmental delay and emotional-behavioural problems at preschool age, in particular for externalising problems. The effect was stronger for boys than for girls, and the authors hypothesised the causes could lay in abnormal brain networks development due to the early birth, which can disrupt the reorganisation and differentiation undergoing in the last months of pregnancy. However, there are also studies showing no differences between late preterm (born after 34 weeks of gestation) and term born children and teenagers with regard to emotional and behavioural problems (Gurka et al., 2010). Although some studies have shown an increased risk for attention deficit/hyperactivity disorder (ADHD) (Chu et al., 2012; Halmøy, Klungsøyr, Skjærven, & Haavik, 2012; Samantha Johnson & Wolke, 2013), even for infants born after 32 weeks of gestation (Lindström, Lindblad, & Hjern, 2011; Sucksdorff et al., 2015), other studies have not found an higher incidence of ADHD in the preterm born population (Rabie, Bird, Magann, Hall, & McKelvey, 2015). Moreover, there are indications that factors different from gestational age might be a better predictor of ADHD risk: in a study enrolling only term-born participants, delivery circumstances predicted ADHD symptoms, while gestational age at birth did not. Only induced labour followed by caesarean section was associated with higher levels of ADHD symptoms (Talge, Allswede, & Holzman, 2016).

Interestingly, a recent study examined the relation between gestational age and behavioural problems from a new perspective: in order to completely eliminate all potential confounders that come with a preterm sample, only term-born children were recruited. Looking at their performance at 6 years of age, researchers found only a small effect of gestational age on behavioural problems, while they found a relation between birthweight and behavioural problems (i.e., conduct problems and hyperactivity), with children with lower birthweight having more problems (Yang, Fombonne, & Kramer, 2011). Another study found a relation between birthweight and adverse outcomes, instead of gestational age. Comparing attention control in 7-year-old children born moderately preterm but with a birthweight appropriate for gestational age with term born children small for gestational age, the latter had a poorer performance (Tanis et al., 2015). Moreover, a study examining a sample constituted by infants born between 2001 and 2002 who required time in the neonatal intensive care unit (NICU), found that they showed more developmental problems than a healthy control group at 2 years of age (corrected for prematurity) (Darlow, Horwood, Wynn-Williams, Mogridge, & Austin, 2009). Infants were admitted to the NICU if born before 34 completed weeks of gestation, if birthweight was <1800g or if they had any illness. Researchers found that infants, born both preterm and at term, admitted to the NICU had more developmental problems than the controls, independently of gestational age at birth (although infants born before 28 weeks of gestation had a higher risk of cerebral palsy and respiratory problems). In particular, NICU children had lower scores in the Psychomotor Developmental Index (PDI) of the Bayley Scales of Infant Development, Second Edition (Bayley, 1993) than controls. Considering only the term born NICU children, they had both Mental Developmental Index (MDI) and PDI scores >1 standard delivery below the mean compared to controls (Darlow et al., 2009).

However, more research is needed on the preterm population born after 32 weeks and in particular after 34 weeks. In fact, the majority of data on long-term developmental outcomes are currently deriving from studies including subjects born between 10 and 40 years ago, therefore sometimes lacking indications about the improvements in neonatal care, as well as social interventions and other tools that prior research helped to make available to medical staff, families, schools and communities (Samra, McGrath, & Wehbe, 2011). This might also be one of the reasons of the disparity between found outcomes in infancy compared to later on in the lives of late-preterm born populations: better outcomes in infancy might come from newer policies adopted pre- and post-birth, of which older individuals did not benefit. New research should investigate in this direction.

1.3 What is social attention?[3]

A possible cause of different developmental delays seen in preterm born infants could lay in visual attention difficulties, in particular with regard to social attention[4]. In fact, visual attention is related to and influences cognitive functioning (i.e., memory and processing speed, Desimone & Duncan, 1995; S A Rose, Feldman, & Jankowski, 2002), and social attention is related to and influences social cognition (Caron, 2009; De Barbaro, Johnson, & Deák, 2013; Emery, 2000; Klein, Shepherd, & Platt, 2009; Meltzoff & Brooks, 2008; Mondloch et al., 1999; Mundy & Jarrold, 2010; Tomasello & Carpenter, 2007; Triesch, Teuscher, Deák, Carlson, & Wolfgang, 2006).

Preterm born infants and children have been shown to follow an atypical development with regards to visual attention and social attention (De Schuymer et al., 2011, 2012; Eryigit-Madzwamuse & Wolke, 2015; Harel et al., 2011; Hitzert et al., 2015; Hsu & Jeng, 2008; Hunnius, Geuze, Zweens, & Bos, 2008; Imafuku et al., 2016; Olafsen et al., 2006; Telford et al., 2016). In adolescence, an atypical and less mature pattern of brain activation regarding information processing and responding to stimuli was found in a preterm born sample (gestational ages ranged from 28 to 35 weeks, M = 32.1, SD = 2.5; Carmody et al., 2006).

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[3] Social attention is defined in this thesis by an array of behaviours showing a shift of attention motivated by social reasons. It includes gaze shifts towards social stimuli (see section 1.4.1), dyadic attention behaviours (see section 1.4.2), and triadic attention behaviours (including joint attention as well as other socially motivated behaviours; see sections 1.4.2, 1.4.3 and 3.3.1.4).

However, still little is known on these topics concerning specifically preterm infants born after 32 weeks of gestation. Recently, a few studies found this population's the earlier exposure to the outside world, compared to term born infants, resulted in some advantages related to visual attention skills (Peña, Arias, & Dehaene-Lambertz, 2014; Romeo, Ricci, et al., 2012). Moreover, there are indications that socio-demographic factors (i.e., parental education) are better outcomes predictors than medical parameters for moderately to late preterm born infants (Cserjesi et al., 2012; Patra, Greene, Patel, & Meier, 2016), pointing towards a more complex picture to explain these infants' atypical attentional skills.

Finally, attention difficulties could be at the root of language delays (Charman et al., 2000; Markus, Mundy, Morales, Delgado, & Yale, 2000; Morales et al., 2000; Morales, Mundy, & Rojas, 1998; Mundy & Gomes, 1998; Tomasello, 1988). Since language problems have been commonly found in the preterm-born population (da Costa Ribeiro, Abramides, Fuertes, Lopes dos Santos, & Lamônica, 2016; Foster-Cohen et al., 2007; Kwon et al., 2016; Lee et al., 2011; Luoma et al., 1998; Rabie et al., 2015; Sansavini et al., 2010; van Noort-van der Spek, Franken, & Weisglas-Kuperus, 2012), the need to explore these skills in a moderately to late preterm born population is even more relevant.

As described in detail in the following section, attention behaviours are influenced by different factors: biological, environmental and social factors. Here are detailed their development and relation to language in a normally developing population. Chapters 3 and 4 cover the same topics with regard to a preterm born population.

1.3.1 The importance of eye-gaze

Eye-gaze is a powerful source of information and infants begin being interested in it from very early on (i.e., Emery, 2000; Flom, Lee, & Muir, 2007). Scaife and Bruner (1975) provided, in a seminal study, results showing that infants from 8 months (with unequivocal results from 11 months) were capable of mutual orientation: they followed the gaze of an experimenter turning her head to the side to look at something not visible to the infant. The authors interpreted these results as evidence of the infants' acknowledgment of the other person's perspective. More recent results showed that, in fact, infants were able of reliably following another person's head turn, or proximal attention following, at much younger ages, between 3 and 4 months of life (Perra & Gattis, 2010).

After the first few weeks after birth, in which attaining an alert state is rather difficult (Colombo, 2001), infants begin orienting towards faces, especially in response to a direct gaze towards them (Farroni, Csibra, Simion, & Johnson, 2002; Farroni, Menon, & Johnson, 2006). At around 8 weeks of age, infants start maintaining visual attention towards faces for longer periods, reducing smiling and gazing towards still faces and increasing these behaviours for responding faces (Trevarthen, 1979). It has in fact been shown that the amount of time spent by infants looking at adults during interactions increases steadily from 1 to 4 months (Lamb, Morrison, & Malkin, 1987). In return, parents see their infants' frequent eye contact, smiles and longer duration of gaze as a meaningful sign that their infants are individuals wanting to have a social bonding (Robson & Moss, 1970). Johnson and Morton (1991) proposed that this shift is due to a decrease in influence of the earlier system accessed via the subcortical visuomotor pathway, occurring from around 2 or 3 months, in favour of a cortical system. The subcortical network is responsible for the preferential tracking of faces in newborns. The exposure to faces and consequent acquisition of information about their structure in the following weeks, enables the cortical system to mature with a bias towards faces, creating the bases for the adult cortical system represented mainly in the fusiform face area (Johnson, 2005).

Therefore, a mixture of biological, environmental and social factors contribute to shape infants' attention behaviours from the very first weeks of life. Attention abilities increase and become more refined at a very fast pace, creating a virtuous circle by which infants continue enriching their presence and role in the social environment around them.

1.3.2 From dyadic to triadic interactions

Although many of the features of "proper" triadic behaviours do not emerge before the 9 to 12 months window, their precursors can be seen as early as between 3 or 4 months of life. In particular, the ability to follow one's head turns, alternate gaze between one's head and where one's gaze is focused, disengage from fixation, and sensitivity to the emotional tone, all emerge before the 9 months mark (Butterworth & Jarrett, 1991; Frick, Colombo, & Saxon, 1999; Perra & Gattis, 2010; Striano, Henning, & Stahl, 2005; Striano & Stahl, 2005).

Dyadic interactions often engage infants from around 2 to 6 months entirely, as it is difficult for them to disengage from the object of their gaze (Colombo & Cheatham, 2006). After this period, they begin to be able to disengage and focus on other elements of the environment (e.g., objects), therefore enabling triadic interactions (Newson & Newson, 1975). The quality and characteristics of the infants' triadic engagement evolve and refine with time, going from a more passive (around 6 months) to a more active style (around 18 months) (Bakeman & Adamson, 1984). However, more recent studies found that the shift between passive and active joint engagement begins as early as around 3 months of age (Perra & Gattis, 2012).

However, rather than by a hard age-driven series of cut offs, the frequency and style of shared attention engagement seem to be influenced by a more general development of the infants' social competence (Striano & Rochat, 1999). Manifestations of dyadic and triadic abilities were in fact found to be positively correlated in two groups of 7 and 10 months olds, without relations to age, level of social engagement, nor (motoric) maturation. The authors suggested the presence of a developmental link between the emergence of dyadic and triadic abilities, depicting a gradual process in using, learning and mastering these social behaviours (Striano & Rochat, 1999), as opposed to a sudden "revolution" that gives new meaning to already existing mechanisms (Tomasello, 1995).

Moreover, the quantity and quality of joint attention (triadic) behaviours shown by infants rely heavily on the adults' style of interaction and communicative signals, which can help scaffolding the infants' development as they mature in the end of the first year of life (Mendive, Bornstein, & Sebastián, 2013; Senju & Csibra, 2008). In general, attention following, through the first two years of life, is influenced by many factors which define the situation, the salience of what is attended, the affective and emotional impact of the communication between the actors, and other elements (for a review see Chris Moore, 2008).

1.3.3 Joint attention

Joint attention is the ability to share a look to direct another person's interest towards something and, reciprocally, understand the meaning of this action when one is the receiver (see Figure 1.3; Mundy & Jarrold, 2010). Scaife and Bruner (1975) pointed out the importance of this ability, suggesting the idea that, when employed properly, it could lead to a richer learning experience for the infant. Being able to respond promptly to a joint attention bid from the caregiver, could place the infant in a good position to learn some new information, while ignoring that look would more likely prevent the infant from getting any information from the caregiver.

Despite the apparently clear definition, many different behaviours, not necessarily involving the same features, are considered a manifestation of joint attention. Like for the majority of human behaviours, situational constraints influence the meaning and aims of these behaviours. However, contrasting theoretical standpoints are the major cause of the many variations of classification for these behaviours.

There are, in fact, different opinions regarding which abilities are sufficient to an infant in order to effectively use eye-gaze to respond to or initiate an attentional bout with another person. Some consider intention understanding necessary in order to fully execute the social exchange, drawing a thick line in the sand between behaviours demonstrated before mastering intention understanding and the ones expressed after (i.e., Tomasello, 1995). Conversely, other researchers view the process of gathering information, interpreting it and actively using one's experiences and feedback on eye-gaze interactions as one of the means to gain the insight that others are intentional beings (i.e., Mundy et al., 2000).

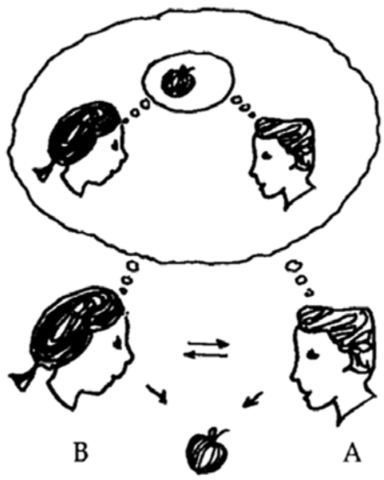


Figure 1.3. Depiction of information processing during joint attention (Mundy & Jarrold, 2010). Each person processes information about the object, the attention direction of the other person towards the object and their own self-referenced information about both the object and the other person. These different attentional processes contribute to the development of a mental representation of a shared experience (Mundy & Jarrold, 2010).

1.3.3.1 Tomasello's 9-month revolution

The Social Cognitive Model (SCM), posited by Tomasello and colleagues (Tomasello, 1995; Tomasello, Carpenter, Call, et al., 2005), develops around the idea that joint attention is defined by social knowledge and derives from it. Tomasello and colleagues identify the 9-month revolution as a period from 9 to 12 months showing a shift in social cognitive abilities. Infants begin to consider others as intentions owners and therefore start using social referencing behaviours (i.e., joint attention) to direct others' attention. At the same time, infants begin responding to others' attentional bids, following the awareness that these bids could in fact have a meaning (Carpenter et al., 1998). Before this point, infants do not behave differently from other primates and do not show signs of considering others as intentional beings (Tomasello & Carpenter, 2007). These new joint attention skills emerge in synchrony simply because they are all the result of a single socio-cognitive skill: the understanding that people are intentional agents (Tomasello, 1999). Already existing cognitive skills, like gaze following, manipulative communication, group action and social learning are transformed into their new collective version (i.e., joint attention, cooperative communication, collaborative action and instructed learning) by the new acquired skills and motivations for shared intentionality (Tomasello & Carpenter, 2007). Moreover, Tomasello and colleagues stated that "there are no known environmental variables that significantly speed up or retard the 9-month revolution" (Tomasello & Rakoczy, 2003, p. 142).

Therefore, the main element characterizing a joint attention episode is in fact the subject's voluntary shift in attention, either in response to a cue from another person to a third element (i.e., object, other person), or to initiate a new attentional bid by looking at the other person before or after having attended a third element (Carpenter et al., 1998). The shift in attention is in fact voluntary, since the third element, the final object of attention, has not been per se a source of any attention-grabbing event (i.e., movement, light, sound). Joint attention behaviours are therefore characterising the infant not only as an active actor within the environment, shaping the amount and type of visual information to be processed, but also as a social actor, sensitive to the behaviour of others and aware of their different perspective (Carpenter et al., 1998).

Simple gaze following (and/or head turn following) is often described as part of the joint attention domain, specifically considering it as part of the following attention behaviours (Carpenter et al., 1998). Many studies have been investigating the underlying cognitive processes of this behaviour given different situational constraints (Brooks & Meltzoff, 2005; D'Entremont, Hains, & Muir, 1997; Flom et al., 2007; Susan Johnson, Slaughter, & Carey, 1998; Luo, 2010; Moll & Tomasello, 2004; Senju & Csibra, 2008; Tomasello, Hare, Lehmann, & Call, 2007). However, Tomasello and colleagues do not consider gaze following as a joint attention behaviour if it happens without the awareness that the other person is an intentional being and is in fact intentionally shaping the subject's attention (Tomasello, 1999).

The point following is also in the following attention behaviours group. Here is a pointing gesture (usually accompanied by a gaze shift) that signals what the other actor wants the subject to pay attention to. Following the pointing, and looking at its target, the subject is interpreting the gesture as an attention directing one (Behne, Carpenter, & Tomasello, 2005; Carpenter et al., 1998; Gliga & Csibra, 2009; Chris Moore & Dunham, 1995; Mundy, Delgado, et al., 2003; Woodward & Guajardo, 2002).

The joint attention bid can of course also be started by the subject, who is in this case not the recipient of a meaningful behaviour, but its agent. Carpenter and colleagues (Carpenter et al., 1998), basing their distinction on previous work (Bates, Camaioni, & Volterra, 1975), identified different directing attention behaviours: imperative gestures, requesting another person's help to reach a goal, and declarative gestures, requesting another person's attention on a particular object or event. These gestures and behaviours have to be directed at a person able to fulfil these requests, in order to be considered an intentional manifestation of directing attention and not a mere expression of an emotional state (Carpenter et al., 1998).

Gaze alternation between another person and an object, as well as the checking back behaviours, are usually a good indicator of joint attention, but not necessarily: they could be a mere manifestation of alternation of attention between the object and the other person, or vice versa, without implying any integration and sharing of attention between the subject and the other person (Carpenter et al., 1998).

1.3.3.2 Mundy's social learning continuum

Mundy and colleagues (Mundy et al., 2000), with their Multiple Process Model (MPM), put forward the idea that the emergence of joint attention during development is influenced by several social executive processes (Mundy, 2003), which contribute in shaping the joint attention abilities. These social executive processes enable the following blooming of joint attention into more complex and diverse socio-cognitive and communication abilities. Joint attention is therefore seen as part of a continuum of social learning, or social knowledge acquisition: sharing and monitoring someone else's attention is shown to be a very useful skill to facilitate the accumulation of many types of knowledge, including social knowledge (see Figure 1.4).

In this framework, the generic idea of joint attention is broken down into the distinct abilities of Responding to Joint Attention (RJA) and Initiating Joint Attention (IJA). This nomenclature was introduced by Seibert, Hogan and Mundy (1982) while describing the cognitive constructs beneath an assessment measure they introduced (the Early Social Communication Scale, ESCS) and has been widely used since, especially in the autism literature (see for example Leekam & Ramsden, 2006; Roos, McDuffie, Weismer, & Gernsbacher, 2008). As defined in a more recent paper, RJA stands for "the ability to follow the direction of gaze and gestures of others", while IJA identifies "the ability to use direction of gaze and gestures to direct the attention of others to spontaneously share experiences" (Mundy et al., 2007, p. 938). Therefore in one situation the focus is on the recipient of a joint attention bid (RJA) and in the other is on the actor of a joint attention bid (IJA). Specific descriptions of the behaviours considered manifestations of IJA and RJA, as well as other social communication constructs (i.e., behavioural request, social interaction) are included in chapter 3, while describing the ESCS (Mundy, Delgado, et al., 2003) experimental measure.

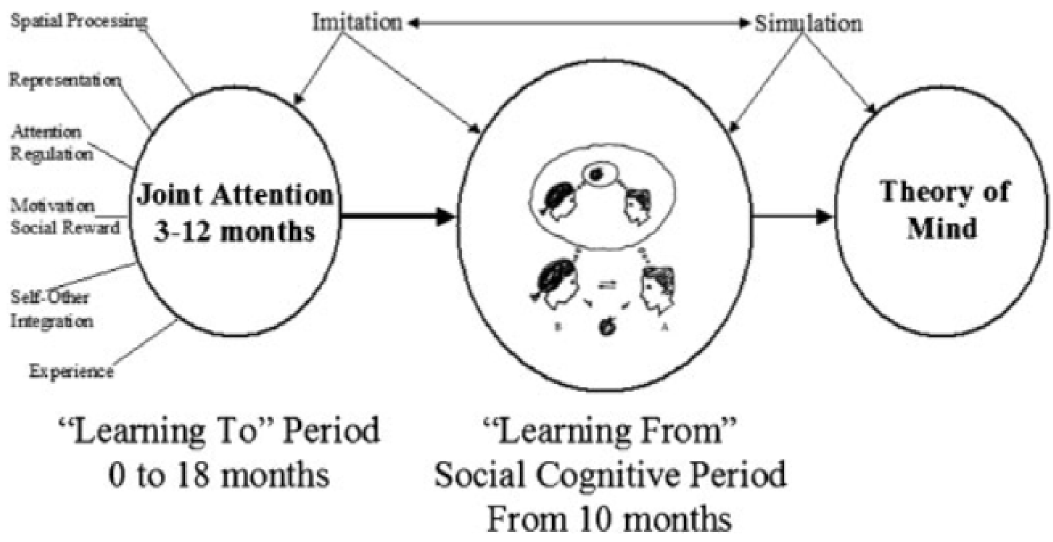


Figure 1.4. Representation of the Multiple Process Model (Mundy et al., 2009).

1.3.3.3 The awareness of others' intentionality

The two theoretical frameworks are therefore standing on a different consideration of the role of the awareness of others as intentional beings relative to the development of joint attention. This difference causes a major separation between these two views with regard to the interpretation of infants' behaviours before 9 months. Tomasello and colleagues (Carpenter et al., 1998; Tomasello, 1995, 1999; Tomasello, Carpenter, Call, et al., 2005) put the rise of joint attention abilities at the end of a period of development of social knowledge, in particular the knowledge that others have intentions, while Mundy and colleagues (Mundy, 2003; Mundy et al., 2000; Mundy & Jarrold, 2010) see joint attention as leading to social knowledge development, rather than following from it.

Research indicates that awareness of other people's intentionality is not a necessary requirement for a purposeful employment of joint attention behaviours. In fact, attention following behaviours are very similar to simple reaction behaviours to stimuli entering the visual field and engaging our attention (Mundy & Jarrold, 2010). Posner's experiments on overt and covert allocation of attention showed that directional cues influence visual attention (Posner, Snyder, & Davidson, 1980). Recent findings with single cell recordings on monkeys showed the presence of a population of mirror neurons in a visual attention area, the lateral intraparietal area (LIP). These neurons fire both when the subject is looking at an object within the neuron's specific receptive field, and when seeing another monkey looking at an object within the same area of the space. The authors interpreted these results as the neural basis of gaze following (Shepherd, Klein, Deaner, & Platt, 2009).

The discovery, 20 years ago, of mirror neurons in macaques (di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Gallese, Fadiga, Fogassi, & Rizzolatti, 1996) and in humans (Fadiga, Fogassi, Pavesi, & Rizzolatti, 1995; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996) linked action perception, encoding and production like never before. The mirror neuron system is defined as a population of neurons discharging when observing a motor action performed by someone else, as well as when the subject is performing the same action (Gallese et al., 1996).

The observation and the execution of an action are therefore linked in the personal experience, creating the bases for acquiring subsequent additional knowledge on that action, which in turn would help interpreting others' actions. Like the as-if-body-loop (Damasio, 2008; Oberman, Winkielman, & Ramachandran, 2007), the like me notion (Meltzoff, 2007) builds on the link between action perception and production. Meltzoff reviewed developmental literature on joint attention, imitation and intention understanding, as well as emotion, finding examples in support of this hypothesis and concluding that "the cross-modal knowledge of what it feels like to do the act that was seen provides a privileged access to people" (Meltzoff, 2007, p. 130). Experimental ways of increasing the direct experience about someone else's perspective do in fact modify infants' behaviours and their awareness of others' intentions. For example, researchers familiarised infants with the effect of blindfolds on vision. This experience reduced the rate of them following the head turns of an experimenter wearing the blindfold herself (Brooks & Meltzoff, 2002; Meltzoff & Brooks, 2008), showing that awareness of others' intentionality is fluid and dependant on experience, rather than on the emergence of a single socio-cognitive skill. Moreover, these results also suggest that even acknowledging others' intentionality, infants need some knowledge of the specific action they are witnessing in order to properly identify it as goal-directed. This idea has also been tested with 3-month-old infants, whose goal perception was influenced by familiarisation with sticky mittens (Sommerville, Woodward, & Needham, 2005). One of two groups was given prior experience with the mittens, which enabled the infants to simply grab objects with a sweeping motion of the hand. Subsequently, by looking at the same type of sweeping motion during an habituation paradigm, the infants who had personal experience with its new effect while wearing mittens, identified it as a goal-directed action while the other group did not (for a review see Woodward, 2009).

1.3.4 Language acquisition

Language is a referential tool, built on the shared agreement that a certain group of sounds refer to a certain entity in the real world. As Waxman and Gelman eloquently put it: "Words do not merely associate; they refer. Words are quintessentially symbolic elements" (Waxman & Gelman, 2009, p. 258).

Consequently, studying how infants establish the word-object connection has been considered by many researchers a good way to gain insight on the processes involved in language acquisition and how these processes express their functions. In fact, word mapping abilities have very often been considered as a proxy for language acquisition. The mapping problem deals with the way in which infants can link a word (i.e., noun, verb, adjective) to the entity (i.e., object, action, quality) it refers to.

1.3.4.1 The innatist and the pragmatic views

Various views, sometimes contrasting, sometimes complementing each other, have been put forward to discuss how humans acquire language. All consider language as a complex function deeply related to other cognitive processes, as well as specific brain substrates, and influenced by these. Recent studies show that the newborn brain has a lateralisation bias related to sound processing (Dehaene-Lambertz, Dehaene, & Hertz-Pannier, 2002; Peña et al., 2003). Despite the fact that the right hemisphere could still take over language processing in case of lesion, the leftward asymmetry, which will in time consolidate into the adult perisylvian areas, is present from birth and across the first year of life (for a review see Dehaene-Lambertz, Hertz-Pannier, & Dubois, 2006). Newborns are able to discriminate between languages belonging to different rhythmic families and, during the first year of life, infants acquire the basic capacities required to process speech (i.e., segmenting speech in words, discriminating phonemes in a categorical manner, neglecting non-pertinent acoustic variations as voice differences) (see Dehaene-Lambertz et al., 2006).

However, the way in which infants, equipped with this complex system, learn to understand and be understood through language varies according to different views. Perhaps the first distinction to be made is between the innatist view and the pragmatic view. The innatist view (i.e., Chomsky, 1968) states that the ability to acquire language is innate: an infant put in a linguistic environment will learn to understand and produce language. Chomsky (1968) defined this ability the Language Acquisition Device. An integral part of the innatist view is the idea of a universal grammar, the innate fashion in which humans express themselves through utterances juxtaposition, on which all languages have been built upon. The child's problem is "to determine which of the (humanly) possible languages is that of the community in which he is placed" (Chomsky, 1965, p. 27). In contrast to this almost automatic view on language acquisition, there are different pragmatic views. The two most notable pragmatic approaches are the associationist approach (i.e., L. B. Smith, 2000) and the social-pragmatic approach (i.e., Bruner, 1975) .

Bruner (1975) placed language inside a social interactional setting in order to define it. Differently from Chomsky's Language Acquisition Device, Bruner (1983) described a Language-Acquisition Support System, bringing attention to the caregiver's role in scaffolding the infant's learning trajectory. Following this approach, language is a particularly social affair, taught and learnt inside a social relationship between an adult and an infant.

1.3.4.2 Joint attention and word learning

In a classic word mapping study, Baldwin (1993) concluded that enhanced salience and temporal contiguity are not sufficient elements for establishing a new word-object link. Other researchers arrived to the same conclusions through different experimental methods (Akhtar, Carpenter, & Tomasello, 1996; Akhtar & Tomasello, 1996; Baldwin et al., 1996; Samuelson & Smith, 1998). As Bruner (1975) suggested in his social-pragmatic approach, something more is required by the infant to make a meaningful connection between word and object: joint attention, the act of sharing attention between the speaker and the listener, directing and following attention through different cues. In fact, joint attention is constructed on a set of cues embedded in the social interaction, which help in establishing the word-object link: gaze direction, head direction, body posture, voice direction, gestures, intonational quality, and facial expressions (Baldwin & Moses, 2001).

Recent studies testing Bruner's (1975) proposal of joint attention being the linking element between preverbal and verbal communication, found that triadic interaction skills are indeed strong precursors of language development (see Figure 1.5, Carpenter et al., 1998; Daum, Ulber, & Gredeback, 2013; Gliga & Csibra, 2009;

Morales et al., 2000; Mundy & Gomes, 1998; Mundy et al., 2007).

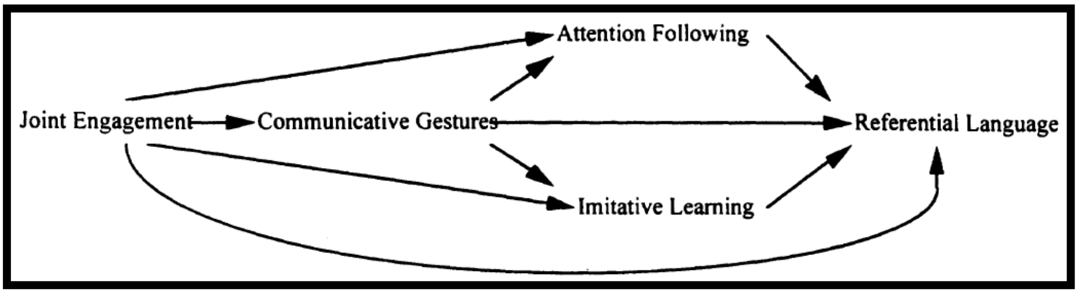


Figure 1.5. Lines represent prerequisite relations, while the direction of the arrows show the order of emergence (Carpenter et al., 1998).

In particular, following joint attention (i.e., following gaze/head/posture movements and/or pointing gestures) at earlier months is related to later receptive vocabulary growth (Brooks & Meltzoff, 2005; Morales et al., 2000, 1998; Mundy, Fox, & Card, 2003; Mundy & Gomes, 1998; Mundy & Jarrold, 2010) and is fundamental for novel word learning in experimental settings, being the necessary base for referentially mapping the new word onto the correct object (Baldwin, 1993, 2000; Mundy et al., 2009). It has been shown that correct interpretation of gaze shifts and pointing gestures, rather than more basic features of the object itself (i.e., attention grabbing features, inherent salience) or of the situation (i.e., temporal contiguity, attentional enhancement caused by the gaze shift), facilitates the establishment of the word-object link (for a review see Baldwin & Moses, 2001). At the same time, IJA abilities have been shown to predict later language acquisition (Mundy, Fox, et al., 2003; Mundy & Jarrold, 2010), but not in such a strong way. There is therefore a distinction between these two aspects of joint attention and their role in language acquisition. However, this is not the same as saying that infants are passively receiving information, but rather that they are able to recognise stimuli denoting situations carrying new information and to act on these stimuli. For example, in a series of studies in which the experimenter provided a novel label for one novel and one known object vs. two novel objects, infants of 13 and 18 months of age, directed gaze more frequently towards the experimenter in the second condition, when they in fact needed more disambiguating information to understand the situation (Vaish, Demir, & Baldwin, 2011).

Given the social nature of language acquisition and its bases in joint attention, caregivers play an important role in the process. The ability of mother-infant dyads of establishing and maintaining joint attentional bouts has been found to be associated with better language outcomes (Markus et al., 2000; Tomasello & Farrar, 1986). Also, children rely on adults' feedback to evaluate their communicative efficacy and improve their knowledge of language's conventions (Tomasello, 1992). At the same time, children play an active role in the building of their vocabulary. Researchers found that individual differences in infants' receptive language skills at 12 months predicted the amount of time spent in joint attention interactions with the mother at 18 months and that expressive language skills at 12 months influenced the infants' ability to initiate joint attention bouts during interactions at 18 months (Markus et al., 2000). Moreover, it has been shown that 2-year-olds can establish a novel word-object link by overhearing conversations (although the results were less clear for action-verb links) (Akhtar, Jipson, & Callanan, 2001).

1.3.5 Conclusions

Infants are actively gathering information from other people from very early on. From preferential attention to faces at 2 months, to proximal attention following between 3 and 4 months, infants show the ability to orient their attentional focus in particular towards stimuli of a social nature. A continuous exchange between neural predispositions, accumulation of personal experience and feedback from caregivers and other people contribute to shape infants' triadic attention skills.

Mundy's view of joint attention as part of a continuum of social learning (Mundy et al., 2000) highlights the importance of dyadic attention abilities developed in the first months of life as precursors of joint attention skills and therefore, later on, of language skills. The conscious awareness that others are intentional beings seems to not be necessary to successfully navigate social interactions in the first year of life, while infants are able to identify the goal-directedness of others' actions through experience, accumulating knowledge on intentionality.

The reciprocal influence of joint attention and language adds another element to the interconnected system of social stimuli and abilities that surrounds infants. In particular, establishing correct referential connections between words and their correspondents in the material world relies heavily on the ability of successfully responding to joint attentional bids.

1.4 Summary

This chapter introduced the two main topics on which this thesis is based on: prematurity and social attention and communication.

Premature birth is a common event worldwide and is not showing clear signs of diminishing. Negative developmental outcomes linked to prematurity affect also infants born at later gestational ages and can last well into childhood and later on. However, infants born closer to the 37 weeks mark have been neglected by developmental psychology research until recently. In particular, there is very little knowledge on the socio-cognitive development of this population.

Socio-cognitive skills play an important role in infants' development and are influenced by caregivers, as well as the infants themselves. Dyadic and triadic attention skills flourish during the first year of life, providing infants with powerful tools to interact with the surrounding environment. The continuous development of these skills supports the growth of receptive and productive language in the second year of life.

The next chapter describes the longitudinal study on which this thesis is built, providing details on its aims, experimental measures and procedures, together with a description of the participants' samples.

Chapter 2 - Methodological and demographical specifications

2.1 Introduction

This chapter presents information and details about the Special Delivery study, describing its aims given the picture described in the first chapter, the measures employed, the general procedures adopted throughout the study, as well as information and details on the participants samples. Specific hypotheses on the outcomes of the tasks included in this thesis are described in the following chapters.

2.2 The Special Delivery study

2.2.1 Aims

Karmiloff-Smith (2006) argues that difficulties found in infants with Williams syndrome, which would traditionally be attributed to different cognitive domains, could in fact be linked in a tight chain. The problems showed by these infants and toddlers in planning visual saccades may lead to atypical triadic interactions and then contribute to late onset of language. Making a point about genetic disorders like Williams syndrome, Karmiloff-Smith stresses the need to trace differences in outcome back to their origins in infancy, exploring the complete developmental trajectory. Given the high interconnectivity of the developing brain in infancy, in fact, the long process of localisation and specialisation of cortical circuits across years could lead to different solutions, which the atypically developing brain employs to overcome limitations. To better understand the quality and extent of the cognitive abilities belonging to an atypical developing population, an atypical brain organisation would therefore need to be explored longitudinally and cross-domain (Karmiloff-Smith, 2007).

The different issues introduced in the preface have been addressed in the Special Delivery study through a short cross-domain longitudinal design and a multi-methods approach. As discussed earlier, premature birth is characterised by a series of medical risk factors possibly leading to adverse developmental outcomes. At the same time, the incidence of these medical risk factors varies greatly depending on gestational age at birth, together with the presence of other risk or protective factors. Although the literature has started reflecting the need of more information on preterm infants born at later gestational ages, this population is still understudied when compared with preterm infants born earlier or infants born at term. Lastly, a greater proportion of psychological research on preterm birth has been focusing on motor, cognitive and language development, rather than social cognition.

Therefore, the Special Delivery study focused on the development of social cognition in preterm infants born at later gestational ages. Specific goals are discussed more in detail in the following paragraphs.

2.2.1.1 Social cognition abilities in the preterm population

The first central feature of this study is the exploration of three areas of socio-cognitive abilities: joint attention, imitation and language. These are tightly related and depend on each other for an optimal socio-cognitive development in the normal population (Carpenter et al., 1998; Charman et al., 2000). However, these abilities are often showing problems within the preterm population, both in terms of a delayed or deviated development. In particular, preterm infants show difficulties in joint attention (De Groote et al., 2006; De Schuymer et al., 2011; Olafsen et al., 2006), as well as language (Cusson, 2003; Guarini et al., 2009; van Noort-van der Spek et al., 2012). To my knowledge, imitation is yet to be assessed in preterm infants in an experimental setting.

In the Special Delivery study, joint attention, imitation and language are investigated longitudinally and through multiple measures examining their different aspects, and focusing on different elements depending on the participants' age. For example, tasks focusing on visual attention and gaze following at 5 months provide a base to better understand the exploration of joint attention skills during the second year.

This approach enabled the study to convey stronger indications about the nature of these abilities' development in our sample, leading to more substantial conclusions.

2.2.1.2 Parenting an infant born preterm

The second central feature of the Special Delivery study is to address questions about parenting, in particular regarding the impact of preterm birth on parenting practices and cognitions. These were investigated mainly through the Baby Care Questionnaire (Winstanley & Gattis, 2013), together with other parent report measures. Moreover, parent-infant interactions were observed throughout the length of the study, in order to explore attentional processes, as well as language usage and intention understanding in the parent-infant pair and how they were affected by preterm birth.

Since social cognition is heavily embedded in the social environment surrounding the infant, exploring the relationship with at least one of the caregivers, provides the study with a stronger set of tools to navigate the complexity of atypical infancy. Furthermore, as we saw in the first chapter, preterm birth is usually related to lower socio-economic and educational status of the mother, a higher difficulty in getting support, more strenuous work situations and less than optimal availability of prenatal care. It is therefore important to not only collect demographic information on the participants, but also investigate more in detail the features of the closest relationship built with the infant, to be able to pose questions on the risk and/or protective factors provided by this relationship and the surrounding social environment.

2.2.1.3 Focusing on preterm infants born at later gestational ages

The third central feature of the Special Delivery study is its focus on preterm infants born at later gestational ages compared to the traditional literature. As described in the first chapter, the majority of the studies in the past decades focused on preterm birth at earlier gestational ages (≤ 32 weeks), though more research has been addressing this gap in the literature in recent years. Despite this recent shift, consequences of preterm birth occurring after 32 weeks remain an understudied topic, in particular regarding the impact on socio-cognitive abilities in the infants as well as the caregivers' role in the first years of life. Given that the majority of preterm births happen at the later gestational ages, studying this group has a great impact on the population and great potential of influencing medical, educational, social and parenting policies and practices.

As mentioned in the preface, focusing on preterm infants born at later gestational ages reduces the number of biases affecting the variables involved in the study. Since their medical situation is usually non-critical, the gravity of its impact on the infants' development is lower compared to preterm infants born at earlier gestational ages. Caring for later, compared to earlier, preterm infants brings less unexpected difficulties in the caregivers' life for many reasons: from the smaller difference between the expected date of birth and the actual one, to the shorter hospital stay after birth, from the less complicated feeding practices, to the higher possibility of close contact from birth. Exploring the features of their social environment and their social-cognition abilities is therefore both providing information about the differences with infants born at term and painting a not so extreme situation. Any conclusions could therefore help filling the literature gap between early preterm infants and term infants, building a continuum and enriching the knowledge on both typical and atypical development.

2.2.2 Experimental measures overview

The multi-methods approach helped setting up more interactive and interesting sessions for the infants and caregivers, as well as enabling us to better follow the cross-domain development of the infants. Furthermore, we were able to compare our results with the existing literature as well as extend our understanding by including both common and less common measures. The Special Delivery study included parent-reports, experimental paradigms, observations, standardised measures, and reviews of medical records. These measures covered different cognitive domains, as well as collecting demographical and medical information (see Table 2.1).

The short longitudinal design was organised in five data waves: data were collected when the infants were born, and subsequently when they were 5, 13, 18 and 24 months old. The rationale behind the choice of the testing ages was to provide both the term and preterm samples with opportunities for performance variety within group, without risking floor performances in the preterm sample and ceiling performances in the term sample. Therefore, the ages were chosen so that, as reported by previous literature, the tested abilities should be part of most of the term infants' repertoire, but still not in a consolidated way.

Moreover, repeating the same experimental measures at 13 and 18 months of age, for example, enabled us to better describe the developmental pathways present in the samples. In particular, continuity and stability were explored in the participants' performances. Both continuity and stability are measures of consistency, but they refer to different levels of longitudinal data (Bornstein, 2002). Continuity is defined at the group mean level: if the mean performance of the group does not change over time, the performance is continuous; if there are differences across time on the group's mean performance, this is discontinuous. Stability is defined at the single participant level: if the performance of a participant does not change over time in relation to the group mean, therefore maintaining its individual rank order, the performance is stable; if there are differences across time on the participant's performance in relation to the group mean, changing its rank order, then the performance is unstable (Bornstein, 2002). These concepts represent independent aspects of development, both statistically and theoretically, therefore providing an important and powerful aspect of the exploration of a longitudinal dataset (Bornstein & Bornstein, 2008).

Table 2.1
Overview of the different measures employed in the Special Delivery longitudinal study.

	SES, medical info	parenting styles and cognition	temperament	memory	motor development	attention, joint attention	imitation	language	cognitive development
Birth	CAI	BCQ	--	--	--	--	--	--	--
	medical records	CODQ							
5m	medical status check	BCQ	R-IBQ	--	--	Gaze following	--	--	--
		CODQ				Attention habituation			
		Freeplay with caregiver				Freeplay with caregiver			
13m	demographic questions	BCQ	--	AnotB non search	motor check	ESCS	Boxes	OCDI	AnotB search
	medical status check	Freeplay with caregiver				Head vs. Gaze	Mouse House		
						Freeplay with caregiver			
18m	demographic questions	CODQ	ECBQ	AnotB non search	(motor check)	ESCS	Boxes	OCDI	AnotB search
		Freeplay with caregiver				Head vs. Gaze	Mouse House		Bayley
						Freeplay with caregiver			
24m	demographic, medical and language questions							OCDI	

Note. List of measures employed

a) AnotB search; classic AnotB task, with two wells (Diamond, 1985)
b) AnotB non search; non search version of the task, as described by (Ahmed & Ruffman, 1998)
c) Attention habituation; a habituation task with a neutral human face administered via a computer screen (an example paper is: Colombo, Freeseman, Coldren, & Frick, 1995)
d) Bayley; Cognitive Scale of the Bayley Scales of Infant and Toddler Development (Bayley, 2006)
e) BCQ; Baby Care Questionnaire (Winstanley & Gattis, 2013)
f) Boxes; adapted version of the "flower box" task described by Brugger et al. (Brugger, Lariviere, Mumme, & Bushnell, 2007)
g) CAI; Cardiff Antenatal Inventory (see Appendix A)
h) CODQ; Concepts of Development Questionnaire (Sameroff & Feil, 1985)
i) Demographic questions (see Appendix B)
j) Demographic, medical and language questions (see Appendix C)
k) ECBQ; Early Childhood Behavior Questionnaire (Putnam, Gartstein, & Rothbart, 2006)
l) ESCS; short version of the Early Social Communication Scales (Mundy, Delgado, et al., 2003)
m) Freeplay with caregiver; a 15 minutes freeplay situation in which the mother and the infant are alone in a room with a standardized set of toys
n) Gaze following; D'Entremont gaze following task (D'Entremont et al., 1997)
o) Head vs. Gaze; adapted version of the task described by Tomasello et al. (2007)
p) R-IBQ; Revised Infant Behaviour Questionnaire (Gartstein & Rothbart, 2003)
q) Medical status check; check of the "red" infant medical book to fill in any information missing from CAI or hospital medical records (see Appendix D)
r) Motor check; test of simple fine motor action necessary to be able to perform on the "Boxes" task
s) Mouse House; adapted version of the task described by Carpenter, Call and Tomasello (2005)
t) OCDI; Oxford Communicative Development Inventory (A. Hamilton, Plunkett, & Schafer, 2000)

2.3 Contributions and focus of this thesis

The different phases of Special Delivery project were mainly carried out by two PhD students of the Development@Cardiff group: Alice Winstanley and myself. In this paragraph, I am going to lay out in detail what has been my contribution to the project and what is included in this thesis.

Participants' recruitment prior to birth was equally shared between Alice and I, while the data collection was divided depending on the data wave. Alice was responsible for data collection at birth and 5 months, while I carried it out at 13, 18 and 24 months. Similarly, task designing, building of the apparatus, recruitment and assessment of additional pilot subjects, contacting participants for scheduling sessions, video coding design and primary video coding, were divided between Alice and I according to the data waves we were responsible for.

Additionally, I have been the secondary video coder for one of the tasks administered by Alice at 5 months. In order to help me with the video coding related to the tasks administered at 13 and 18 months, I have trained three other people (a PhD student, an RA and a Master's student intern) who have completed the secondary coding (or, for two tasks, the primary coding). With regard to the testing visits at participants' homes, I have trained three RAs to administer them, while I only carried out a very small number of sessions.

This thesis focused on a subset of the data collected at the ages I was responsible for, including data collected cross-domain, longitudinally and through different types of measures. The main part of the data reported here has been collected with two experimental measures administered at 2 ages (13 and 18 months), a parent report administered at 3 ages (13, 18 and 24 months) and a standardised measure administered at 18 months, as well as from the participants' medical records. Details on the measures are specified in the following chapters.

In the following paragraph I am describing procedures pertaining to the whole Special Delivery project, although giving more details about the 13, 18 and 24 months data waves for which I was responsible and are the focus of this thesis.

2.4 Procedures

All the procedures have been reviewed and approved by two different ethics bodies in 2011. By the Cardiff University's School of Psychology (Research Ethics Committee) and by the NHS (Research & Development and South East Wales Research Ethics Committee). Later additions and changes have also been approved by both Committees.

2.4.1 Data collection

2.4.1.1 Questionnaires at birth

After consenting to participate, caregivers received three paper questionnaires to fill in and return to the researcher (or send back by post with a freepost envelope within 35 days from the infant's birth, to accommodate for more complicated medical and family situations).

2.4.1.2 Testing sessions at the university

The sessions involving experimental measures (5, 13 and 18 months) took place at the School of Psychology, Cardiff University. To accommodate for both families' and lab's time needs, as well as looking for a time at which the infants were most likely to be awake and ready to play, we allowed for a window of ±15 days around the date at which each infant was turning 5, 13 or 18 months, considering their chronological age.

The laboratory had been designed to be baby friendly. Infant and caregiver were welcomed by the experimenter into a lounge area with comfortable sofas, refreshments and toys. An initial warm up period (usually between 5 and 20 minutes long) helped both the infant and the caregiver to get accustomed to the new situation. After taking the infants' measurement (weight, length and head circumference - only at the 13 and

18 months visits), the experimenter played with the infant while giving details to the caregiver about the upcoming tasks. Once the experimenter deemed that the infant was alert and settled, everybody walked to a nearby testing room and data collection began. At 13 and 18 months, since the testing sessions were longer, a break was introduced halfway through (after the first 15/20 minutes). The infant and caregiver were walked back to the lounge area, so that the infant could have some refreshments and play freely at his/her own pace for a few minutes, while the testing room was set up for the upcoming tasks (see Table 2.2).

Table 2.2
Administration order and duration for the 13 and 18 months testing session at the university.

warm up (lounge)	**AnotB non search**	**AnotB search**	**boxes task**	**mouse house task**	*break (lounge)*	**head vs. gaze task**	**ESCS short version**	**freeplay session**	*(lounge)*
10 min	**5 min**	**5 min**	**5 min**	**5 min**	*10 min*	**2 min**	**10 min**	**15 min**	*10 min*

Note. The total testing time was ~ 50min, with the total time spent at the university being ~ 1h 30min. The tasks were always administered in the same order for all participants at both 13 and 18 months.

Design

At both 13 and 18 months sessions, the tasks' administration order was the same for all participants. This configuration had been chosen so that the experimental tasks that mostly required the establishment of a positive interaction between the experimenter and the infant were not administered at the beginning of the testing session. Moreover, hypothesised shorter attention span and easier tendency towards fatigue and fussiness from the preterm sample (van de Weijer-Bergsma, Wijnroks, & Jongmans, 2008), dictated the choice of placing the most cognitively demanding tasks at the beginning of the session and the ones with adjustable administration pace at the end.

The counterbalancing was organised by grouping the participants (Pollatsek & Well, 1995) according to eight different possible combinations. Each combination mixed different counterbalancing orders conditions (for details see the Methods sections describing each task, in the following chapters). Each infant was tested following the same counterbalancing combination both at 13 and 18 months, to allow for more straightforward cross-age comparisons.

Video coding, scoring and reliability

The testing room was equipped with 4 cameras (two Sony Mini DV DCR-PR110E and two Sony HQ1 500 TVL vari-focal bullet cameras) that fed into an XVision 4 Channel Colour Quad. Audio feed came from a beyerdynamic MPC 66 VC SW boundary microphone into the Phonic MM1202a sound mixer. The room measured 350 x 430 cm and a rug in the centre (133 x 190 cm, padded with a blanket and covered with an easily washable black bed sheet) marked the area that was best captured by the cameras.

Video coding was carried out with the INTERACT software (version 9.1.2; Mangold, 2010) on PCs running Windows XP. A set of general rules established the ground for the coding style to reduce variability and minimise personal interpretation in scoring the behaviours. For example: a) be conservative: if a gesture is not well defined, it may not be rateable. It is better to not rate a gesture than to categorize it haphazardly without sufficient information; b) use the code when the described action begins, without considering the necessary movements before it (i.e., "touching" starts when the finger touches x, not when the hand starts moving towards x).

When trained to use a new set of codes, both coders would work on the same 4 to 6 videos and run an inter-rater reliability check. Thorough discussion would highlight the misunderstandings towards the wording of the codes' operational definitions, potential infant's behaviours that were unmatched by the codes and similar issues that needed solving before continuing. This phase was repeated until both coders would feel comfortable with the codes and inter-rater reliability was achieved. The main coder would then work on the entire sample, with the secondary coder working on a randomly chosen 25% of the videos. As the two coders would concurrently work through the sample, regular inter-rater reliability checks would make sure that the codes were still applied in the same fashion by both researchers, avoiding coding drift.

The inter-rater reliability was measured with Cohen's kappa (Cohen, 1960) using the built-in INTERACT tool for calculating it on different classes of codes. As Hollenbeck (1978) pointed out, since this statistic corrects for chance agreement, it produces lower values than the percentage agreement statistics often reported in the literature.

All Cohen's kappa (κ) values for reliability are reported in the individual tasks' method sections ahead. According to the characterisation of different κ values ranges by Landis and Koch (1977), $\kappa > 0.75$ may represent excellent, $0.40 < \kappa < 0.75$ may represent fair to good and $\kappa < 0.40$ may represent poor agreement beyond chance.

2.4.1.3 Questionnaires at 5, 13, 18 and 24 months

Questionnaires were collected for each of the three testing sessions carried out at the University. For the 5 months session, the caregiver was given a printed version of the questionnaires and was asked to complete them in the laboratory, after the testing was finished. Since the duration of the session was greater at 13 and 18 months, an online version of the questionnaires was set up to a hosting website (SurveyMonkey at first and later on Qualtrics). Caregivers were sent a link one week before the university appointment, so that they could more comfortably complete them at their convenience. In case caregivers were not able to complete the questionnaires on the day at 5 months, or online at the other visits, they were provided a freepost envelope with the printed questionnaires, so that they could easily return them after the testing session. The same online method was used to collect questionnaires at 24 months, age at which no testing appointment was due.

2.4.1.4 Testing sessions at participants' homes

At 18 months, a second testing session was scheduled after the one in the university laboratory, usually the subsequent week, in order to administer the Bayley Cognitive Scale (Bayley, 2006). To avoid asking the families to travel twice to the university, this session took place at the participants' homes. One of three research assistants, or the main experimenter, administered the task usually in the front room of the house, or any room the caregiver considered big enough. A foldable table and chair, plus two toddler size stools, were brought to every home to guarantee that the task was carried out in a comparable environment. A compact camcorder with a wide-angle lens (Veho VCC-005-MUVI-HD7 Muvi HD Mini Camcorder) was used to record the sessions. A set of toys, books and props are supplied with the test.

Scoring and reliability

Scoring is done during the testing, marking a 1 (pass) or a 0 (fail) for each task based on the child's performance. For the administration to be discontinued, the child needs to fail 5 tasks in a row. The total number of passed tasks constitutes the raw score of the scale. A portion of the test (20% per research assistant) has been secondary marked by the main experimenter and showed a very high correspondence.

2.4.2 Defining age (chronological and corrected)

As already mentioned, the testing sessions were scheduled based on the participants' chronological age. Contrary to what was discussed in the first chapter about the definition of prematurity, a large consensus is present regarding the labels' defining infant's age after birth (see Figure 2.1). Chronological age (or postnatal age) describes the infant's age counting the days, weeks, months and/or years from the day of birth. Corrected age (or adjusted age) describes the infant's age counting from the expected date of birth (40^{+0} weeks of gestation) regardless of when the baby was born. These two are therefore only the same if the infant is born at 40^{+0} weeks of gestation.

However, corrected age is usually only used for preterm infants. Therefore, for an infant born at 35^{+0} weeks there is a 5 weeks difference between the chronological and corrected age: at 5 months chronological age, the corrected age would roughly be 3 months and 3 weeks (depending on the length of the month). On the other hand, for an infant born at 37^{+4} weeks, commonly no correction is used for the 2^{+2} weeks separating the actual date of birth from the expected one, and therefore the chronological and corrected age are falsely considered to be matching.

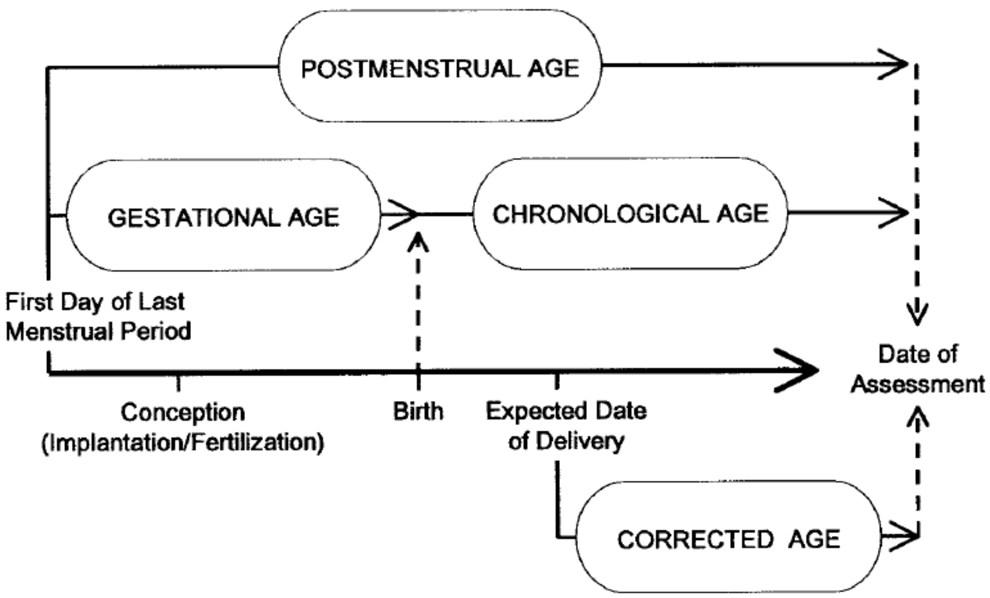


Figure 2.1. Age terminology for the perinatal period (Committee on Fetus and Newborn, 2004).

Age correction is used to mitigate the potentially confounding consequences of biological immaturity due to preterm birth on performance and growth measurements (DiPietro & Allen, 1991). However, even with large consensus on the definitions, the practice of correcting age for prematurity is applied in an inconsistent fashion. Although the most common way to approach age correction is to apply it until the child is 2 years of age (Den Ouden, Rijken, Brand, Verloove-Vanhorick, & Ruys, 1991), some clinicians and researchers recommend its use up to 3 years of age (Committee on Fetus and Newborn, 2004) and some continue correcting through age 5 and beyond (for reviews see DiPietro & Allen, 1991; Wilson & Cradock, 2004). In particular, given the widespread use of the Bayley developmental Scales (i.e., Bayley, 1993), many researchers recommend different - sometimes contrasting - approaches for the different subscales and at different ages within the first 2 years. Sometimes age correction is avoided since it can result in overestimation of preterm infants' performance or results comparable with their term peers, while for other subscales and/or at different ages is recommended due to significant difference between term and preterm infants' performances (Barrera, Rosenbaum, & Cunningham, 1987; Lems et al., 1993; Romeo et al., 2010; Susan A Rose, Feldman, & Jankowski, 2005; Wilson & Cradock, 2004). Moreover, most of the research addressing the prediction value of age correction is now dated and might not reflect the current features of the preterm population (Wilson & Cradock, 2004), other than being particularly focused on early rather than late premature births.

As Wilson and Cradock (2004) summarised in their review, the two different approaches are based on two theoretical perspectives on infant maturation. The biological standpoint, viewing early development as a maturation starting at conception independent of environmental influence, supports the age correction stance in order to remove the delay until preterm infants "catch up" with their term peers after the first years of life. The environmental standpoint, on the other hand, focuses on the role of the environment on development and the importance of social variables in overcoming the prematurity delay, therefore supporting the use of chronological age.

Since the last few decades, it has been shown that is important to consider both corrected and uncorrected performance scores. In this way, with the first, immaturity can be acknowledged and caregivers can have less daunting milestones timelines in mind (as such, avoiding over-referral), and with the latter, problematic developmental lags can be identified early and acted upon if necessary (Barrera et al., 1987; Den Ouden et al., 1991). In recent years, a more complex view on the subject has been consolidated. For various reasons, included the varied nature of the causes of premature birth, the differences in outcome gravity depending on the gestational age at birth, the presence of any co-occurring pathology, and the different developmental rate characterising various cognitive abilities and physical growth, applying a generic correction based on one single parameter could in fact introduce some bias in certain occasions, especially when exploring causal rather than descriptive models (A. J. Wilcox et al., 2011). A simple answer is therefore probably not possible for this issue, while different approaches, depending on the variables of interest and the scope of each study, seem to better adapt to the multi-faceted needs of preterm birth research. Nevertheless, age correction still seems the best approach in clinical settings and with regard to the families to better guarantee comparable scores and clearer developmental timelines.

As already mentioned, an issue with the age correcting practice is that it possibly hides problems, which then come up when the correction is discontinued and the toddlers' performance is suddenly evaluated on a different scale. The literature on long-term effects of preterm birth does show that preterm toddlers "catch up" with their term peers by the age of 2 when considering motor development, but results are mixed with regard to cognitive development, partially due to the heterogeneous participants samplings (for a review see Wilson & Cradock, 2004). Although the reason is not clearly attributable to the age correcting practice, it is common for toddlers and children born preterm to start showing difficulties in a gradual way, manifesting new or worsen negative outcomes as more complex abilities start to emerge, becoming even more evident and stable at pre-school and school ages, or even later on (Luciana, 2003; Marlow, Wolke, Bracewell, & Samara, 2005; Sansavini, Savini, et al., 2011).

Finally, an important, although frequently overlooked, element of this debate is the imprecision inherent in the calculation of the expected date of birth, which in turn weakens the validity of the gestational age estimate and therefore the age correction itself. Older ways of dating a pregnancy, like clinical obstetrics assessments and post-natal assessments are now mostly in disuse (for a review see DiPietro & Allen, 1991), leaving three main methods currently available: dating based on the last menstrual period, on basal body temperature, and on ultrasound. Dating based on the last menstrual period, commonly following Nägele's rule of 280 days developed in the early 19th century by the obstetrician Franz Nägele, could often be made unreliable by the woman's inaccurate recall of her last menstrual period, the irregularity of her cycle (usually influenced by young age, smoking, breastfeeding, oral contraceptive use and many other factors), the actual length of her cycle (which could deviate from the typical 28 days), the presence of early or light bleeding, undetected spontaneous abortions, and other elements (for reviews see DiPietro & Allen, 1991; Hunter, 2009). In a review summarising more recent studies, Hunter (2009) noted that dating based on basal body temperatures is usually considered more reliable, and used during insemination and in vitro fertilisation techniques. However, since measuring basal body temperatures is not a common monthly procedure for most women (and many pregnancies are unplanned), it cannot be considered a useful standard measure (Hunter, 2009). Dating based on ultrasound is the most reliable and available method, with different studies reporting different error ranges, but consistently around 8% of the gestation and so is most accurate in the first trimester (in which the estimated error is around ±7 days) (Hunter, 2009). Therefore, routinely calculating the expected date of birth via ultrasound scans, rather than last menstrual period, would help on many fronts: provide families with a more accurate date, or better yet, an "expected week of delivery", helping with the numerous social, emotional and practical matters related to it; reduce the number of post-term induced deliveries (by as much as 70%) due to incorrect dating and the preceding frequent medical checks (Hunter, 2009).

I would add that a more accurate dating would also potentially change the classification of many births occurring around the 37 weeks of gestation mark. In fact, even knowing that the estimate error is probably usually bigger than the optimal ±1 week range, acknowledging this error range would arise problems in the application of polices for medical care and is therefore commonly overlooked, creating situations in which infants born around 37 weeks of gestation might receive different levels of care for being considered officially born preterm or not. Moreover, regarding the debate around correcting age for prematurity, given that, if applied, the correction is used only for infants born before 37 weeks (and not for infants born between 37 and 40 weeks, or after 40 weeks), this practice would favour infants born right before the 37 weeks mark, compared to infants born right after it.

In the present study it was chosen to rely on chronological age to define the time of assessment for all participants, whether born preterm or at term. This choice was driven by the main aims of the study focusing on social development, and therefore the amount of infants' interactions with the environment and with the caregivers was deemed as important. Assessments based on chronological age enabled the Special Delivery project to consider the time actually spent by the infants outside the womb, interacting with caregivers and the world, in order to evaluate their ability level in doing so. Moreover, this choice guaranteed the same experience for all the participating families, with the same time window length in between the various data collection waves. Finally, Caputo, Goldstein and Taub (1981) suggested the use of chronological age for longitudinal studies, in order to better evaluate the presence of an actual deficit, a slower development or a temporary delay before the "catch up".

2.4.2.1 Gestational age as a continuous measure

In order to better report on outcomes differing by length of gestation, this thesis considers gestational age as a continuous measure and does not merely focus on group differences between infants born preterm and infants born at term. This decision was made due to the inherent difficulties in estimating the expected delivery date, and findings reporting that infants born between 37 and 40 weeks show more adverse outcomes than infants born at 40 weeks (Engle, 2011; Jean-Bernard Gouyon et al., 2010; Madar et al., 1999). Previous studies have already found a gradient showing that adverse outcomes decrease in rate as gestational age increases, linking preterm and term infants on a continuum rather than dividing them by a fixed cut off (Engle, 2011; i.e., Engle et al., 2007; Escobar, McCormick, et al., 2006; Escobar, Clark, et al., 2006; Oddie, Hammal, Richmond, & Parker, 2005).

2.5 The sample

2.5.1 Recruitment

All participants were recruited between April 2011 and November 2012. The majority of caregivers were approached at the University Hospital Wales (UHW), in Cardiff, UK, during hospitalization following delivery; additional parents were recruited while registering their baby at the Cardiff city registry office, or during family events, such as sales by the National Childbirth Trust (NCT). All parents provided informed written consent. A total of 147 participants were recruited, of which 62 (36 males) were born preterm and 85 (49 males) were born at term.

While recruiting at the UHW, the medical situation of possible participants was firstly checked with the hospital staff, so that caregivers were not approached if any neurological or congenital anomalies were diagnosed or suspected. Specifically, to be included in the study, infants had to meet four primary criteria: a) gestational age ≥ 30 weeks; b) singleton birth; c) no surgical intervention required before 8 weeks of age; d) absence of major cerebral damage [i.e., periventricular leukomalacia (PVL), severe intraventricular haemorrhage (IVH grade II or more), hydrocephalus], severe internal and respiratory problems [i.e., bronchopulmonary dysplasia (BPD), chronic lung disease

(CLD), necrotizing enterocolitis (NEC)], severe sensory impairments [i.e., retinopathy of prematurity (ROP)], chromosomal disorders or congenital abnormalities that could affect development. Additionally, mothers had to be 18 or older, and families needed to be able to reach Cardiff to continue the longitudinal study (all the families lived in the city or at no more than 2 hours away when recruited). A small group of 5 participants (3 born preterm and 2 at term) was excluded after recruitment, for different reasons: one infant was placed for adoption, one was added to the "child in need" register, one had health complications, one exclusion was due to the mother's history of depression and the last was wrongfully recruited since it was a twin birth.

Participation was rewarded with an age appropriate present at recruitment and at each testing session (a wooden rattle, a t-shirt, a book, a wooden clacker and another t-shirt), plus a £25 voucher at the last visit at the university (at 18 months) to motivate families to remain in the study. Each participant received a birthday card for their first birthday, which doubled as an additional reminder for the upcoming session, since the break between 5 and 13 months was the longest within the project.

When participants did not respond or were not able to take part in one of the testing sessions within the available time window, they were contacted again for the following one, unless they already lost two sessions in a row. A total of 29 participants (13 born preterm, 10 males; 16 born at term, 12 males) dropped off the study after completing the questionnaires at birth by participating in neither the 5 nor the 13 months sessions (by not responding when contacted, stating that they were not interested anymore, or not showing for a booked session). Attrition rates from the initial sample of 142 (after exclusions) were 20% considering both samples, 22% for the preterm born sample and 19% for the term born sample.

Of the remaining participants, 3 (all born preterm) took part only in the 5 months testing session. Therefore, focusing on the testing sessions for which I was responsible (one at 13, two at 18 and one at 24 months), a total of 110 participants were tested for at least one of these four sessions; 43 (23 males) were born preterm and 67 (35 males) were born at term. Attrition rates from the initial sample after exclusions were 23% considering both samples, 27% for the preterm born sample and 19% for the term born sample. The final participants number for each task is reported in the individual methods sections in the following chapters, since they include specific reasons for exclusions depending on the single task.

2.5.1.1 Specifications on recruiting the preterm born sample

There are many methodological problems linked with the investigation of the preterm population, since a series of elements can create important differences across studies. Such elements include: heterogeneity of the cohorts (for country and/or year of study), changes in the composition of preterm population given by different treatments and techniques in different Neonatal Units, differences in the parameters used to define prematurity (gestational age or birthweight), inconsistencies in the criteria used to report disabilities and their severity, varying ages of reporting outcomes (issue worsen by different practices in correcting age for prematurity), use of different assessment tests and techniques, as well as high attrition rates (Aylward, 2002b; Fernell & Gillberg, 2012; Myatt et al., 2012; Saigal & Doyle, 2008; van de Weijer-Bergsma et al., 2008). Moreover, preterm newborns do not necessarily belong to this group for the same reasons: as we saw in the first chapter, premature birth can be caused by and associated to a variety of circumstances and outcomes, each plausibly adding something different to the picture. Finally, participants born at term are chosen for the control group, although sometimes other choices (e.g., based on birthweight, based on medical complications before or at birth) would better fit with the hypotheses (Aylward, 2002b).

The Special Delivery study's inclusion and exclusion criteria addressed some of these difficulties as well as others. First of all, although birthweight was recorded, sample recruitment and classification was based on gestational age at birth. Focusing on infants born after 30 weeks of gestation, the more extreme medical situations were generally excluded, while the ones that would have still fallen into our sample have been excluded by the remaining medical requirements implemented for the study. Although these inclusion criteria do not necessarily guarantee a more homogeneous sample with regard to the causes of the preterm delivery, they should at least vouch for a more homogeneous wellness level within the preterm sample. Recruiting almost the entirety of the samples from the UHW contributed to address two issues: the medical care received by the study participants had to follow the rules applied in one single hospital within less than 2 years, reducing cohort differences; the demographical characteristics of the samples, although limited by the necessity of knowing a reasonable amount of English, were as varied as the hospital patients population can be. Finally, the choice of including only singleton births was motivated by the main aims of the Special Delivery study, as it focused on the social cognition and the social relations shaping the infants' environment. Although family composition varied across participants, the presence of twin pairs would have introduced a more substantial difference in parenting practices as well as social environment, which would have requested the creation of a sub-sample (see Carpenter et al., 1998).

2.5.2 Medical characteristics

Some history of medical complication was present across both samples, not necessarily just for the preterm infants: small for gestational age, suspected sepsis, signs of Respiratory Distress (RD), pneumonia, jaundice, hypoglycaemia, reflux, and intrauterine growth restriction. One preterm infant had IVH grade I. The two groups did not differ for Apgar scores at 5 minutes (see Table 2.3), showing the general good condition of the preterm sample at birth.

Table 2.3
Physical characteristics of the two samples at birth, 13 and 18 months of age (N=110).

		Preterm sample	Term sample	Difference between samples
		M (*SD*)	*M* (*SD*)	
Gestational age		34.27 (1.80)	39.95 (1.45)	$t(108) = 18.25, p < .001, r = .87$
Apgar score at 5 minutes		9	10	$U = 955.5, z = -1.94, p = .052, r = -.20$
Length of hospital stay (days)		7	2	$U = 2{,}484.5, z = 7.19, p < .001, r = .70$
Weight (g)	Birth	2162.23 (540.40)	3438.12 (569.77)	$t(108) = 11.69, p < .001, r = .75$
	13m	9821.75 (1208.36)	10389.64 (1114.17)	$t(94) = 2.38, p = .019, r = .24$
	18m	10903.24 (1531.71)	11700.16 (1317.54)	$t(96) = 2.73, p = .008, r = .27$
Head circumference (cm)	Birth	31.14 (1.91)	34.78 (1.66)	$t(84) = 9.46, p < .001, r = .72$
	13m	46.49 (1.51)	46.79 (1.33)	$t(100) = 1.07, p = .287, r = .11$
	18m	47.45 (1.47)	47.66 (1.30)	$t(96) = .74, p = .462, r = .07$
Length (cm)	13m	75.45 (3.61)	78.07 (3.40)	$t(99) = 3.72, p < .001, r = .35$
	18m	79.89 (4.43)	82.28 (3.52)	$t(96) = 2.96, p = .004, r = .29$

Note. The preterm infants sample included 43 subjects; the term infants sample included 67 subjects. Apgar scores were negatively skewed, while length of hospital stay was positively skewed, so a non-parametric test was used for these variables and the median (*Mdn*) was reported instead of the mean (*M*) and standard deviation (*SD*). Data were missing for: Apgar scores for 10 term and 1 preterm infants; length of hospital stay for 2 term and 1 preterm infants; weight at 13 months for 11 term and 3 preterm infants; weight at 18 months for 6 term and 6 preterm infants; head circumference at birth for 19 term and 5 preterm infants; head circumference at 13 months for 7 term and 1 preterm infants; head circumference at 18 months for 6 term and 6 preterm infants; length at 13 months for 7 term and 2 preterm infants; length at 18 months for 6 term and 6 preterm infants.

Regular checks with the families guaranteed that the researchers have been informed of any new medical problem emerged after recruitment (see Appendices B, C and D). Five participants (3 born preterm and 2 born at term) needed surgery: one at 8 weeks, two at around 5 months, one at 23 months, while another needed a second operation at 9 months after having the first at 4 for a dislocated hip and had to wear a cast for a period of time which slowed down her gross motor abilities. One participant born at term (GA 37^{+1}) was diagnosed at around 1 year with very mild cerebral palsy. When contacted for the 2 years questionnaires, one of the preterm born participants (GA 35^{+0}) reported a diagnosis for a genetic disease (Cystinosis, which caused Fanconi syndrome), while one of the term born participants (GA 39^{+6}) showed delayed language and was referred for possible ASD since it was already present in the family. All participants were tested with the third edition of the Bayley Scales (Bayley, 2006) at 18 months to check for cognitive development (see Appendix G for results).

Physical characteristics of both samples are summarised in Table 2.3. Considering the total of tested participants for the data waves included in this thesis (N = 110), the gestational age at birth and the birthweight were significantly different between samples, as expected (both *ps* < .001). Gestational age ranged between 30^{+0} and 36^{+6} weeks for the preterm sample and between 37^{+0} and 42^{+2} weeks for the term sample (days are reported in decimals in Table 2.3). Birthweight ranged between 880 and 3060 g for the preterm sample and between 2060 and 4680 g for the term sample. Additional variables that were significantly different between samples were: length of hospital stay, head circumference at birth, and, with small to medium effect sizes, weight and length at both 13 and 18 months (see Table 2.3).

Length of hospital stay ranged between 3 and 51 days for the preterm sample and between 0 and 20 days for the term sample. For some participants, part or all of this stay took place in the neonatal intensive care unit (NICU): for the preterm sample, 27 infants (63%) stayed at least one day in the NICU, while 16 (37%) did not; for the term sample, 4 infants (6%) stayed at least one day in the NICU, while 63 (94%) did not. There was a significant association between birth status (preterm vs. term born) and whether or not an infant stayed in the NICU, $\chi^2(1, N = 110) = 41.78, p < .001$. Odds ratio indicated that infants born preterm were 26.58 times more likely to stay at least one day in the NICU than infants born at term.

2.5.3 Demographical characteristics

The two samples (*N*=110) presented similar demographics (see Appendix A for the inventory used to collect this data at birth). Gender representation was comparable for the preterm (23 males, 53%; 20 females, 47%) and term (35 males, 52%; 32 females, 48%) born infants, $\chi^2(1, N = 110) = 0.16, p = 1.00$.

Table 2.4
Maternal demographical characteristics for the two samples at birth (N=110).

			Preterm sample	Term sample	Difference between samples
Age		*M* (*SD*)	31.35 (5.33)	32.34 (4.43)	$t(108) = 1.06, p = .291, r = .10$
Level of education	GCSE	*N* (%)	9 (21%)	7 (10%)	$\chi^2(3, N = 109) = 2.49, p = .489$
	A-level	*N* (%)	6 (14%)	8 (12%)	
	Bachelor's	*N* (%)	13 (30%)	24 (36%)	
	Postgraduate	*N* (%)	15 (35%)	27 (40%)	
Marital status	Married or engaged	*N* (%)	29 (67%)	49 (73%)	$\chi^2(3, N = 109) = 2.12, p = .617$
	Co-habiting	*N* (%)	5 (12%)	8 (12%)	
	In a relationship	*N* (%)	-	1 (2%)	
	Single or divorced	*N* (%)	9 (21%)	8 (12%)	
Household income	< £14,999	*N* (%)	10 (23%)	4 (6%)	$\chi^2(2, N = 107) = 8.19, p = .014$
	£15,000 - 39,999	*N* (%)	12 (28%)	16 (24%)	
	> £ 40,000	*N* (%)	20 (47%)	45 (67%)	

Note. The preterm infants sample included 43 subjects; the term infants sample included 67 subjects. Data were missing for: level of education for 1 term infant; marital status for 1 term infant; household income for 1 preterm and 2 term infants.

The study included both first-born and non-first-born infants (due either to the presence of natural or half siblings). First-born infants were more common in both samples (23 preterm, 54%; 42 term, 63%), rather than non-first-born infants (17 preterm, 39%; 25 term, 37%); data were missing for 3 preterm infants. There was no difference in the frequency of first-born or non-first-born infants between samples, $\chi^2(1, N = 107)$

= 0.28, p = .683.

Mothers' age collected at infants' birth ranged between 18 and 40 for the preterm sample and between 20 and 43 for the term sample, and did not differ between the two samples in a significant way. There were no differences between samples for maternal level of education and marital status, but there was a significant association between birth status (preterm vs. term born) and household income (see Table 2.4). Not all participants spoke English and the sample presented a high rate of bilingualism (see Appendix F).

2.6 Statistical analyses

The infants' performances have mainly been explored with two types of analyses. The first type was a series of factorial repeated-measures ANOVAs with age as the within-subjects factor and birth status as the between-subjects factor. This analysis was employed to check for group differences between preterm and term born infants, as well as for within group differences due to age in our longitudinal study. The choice of comparing the two samples was motivated by the predominance of this approach in the literature: although in recent years it has been shown that also early term infants have more negative outcomes than full term infants (i.e., Engle, 2011) and that there is a direct relation between higher gestational age and more positive outcomes (i.e., Jean-Bernard Gouyon et al., 2010), results are still predominantly presented as a group difference between infants born before or after 37 completed weeks of gestation. Therefore, the participants' performance was analysed comparing it between groups. This choice was made in order to compare the results with the available literature in a more direct way, as well as to ease other researchers' approach to the Special Delivery study's findings. This approach was more straightforward and could also be more helpful for translating the findings into indications for interventions or other practical activities and policies for families, schools and health workers. Finally, given our strict inclusion criteria, gestational age was supposedly the main element of difference between the two groups and this approach was therefore backed by a more solid study setup compared to other studies which might include also infants with serious medical conditions or other problems within the preterm born group.

The second type was a series of bivariate correlations exploring the relation between gestational age and the infants' performance in a given task. This analysis was included in order to be able to consider gestational age as a continuous variable and collapse all participants in one group instead of dichotomizing the sample. Therefore, it was possible to assess the relation between gestational age and outcome in a very simple, very direct way, also making the effect of gestational age in the late preterm and early term groups visible, without the influence of more extreme scores from participants at the ends of the gestational age scale. Also, in case of a group difference found with the first analysis, the correlations would help understanding if this was due to gestational age or not, making the first step towards more fine-grade analyses (i.e., moderation analyses) to investigate the reasons behind the group difference. The series of correlations was preferred to a series of one-way ANOVAs in order to reduce the possibility of Type 1 errors. In order to use ANOVAs, given the longitudinal design, it would have been necessary to use repeated-measures ANOVAs, which are however more commonly employed only with categorical, rather than continuous, data.

2.7 Summary

This chapter presented the Special Delivery study with its aims and methodological specifications. The two samples included in the study were described based on medical and demographical characteristics. From the following chapter, the focus shifts to the experimental measures used in the later data waves.

Chapter 3 - Social attention

3.1 Introduction

Infants born preterm show a different pattern of attention development compared to term infants, although not necessarily worse. This is true for pure attention behaviours – covert & overt orienting, sustained attention, endogenous attention (for a review see van de Weijer-Bergsma et al., 2008) – as well as for gaze following (i.e., Peña et al., 2014) and triadic (joint attention) behaviours, often explored in free-play mother infant interactions (i.e., Garner, Landry, & Richardson, 1991).

The normal development of visual attention describes many U shapes within the first two years of age. This has been shown for look duration as well as look latencies, both declining in the first six months and then rising again by around 12 months (Colombo & Cheatham, 2006). Colombo and Cheatham (2006) suggested that this change in tendency around the end of the first year of life depends on the development of a more endogenous type of attention. In fact, many changes in different brain areas (i.e., availability of better memory for sequences of actions) enable infants to have more control over what they pay attention to (i.e., what to orient to, how long to pay attention to it and when to start disengaging), shifting from a more exogenous to a more endogenous attention (Colombo & Cheatham, 2006). If measured at different ages, then, look duration is correlated with better cognitive outcomes in completely opposite ways: in the early months the optimal correlation is negative (i.e., shorter looks correspond to better cognitive abilities), while beyond one year, it is positive (i.e., longer looks correspond to better cognitive abilities). In a similar way, look latencies reflect two different processes before and after the end of the first year: earlier they are a measure of the ability to disengage attention, while later they show the infant's ability to inhibit the shifting of attention towards a distractor (Colombo & Cheatham, 2006). Results obtained from preterm samples showed deviant trajectories of development, with the preterm infants sometimes performing better than their full term counterpart, sometimes worse (for a review see van de Weijer-Bergsma et al., 2008). In particular, better performances were usually present at earlier ages, while as the preterm infants grew older, their initial advantage on their term peers ceased to exist and they begun lagging behind (van de Weijer-Bergsma et al., 2008). A particularly common result reported in the literature regards the difficulty, showed by preterm infants younger than 7 months (corrected age), to disengage from a visual stimulus (van de Weijer-Bergsma et al., 2008). However, the studies that are usually cited are either a bit dated (Landry, 1985; Susan A Rose, Feldman, McCarton, & Wolfson, 1988), have very small sample sizes (Landry, 1985), have a preterm sample with very low gestational ages at birth (*M* = 30.9, *SD* = 1.4, De Schuymer, De Groote, Desoete, & Roeyers, 2012; *M* = 29.6, *SD* = 2.9, Rose, Feldman, & Jankowski, 2001), or include infants with high risk medical situations (Landry, 1985; Susan A Rose et al., 1988). Moreover, researchers also found no difference between preterm and term infants in duration of looking between 2 and 6 months, corrected age (Bonin et al., 1998; Wilcox, Nadel, & Rosser, 1996).

With regard to indications of the influence of the extrauterine environment on the development of elements of the visual system, Jandó and colleagues (Jandó et al., 2012), using visual evoked responses, found that preterm infants developed binocularity at the same time than term born infants (i.e., at around 4 months, chronological age). The preterm sample was described as healthy and had a mean gestational age of 31.27 weeks (±3.03 weeks; range, 27–34 weeks), while the term sample had a mean gestational age of 39.07 weeks (±1.33 weeks; range, 37–40 weeks).

Concerning gaze following, recent results point towards an advantage for healthy preterm infants (even if born extremely preterm), given their early exposure to visual stimuli, compared to term born infants. Researchers found comparable performances between infants born extremely preterm and infants born at term, even testing the preterm infants at chronological age (at 7 months) (Peña et al., 2014). Two groups of extremely preterm infants (born between 29 and 31 weeks gestational age) were tested with the same procedure as two groups of term infants (born between 38 and 42 weeks gestational age). Infants in the preterm sample were healthy (i.e., had normal birthweight, Apgar score of 7 or higher at 1 and 5 minutes and were discharged from the hospital at around 34 weeks gestational age). The four groups enabled researchers to compare same/different chronological age as well as same/different corrected age across the preterm and term born samples. Gaze following responses were measured through eye-tracker and elicited via screen-presented photos of a researcher looking to the side to an object either orienting both head and eye gaze, or only eye gaze. Results showed that both preterm samples' performance was equivalent to that of the older term born sample, both in terms of correctness and latency of first gaze direction. Therefore extremely preterm healthy infants had gaze following performance at 7 months chronological age (4 months corrected age) comparable to both term infants at the same chronological age and preterm infants at 10 months chronological age (7 months corrected age), while the term born sample tested at 4 months lagged behind in both measures. Authors (Peña et al., 2014) concluded that the longer extrauterine experience helped the development of gaze following in the preterm samples, suggesting that the neural substrate was already mature enough to learn and process information from the environment and therefore stating the higher importance of chronological rather than corrected age when considering this ability.

Concerning triadic interactions, older studies, mainly comparing infants in free-play mother infant situations, reported that preterm infants had more difficulties with directing (IJA) rather than following attention (RJA) (Garner et al., 1991; Landry, Smith, MillerLoncar, & Swank, 1997). However, these studies grouped infants based on their birthweight (rather than gestational age) and lacked a comprehensive description of the medical situation of the infants. More recent and detailed studies found a more complex picture (De Groote et al., 2006; De Schuymer et al., 2011; Olafsen et al., 2006). Testing preterm infants around 24 months (chronological age) with the Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord et al., 2000), researchers found less than optimal development in the preterm compared to the term born group, with the first showing more difficulties with IJA (De Groote et al., 2006). An intervention study testing preterm infants at 12 months (corrected for prematurity) with the Early Social Communication Scales (ESCS; Mundy, Delgado, et al., 2003) found they had more difficulties with RJA (Olafsen et al., 2006), while another study using the ESCS, but at 14 months of age (corrected for prematurity) found no differences regarding IJA nor RJA between their preterm and term groups (De Schuymer et al., 2011). However, each of these three more recent studies included only very or extremely preterm infants (born before 32 weeks gestational age), with a high number of brain lesions and medical complications. Moreover, a percentage of the participants were twins and age was corrected for prematurity up to 2 years of age, but not beyond.

This chapter describes two studies designed to assess the infants' social attention. The first study explored gaze following, while the second study explored a series of social behaviours, including joint attention, behavioural requests and social interactions. Following Mundy and colleagues' view (Mundy, 2003; Mundy et al., 2000; Mundy & Jarrold, 2010) on the emergence of social attention skills (described in sections 1.3.3.2 and 1.3.3.3), the different social attention behaviours that were assessed were considered related to each other and not necessarily dependent on the awareness of others' intentionality in order to be refined and to provide the infants with useful tools to navigate their social world. Therefore, these tasks had an additional aim: examining if this model was supported by data also from the preterm sample. The first task tested the infants' interpretation of another person's eye movements compared to head movements, therefore examining on which cue were the infants (mostly) basing their reading of the situation. The second task tested the infants' performance on a series of behaviours chosen by Mundy and colleagues (Mundy, Delgado, et al., 2003) to examine different components of social attention and to assess if these behaviours rely on different cognitive networks.

3.2 Study 1: Head vs. Gaze task

It is easier to detect the direction of someone's gaze when gaze and head direction are congruent rather than incongruent (i.e., Ricciardelli & Driver, 2008). However, gaze alone is a very important source of information for humans, in particular with regard to attention direction (i.e., Emery, 2000).

Tomasello and colleagues (Tomasello et al., 2007) defined their cooperative eye hypothesis in relation to humans' tendency to engage in communicative and cooperative behaviours (i.e., joint attention behaviours) more frequently than other primates (Tomasello, Carpenter, & Hobson, 2005). This hypothesis is based on the particular morphology of the human eye: humans, compared to other primates, have exceptionally visible eyes (Emery, 2000; Kobayashi & Kohshima, 2001). In particular, when checked against more than 80 other primate species, it was shown that humans have the largest ratio of exposed sclera area and remarkable horizontal elongation of the eye outline (Kobayashi & Kohshima, 2001). In addition, the sclera is free of pigmentation and therefore contrasts with the coloured iris and pupil, as well as with the facial area around the eye. This suggests an adaptation to enhance the gaze signal, as opposed to the low colour contrast present in the other primates, which shows an adaptation to camouflage the gaze signal (Kobayashi & Kohshima, 2001). Recent findings supported the importance of the sclera from early on in development with regard to its role in conveying communicative information. Using an EEG paradigm, researchers found that 7-month-olds were capable of emotion recognition (between fearful vs. non-fearful eyes) and gaze direction detection (direct vs. averted) simply by unconsciously processing sclera information. In fact, even though the stimuli were presented subliminally (i.e., for only 50 ms), they had an effect on the participants' responses (Jessen & Grossmann, 2014).

The Head vs. Gaze task administered in the Special Delivery study has been adapted from the version used with great apes and infants by Tomasello and colleagues (Tomasello et al., 2007). In their study, the experimenter would sit in front of the participant, call attention to himself and then look at the ceiling (with no particular stimulus present there) for about 10 seconds. Participants' responses were assessed for attention following in each trial by examining the presence of looks at the ceiling (i.e., orienting the head and eyes upward) vs. other directions. Six possible conditions were set by differences in the experimenter's style in looking at the ceiling. In the Head Only condition, the experimenter closed his eyes and moved his head as if looking at the ceiling; in the Eyes Only condition, he kept his head straight and moved his eyes towards the ceiling; in the Both condition, he moved both eyes and head to look at the ceiling; in the Neither condition, the experimenter kept both eyes and head straight looking at the subject. Two control conditions, in which the experimenter sat with his back to the subject, were implemented: the Back of Head condition, in which the experimenter looked at the ceiling; and the Back Control, in which the experimenter kept looking straight ahead.

The procedure has been adapted in multiple aspects for different reasons. First of all, the Back of Head condition and the Back Control condition were not included in the procedure because of indications from the original study. Tomasello et al. reported that *"The Back Control condition was not used with the infants because pilot testing revealed that many infants became upset when the experimenter turned his back and paid no attention to them"* (Tomasello et al., 2007, p. 317). Because of this, in the

Special Delivery study was excluded also the Back of Head condition in order to have a more balanced set of conditions: Tomasello et al. (2007) compared results from the Back of Head condition with the ones from the Neither condition, but excluding both conditions in which the experimenter was not facing the infant seemed a cleaner option. Additionally, it seemed plausible that the infants would become upset also with the Back of Head condition and I wanted to avoid any element of discomfort, especially since this task was administered right before a task that required a positive environment (see section 3.3). Moreover, the direction of the head/gaze movement was changed from the ceiling to the sides, for multiple reasons. Piloting testing revealed that the infants at 13 months tended to not follow the experimenter's head/gaze movement towards the ceiling once they saw that there was nothing particularly interesting there, while their response was more reliable if there was a clear stimulus that could be the focus of the head/gaze movement. It therefore seemed both useful and practical to direct the infants' attention towards the posters attached to the sides of the room. The number of trials was therefore counterbalanced across the two sides. Finally, the total number of trials was diminished in order to keep the total length of the testing session manageable.

The results from the study by Tomasello et al. (2007) confirmed their cooperative eye hypothesis: infants relied more on eye than head movements, while the non-human primates did the opposite. Looking only at the results from the human participants, there was a main effect of age, with 18-month-old participants following gaze more often than 12-month-olds.

Other studies investigated the difference between head and eyes cue on infants' gaze following (Brooks & Meltzoff, 2002, 2005). Although younger infants seem to recognise the importance of gaze, results showed that infants do not follow the direction of gaze alone until around 18 months (for a review see Moore, 2008).

Research focusing specifically on gaze following abilities in a preterm born sample is scarce, but studies focusing on gaze shifting abilities in first few months of life reported that infants born preterm have more difficulties and a more immature pattern of gaze behaviours (Butcher, Kalverboer, Geuze, & Stremmelaar, 2002; De Schuymer et al., 2012; Harel et al., 2011). Moreover, preterm born infants have been shown to avert gaze more often than their term born peers in social situations (De Schuymer et al., 2012). However, a recent study on healthy low-risk preterm infants showed that they do not demonstrate differences in gaze following compared to term infants, even if tested at chronological age (Peña et al., 2014). Despite this last study, the hypothesis for this task was that the preterm born sample would follow gaze less reliably than the term born sample. An effect of age was expected, as shown by previous research on term infants (Brooks & Meltzoff, 2002; Warneken & Tomasello, 2007).

3.2.1 Methods

3.2.1.1 Participants

A total of 89 participants had a viable set of data for both the 13 and 18 months testing session and could therefore be included in the analyses: 33 (21 males) from the preterm sample and 56 (27 males) from the term sample. From the initial sample of 110 participants, 21 (10 preterm, 2 males; 11 term, 8 males) were not included for different reasons.

At 13 months, 1 participant did not take part in the session due to health problems and another 9 were excluded after testing (3 for failure of the recording equipment, 2 because of fussiness, 1 because the coding of the gaze location was too uncertain due to lazy eye, and 3 because they did not meet the minimum number of valid trials - see section 3.2.2). At 18 months, 12 participants did not take part in the session (5 due to health problems with the mother or other family complications, 1 because they moved to Australia and 6 because of no response or lack of interest) and another 6 were excluded after testing (2 because of fussiness/restlessness, and 4 because they did not meet the minimum number of valid trials - see section 3.2.2). Since in some cases there have been complications with the same participant both at the 13 and 18 months testing session, the sum of participants not included at each age ($N = 28$) is higher than the total of participants not included at both ages ($N = 21$).

3.2.1.2 Materials

Four posters (52 x 76 cm) were hung on the testing room walls, depicting colourful pictures of numbers, animals and/or daily activities. For this task, only two posters were involved in the experimenter's demonstration: the ones hung to the infant's sides. They were placed at about 90° to the left and right from a small table (33 cm L x 40 cm W x 46 cm H) and chair (with the seat at 20 cm from the floor) where the infant was sitting (see Figure 3.1). A colourful squeaky rattle was used by the experimenter to get the infant's attention.

3.2.1.3 Procedure

The parent was asked to sit behind the infant and to not interfere with the testing. The experimenter was sitting on the floor, across a little table, while the infant was sitting on a little chair, so their eye line of view was about the same height. Moreover, the experimenter never wore glasses and made sure that her hair was not covering her face.

The experimenter began the task by directing the infant's attention to her face with the help of a squeaky rattle. In case the infant was not redirecting the gaze towards the rattle, the experimenter would run her fingers on the table and/or call the infant's name. If the gaze locked on the rattle rather than being shifted to the experimenter's face, the experimenter would touch her nose to help the transition.

Figure 3.1. Picture of the testing room ready for the second half of the testing session, including the Head vs. Gaze task and ESCS.

Once the experimenter was sure the infant was looking at her face, she would direct her attention at one of the two posters. Depending on the condition, this could be done in three ways: a) Head and Eyes condition, turning the head towards the poster with open eyes; b) Head Only condition, closing the eyes and turning the head towards the poster; c) Eyes Only condition, keeping the head straight while moving the eyes towards the poster (see Figure 3.2).

The experimenter looked/faced the poster for 3 seconds before returning looking at the infant and smiling. If necessary, the experimenter repeated the attention-gaining actions before starting the following trial.

3.2.1.4 Task structure and counterbalancing

Trials were organised so that turns towards left and right were always alternated. Each participant was presented with two trials per condition, one towards the left poster and the other towards the right one, for a total of six trials. Counterbalancing was implemented throughout the participants' sample by swapping the order of the conditions (four possible orders were used) and the starting side (for half of the sample the experimenter turned left first). The same order was used for each participant at both the 13 and 18 months sessions.

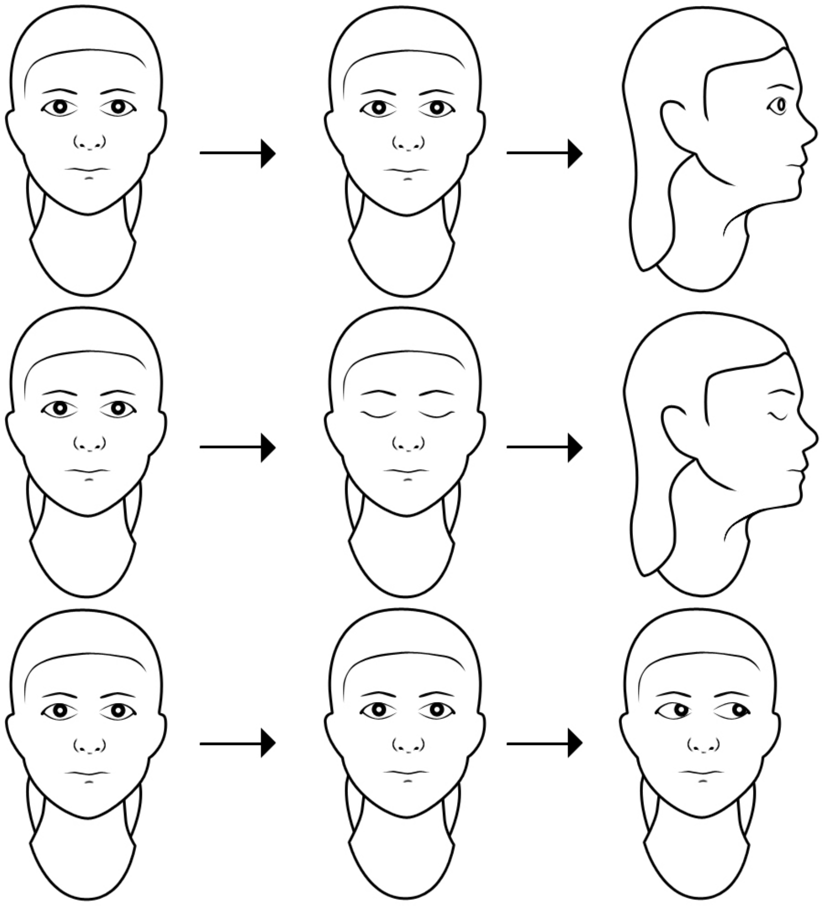


Figure 3.2. Illustration of the actions performed by the experimenter during the Head vs. Gaze task. From the top: Head and Eyes condition, Head Only condition and Eyes Only condition (all towards the left poster).

3.2.1.5 Video coding and reliability

The coding was focused on the end location of the infants' looks. This was coded with exhaustive and mutually exclusive codes marking if the infant was looking to one of seven locations, was fussy (i.e., crying, trying to escape the chair or wondering around the room), or if the eyes were not visible. The seven possible locations were: to the right/left side (i.e., between 30° and 90° from the experimenter's position), to right/left behind (i.e., between 90° and 180° from the experimenter's position), to the experimenter (e.g., her face, torso or hands), to the caregiver (who was usually sitting behind the infant or slightly to the side) or away (e.g. at/under the table, to the ceiling, at the cameras, at the toy box).

The experimenter's behaviours were coded to mark the beginning of each trial with discrete codes applied to a single frame. This was identified as the moment in which the experimenter started turning her head and/or eyes towards one side. To keep this uniform across conditions, the same was done also in the Head Only condition, although the experimenter closed her eyes and faced the infant for about one second before the head turning.

A reliability coder (blind to the hypotheses and participants' birth status) coded two random selections of the videos, one per age group. The mean inter-rater agreement across both ages for the infants' behaviours was $\kappa = .84$. At 13 months, 26 out of 103 (25%) videos were secondary coded, with an excellent inter-rater agreement for the infants' behaviours (mean $\kappa = .83$, min $\kappa = .58$, max $\kappa = 1$). At 18 months, 24 out of 96 (25%) videos were secondary coded, again with an excellent inter-rater agreement for the infants' behaviours (mean $\kappa = .85$, min $\kappa = .55$, max $\kappa = 1$). The experimenter's behaviours always scored a perfect agreement of $\kappa = 1$.

3.2.1.6 Design

The administration of the task followed a repeated measures design. The dependent variable included in the analyses reported here was frequency of correct gaze, calculated for each of the three experimental conditions at both ages. A correct gaze corresponded to the presence of one of the two goal codes – to the right/left side or to the right/left behind – as the first coded infant's behaviour after the experimenter begun a trial directed to the matching direction (right or left). In case the first coded infants' behaviour after the beginning of the trial was a to the experimenter code, the correct gaze corresponded to the presence of one of the two goal codes as the second coded infant's behaviour after the beginning of the trial. Since different participants had a different number of valid trials per condition, frequency of correct gaze was computed as a percentage.

3.2.2 Results

Initially, coded behaviours were checked in order to distinguish valid and invalid trials. A trial was defined as valid if the infant looked at the experimenter at least from the beginning of the eye/head turn marking the new trial or within 1 second after the beginning, so that the infant could properly experience the stimulus (see Table 3.1). Participants with 0 valid trials for one or more conditions either at the 13 or 18 months testing session were excluded from all analyses ($N = 3$; 1 born preterm and 2 born at term; see section 3.2.1.1).

Table 3.1
Number of participants with 2, 1 or 0 valid trials per each condition at both 13 and 18 months.

		Preterm sample			Term sample		
	Number of valid trials	2	1	0	2	1	0
13 months	Head and Eyes	29	5	0	56	2	0
	Head only	27	7	0	52	6	0
	Eyes only	27	6	1	53	5	0
18 months	Head and Eyes	24	10	0	45	13	0
	Head only	21	13	0	36	21	1
	Eyes only	19	15	0	39	17	2

Note. The total number of participants per age group reported in this table ($N = 92$) differed from the total included in the analyses ($N = 89$) since it included also 3 participants who had 0 valid trials in at least one condition.

Preliminary analyses showed that no group differences on frequency of correct gaze resulted from participants belonging to the 8 different counterbalancing orders, nor different genders, at both ages (all $ps > .265$). Therefore groups based on these parameters were collapsed into a single one for subsequent analyses.

3.2.2.1 Analysis by birth status

Mean percentages of gaze following to the correct location for participants with

2 valid trials were summarised in Table 3.2, based on raw data for ease of interpretation. A series of Independent-Samples Mann-Whitney tests were run to check for differences between the two samples for each condition at both ages, including only participants with 2 valid trials. The number of trials with infants' gaze towards the correct location did not differ significantly between the preterm and the term born samples in any condition for both ages (all *ps* > .370). Also, a series of Related-Samples Wilcoxon Signed Rank tests were run to check for differences within the two samples for each condition across the two ages. Results showed no significant differences in the number of infants' gaze towards the correct location for any condition across ages in the two samples (all *ps* > .05).

Table 3.2
Mean percentages of infants' gaze towards the correct location. Results are reported only for participants with 2 valid trials in each condition at both ages (preterm N = 10, term N = 25).

		Preterm sample *M* (*SD*)	Term sample *M* (*SD*)
13 months	Head and Eyes	0.15 (0.34)	0.20 (0.29)
	Head only	0.25 (0.43)	0.24 (0.29)
	Eyes only	0.05 (0.16)	0.14 (0.23)
18 months	Head and Eyes	0.10 (0.21)	0.14 (0.23)
	Head only	0.20 (0.26)	0.10 (0.20)
	Eyes only	0.05 (0.16)	0.06 (0.17)

3.2.2.2 Analysis by gestational age

Data was also analysed collapsing the two samples into a single one and exploring the relation between gestational age and the dependant variable. A bivariate correlation showed that the direction of the association was different depending on the experimental condition and the age of participants (see Table 3.3). However, only one correlation reached statistical significance (infants born at younger gestational ages showed fewer correct responses in the Head and Eyes condition at 13 months), underlying the general absence of an association between gestational age and frequency of correct gaze.

Table 3.3
Spearman's rho correlations between gestational age and frequency of correct gaze for the different experimental conditions at both ages.

	Frequency of correct gaze					
	13 months			18 months		
	Head and Eyes	**Head only**	**Eyes only**	**Head and Eyes**	**Head only**	**Eyes only**
Gestational age	.210*	.050	-.020	-.128	.018	-.131

Note. * $p < .05$ (two-tailed)

3.2.3 Discussion

Results showed that infants made the same number of correct looks, following the experimenter's shift in attention, across all experimental conditions. Also, there was no effect of age on the results, showing that performance at the group level was continuous between 13 and 18 months. The same results were true for both preterm and term infants.

The correlations between gestational age and participants' performance were mainly non-significant. There was only one positive correlation with correct performance at 13 months in the Head and Eyes condition, indicating that the frequency of correct gaze increased with gestational age. However, although results were not significant, this relation was negative at 18 months. Again, although not significant, performance in the Head only condition was better as gestational age increased, while performance in the Eyes only condition worsened as gestational age increased.

3.2.3.1 Conclusions

Two main conclusions can be made. First, contrary to the hypothesis that birth status (preterm vs. term) would have a significant effect on performance, no difference was found across samples. A positive correlation with gestational age was found with regard to the Head and Eyes condition at 13 months, suggesting that infants born at earlier gestational ages could have more difficulties. However, as this is the supposedly easiest condition, it was surprising to not find similar correlations with performance in the other conditions (especially the one including only gaze movement). Although no significant difference was found across experimental conditions, therefore not supporting the cooperative eye hypothesis by Tomasello et al. (2007), by looking at the descriptive data it can be seen that infants of both samples relied more on head movements alone rather than eye movements or eye and head movements combined. This indication, although not statistically significant, but could be due to a series of limitations of the study (see section 3.2.3.2).

Second, also contrary to expectations, no effect of age was found, showing that infants behaved similarly at 13 and 18 months, for both the preterm and the term samples. In particular, it was surprising to not find an age effect in the term born sample, given past findings showing that infants do reliably follow the direction of gaze alone from around 18 months (Chris Moore, 2008). Again, possible reasons for which the task could have been too difficult even for term born infants at 18 months, or not enough sensitive to differences in performance, are listed in the limitations section (3.2.3.2).

3.2.3.2 Limitations

Many limitations should call for cautiousness in the interpretation of the results.

Most importantly, only 2 trials per condition were administered, providing a very limited number of data in order to properly compare the three conditions. Moreover, many trials had to be excluded because invalid (see section 3.2.2), leaving a good number of participants with only 1 valid trial per condition. The lack of an age effect could probably be due to this problem, which favoured the presence of extreme results (i.e., only one correct trial was sufficient for a perfect performance and only one wrong trial was sufficient for a floor performance). Conversely, including in the analyses only participants with two valid trials, the sample size was rather small and very uneven across groups (preterm $N = 10$, term $N = 25$), therefore only allowing for a limited exploration of the data.

Secondly, despite piloting the task before beginning data collection, it is possible that the administration lacked interest for many participants. From video coding, it was noted that this was the task during which infants would often become more impatient and fussy, compared to the rest of the experimental session, especially at 18 months. The behaviour of the experimenter could have been easily seen as deviant from a normal interaction (especially since the experimenter was not talking during the task administration) and the posters on the walls were not a particularly interesting target location to look at.

3.2.3.3 Future directions

Future analyses on this dataset, or a more complete dataset with a higher number of trials per condition, could focus on two aspects. The direction of infants' gaze could be checked in order to have a better picture of what they were looking at when they were not matching the experimenter's head/eyes turn. From video coding it was noted that the experimenter's behaviour in the Eyes only condition was often followed by the infants' look under the table, or to the floor. It is possible that since the eye lids would cover half of the experimenter's eyes while looking to the side and keeping the head straight, this was interpreted as a look to the floor, rather than to the side. This element could also explain the absence of a match with the results by Tomasello and colleagues (Tomasello et al., 2007), since instead of looking to the left or right side, the experimenter in their study would look to the ceiling, clearly showing the entire eye.

Duration and latency of looks could be analysed on the collected data, to check for differences across samples, as well as correlations with gestational age. As reported by Colombo and Cheatham (2006), performances on these two measures should change around the end of the first year of life, starting to rise after months of declining. Differences between samples might therefore be visible at the 13 months testing, when term born participants should show higher scores than their preterm peers. Since this shift in duration could be dependent on a shift from exogenous to endogenous attention, look duration and latency should correlate with results on the AnotB task at 13 months, which measures action inhibition. If longer look duration and latency correspond to higher control on attention direction, higher inhibition against distractors, better memory for sequences of actions, data from the Head vs. Gaze task should correlate with other measures of these cognitive abilities included in the Special Delivery study. Analyses could explore the predictive value of look duration and latency at 13 months on results on the AnotB task at 18 months, as well as on the Bayley cognition scale at 18 months.

3.3 Study 2: Shortened version of the Early Social Communication Scales

The Early Social Communication Scales (ESCS) were developed by Mundy and colleagues in the early '80s of the past century (Seibert et al., 1982). The original scale was designed with a clinical aim, based on two main constructs: a cognitive, Piagetian, stage-related one, and a pragmatic-functional construct. The semi-structured situation was arranged to elicit and encourage interaction between the tester and the infant. The videotaped behaviours were scored according to the two constructs, considering: the developmental stage (simple, complex, conventional, symbolic), the communicative goal (joint attention, behavioural request or social interaction), and the infant's role (initiating the interaction or responding to it).

The new abridged version (Mundy, Delgado, et al., 2003) presents a simplified structure and is a very accessible and practical instrument. Requiring between just 15 and 25 minutes to be administered, this new version can be either used in a research or a clinical setting. It is designed to assess typically developing infants between 8 and 30 months of age, and/or infants with developmental delays with matching verbal age. Therefore, the new version can measure both individual and group differences. The abridged ESCS is defined as a "videotaped structured observation measure" (Mundy, Delgado, et al., 2003, p. 1) aiming to enable the infant to show his/her nonverbal communication skills, by using a friendly and stimulating setting. The theoretical framework reflected in the abridged scale is broader compared to the original scale, and the authors refer to a wide range of social, cognitive, regulatory and affective processes as cause of the measured behaviours (Mundy, Delgado, et al., 2003). The behaviours observed and scored during administration belong to three classes: joint attention, behavioural request, and social interaction. These are further classified based on the function of the behaviour: if it is used to initiate a communication bout or to respond to it. ESCS scores are therefore calculated on six scales: initiate (IJA) and respond (RJA) to joint attention, initiate (IBR) and respond (RBR) to behavioural request, initiate (ISI) and respond (RSI) to social interaction (see section 3.3.1.4 for a detailed description of the behaviours assessed with the ESCS).

Employed with a typically developing sample, the new ESCS showed dissociations between different joint attention abilities, suggesting that their development depends on separate cognitive processes. In particular, frequency of IJA behaviours did not display the same linear increase as the other abilities (see Figure 3.3; Mundy et al., 2007).

Neuropsychological research showed that RJA was associated with parietal activation, IJA was regulated by the activation of frontal systems, while IBR and RBR were not as clearly associated with the anterior or the posterior attentional systems (Mundy et al., 2000). The posterior attentional system, regulating RJA, is involved in rapid and involuntary attention orienting, prioritising biologically meaningful stimuli. It is supported by neural networks involved in more complex attention processes, like the perception of eye and head orientations of others and the elaboration of these information to redirect one's gaze (for a review see Mundy & Jarrold, 2010). The anterior attentional system, regulating IJA, is involved in a more self-initiated and goal-directed type of attention. For example, its development provides 4-month-olds with the ability to inhibit automatic saccades towards a first stimulus in order to attend to a more interesting second one, as well as 6-month-olds with the ability to disengage from a more relevant stimulus in order to attend to a peripheral target (for a review see Mundy & Jarrold, 2010).

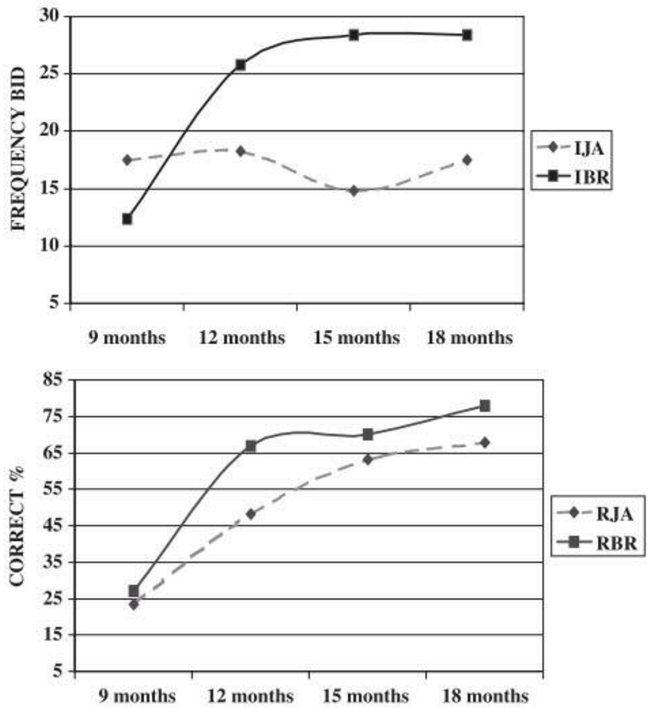


Figure 3.3. Age related growth patterns for IJA and IBR (top) and RJA and RBR (bottom) in a typically developing sample (Mundy et al., 2007).

In fact, Mundy and colleagues (Mundy et al., 2007) found no correlation between performances on the IJA and the RJA scales. Instead, scores on IBR and RBR scales were positively correlated, showing some commonality of processes guiding the behaviours measured in these scales. Moreover, IJA and RJA showed a significant stability across the three periods of 9-12, 12-15, and 15-18 months. On the other hand, performances on IBR showed limited stability and RBR scores showed no stability across these ages (Mundy et al., 2007)

To my knowledge, only two other studies have documented differences between preterm and term populations on the Early Social Communication Scales (Mundy, Delgado, et al., 2003) at around the same ages as the ones investigated within the Special Delivery study (De Schuymer et al., 2011; Olafsen et al., 2006).

De Schuymer et al. (2011) investigated the effect of joint attention on language, testing infants multiple times between 3 and 30 months. While results relative to language performance are discussed in chapter 5, here I focus solely on the ESCS results. Infants were tested at 14 months (age corrected for prematurity for the preterm sample) with the ESCS. Considering frequencies in initiating (IJA) and responding (RJA) to joint attention and initiating behavioural response (IBR), De Schuymer et al. found differences only in IBR between their preterm and term samples, with preterm infants performing IBR behaviours less frequently. However, considering their results from the 9 months testing (age corrected for prematurity for the preterm sample), authors showed a difference between preterm and term infants. Infants were tested through an interaction with an experimenter who alternated dyadic and triadic attention conditions. Preterm infants showed on average less than half of RJA behaviours (to the side locations) compared to term infants. In this case the authors did not consider the frequency of the behaviour, but the percentage duration of gazing at the target minus gazing at the non-target. Results from the 9-months-old participants testing are relevant here since considering the participants' chronological age (between 14 and 8 weeks higher given their gestational ages at birth), the chronological age of their preterm sample would have been between 11 and 12.5 months.

The second study comparing preterm and term infants on their performance on the ESCS is an intervention study by Olafsen et al. (2006). The intervention focused on teaching parents to identify the infants' cues, enabling them to respond promptly or to suspend response when more appropriate given the infants' needs. Each family had 11 hours of hourly sessions with a specially trained nurse, between 2 weeks before the planned discharge and 19 days after discharge. Infants were then tested with the ESCS (Mundy, Delgado, et al., 2003) at 12 months (age corrected for prematurity for the preterm sample). Their intervention had a positive effect on the IJA, IBR and RSI (responding to social interaction) indexes, but no effect on the RJA or the RBR ones. They therefore concluded that RJA and RBR were the abilities mostly affected by prematurity.

Another study tested a preterm born sample with the ESCS (results from the same testing in 1986-90 were reported in two publications; Smith & Ulvund, 2003; Ulvund & Smith, 1996), but the first version of the scale was used. Since many of the tasks included in the first version (Seibert et al., 1982), as well as the theoretical framework they were built on, presented substantial differences compared to the abridged new version (Mundy, Delgado, et al., 2003), it would be hard to compare the results of that study with the ones presented in this thesis.

Both studies on preterm samples (De Schuymer et al., 2011; Olafsen et al., 2006) reported a difference based on birth status on RJA scores, with preterm infants scoring lower than their term peers at 9 and 12 months, corrected age. Therefore, with regard to the results presented here, preterm infants were expected to report lower scores on the RJA at 13 months. Since no differences were found between samples at 14 months, corrected age (De Schuymer et al., 2011), the hypothesis for Special Delivery results at 18 months, was to find no differences based on birth status. Both studies found no differences on the IJA scale (De Schuymer et al., 2011; Olafsen et al., 2006) and I therefore hypothesised the same for our samples. With regard to IBR and RBR the two studies found opposite results: in one preterm infants did worse on IBR and presented no difference on RBR with term infants (De Schuymer et al., 2011), while in the other preterm infants did worse on RBR and presented no difference on IBR with term infants (Olafsen et al., 2006). No results were reported on the ISI and RSI scales (De Schuymer et al., 2011; Olafsen et al., 2006), as they are commonly overlooked also in typical development studies (i.e., Mundy et al., 2007). I therefore had no clear hypotheses regarding results on these four scales.

3.3.1 Methods

3.3.1.1 Participants

A total of 91 participants had a viable set of data for both the 13 and 18 months testing sessions and could therefore be included in the analyses: 34 (21 males) from the preterm sample and 57 (28 males) from the term sample. From the initial sample of 110 participants, 19 (9 preterm, 2 males; 10 term, 7 males) were not included for different reasons.

At 13 months, 1 participant did not take part in the session due to health problems and other 4 were excluded after testing (2 for failure of the recording equipment and 2 because of fussiness). At 18 months, 12 participants did not take part in the session (see section 3.2.2.2 for reasons) and other 3 were excluded after testing (3 because of fussiness/restlessness). Since in one case there have been complications with the same participant both at the 13 and 18 months testing session, the sum of participants not included at each age (N = 20) is higher than the total of participants not included at both ages (N = 19).

A few participants were later excluded from single tasks within the ESCS due to specific problems (i.e., not liking the sound or motion of the mechanical toys or experimenter's errors). Detailed *Ns* per tasks are noted in the results section when necessary.

3.3.1.2 Materials and procedure

The ESCS manual (Mundy, Delgado, et al., 2003) lists a detailed description of how to administer each of the tasks included in the scale, together with a description of the room set-up and general administration guidelines. Throughout these instructions emphasis is always put on keeping the infant interested in what is happening, and maintaining a positive relationship that would enable the infant to interact with the tester.

A set of toys (see Figure 3.4), posters on the walls, and proper interactive elements (i.e., singing, tickling), were the means by which the infant was prompted by the tester. The different tasks were aimed at creating the best setting for different social-communication behaviours to be used; therefore the tester performed different actions in all of them. The eight ESCS tasks can be carried out with more than one object/toy, to allow multiple trials during one administration and avoid repetitions that could make the infant lose interest.

Figure 3.4. Set of toys used in the Special Delivery study during the administration of the short version of the abridged ESCS (Mundy, Delgado, et al., 2003).

The room for the ESCS was set up so that the tester and the infant were sitting face to face across a little table. The experimenter was sitting on the floor, while the infant was sitting on a little chair, so that their eye line of view was about the same height. Moreover, the experimenter never wore glasses and made sure that her hair was not covering her face. A box with the toys was put next to the tester, who could have access to them, while the infant could only see these toys (see Figure 3.1). The caregiver was present to make the infant more comfortable, but was asked not to intervene in the interaction.

A simplified description of the procedures is reported in Appendix E, but the complete details are available in the original manual (Mundy, Delgado, et al., 2003).

3.3.1.3 Task structure and counterbalancing

Following Peter Mundy's advice (*personal communication*), not all the tasks included in the original abridged ESCS (Mundy, Delgado, et al., 2003) were used in the Special Delivery study, in order to shorten the testing session. As suggested in the original manual (Mundy, Delgado, et al., 2003), the presentation order was the same for all participants and the same type of task was repeated twice with some difference. The first four tasks were: a) a Response to Invitation task (with a hat); b) an Object Spectacle task (with a wind-up frog and a hand-held fish); c) a Social Interaction task (singing "Itsy-bitsy Spider"); d) a Gaze Following task (pointing to the four posters going from Left, to Left Behind, to Right and Right Behind). The second half of the shortened ESCS included: a) a Turn Taking task (with a ball); b) the same Object Spectacle task run with different toys (a wind-up boat and a hand-held clown); c) the same Social Interaction task; d) the same Gaze Following task run pointing at the posters in a different order (Right, Right Behind, Left, Left Behind).

3.3.1.4 Behaviours of interest and general coding/scoring guidelines

The ESCS (Mundy, Delgado, et al., 2003) is designed to elicit early social-communication behaviours and measure individual and group differences in the manifestation of these behaviours. The complexity construct included in the original version (Seibert et al., 1982), after which behaviours were referred to one of four developmental stages, was later narrowed to a two levels categorisation: higher and lower level behaviours. The other two elements constituting the base of behaviour classification within the ESCS are: the communicative goal (joint attention, behavioural request or social interaction), and the infant's role (initiating the interaction or responding to it). The behaviours of interest are therefore categorised according to three different criteria, and the coding process labelled each behaviour referring to all three types of categories (see Table 3.4). The coding structure begins by classifying the function of the behaviour, moving on to who initiated it, and finishing by identifying the complexity level and the specific code (Mundy, Delgado, et al., 2003).

Once the behaviours were coded, the scoring was simply done on the basis of frequency of occurrence; different indexes were then calculated using the raw frequencies. The most used indexes were the frequencies of initiating behaviours, and the percentages of correct responding behaviours (calculated on the total number of trials).

Understanding how behaviours of interest are considered to score the infant's performance, we can now have a closer look at the specific behaviours (always refer back to Table 3.4 for a summary).

3.3.1.4.1 Joint Attention

The general function of Joint Attention (JA) behaviours is to share attention with the other person, or to monitor the other person's attention (Mundy, Delgado, et al., 2003).

This kind of behaviour is therefore initiated (IJA) with eye contact, then either followed by alternating the gaze between the other person and an object of interest, or started by a pointing gesture towards something, or more explicitly showing an object to the other person (by bringing it close to his/her face, so that it can be seen). When using a JA behaviour, a person is expressing his/her desire that another person pays attention to something, usually the same thing s/he is attending. JA behaviours are used first of all to monitor the other person's focus of attention, and if this is different from the one we would like it to be, such behaviours can be used to change the focus of attention.

Responding to a JA (RJA) bid implies paying attention to the other person's request, and is therefore accomplished by turning the head and/or moving the gaze in order to follow the line of pointing or regard.

Table 3.4
Behaviours of interest in the coding of the ESCS.

Behaviour's Function	Infant's role	Complexity Level	Specific Behaviour's Code
Joint Attention (JA)	Initiating (IJA)	Lower level	Eye contact Alternate
		Higher level	Point Show
	Responding (RJA)	Lower level	Following proximal point
		Higher level	Following line of regard
Behavioural Request (BR)	Initiating (IBR)	Lower level	Eye contact Reach Appeal
		Higher level	Point Give
	Responding (RBR)		Follow command
Social Interaction (SI)	Initiating (ISI)		Initiate turn-taking Tease
	Responding (RSI)	Lower level	Eye contact Act Appeal
		Higher level	Response to turn-taking Response to invitation
Other behaviours	Bid to caregiver (IJA or IBR) Point in imitation Language (IJA or IBR)		

3.3.1.4.2 Behavioural Request

By using a Behavioural Request (BR) a person asks someone else for aid in obtaining something, like an object, or in performing an action (Mundy, Delgado, et al., 2003). In the situation created with the ESCS tasks, the infant can, for example, ask the tester to give him/her an object, to repeat an action, or to get rid of an object.

The behaviours employed to initiate a BR (IBR) can be: eye contact, pointing to the object, trying to reach it with a hand, or a combination of these. The infant can also give an object to the tester, to ask for it to be activated/used, or put away.

Responding to a BR (RBR) also means to attend to the other person's request, understand it and act accordingly. The only type of BR initiated by the tester in the ESCS, requires the infant to give back a toy, therefore the response is coded whenever the infant comprehends this request (either by giving the toy back, responding "no", or performing similar behaviours).

3.3.1.4.3 Social Interaction

"Social Interactions behaviours refer to the capacity of the infant to engage in playful, affectively positive turn-taking interactions with others" (Mundy, Delgado, et al., 2003, p. 1). Within the ESCS there are tasks designed to elicit these behaviours, but these can also been shown by the infant any time during the administration. They generally relate more to regulating face-to-face interactions rather than being linked to the objects in use, like in the other two categories.

To initiate a SI bid (ISI), the infant starts a turn-taking action with a toy (i.e., rolls a ball to the tester). Another initiating action is a tease: the infant maintains eye contact with the tester and performs a prohibited act (i.e., not returning a toy to the tester after a request). Both these behaviours clearly show the intention of the infant in keeping the interaction going, prompting a reaction from the other person.

When the tester starts a SI bid, the infant can respond (RSI) in different ways that will be coded as behaviours of interest. During a task in which the tester tickles the infant, a RSI is eye contact, an action that shows excitement (i.e., slapping the table, clapping, loud vocalizations, etc.), or these two combined. During a task in which the tester rolls a ball to the infant, a RSI is a response to this action, rolling the ball back and continuing the turn-taking activity. A similar behaviour is the response to invitation: the infant performs an action for the tester, always as part of a playful interaction (i.e., puts a hat on the tester's head).

3.3.1.4.4 Summary

The coding – and later on scoring – process needs to be carried out always having a clear view of what is going on in the interaction in each particular moment. As we saw, the same behaviour can be employed for different functions (i.e., making eye contact and pointing can be used to establish JA or to make a BR). At the same time, an action can be labelled in different ways on the basis of subtle differences, always depending on its function within the interaction (i.e., "show", in which the object is raised towards the person's face/eyes, and "give", in which the object is raised towards the person's body/hands). Hence the need to first establish the function of the behaviour by attributing a general intention to it (e.g., joint attention, behavioural request or social interaction) before labelling it.

3.3.1.5 Video coding and reliability

The coding guidelines described in the ESCS manual (Mundy, Delgado, et al., 2003), originally intended for a pen-and-paper procedure, were implemented in INTERACT (version 9.1.2, Mangold, 2010) for easier use and the opportunity to record precise time information. The specifics for each code are illustrated in Appendix E, together with the experimenter's codes, created ex novo for this study, in order to allow temporal analyses.

A reliability coder (blind to the hypotheses and participants' birth status) coded two random selections of the videos, one per age group. The mean inter-rater agreement across both ages for the infants' behaviours was $\kappa = .75$. At 13 months, 26 out of 105 (25%) videos were secondary coded, with an excellent inter-rater agreement for the infants' behaviours (mean $\kappa = .79$, min $\kappa = .56$, max $\kappa = .95$) and for the experimenter's behaviours (mean $\kappa = .92$, min $\kappa = .69$, max $\kappa = 1$). At 18 months, 24 out of 95 (25%) videos were secondary coded, with a good inter-rater agreement for the infants' behaviours (mean $\kappa = .72$, min $\kappa = .57$, max $\kappa = .83$) and an excellent one for the experimenter's behaviours (mean $\kappa = .92$, min $\kappa = .71$, max $\kappa = 1$).

3.3.1.6 Design

The administration of the task followed a repeated measures design. The dependent variables included in the analyses reported here, calculated at both ages, were: Initiating Joint Attention (IJA), Responding to Joint Attention only for the higher level (RJA), Initiating Behavioural Request (IBR), Responding to Behavioural Request (RBR), Initiating Social Interaction (ISI) and Responding to Social Interaction (RSI). Due to the use of a shortened ESCS version, no task measured RJA at the lower level. Details on the variables were covered in section 3.3.1.4 and summarised in Table 3.4. In the same way they are usually reported in the literature (i.e., Mundy et al., 2007), scores relative to the RJA and the RBR scales were expressed as percentages: due to nature of these tasks, some participants were administered a lower number of trials than others. Since a shortened version of the ESCS was used in this study, there was a possibility that infants received a reduced number of ISI trials, so the ISI scale scores were also expressed as percentages.

3.3.2 Results

Preliminary analyses showed significant differences on some of the variables from male vs. female participants, with females scoring higher than males on all of variables with differences. Non-normality was resolved through a log transformation. Groups differed significantly or close to significance on: RJA at 13 months (females: $M = 0.35$, $SD = .24$; males: $M = 0.26$, $SD = 0.21$), $t(91) = 1.95$, $p = .054$, $r = .20$; RJA at 18 months (females: $M = 0.55$, $SD = 0.25$; males: $M = 0.43$, $SD = 0.24$), $t(89) = 2.32$, $p = .022$, $r = .25$; IJA at 18 months (females: $M = 9.74$, $SD = 4.77$; males: $M = 7.63$, $SD =$

5.13), t (93) = 2.47, p = .015, r = .21; IBR at 18 months (females: M = 11.37, SD = 5.02; males: M = 9.52, SD = 6.02), t (93) = 2.06, p = .043, r = .16; RBR at 18 months (females: M = 0.70, SD = 0.30; males: M = 0.53, SD = 0.24), t (89) = 2.51, p = .014, r = .30. All remaining ps > .080. Therefore, gender was added as a covariate in subsequent analyses. As per the ESCS manual (Mundy, Delgado, et al., 2003), tasks were always administered following the same order and there were no counterbalancing groups.

3.3.2.1 Analysis by birth status

Prior to data analysis, all variables were tested for the assumptions of normality, homogeneity of variance, and for influential outliers. Some of the variables were positively skewed and non-normality was resolved with either a logarithmic transformation (IJA and ISI) or a square root transformation (IBR and RSI).

Descriptive analyses were summarised in Figure 3.5, showing the mean score for each ESCS scale at the two ages for both samples, based on raw data for ease of interpretation.

A series of factorial repeated-measures ANOVAs was used to examine participants' performance on the six ESCS scales with Age (13 vs. 18 months) as the within-subjects factor and Birth Status (preterm vs. term) as the between-subjects factor. Since the repeated-measures variables had only two levels, the assumption of sphericity was met.

Performance on the RJA scale (N = 31 preterm, 50 term born infants) showed a significant main effect of Age, $F(1, 79) = 32.55$, $p < .001$, $\eta_p^2 = .292$. Pairwise comparisons revealed that mean scores at 18 months were significantly higher than at 13 months, $p < .001$, adjusted with Bonferroni correction. There was also a significant main effect of Birth Status, $F(1, 79) = 22.26$, $p < .001$, $\eta_p^2 = .220$, and pairwise

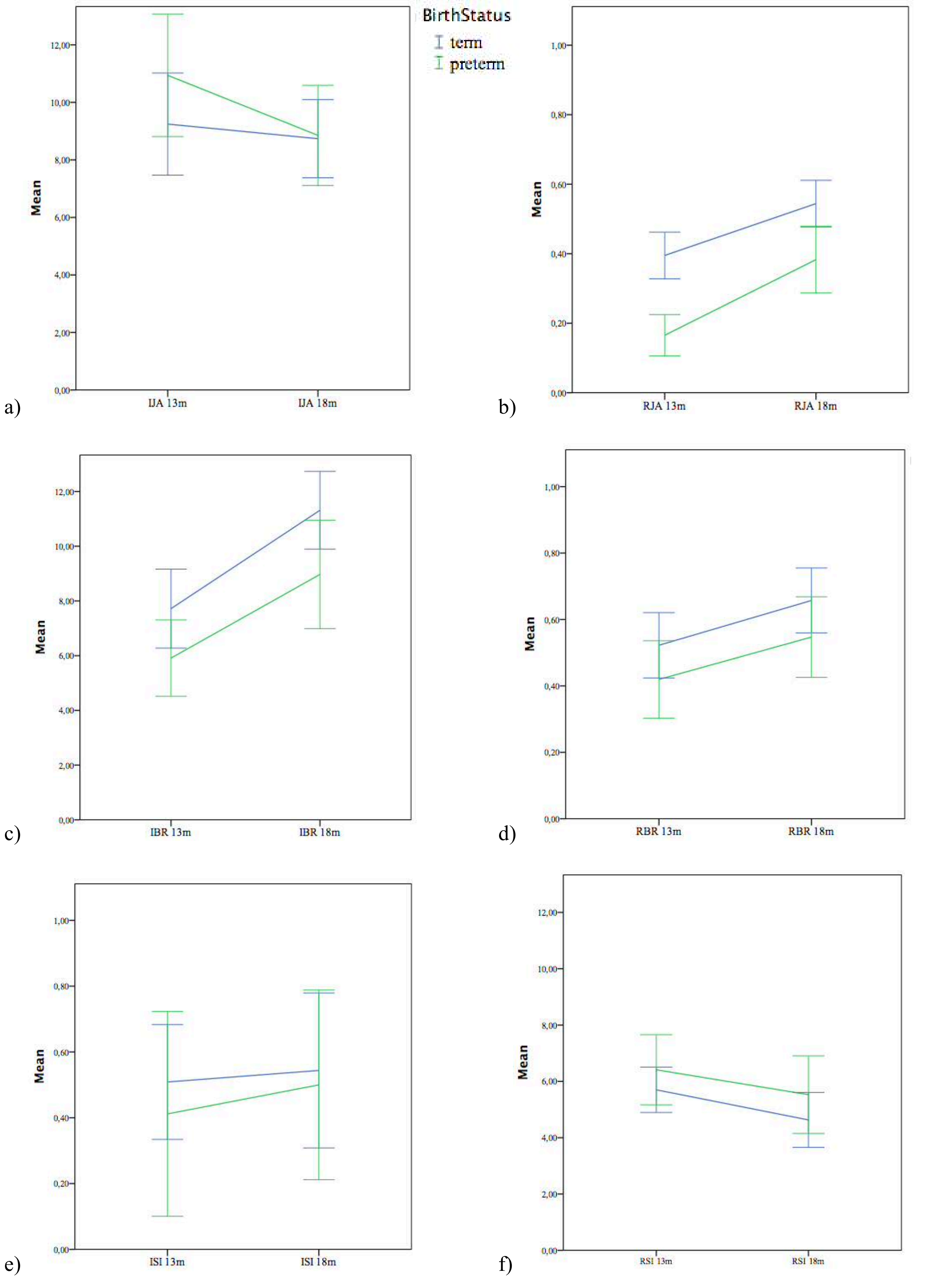


Figure 3.5. Developmental trajectories of preterm (green line) and term (blue line) participants for the six ESCS scales (mean values) at 13 and 18 months of age. Each panel shows values for one scale: a) IJA; b) RJA; c) IBR; d) RBR; e) ISI; f) RSI. Errors bars report 95% confidence intervals.

comparisons revealed that term infants had significantly higher scores than preterm infants, $p < .001$, adjusted with Bonferroni correction. No significant interaction between factors was found, $p = .290$. Therefore, both preterm and term infants showed discontinuity and a similar increase in performance with age. Adding Gender as a covariate, significance levels of main effects and interaction between factors did not change, but a between-subjects main effect of Gender was found, $F(1, 78) = 5.56$, $p = .021$, $\eta_p^2 = .067$. Estimated marginal means showed that female participants scored higher than male participants both at 13 and 18 months. Separate factorial repeated-measures ANOVAs were run for male ($N = 44$; 24 born at term) and female ($N = 37$; 26 born at term) participants, showing a significant main effect of Age both for male, $F(1, 42) = 17.66$, $p < .001$, $\eta_p^2 = .296$, and female participants, $F(1, 35) = 15.80$, $p < .001$, $\eta_p^2 = .311$. Pairwise comparisons revealed that mean scores at 18 months were significantly higher than at 13 months, both *ps* < .001, adjusted with Bonferroni correction.

Similarly, performance on the IBR scale showed a significant main effect of Age, $F(1, 89) = 14.81$, $p < .001$, $\eta_p^2 = .143$. Pairwise comparisons revealed that mean scores at 18 months were significantly higher than at 13 months, $p < .001$, adjusted with Bonferroni correction. There was also a significant main effect of Birth Status, $F(1, 89) = 4.73$, $p = .032$, $\eta_p^2 = .050$, and pairwise comparisons revealed that term infants had significantly higher scores than preterm infants, $p = .032$, adjusted with Bonferroni correction. No significant interaction between factors was found, $p = .674$. Therefore, both preterm and term infants showed discontinuity and a similar increase in performance with age. Adding Gender as a covariate, significance levels of main effects and interaction between factors did not change. No main effect of Gender was found ($p = .337$), nor an interaction with Age ($p = 311$).

Also performance on the RBR scale ($N = 32$ preterm, 50 term born infants) showed a significant main effect of Age, $F(1, 80) = 6.33$, $p = .014$, $\eta_p^2 = .073$. Pairwise comparisons revealed that mean scores at 18 months were significantly higher than at 13 months, $p = .014$, adjusted with Bonferroni correction. Birth Status showed a main effect just above the significance level, $F(1, 80) = 3.58$, $p = .062$, $\eta_p^2 = .043$, with pairwise comparisons indicating that term infants had higher scores than preterm infants, $p = .062$, adjusted with Bonferroni correction. No significant interaction between factors was found, $p = .944$. Therefore, both preterm and term infants showed discontinuity and a similar increase in performance with age. Adding Gender as a covariate, the main effect Age resulted not significant ($p = .221$) as well as the main effect of Birth Status ($p = .107$). The Age x Birth Status interaction remained not significant. There was no significant Age x Gender interaction ($p = .329$), but Gender showed a main effect close to the significance level, $F(1, 79) = 3.76$, $p = .056$, $\eta_p^2 = .045$. Separate factorial repeated-measures ANOVAs were run for male ($N = 44$; 24 born at term) and female ($N = 38$; 26 born at term) participants, showing a significant main effect of Age for female, $F(1, 36) = 5.29$, $p = .027$, $\eta_p^2 = .128$, and not for male participants ($p = .221$). Pairwise comparisons revealed that mean scores at 18 months were significantly higher for girls than at 13 months, $p = .027$, adjusted with Bonferroni correction.

Finally, performance on the RSI scale showed a significant main effect of Age, $F(1, 89) = 4.73$, $p = .032$, $\eta_p^2 = .050$. Pairwise comparisons revealed that mean scores at 18 months were significantly lower than at 13 months, $p = .032$, adjusted with Bonferroni correction. Birth Status did not show a significant main effect, $F(1, 89) = 1.57$, $p = .214$, $\eta_p^2 = .017$. No significant interaction between factors was found, $p = .629$. Therefore, both preterm and term infants showed discontinuity and a similar increase in performance with age.

In the two remaining scales, performances showed no significant effect of Age

(IJA $p = .377$; ISI $p = .627$) or Birth Status (IJA $p = .179$; ISI $p = .413$), as well as no significant interaction between factors (IJA $p = .292$; ISI $p = .519$). Therefore, ISI and IJA showed continuity from 13 to 18 months and performance was similar regardless of birth status.

However, introducing gender as a covariate, a main effect of Age was found on the IJA performance, $F(1, 88) = 4.95$, $p = .029$, $\eta_p^2 = .053$, as well as a significant Age x Gender interaction, $F(1, 88) = 5.49$, $p = .021$, $\eta_p^2 = .059$. Separate factorial repeated-measures ANOVAs were run for male ($N = 49$; 28 born at term) and female ($N = 42$; 29 born at term) participants, showing a significant main effect of Age for males, $F(1, 47) = 4.61$, $p = .037$, $\eta_p^2 = .089$, but not for females ($p = .258$). Pairwise comparisons revealed that mean scores at 18 months were significantly lower for boys than at 13 months, $p = .037$, adjusted with Bonferroni correction. Also, Birth Status showed a main effect close to significance for male participants only, $F(1, 47) = 3.69$, $p = .061$, $\eta_p^2 = .073$, with preterm born boys scoring higher than their term peers, as indicated by pairwise comparisons.

A series of correlations was run to check for stability across performance at 13 and at 18 months within each ESCS scale, separately for the preterm and term born samples. Results showed only one significant positive correlation: for term born infants on the RSI scale, $r = .32$, $p = .016$, two-tailed. Term born infants' scores also indicated a positive correlation close to the significance level on the RJA scale, $r = .26$, $p = .068$, two-tailed. Performance on all the other scales showed no significant correlation (all *ps* $> .200$) and therefore all other scales were unstable from 13 to 18 months.

3.3.2.2 Analysis by gestational age

Data were also analysed by collapsing the two samples into a single one and exploring the relation between gestational age and performance on each ESCS scale. A series of bivariate correlations (see Table 3.5) showed that gestational age had correlations, significant or close to significance, mostly with performance at 13 months, but not at 18 months (for the IJA, IBR and ISI scales). Infants born at an earlier gestational age showed a tendency to perform more IJA, less IBR and less ISI behaviours at 13 months. However, the strongest correlations were found with the RJA scale scores, showing positive significant relations at both ages. Infants born at an earlier gestational age showed fewer RJA behaviours both at 13 and 18 months.

Table 3.5
Correlations between Gestational Age (GA) and performance on the six ESCS scales at both ages.

	IJA		RJA		IBR		RBR		ISI		RSI	
	13m	18m	13m	18m	13m	18m	13m	18m	13m	18m	13m	18m
GA	-.20°	-.03	.49***	.29**	.20°	.14	.19	.19	.26*	.05	-.07	-.05

Note. ° $p < .060$, * $p < .05$, ** $p < .01$, *** $p < .001$, two-tailed. $N = 91$ for IJA, IBR, ISI, RSI; $N = 82$ for RBR; $N = 81$ for RJA.

3.3.3 Discussion

Performance on the IJA scale showed no age or birth status effect. However, when controlling for the effect of gender on the analysis, age showed a significant effect and there was a significant interaction between age and gender. Stability showed no consistency between 13 and 18 months for either sample. Gestational age was negatively correlated with scores at 13 months (although only with a tendency towards significance), indicating a tendency of infants born at earlier gestational ages to score higher. No significant correlation was present between gestational age and scores at 18 months (although the direction of the relation was still negative).

Performance on the RJA scale showed a significant effect of age, with scores at 18 months being higher than at 13 months, as well as a significant effect of birth status, with term infants scoring significantly higher than preterm infants. Both samples showed a similar increase in performance between ages. Adding gender as a covariate, the analysis showed a main effect: female participants scored higher than male participants both at 13 and 18 months. Both groups showed higher scores at 18 months than at 13 months. Stability showed no consistency between 13 and 18 months for either sample (although results tended towards significance for the term sample). Gestational age was strongly positively correlated with performance at both ages, showing that infants born at earlier gestational ages scored lower.

Results for the IBR scale were similar, with scores at 18 months being higher than at 13 months, and term infants scoring significantly higher than preterm infants. Both samples showed a similar increase in performance between ages. Controlling the analysis for gender no new effect was found. Stability showed no consistency between 13 and 18 months for either sample. There was no significant correlation between scores on this scale and gestational age.

Performance on the RBR scale showed an effect of age, with scores at 18 months being higher than at 13 months. However, the effect of birth status was just above significance level (with term infants scoring higher than preterm infants). Both samples showed a similar increase in performance between ages. When controlling the analysis for gender, the age effect was not significant, but gender showed an effect close to significance. Further analyses showed that the effect of age was present only for female participants, with scores at 18 months being higher than at 13 months, and not for male participants. Stability showed no consistency between 13 and 18 months for either sample. There was no significant correlation between scores on this scale and gestational age.

Scores on the ISI scale showed no significant effect of age or birth status. Performance was therefore continuous between ages, regardless of birth status. Stability showed no consistency between 13 and 18 months for either sample. There was a significant positive correlation between gestational age and scores at 13 months, indicating that infants born at earlier gestational ages scored lower. However, the correlation was not significant at 18 months.

Finally, performance on the RSI scale showed a significant effect of age, but in the opposite direction: scores at 13 months were higher than at 18 months. There was no difference between preterm and term samples and both had a similar increase in performance with age. Term born participants showed consistency in their rank order between 13 and 18 months, while stability was not shown by the preterm sample. There was no significant correlation between scores on this scale and gestational age.

Hypotheses were therefore confirmed with regard to scores on the IJA: there was no difference between samples, both at 13 and 18 months. The negative correlation between gestational age and IJA at 13 months, although not significant, could fit with the results reported by Mundy and colleagues on their typically developing sample. In fact, they showed a decrease in frequency of IJA behaviours between 12 and 15 months (Mundy et al., 2007). The youngest participants in our sample (i.e., born at earlier gestational ages) could therefore show a minimally delayed development of IJA and a partial influence of biological immaturity on this ability. The absence of an age effect in the term sample was in line with results from typically developing toddlers, who do not show an increase in frequency of IJA behaviours between 9 and 18 months (Mundy et al., 2007). The absence of an age effect in the preterm sample showed that infants born preterm followed the same developmental pathway as their term peers, with regard to IJA. Participants in both samples of this study showed no stability across ages for IJA scores, while it was reported in the typically developing sample (Mundy et al., 2007). However, although covering the same age period, our testing waves were further apart (13-18 months) than the ones reported in that study (12-15 months and 15-18 months), which could have caused the difference. Finally, results reported in this thesis showed an effect of gender, with IJA scores being higher at 18 rather than 13 months only for boys, and boys having an almost significant effect of birth status on performance (with preterm boys having higher scores than term boys). No effect of gender was reported by Mundy and colleagues on this scale, except for an advantage for girls at 9 months (Mundy et al., 2007).

Hypotheses were also confirmed for the RJA scale, which showed a significant difference between preterm and term infants at 13 months, with term infants scoring higher. Contrary to prediction, though, the difference remained also at 18 months, showing a more stable result than the one reported by De Schuymer and colleagues (De Schuymer et al., 2011). The impact of prematurity on performance on the RJA scale was further stressed by the positive correlation between gestational age and RJA scores, both at 13 and 18 months. Results showed, also for this scale, that preterm and term infants had a similar trajectory of development, with higher 18 months scores than 13 months scores and a similar increase in performance with age. However, again differently than what Mundy and colleagues reported (Mundy et al., 2007), neither group showed stability of performance across ages, which could again be cause by the larger gap between data collection waves. Contrary to what reported by Mundy and colleagues (Mundy et al., 2007), who found no effect of gender, this data showed that girls had higher scores than boys both at 18 and 13 months.

No clear hypotheses were formulated for the IBR scale, but results were in line with the study by De Schuymer (De Schuymer et al., 2011), since there was a significant difference between samples and preterm infants scored lower than term infants. However, the lack of correlation between gestational ages and IBR scores, might suggest that the difference could be due to some more extreme performances within samples, rather than to a more distributed trend across all participants. The effect of age, with higher scores at 18 months than 13 months, was probably due to the presence of preterm infants, since Mundy and colleagues found a significant difference between 9 months scores and 12, 15 and 18 months scores, but no difference between 12 and 18 months scores (Mundy et al., 2007). Again, both samples showed similar developmental pathways, with a similar increase in performance with age, but no stability across ages, while Mundy and colleagues found that scores at 9 and 12 months predicted 18 months scores (Mundy et al., 2007).

Again, results were in line with the findings of De Schuymer and colleagues (De Schuymer et al., 2011) with regard to the RBR scale. In fact, there was no significant difference between the term and the preterm sample and no significant correlation between gestational age and performance on this scale. The higher scores at 18 months, compared to 13 months, were in line with findings from Mundy and colleagues (Mundy et al., 2007). Also for this scale, the same developmental pathway was shown by preterm and term infants. Like in the study from Mundy and colleagues (Mundy et al., 2007), results did not show stability across ages.

The ISI and RSI scales were not reported by Mundy and colleagues (Mundy et al., 2007), nor in the two studies on preterm samples (De Schuymer et al., 2011; Olafsen et al., 2006) and therefore no meaningful comparisons can be made.

3.3.3.1 Conclusions

The results clearly depicted a multi-faceted set of abilities, rather than a single socio-cognitive skill. The biggest difference was within the core joint attention abilities, IJA and RJA. In fact, performances in the IJA scale did not show an age or a birth status effect; on the other hand, performances in the RJA, IBR and RBR all showed higher scores at 18 rather than 13 months. Scores on the RJA and IBR scales were also different depending on birth status. These findings were therefore supporting the Multiple Process Model by Mundy and colleagues and were in line with their description of IJA and RJA as dependant on different dissociable processes (Mundy et al., 2000).

Conclusions regarding prematurity should bring attention to the fact that premature infants were tested at chronological age for this study. Despite this, the results were mostly in line with previous studies testing preterm infants on the ESCS (De Schuymer et al., 2011; Olafsen et al., 2006), in particular with the one by De Schuymer and colleagues (De Schuymer et al., 2011). As already mentioned, these two studies included participants with complicated medical situations, born extremely preterm, and tested them at corrected age. The fact that participants in the Special Delivery study did not show a worse performance compared to participants in these other two studies, could suggest that age correction is not necessary for evaluating these socio-cognitive skills in a healthy low-risk sample, born at later gestational ages, at least in the first six months of the second year of age.

Moreover, although it has been reported that preterm infants are less involved during interactions (Landry, 1986; Landry, Smith, Miller-Loncar, & Swank, 1997), this did not seem the case with this sample, showing no difference in IJA compared to the term sample. Again, this result is particularly important considering that infants were tested at their chronological age. However, prematurity showed the biggest impact on the RJA scale, for which gestational age correlated at both ages. The lower number of responses to joint attention bids could reflect a lower engagement in the interaction.

More in general, premature infants did not show a deviant developmental trajectory on any of the measures. Conversely, they showed the same developmental pathway as term infants, although delayed for some of the abilities. Again, the delay should also be seen in the light of the fact that infants were tested at chronological age. The same amount of extrauterine experience as the term sample had therefore an impact on some of the joint attention behaviours measured by the ESCS in the preterm sample, but not all of them, with RJA being the less modifiable by this extra experience.

3.3.3.2 Future directions

Future analyses on this dataset could focus on looks durations and latencies across the different scales, in order to eventually identify subtler differences between samples. Although this type of analysis was not included in the ESCS manual (Mundy, Delgado, et al., 2003), and results would not be easily comparable with the literature, identifying specific tasks within the ESCS, the results could be compared with different experimental paradigms.

Also, again contrary to what specified in the ESCS manual (Mundy, Delgado, et al., 2003), infants' pointing gestures were coded during the point following task. This task sees the experimenter turning and pointing to four posters placed in different locations around the infant, while saying the infant's name. Participants' responses were coded for RJA, but they would very often also imitate the pointing gesture (classified as IJA in the ESCS). Analysing which are the features of this behaviour, could add some interesting details to the results on the RJA, especially because this was the scale with the bigger difference across samples. Weighted scores could be attributed to the infants' responses, considering the direction of the gaze and the presence/direction of the pointing. Moreover, in the analyses included here, only the first look was considered, while the videos were coded for the entire length of the infant's response (or until a certain amount of time passed). In case of incorrect look (i.e., towards a poster which did not match the one looked by the experimenter), the direction of the look could be explored, examining the infants' ability to inhibit distracting stimuli and disengage from the main one.

3.4 Summary

This chapter covered visual attention, gaze following and triadic abilities, as they develop during the first year and a half of life and sometimes present different characteristics in populations of infants born before or after term. The results from the ESCS scale are be considered again in chapter 5, in order to explore their predictive value on the language abilities shown by participants in the Special Delivery study.

The following chapter introduces language abilities in preterm and term born samples and reports results from a language questionnaire employed in the Special Delivery study at three ages.

Chapter 4 - Language

4.1 Introduction

Unfortunately, as Sansavini and colleagues (Sansavini et al., 2010) noted, results on language development – especially on vocabulary size – in the preterm population do not converge into a uniform picture. The authors suggested that the differences, at least in some part, could be due to the usual methodological difficulties encountered in preterm research.

Despite these difficulties, delayed language is often reported as one of the most long-lasting effects of preterm birth, even when mental and physical development gradually improve (Cusson, 2003; Guarini et al., 2009; van Noort-van der Spek et al., 2012), especially for infants born at earlier gestational ages (for a review see Aylward, 2005). However, it is common for language delays in preterm samples to go undetected until pre-school or even school age, appearing only when the child is involved in more complex activities, like reading (Aylward, 2005; Guarini et al., 2009; Luoma et al., 1998). For example, the vocabulary and grammar abilities of preschool-aged (M = 72.6 months, chronological age) children born preterm (gestational age ≤ 33 weeks) have been found to be compromised, although the delay was not severe (Guarini et al., 2009). Lee and colleagues (Lee et al., 2011) controlled their results for socio-economic status and IQ and found that 9 to 16 years old, born at less than 36 weeks of gestation without brain complications, had less problems on crystallized functions (receptive vocabulary, syntactic comprehension and decoding), rather than fluid functions (linguistic processing speed, verbal memory and reading comprehension). Some studies even found that language problems can increase with age (i.e., between 3 and 12 years of age) for children born preterm (for a review see van Noort-van der Spek et al., 2012).

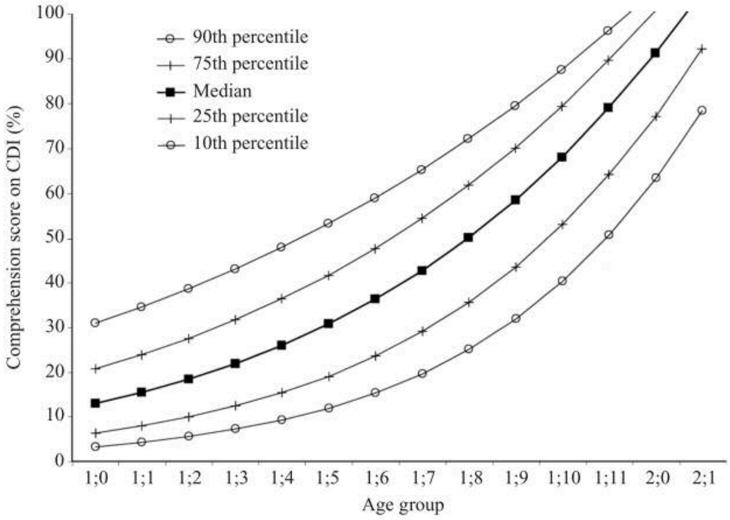
Looking at results closer to the ages included in the Special Delivery study, Cusson (2003) found that both receptive and expressive vocabularies were delayed at 26 months (corrected age) in a preterm sample (gestational age $M = 30.94$, $SD = 2.61$) with uncomplicated medical situations at birth.

On the other hand, Sansavini and colleagues (Sansavini et al., 2010) found opposite results. They tested preterm and term infants at 2 years and 6 months and at 3 years and 6 months (at corrected age for the preterm sample), with various indirect and direct measures of expressive language and grammar. The preterm sample was constituted predominantly by infants who were very or extremely preterm (GA $M =$ 30.4 weeks, range from 24.5 to 33) and some participants presented some level of brain injuries. Despite the unfavourable medical situation of the preterm sample, no difference between the two groups was found on the expressive vocabulary at 2 years and 6 months.

Given the complex picture described by the current literature, no clear expectation guided the analysis of these results. As language delays are very common in the preterm population, differences between samples were hypothesised. However, since participants were not tested on complex language abilities and given their young age, the absence of differences between samples could be expected.

4.1.1 Oxford CDI

The Oxford Communicative Development Inventory (OCDI; Hamilton et al., 2000) is the British adaptation of the American MacArthur-Bates Communicative Development Inventory (MCDI; Fenson et al., 1993). This parent report is a checklist of 416 words, chosen to assess the development of receptive and productive vocabulary in infants and toddlers from around 11 to 26 months of age. Norm scores for typically developing British infants on the OCDI are reported in Figure 4.1 (Hamilton et al., 2000).



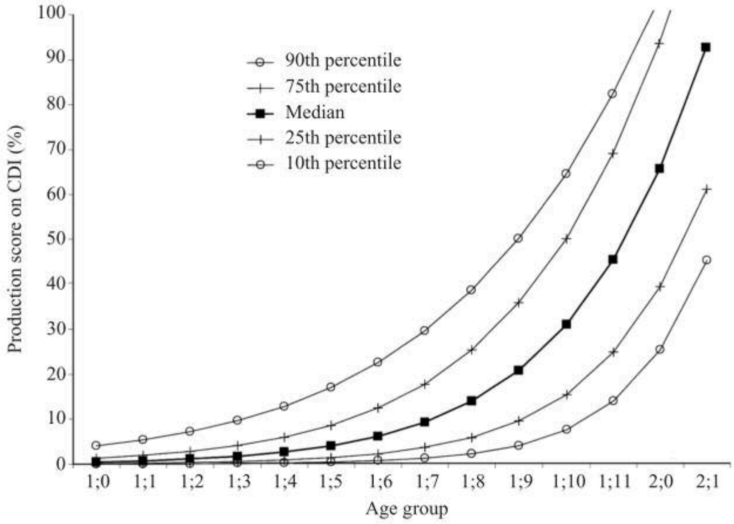


Figure 4.1. Norm scores for typically developing British infants on the OCDI for comprehension (above) and production (below) (A. Hamilton et al., 2000).

4.2 Methods

4.2.1 Participants

A total of 79 participants had a viable dataset from data collection at all three ages (13, 18 and 24 months) and could therefore be included in the analyses: 34 (20 males) from the preterm sample and 45 (22 males) from the term sample. From the initial sample of 110 participants, 31 (9 preterm, 3 males; 22 term, 13 males) were not included for different reasons.

At 13 months, 5 participants did not respond to reminders about completing the online questionnaire. At 18 months, 4 participants did not respond to reminders about completing the online questionnaire and in other 5 cases the mother had health problems or there were other family complications. At 24 months, 19 participants did non respond to reminders about completing the online questionnaire, or opened the link without then finishing filling it in and in other three cases the mother had health problems or there were other family complications.

Five additional term born participants were excluded from analyses due to conditions that could have affected their language performance (see section 2.5.4).

4.2.2 Materials

The OCDI (Hamilton et al., 2000) lists 416 words, divided in different sections. It includes nouns (i.e., animals, vehicles, toys, foods, body parts), adjectives, verbs, adverbs (i.e., temporal, spatial, quantity adverbs), prepositions and social formulas (i.e., greetings). For each of the words listed, caregivers are asked to choose one of three options: a) mark it as understand, if their child is able to understand the word; b) mark it as understand and say, if their child is able to both understand and say (even in an imprecise way) the word; c) leave it blank, if the word is still not part of their child's vocabulary.

4.2.3 Administration and scoring

One week before the 13 and 18 months testing sessions, caregivers were sent a reminder email with a link to find the online version of the questionnaires (see section 2.4.1.3), or, alternatively, were sent a paper copy that they could return during the testing session. Additional reminders were sent after the testing session, if necessary. The same procedure was followed for the 24 months questionnaire, although at this time the questionnaire was not paired with a testing session at the university. In case the caregiver requested a paper version, a freepost envelope was provided so that the questionnaire could be returned by mail without charge.

The OCDI (A. Hamilton et al., 2000) produces two final scores: a comprehension and a production score. These scores are simply calculated counting the marked words in the checklist: all the ones marked as understand and understand and say are counted towards the comprehension score; all the ones marked as understands and says are also counted towards the production score. A database is available to check the distribution of responses for infants and toddlers aged 9.5-27.2 months (http://psyweb.psy.ox.ac.uk/babylab/cdi.html).

4.2.4 Design

The administration of the questionnaire followed a repeated measures design. The dependent variables included in the analyses reported here were the comprehension and the production scores, calculated for each of the three ages.

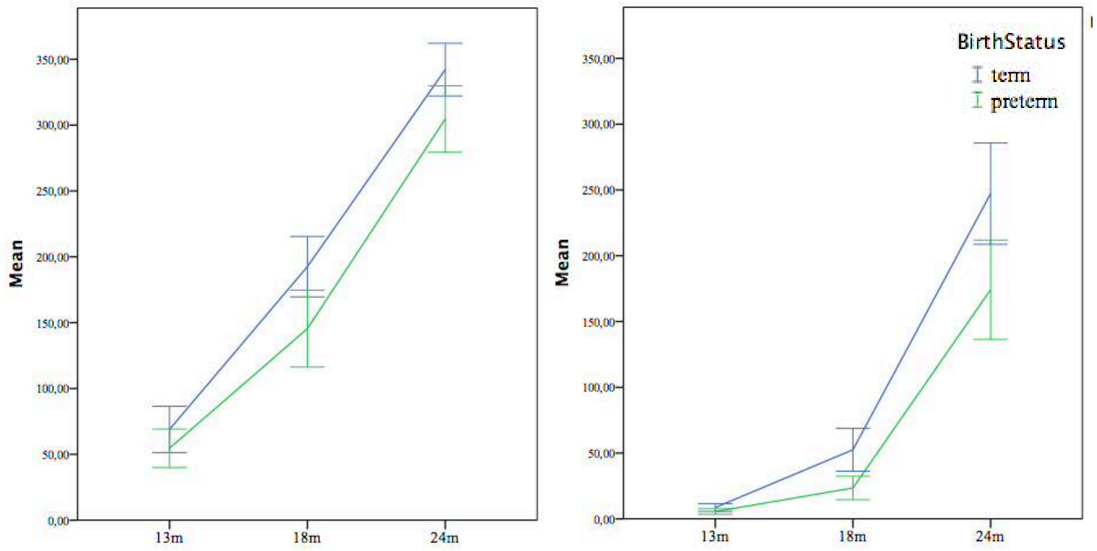
4.3 Results

Preliminary analyses showed that no group differences on OCDI scores resulted from participants belonging to different genders, at all ages (all *ps* >.170). Therefore groups based on this parameter were collapsed into a single one for subsequent analyses.

4.3.1 Analysis by birth status

Prior to data analysis, OCDI scores were tested for the assumptions of normality, homogeneity of variance, sphericity, and for influential outliers. The data was positively skewed for comprehension scores at 13 months and production scores at 13 and 18 months. Non-normality was resolved with a square root transformation.

Descriptive statistics were calculated on raw data: for comprehension at 13 months (preterm: $M = 69.03$, $SD = 75.47$; term: $M = 82.87$, $SD = 71.26$), 18 months (preterm: $M = 148.13$, $SD = 87.12$; term: $M = 206.97$, $SD = 90.45$) and 24 months (preterm: $M = 300.81$, $SD = 75.12$; term: $M = 344.28$, $SD = 66.05$); and for production at 13 months (preterm: $M = 6.36$, $SD = 7.13$; term: $M = 9.95$, $SD = 10.47$), 18 months (preterm: $M = 23.84$, $SD = 25.25$; term: $M = 57.50$, $SD = 57.35$) and 24 months (preterm: $M = 171.11$, $SD = 107.94$; term: $M = 248.94$, $SD = 128.49$). Mean scores were summarised in Figure 4.2, based on raw data for ease of interpretation.



Comprehension Production

Figure 4.2. Developmental trajectories of preterm (green line) and term (blue line) participants for the comprehension (left) and production (right) scores (mean values) at 13, 18 and 24 months of age. Error bars report 95% confidence intervals.

Two factorial repeated-measures ANOVAs were used to examine participants' performance relative to comprehension and production with Age (13 vs. 18 vs. 24 months) as the within-subjects factor and Birth Status (preterm vs. term) as the between-subjects factor.

Comprehension scores showed a main effect of Age, $F(2, 154) = 447.52$, $p < .001$, $\eta_p^2 = .853$. Contrasts revealed that mean scores at 13 months, $F(1, 77) = 1028.05$, $p < .001$, $\eta_p^2 = .930$, and 18 months, $F(1, 77) = 232.03$, $p < .001$, $\eta_p^2 = .751$, were significantly lower than mean scores at 24 months. There was also a significant main effect of Birth Status, $F(1, 77) = 6.18$, $p = .015$, $\eta_p^2 = .074$, and pairwise comparisons revealed that term infants had significantly higher scores than preterm infants, $p = .015$. No significant interaction between factors was found, $p = .082$. Therefore, both preterm and term infants showed discontinuity and similar increases in performance with age.

In relation to the analysis of production scores, Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of Age, $\chi^2(2) = 34.40$, $p < .001$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimate of sphericity, $\varepsilon = 0.73$. Results showed a significant main effect of Age, $F(1.47, 112.90) = 452.45$, $p < .001$, $\eta_p^2 = .855$. Contrasts revealed that mean scores at 13 months, $F(1, 77) = 550.47$, $p < .001$, $\eta_p^2 = .877$, and 18 months, $F(1, 77) = 463.04$, $p < .001$, $\eta_p^2 = .857$, were significantly lower than mean scores at 24 months. There was also a significant main effect of Birth Status, $F(1, 77) = 8.35$, $p = .005$, $\eta_p^2 = .098$, and pairwise comparisons revealed that term infants had significantly higher scores than preterm infants, $p = .005$, adjusted with Bonferroni correction. A significant Age x Birth Status interaction was found, $F(1.47, 112.90) = 4.04$, $p = .032$, $\eta_p^2 = .050$, and within-subjects contrasts revealed that the interaction was significant when comparing 13 vs. 24 months scores, $F(1, 77) = 4.55$, $p = .036$, $\eta_p^2 = .056$, but not 18 vs. 24 months scores, $p = .675$. Therefore, both preterm and term infants showed discontinuity, with different increases in performance between 13 and 18 months, but similar increases in performance between 18 and 24 months. Separate one-way repeated-measures ANOVAs were run for preterm and term born participants. Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of Age both in the preterm, $\chi^2(2) = 20.11$, $p < .001$, and term born samples, $\chi^2(2) = 18.79$, $p < .001$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity both for the preterm, $\varepsilon = 0.68$, and term born samples, $\varepsilon = 0.74$. A significant main effect of Age was found both for preterm, $F(1.36, 45.01) = 171.54$, $p < .001$, $\eta_p^2 = .839$, and term infants, $F(1.48, 64.99) = 303.29$, $p < .001$, $\eta_p^2 = .873$. Pairwise comparisons revealed that mean scores at 13 months were significantly lower than 18 and 24 months scores and that scores at 18 months were significantly lower than 24 months scores, for both samples, all *ps* < .001, adjusted with Bonferroni corrections.

A series of correlations was run to check for stability across performance at 13, 18 and 24 months for comprehension and production, separately for the preterm and term born samples (see Table 4.1). Results showed stability for comprehension scores across the three ages for the term sample, while only from 13 to 18 months and from 13 to 24 months, but not from 18 to 24 months for the preterm sample. Stability in the production scores was found across the three ages for both samples.

Table 4.1
Correlations between comprehension scores across 13, 18 and 24 months for preterm and term infants.

	Comprehension			Production			
	13m	18m	24m	13m	18m	24m	
13m		.59***	.37*		.61***	.42**	
18m	**.47****		.73***	**.57*****		.76***	Term
24m	**.64*****	**.25**		**.34***	**.53****		
				Preterm			

Note. * $p < .05$, ** $p < .01$, *** $p < .001$, two-tailed.

Differences by birth status in the consistency of the rank order scores was tested between the two samples using z tests. For comprehension scores, consistency from 18 to 24 months was significantly higher in term than in preterm infants, $z = 2.84$, $p = .005$, two-tailed, reflecting that term infants scores at 18 months were better predictors of their performance at 24 months than for preterm infants. There was no difference in consistency between preterm and term infants from 13 to 18 months ($p = .478$), nor from 13 to 24 months ($p = .103$). For production scores, there was no difference in consistency between preterm and term infants from 13 to 18 months ($p = .795$), 13 to 24 months ($p = .689$), nor from 18 to 24 months ($p = .087$).

4.3.2 Analysis by gestational age

Data was also analysed collapsing the two samples into a single one and exploring the relation between gestational age and OCDI scores. A bivariate correlation (see Table 4.2) showed that gestational age was positively correlated with both comprehension and production at 18 and 24 months, but not at 13 months. Infants born at earlier gestational ages showed lower comprehension and production scores at both

18 and 24 months.

Table 4.2
Correlations between Gestational Age (GA) and performance on the OCDI at 13, 18 and 24 months.

	Comprehension			Production		
	13m	18m	24m	13m	18m	24m
GA	.12	.38**	.28*	.15	.40***	.25*

Note. * $p < .05$, ** $p < .01$, *** $p < .001$, two-tailed.

4.4 Discussion

For performance on comprehension, results showed an effect of age, with scores at 13 and 18 months being significantly lower than scores at 24 months. There was also an effect of birth status, with infants born at term scoring significantly higher than infants born preterm. Results indicated that both preterm and term infants had similar increases in performance with age. With regard to stability, participants in the term sample maintained their rank order across all three ages, while participants in the preterm sample had unstable scores between 18 and 24 months (but scores were stable between 13 and 18, as well as between 13 and 24 months). Stability was significantly more consistent for term rather than preterm infants between 18 and 24 months, showing that for the term sample comprehension scores at 18 months were better predictors of performance at 24 months, compared to the preterm sample.

For performance on production, results showed again an effect of age, with scores at 13 and 18 months being significantly lower than scores at 24 months. There was also an effect of birth status, with infants born at term scoring significantly higher than infants born preterm. Results indicated that preterm and term infants had different increases in performance between 13 and 18 months, but similar between 18 and 24 months. However, further analyses did not reveal a difference between the two samples with regard to the effect of age on performance, with scores at 13 months being the lowest and scores at 18 months being lower than 24 months scores for both samples.

With regard to stability, both preterm and term infants maintained their rank scores across the three ages and there was no difference across samples in terms of consistency.

The analysis by gestational age found significant positive correlations between gestational age and both measures at 18 and 24 months, but not at 13 months. Therefore infants born at lower gestational ages scored lower for both comprehension and production at 18 and 24 months. The absence of correlation at 13 months is probably due to the very similar scores showed by both samples at that age on each of the two measures.

More in general, the developmental trajectories of the samples fitted with the norm scores of the OCDI (Hamilton et al., 2000). The comprehension scores followed a more linear increment, while the production scores showed an accelerated increase in performance after 18 months.

4.4.1 Conclusions

Results showed an impact of prematurity on both receptive and expressive vocabulary, with infants born preterm consistently scoring lower than their term peers across the second year of life. Also, gestational age was positively correlated with scores on both scales at 18 and 24 months, showing that infants born at lower gestational ages had more difficulties on both comprehension and production. However, both samples showed continuity of performance on both scales, indicating that preterm infants followed the same developmental pathway than their term peers. Also stability was consistent for both samples on both scales, showing that individual performances at earlier ages were good predictors of performances at later ages. However, this was not true for preterm infants between 18 and 24 months on the comprehension scale, indicating that between these two ages, when the increase in performance typically accelerates, more infants than not would change their rank order within the group.

4.5 Summary

This chapter introduced a language measure, showing that preterm infants had a stable delayed development on both production and comprehension. These results are further explored in the following chapter, which brings together results from chapter 3 as well as from this chapter to assess the impact of joint attention abilities on language development.

Chapter 5 - Triadic interaction skills and language

5.1 Introduction

As introduced in chapter 1, there is a substantial body of evidence linking preverbal and verbal communication, showing that triadic interaction skills are strong precursors of language development (Carpenter et al., 1998; Daum, Ulber, & Gredeback, 2013; Gliga & Csibra, 2009; Morales et al., 2000; Mundy & Gomes, 1998; Mundy et al., 2007).

The dissociation between RJA and IJA is evident also in this context. RJA abilities showed a strong relation with language acquisition in many different experimental settings, in particular with receptive vocabulary growth (Brooks & Meltzoff, 2005; Morales et al., 2000, 1998; Mundy, Fox, et al., 2003; Mundy & Gomes, 1998; Mundy & Jarrold, 2010). On the other hand, although it has been found that IJA abilities predicted language acquisition (Mundy, Fox, et al., 2003; Mundy & Jarrold, 2010), these conclusions are not so common in the literature.

More in detail, Morales and colleagues (Morales et al., 2000) reported an exhaustive set of data showing that better RJA abilities at earlier months (6, 8, 10 and 18) predicted a more substantial vocabulary growth later on (at 24 and 30 months), including both expressive and receptive language. In the study, the ESCS (Mundy, Delgado, et al., 2003) was used to measure RJA abilities (with an adapted version of the point following task administered at 6 months), while vocabulary growth was measured with three measures. The MCDI – the American equivalent of the OCDI – (Fenson et al., 1993) was administered at 24 and 30 months, while two standardised measures of lexical development, the Peabody Picture Vocabulary Test - Revised (PPVT-R; Dunn & Dunn, 1981) and the Expressive Vocabulary Test (EVT; Williams, 1997), were administered only at 30 months. Very interestingly, although RJA scores at any of the four ages tested correlated with at least one of the language measures, RJA scores measured at 6 months correlated with all three (MCDI at 24 and 30 months, PPVT-T at 30 months and EVT at 30 months). Moreover, when researchers controlled for the MCDI parent report data at 24 months, the association between RJA abilities across the 6-18 months period and language abilities at 30 months remained significant. Therefore, RJA abilities were a better predictor of vocabulary growth at 30 months compared to another language measure, the parent report administered at 24 months.

A small number of studies documented the relationship between triadic interaction abilities and language development in preterm infants and children (De Schuymer et al., 2011; Ulvund & Smith, 1996). De Schuymer and colleagues (De Schuymer et al., 2011) tested preterm and term infants on triadic abilities at three ages: at 6 months with a modified still-face procedure designed to elicit re-engagement actions in the infants; at 9 months with a gaze following task in which the experimenter alternated gaze between the infants and a target object; at 14 months with the ESCS (Mundy, Delgado, et al., 2003). The preterm sample was tested at age corrected for prematurity. Language performance was tested at 30 months (chronological age for both samples) with the Dutch version of the Reynell Developmental Language Scales. The Reynell Scales (RDLS; Reynell & Gruber, 1990) are a standardised test of receptive and expressive language skills for children between 1 and 7 years. Results showed that receptive language at 30 months was positively correlated with performances at 9 and 14 months, but not 6 months. At 14 months the significant correlations were with RJA (but only for the behind poster locations) and IBR. Expressive language at 30 months was positively correlated with performances at 6, 9 and 14 months. At 14 months the significant correlations were again with RJA (but only for the behind poster locations) and IBR (but only for the behaviours marked as high level in the ESCS). Ulvund and Smith (1996) included only infants born before 34 weeks (range 24-34 weeks), with one third presenting high risk medical situations.

Participants were tested at 13 months (corrected for prematurity) with the first version of the ESCS (Seibert et al., 1982), at 2 and 3 years (corrected for prematurity) with the Norwegian version of the RDLS (Reynell & Gruber, 1990), and at 5 years with the verbal comprehension factor of the Stanford-Binet Intelligence Scale (Thorndike, Hagen, & Sattler, 1986). Results showed that RJA scores correlated positively with comprehension at 2 and 3 years and with production at 3 years; IJA scores correlated positively with both comprehension and production at 2 and 3, and with comprehension at 5 years; RBR scores correlated positively with comprehension at 2 and 3 years; IBR scores correlated positively with both comprehension and production at 2 and 3.

Considering previous studies on both term and preterm samples, hypotheses on the results included a predictive role of RJA skills on later language performance, especially on comprehension scores and especially at 13 months, but not at 18. Since IJA scores correlated with language performance only in the study by Ulvund and Smith (1996) and not in the one by De Schuymer and colleagues (De Schuymer et al., 2011), this correlation was not expected in the present data. In fact, Ulvund and Smith used the first version of the ESCS (Seibert et al., 1982), which had different definitions of the theoretical bases for scoring triadic behaviours. Although correlations between the IBR and RBR scales and language performance are not usually found in typically developing samples (i.e., Mundy et al., 2007), both studies on preterm samples found these correlations (De Schuymer et al., 2011; Ulvund & Smith, 1996). Therefore, the present results are expected to show correlations between the IBR and RBR scales and language performance.

5.2 Methods

5.2.1 Participants

Viable datasets from the ESCS and the OCDI studies were collapsed (see sections 3.3.1.1 and 4.2.1); including only participants who had complete data for all

ESCS scales at both ages (13 and 18 months) and completed the OCDI at 24 months. The final sample included 58 participants: 27 (19 males) born preterm and 31 (13 males) born at term.

5.2.2 Design

The dependent variables included in the analyses reported here were variables from the ESCS and the OCDI studies (see sections 3.3.1.6 and 4.2.4). All ESCS scales scores (IJA, RJA, IBR, RBR, ISI and RSI) were included at both ages (13 and 18 months). Only comprehension and production scores from the 24 months questionnaire were included from the OCDI.

5.3 Results

5.3.1 Regression analysis

Prior to data analysis, all variables were tested for the assumption of normality and for influential outliers. Some of the variables were positively skewed (RJA, IBR and ISI at 13 months; IJA, ISI and RSI at 18 months) and non-normality was resolved with a square root transformation.

A bivariate correlation explored associations between ESCS scores at 13 and 18 months and OCDI scores at 24 months, for both samples collapsed. Correlations between gestational age and the dependent variables were also examined (see Table 5.1). Gestational age showed positive correlations with both comprehension and production, as well as with RJA at 13 and 18 months and RBR at 18 months. There was no significant correlation between IJA and the OCDI scores, while RJA at 13 months correlated positively with the comprehension score. Scores on the Behavioural Request scale correlated positively with both comprehension and production, but at different ages: RBR at 13 months and IBR at 18 months.

Table 5.1
Correlations between Gestational Age (GA), performance on the ESCS at 13 and 18 months and performance on the OCDI at 24 months.

		GA	Comprehension	Production
GA			.31*	.37**
IJA	13m	-.17	-.19	-.09
	18m	.11	-.04	.17
RJA	13m	.44**	.39**	.20
	18m	.34*	.17	.17
IBR	13m	.22	.11	.17
	18m	.20	.32*	.39**
RBR	13m	.19	.30*	.39**
	18m	.27*	.16	.24
ISI	13m	.24	.07	.10
	18m	-.01	.12	-.01
RSI	13m	.05	-.22	-.14
	18m	-.12	-.09	-.01

Note. * $p < .05$, ** $p < .01$, two-tailed.

Given the results on the correlation analysis, a series of forced entry hierarchical multiple linear regressions were computed including the following variables: IJA, RJA, IBR and RBR at 13 and 18 months, comprehension and production scores at 24 months and gestational age.

The first regression assessed the amount of variance explained in the comprehension scores. Coefficients were entered in the analysis following the strength of the correlation previously found with the dependent variable, the hypotheses of this study, as well as indications from the literature (i.e., Mundy et al., 2007). Results are summarised in Table 5.2. Each one of the four models explained a significant amount of variance in the comprehension score (all *ps* < .05). However, the analysis showed that the only significant predictor was RJA at 13 months in the first model ($p = .024$), while gestational age was not a significant predictor of the comprehension score ($p = .225$). Moreover, adding other variables in the three subsequent steps did not make a significant contribution to the explanation of variance in the models (for all *F Change*, $p > .05$), with RJA at 13 months remaining the strongest predictor in all models, followed by RBR at 13 months.

Table 5.2
Linear model of predictors of OCDI comprehension scores at 24 months.

	B	*SE B*	*β*	*p*	*F* *(df)*	*R*	*Adj. R²*	*ΔR²*
Step 1				.005**	5.82 (2, 57)	.42	.15	.18
GA	0.11	0.09	.17	.225				
RJA 13m	2.35	1.01	.32	.024*				
Step 2				.004**	4.40 (4,57)	.50	.19	.08
GA	0.08	0.09	.12	.358				
RJA 13m	1.92	1.01	.26	.062				
IBR 18m	0.37	.027	.18	.179				
RBR 13m	1.13	0.81	.18	.170				
Step 3				.031*	2.44 (7,57)	.50	.15	.01
GA	0.08	0.10	.12	.406				
RJA 13m	2.12	1.09	.28	.057•				
IBR 18m	0.35	0.31	.17	.260				
RBR 13m	1.16	0.84	.18	.176				
RJA 18m	-0.55	1.27	-.06	.665				
IBR 13m	-0.01	0.30	-.01	.970				
RBR 18m	0.29	0.95	.04	.761				
Step 4				.026*	2.38 (9, 57)	.56	.18	.05
GA	1.06	0.10	.10	.520				
RJA 13m	2.03	1.07	.27	.064				
IBR 18m	0.48	0.31	.23	.130				
RBR 13m	1.41	0.84	.22	.102				
RJA 18m	-0.97	1.27	-.11	.449				
IBR 13m	0.04	0.30	.02	.894				
RBR 18m	0.28	0.96	.04	.770				
IJA 13m	-0.47	0.31	-.20	.138				
IJA 18m	-0.25	0.34	-.10	.467				

The second regression assessed the amount of variance explained in the production scores. Again, coefficients were entered in the analysis following the strength of the correlation previously found with the dependent variable, the hypotheses of this study, as well as indications from the literature (i.e., Mundy et al., 2007). Results are summarised in Table 5.3. Each one of the three models explained a significant amount of variance in the comprehension score (all *ps* < .05). In the first model, including gestational age (p = .023), IBR at 18 months (p =.049) and RBR at 13 months (p =.035), all three coefficients were significant predictors of the production score. Adding other variables in the two subsequent steps, did not make a significant contribution to the explanation of variance in the models (for all *F Change*, $p > .780$), with RBR at 13 months remaining the strongest predictor in all models, followed by IBR at 18 months.

Table 5.3
Linear model of predictors of OCDI production scores at 24 months.

	B	*SE B*	*β*	*p*	*F* (*df*)	*R*	*Adj. R^2*	*ΔR^2*
Step 1				< .001***	7.72 (3, 57)	.55	.26	.30
GA	0.42	0.18	.27	.023*				
IBR 18m	1.17	0.58	.25	.049*				
RBR 13m	3.82	1.77	.26	.035*				
Step 2				.002**	4.60 (5, 57)	.55	.24	.01
GA	0.38	0.19	.25	.054•				
IBR 18m	1.06	0.63	.22	.100				
RBR 13m	3.74	1.83	.26	.046*				
IBR 13m	0.32	0.63	.06	.613				
RBR 18m	1.11	2.01	.07	.583				
Step 3				.015*	2.61 (9, 57)	.57	.20	.02
GA	0.38	0.22	.25	.094				
IBR 18m	1.22	0.70	.26	.089				
RBR 13m	4.12	1.90	.28	.035*				
IBR 13m	0.35	0.68	.07	.605				
RBR 18m	0.55	2.15	.04	.799				
RJA 13m	-0.45	2.42	-.03	.854				
RJA 18m	-1.46	2.85	-.07	.612				
IJA 13m	-0.83	0.71	-.16	.246				
IJA 18m	0.34	0.77	.06	.660				

5.3.2 Mediation analysis

The relation between gestational age, RJA scores and comprehension performance could be better examined with a mediation analysis. Since gestational age correlated positively with both RJA (at 13 and 18 months) and comprehension performance, and since RJA at 13 months predicts receptive vocabulary size, a mediation effect of gestational age on the relation between RJA scores at 13 months and receptive vocabulary size at 24 months is to be expected.

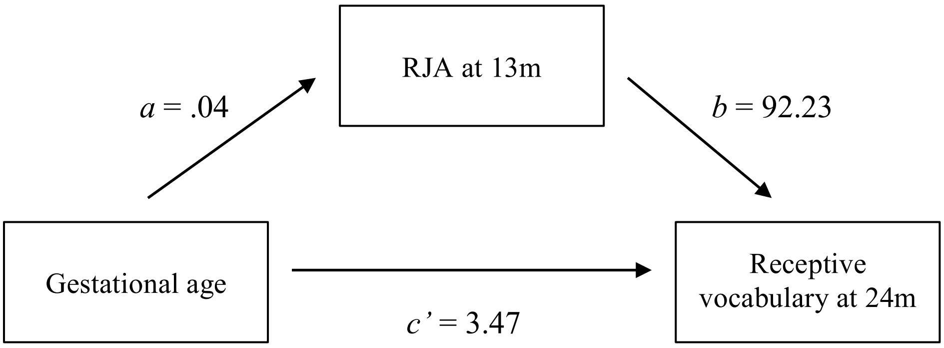


Figure 5.1. Statistical diagram representing the simple mediation analysis between gestational age, RJA scores at 13 months and comprehension scores at 24 months.

A simple mediation analysis was conducted with PROCESS Procedure for SPSS (release 2.12.1, Hayes, 2013), showing that gestational age indirectly influenced receptive vocabulary at 24 months through its effect on RJA scores at 13 months. As can be seen in Figure 5.1 and Table 5.4, infants with higher gestational age at birth scored higher on the RJA scale at 13 months (a = .04, p < .001), and infants with higher scores on the RJA scale at 13 months had a broader receptive vocabulary at 24 months (b = 92.23, p = .025). A bias-corrected bootstrap confidence interval for the indirect effect (ab = 3.47) based on 1,000 bootstrap samples was entirely above zero (0.62 to 7.79). There was no evidence that gestational age alone influenced receptive vocabulary size at 24 months independent of its effect on RJA scores at 13 months (c' = 3.47, p = .258).

Table 5.4
Model coefficients for the simple mediation analysis between gestational age, RJA scores at 13 months and comprehension scores at 24 months.

		RJA at 13m				Receptive vocab. at 24m		
		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
Gestational age	a	.04	.01	< .001	c'	3.47	3.05	.258
RJA at 13m		__	__	__	b	92.23	40.25	.025
constant	i_1	-1.12	.31	< .001	i_2	170.54	109.46	.124
		R^2 = .25				R^2 = .16		
		F (1, 66) = 21,69, p < .001				F (2, 65) = 6,08, p < .01		

5.4 Discussion

A correlational analysis showed that gestational age was positively correlated with both comprehension and production scores, therefore showing that infants born at lower gestational ages had smaller receptive and expressive vocabulary at 24 months. Moreover, gestational age was positively correlated with scores on the RJA scale at both 13 and 18 months and with scores on the RBR scale at 18 months. Therefore, infants born at lower gestational ages had lower scores on these ESCS scales. Results were different from the ones presented in chapter 3, probably due to the reduction of the samples in this chapter in order to include complete datasets from two measures at three ages. For the ESCS scales that showed differences across chapters, attrition rate between participants included in the analyses in chapter 3 vs. chapter 5 were: for the preterm sample 13% on the RJA scale, 16% on the RBR scale, and 21% on the ISI scale; for the term sample 38% on the RJA and RBR scales, and 46% on the ISI scale.

Positive correlations were found between performance on the ESCS and OCDI scores, on both samples collapsed. Comprehension was positively correlated with RJA and RBR at 13 months, and with IBR at 18 months, showing that lower scores on these ESCS scales at these ages predicted lower scores on receptive vocabulary at 24 months. Production was positively correlated with RBR at 13 months and IBR at 18 months, showing that lower scores on these ESCS scales at these ages predicted lower scores on expressive vocabulary at 24 months.

Two regression analyses were run to explore the amount of variance in OCDI scores at 24 months predicted by ESCS scores at 13 and 18 months, as well as gestational age. Variables from the ESCS were chosen following the results of the previous correlational analyses, the hypotheses of this study, as well as indications from the literature (i.e., Mundy et al., 2007). Scores from the IJA, RJA, IBR and RBR scales at both ages were included, while the ISI and RSI scales were excluded.

With regard to the analysis on comprehension, RJA at 13 months was the only significant predictor, although the strength of the prediction lowered as other variables were added to the analysis. With regard to the analysis on production, RBR at 13 months was the strongest significant predictor, even when all other variables were included in the model. Other significant predictors were gestational age and IBR at 18 months.

In line with the hypotheses, RJA at 13 months predicted receptive vocabulary size at 24 months. RJA at 18 months did not predict the comprehension performance, as suggested by results on typically developing samples, for which RJA scores at earlier, rather than later, ages had a better correlation with comprehension later on (Morales et al., 2000). Moreover, the positive correlation between gestational age and RJA scores at both 13 and 18 months remained significant (as in chapter 3), despite the smaller sample size. Gestational age did not predict receptive vocabulary size, although being positively correlated with the score. This last result can be better explained with the mediation analysis run between gestational age, RJA scores at 13 months and comprehension at 24 months. In fact, the moderation model found that gestational age alone did not influence comprehension performance at 24 months, but it did so indirectly through its influence on RJA scores at 13 months.

No correlation was found between IJA scores at any age and language performance, nor did IJA scores predict language performance. Results were in line with the study by De Schuymer and colleagues (De Schuymer et al., 2011), who tested participants with the new version of the ESCS (Mundy, Delgado, et al., 2003).

As suggested by previous results on preterm samples (De Schuymer et al., 2011; Ulvund & Smith, 1996), both IBR and RBR predicted language performance. In particular, RBR at 13 months and IBR at 18 months predicted expressive vocabulary size. Moreover, performance on production was predicted by gestational age. These results are not common in the literature on typical development (i.e., Mundy et al., 2007) and are therefore of difficult interpretation.

5.4.1 Conclusions

Triadic interaction skills showed a robust impact on language development later on, including both preterm and term born infants.

In particular, the classical finding regarding RJA skills predicting receptive vocabulary size was confirmed in the present study. Despite De Schuymer and colleagues (De Schuymer et al., 2011) found that birth status predicted receptive vocabulary size, in this study gestational age was not correlated with comprehension. This discrepancy could be due to the fact that the Special Delivery sample included participants with a continuum of gestational ages from 30 to 42 weeks, and a high number of infants born late preterm. The preterm sample in the other study (De Schuymer et al., 2011) included only infants born before 32 weeks of gestation, with some presenting serious medical complications at birth. Moreover, the term sample did not include infants born between 37 and 38 weeks of gestation (De Schuymer et al., 2011), therefore excluding participants with potentially less than optimal outcomes and creating two distinct groups with very different mean values for gestational age. Conversely, the absence of a correlation between gestational age and comprehension could reflect a more detailed picture than the one found by De Schuymer et al. (2011), as shown by the mediation analysis. Gestational age was found to influence the comprehension score entirely through its influence on the RJA scores, rather than in a direct way. The fact that the influence of gestational age on language development was found to be indirect, could suggest a possible explanation for the conflicting results (see Sansavini et al., 2010) found on language development in preterm born samples.

The role of IBR and RBR in the prediction of production scores was in line with results from other preterm samples (De Schuymer et al., 2011; Ulvund & Smith, 1996).

However, additional analyses would be needed for the interpretation of these results.

5.4.2 Future directions

More in depth analyses of the different subscales of the ESCS and their relation with language performance could depict a more detailed picture of which are the triadic behaviours that could have a bigger impact on later language outcomes. In particular, the results involving the IBR scale could be clarified by specifying if eye gaze behaviours had a different role compared to hand actions in the prediction of production scores.

Additionally, separate regression analyses could be run for the preterm and term samples, in order to better identify differences in the way triadic abilities predict language performance than with the inclusion of gestational age in a single analysis. These analyses were not included in this thesis since the samples would have seen a much smaller number of participants than in the previous chapters, possibly suggesting biased comparisons.

5.5 Summary

This chapter presented analyses including measures presented in the previous chapters, in order to evaluate how earlier behaviours would predict a later outcome. The role of triadic behaviours at 13 and 18 months was assessed with regard to language performance at the end of the second year of life. The next chapter is summarising the results presented in this thesis and drawing general conclusions.

Chapter 6 - General discussion

6.1 Introduction

This chapter is summarising results from all the measures included in this thesis, in order to have an overview of the conclusions that they suggest. Additionally, limitations and suggestions for future studies are described.

6.2 Summary of main findings

6.2.2 Gaze following: Head vs. Gaze task

Infants were tested at 13 and 18 months in a gaze following task. Three different conditions corresponded to three ways in which the experimenter turned her head and/or eyes towards the target location (on the side). Results showed no significant effect across conditions. Also, no differences were found across ages, or between participants' samples. Correlations with gestational age were mainly not significant.

Results could be interpreted as showing that gaze following abilities were not affected by prematurity. This interpretation would be in line with recent results on healthy low-risk preterm infants (Peña et al., 2014) who showed no differences when compared with full term infants in a gaze following task. Moreover, due to be absence of difference across conditions, the central role of eyes in conveying gaze direction information, compared to head position, and their communicative and cooperative role within the interaction (Tomasello et al., 2007), could not be confirmed by the present study.

However, the absence of an experimental effect across conditions together with an absence of effect from both age and birth status, should favour a cautious interpretation due to the limitations inherent in the administration of the task. The limited number of trials did not offer a reliable base from which was possible to draw solid information, also due to the fact that a substantial number of participants did not have a full number of valid trials. Additionally, one adaptation of the paradigm from the original paper could have made the task more difficult, therefore worsening the performance of both samples and favouring the absence of an age effect (i.e., even term born infants could not follow the eye gaze at 18 months, since the stimulus was made less prominent by looking to the side rather than to the ceiling). The limited data set should therefore suggest to not consider the results as convincing.

6.2.3 Triadic interaction skills: ESCS

The ESCS (Mundy, Delgado, et al., 2003) is a semi-structured observation measure designed to elicit triadic responses in infants and toddlers. Behaviours are scored according to three main classes and two roles that the infant could take on. Six scales are therefore obtained, on which infants' performances are scored: initiate (IJA) and respond (RJA) to joint attention, initiate (IBR) and respond (IBR) to behavioural request, initiate (ISI) and respond (RSI) to social interaction.

Results showed that the preterm and term samples differed on performance on three out of the six scales: RJA, IBR and RBR. However, the participants' performances changed in a similar way over time, on all of the six scales. Both samples increased their performances with age as expected by previous research on both term and preterm infants, with the exception of scores on the IJA, again as expected (De Schuymer et al., 2011; Mundy et al., 2007; Olafsen et al., 2006). These results were therefore showing a delayed, but not deviant, development in the preterm sample with regard to some triadic abilities.

The fact that results from this study were comparable with results from other studies on preterm sample, despite their participants have been tested at corrected age (De Schuymer et al., 2011; Olafsen et al., 2006), vouched for a positive impact of the environment on the development of these skills, like it was hypothesised, rather than for an impact of biological immaturity. The difference between this sample and the samples included in the other studies (De Schuymer et al., 2011; Olafsen et al., 2006) concerned gestational age at birth (higher for this sample) and medical complications (fewer for this sample). Therefore, the generally low-risk medical situation of this sample enabled the infants to capitalise on the additional extrauterine time in a social environment they experienced compared to term infants.

6.2.4 Language development: OCDI

Receptive and expressive vocabulary size was assessed via parent report (A. Hamilton et al., 2000) at 13, 18 and 24 months. The literature on preterm infants presents conflicting results regarding language development, however, delayed language is often reported, especially at pre-school and school ages (Aylward, 2005; Cusson, 2003; Guarini et al., 2009; van Noort-van der Spek et al., 2012).

Results showed both continuity and stability of performance in both samples across the three ages (a part from preterm infants between 18 and 24 months). Performances were therefore consistent both at the group and at the single participant level, showing that language development followed a very reliable increasing trajectory in both samples, without deviations for the preterm infants. Prematurity showed an effect on both comprehension and production. The effect was shown by the analyses comparing preterm and term infants, with the former scoring lower than the latter. Additionally, the effect was confirmed and specified by the correlational analysis, which found that gestational age correlated positively with performances from both samples at 18 and 24 months.

6.2.5 Influence of triadic interaction skills on language development: ESCS and OCDI

Triadic interaction skills are strong precursors of language skills, as shown by many studies on typical development. The ability to successfully interact in a joint attention bout in the first year of life predicts better language outcomes in the second year of life and beyond (commonly, up to 5 years of age) (Carpenter et al., 1998; Daum, Ulber, & Gredeback, 2013; Gliga & Csibra, 2009; Morales et al., 2000; Mundy & Gomes, 1998; Mundy et al., 2007). This relation between non-verbal and verbal communication skills has been found also in samples of infants born preterm, although with some variations from the typical development literature regarding which triadic abilities are the better predictors for later language outcomes (De Schuymer et al., 2011; Ulvund & Smith, 1996).

Data from the ESCS scales (Mundy, Delgado, et al., 2003) at 13 and 18 months were analysed with data from the OCDI (A. Hamilton et al., 2000) at 24 months through a regression analysis. Gestational age correlated positively with OCDI scores at 24 months on both the comprehension and the production scales. However, gestational age was a significant predictor of performance only on the production scale, and not on the comprehension scale. Conversely, RJA scores from the ESCS at 13 months were the only predictor of later performance on the comprehension score. With regard to prediction of scores on the production scale, three variables were reliable predictors: RBR at 13 months, gestational age and IBR at 18 months. Therefore, gestational age had a direct impact on production compared to comprehension. A simple mediation analysis added more information about the relation between gestational age, RJA scores from the ESCS at 13 months and the comprehension score from the OCDI at 24 months: although gestational age did not directly correlate with scores on comprehension, it did have an indirect effect through RJA scores at 13 months. Therefore, participants with lower/higher gestational age had lower/higher RJA scores, which predicted lower/higher scores on comprehension at 24 months.

Different relations found in these data confirmed previous studies. Firstly, the relation between responding to joint attention and receptive vocabulary was expected from research on both preterm and term samples (De Schuymer et al., 2011; Mundy et al., 2007) and confirms the influence of earlier joint attention behaviours on later vocabulary size. Secondly, the relation between initiating/responding to behavioural requests and expressive vocabulary has been found also in previous studies on preterm infants (De Schuymer et al., 2011; Ulvund & Smith, 1996) and could therefore be explored with more detail to assess if constitutes a difference in language development between preterm and term infants. Lastly, the dissociation between IJA and RJA in their predictive role on language development (Mundy et al., 2000; Mundy & Jarrold, 2010) was confirmed by the present results. Therefore, it can be concluded that prematurity did not affect the relation between social attention abilities and language development. The influence of the former on the latter was preserved and showed the same characteristics typically present in a term born sample.

6.3 Implications

Results from the different tasks included in this thesis described a quite precise picture of the features of development in preterm and term infants between 13 and 24 months on social attention and language skills.

Generally, preterm infants showed a delayed development compared to their term peers, in particular in responding to joint attention skills and on receptive and expressive vocabulary size. Differences based on birth status were also present in initiating and responding to behavioural requests. However, prematurity did not show an effect on initiating joint attention skills. The typical relation between responding to joint attention skills and language comprehension was found, showing that the role of non-verbal communication in the first year does influence language development also in the preterm sample. Additionally, it was found that this relation was influenced by gestational age. In particular, gestational age did not disrupt the role of responding to joint attention skills on language comprehension, therefore maintaining a typical relation between the development of these skills, but influenced the infants' performance on these skills (with lower gestational ages being related to lower responding to joint attention skills and more limited language comprehension).

6.3.2 Methodological implications

The preterm sample was tested at chronological age in order to explore the role of the social environment on development, considering that preterm infants had additional extrauterine experience compared to term infants. The general low-risk medical situations presented by the preterm sample, together with gestational ages at birth above 30 weeks, guaranteed that infants were not suffering from particularly complicated medical circumstances and could be tested at chronological age. The presence of lower performances when compared to the term sample showed that the preterm sample was affected by the premature birth on different cognitive and social domains. The role of the additional extrauterine experience was not enough to perform at a typical level on triadic interaction skills (with the exception of initiating joint attention), or to have a typical vocabulary size. However, the use of chronological over corrected age helped identifying developmental differences between different types of triadic interaction skills. Moreover, it provided an objective description of the socio-cognitive skills mastered by the preterm sample in relation to the environment and common demands they daily compare themselves against, together with their caregivers.

The use of gestational age as a continuous variable, together with comparing groups based on birth status, provided a more complete description of the results. The two types of analyses brought sometimes contrasting evidence, that helped showing how complicated is the particular developmental pathway set by a preterm birth. In fact, the mediation analysis showed that a difference in performance between groups was present even without a significant correlation between gestational age and the sample's performance. Therefore indicating that the influence of gestational age on performance was indirect.

The age chosen for testing the infants were motivated by previous research on the emergence of social attention and language abilities in term born samples (see section 1.3). The aim was to choose ages (13 and 18 months) at which most but not all of the term born infants would master the tested abilities, in order to have group variance and to not risk a ceiling effect. Not choosing to test at the age at which the abilities would just be emerging, did also give some more time to the preterm born infants to possibly reach a better skill level, to not risk a floor effect, especially given that they were tested at chronological age. A better design would have provided testing opportunities of the preterm born sample at both chronological and corrected ages, but it would have added more constraints. One way of implementing this would have been to test the preterm participants twice (at chronological and corrected age), but it would have meant that these participants were experiencing the study very differently from the term born ones. Doubling the number of testing session would have been too challenging for many families, possibly leading to more participants' drop-outs. Moreover, the preterm born infants would have had more experience with the experimental tasks compared to their term born peers, therefore affecting data collection. A solution to these problems could have been brought by recruiting double the number of preterm born infants and to divide the sample in two: one tested at chronological age and one at corrected age. However, this option seemed of very unlikely making, given the long time it took to recruit the preterm born sample respecting our inclusion criteria.

6.3.2 Theoretical implications

Being able to compare preterm infants' performance with the one by their term peers, by collecting data both at chronological and corrected ages, would have made possible to reach much stronger conclusions. In this way, in fact, one could deduce with more detail the role of both biological immaturity and experience on the preterm infants' performance. The preterm infants tested at chronological age would have had the same amount of time as the term born infants to gain experience, while the preterm infants tested at chronological age would have had the same biological maturity as the term born infants. A possibly different set of results coming from comparing each preterm born group with the term born controls, could have indicated which areas were more at risk from less experience and/or biological immaturity, and which areas were more protected by more experience and/or biological maturity. On the other hand, the Special Delivery design put the accent on the role of experience in the development of social attention and language. The results, showing that the preterm born sample had lower scores in responding to joint attention, initiating and responding to behavioural request and in language development, suggested that the risk factors due to prematurity were stronger than the protective role of experience for the development of these skills. Conversely, the absence of difference between groups (as well as the absence of correlation with gestational age) in initiating joint attention skills, could point towards a protective role of experience on the cognitive processes underlying these behaviours.

Moreover, the different results related to initiating and responding to joint attention helped corroborating the model by Mundy and colleagues (Mundy, 2003; Mundy et al., 2000; Mundy & Jarrold, 2010). Since the two skills did not present the same pattern of development, they could not depend on the same cognitive bases influenced by the single knowledge of other people being intentional beings in order to function, like described by Tomasello and colleagues (Tomasello, 1995; Tomasello, Carpenter, Call, et al., 2005). Both preterm and term infants presented the dissociation between initiating and responding to joint attention, pointing towards the possibility that both samples shared the same neural organisation with regard to these skills. Further research is needed in order to confirm this.

Hypothesising a similar neural organisation between preterm and term born infants with regard to initiating joint attention, given the similar results, one could also hypothesise a different neural organisation between the two samples for networks related to responding to joint attention abilities. On the other hand, the fact that both samples showed a similar increase in performance with age in responding to joint attention (as well as in other social attention skills) points towards a similar neural organisation for the two samples, but a delay in the development of these skills for the preterm born sample. It could also be possible that the differences are subtle and possibly changing overtime, sometimes leading to a solution of a problem, and sometimes increasing the developmental delays (i.e., problems with responding to joint attention which lead to problems with language development). Like argued by Karmiloff-Smith (2006), different solutions are possible in the brain organisation during the highly plastic infancy period and longitudinal studies offer the best solution to investigate these changes. Similar arguments can be made on the recent study by Peña and colleagues (2014). The advantage found in the preterm sample could be a temporary byproduct of the atypical solutions employed by the preterm brain after being exposed to a higher than typical amount of stimuli in the first weeks of life, or could lead to long-lasting protective factors with regard to gaze following skills. Since the gaze following task presented in this thesis did not produce reliable data, unfortunately these hypotheses could not be supported or denied by this work. However, since the preterm sample presented delays in responding to joint attention, which was operationalized as following pointing (as well as a head, gaze and body shift), this thesis brings more evidence discrediting a long-lasting advantage within this set of skills.

6.4 Limitations

As Hack (2012) noted, predicting outcomes when testing an infant population is always going to be affected by unavoidable problems, both if testing normal or at-risk populations. However, despite some difficulties with the Head vs. Gaze task that could have been piloted for a longer time, data collection has gone reasonably well, providing a great number of viable data and entertaining infants and caregivers at the same time.

Therefore, seeing that participants who took part in the testing sessions at the university generally enjoyed them, a limitation of the study has been to not retain more participants after initial recruitment. Perhaps some way of allowing caregivers to have a glimpse of the experience at the university in advance would have convinced more participants to not drop off the study. In this respect, the use of social media, as well as a regular website to present a friendly image of the laboratory and the research group, and provide some practical information about what is involved in a testing session, could make the difference for some participants.

With regard to the sample size and the distribution of participants along the gestational age continuum, a greater number of participants born at earlier gestational ages would have provided an even more balanced picture. Also, a higher number of participants would have given more power to the analyses, possibly clarifying some unexpected results.

The biggest limitation of this thesis has been posed by the Head vs. Gaze task, which did not provide a reliable set of results. A modification of the original paradigm could have been the reason of the absence of differences across experimental conditions (i.e., following gaze to the sides instead of to the ceiling, could have proved more difficult given that the pupil is less visible in the former rather than in the latter condition).

6.5 Suggestions for future studies

The two imitation tasks administered at 13 and 18 months would provide the missing piece to fully explore intention understanding and social communication in both preterm and term samples. In fact, as shown by previous studies, joint attention, imitation and language depend on each other for an optimal socio-cognitive development in the normal population (Carpenter et al., 1998; Charman et al., 2000).

The absence of difference in initiating joint attention scores between samples set an interesting stage for the analyses of the imitation tasks. In fact, initiating joint attention abilities, relying on a frontal neural network (Mundy & Jarrold, 2010), are supposedly involved in mechanisms dedicated to the understanding of differences between self and other, and therefore also understanding intentionality, together with social motivation (see Mundy et al., 2007). Is therefore possible that no difference based on birth status will be found in the analyses of performance on those tasks.

The different attention abilities and strategies adopted by infants born preterm, compared to term infants, have an influence on their interaction partners. In fact, compared with behaviours deviant from what they would normally expect, parents of infants born preterm, could find it more difficult to interact with their infants (Goldberg & DiVitto, 2002). Maternal sensitivity influences infants' joint attention abilities (Yoder & Warren, 1999) and, more in general, cognitive and social skills (Landry, Smith, Swank, Assel, & Vellet, 2001). Future analyses could explore the mother-infants interactions recorded at 13 and 18 months. Results could be correlated with results from the same type of interactions recorded at 5 months, to investigate stability and continuity of performance, as well as being correlated with triadic interaction skills scores in order to evaluate the reciprocal impact. Since demographical information did not substantially differed between the preterm and the term sample, the mother-infant interactions are an important source of information to evaluate the role of the social environment on the infants' performances and development.

Mother-infant interactions at 13 and 18 months could also be analysed with regard to language. Transcriptions of the language used during the interactions would possibly add information about the infants' language development. Moreover, the mothers' language could be analysed to explore its qualities and then checked against the infants' vocabulary size to draw conclusions on the reciprocal influence. Finally, mothers' language could be analysed for the presence of mentalistic features and results could be checked again the infants' performance on the imitation tasks, to assess the mother's language's influence on the development of intention understanding (Astington & Baird, 2005).

6.6 Summary

This chapter summarised the main results presented in the three previous chapters, drawing general conclusions on their implications and meaning. Limitations of the study were mentioned, as well as suggestions for future studies.

References

Ahmed, A., & Ruffman, T. (1998). Why Do Infants Make A Not B Errors in a Search Task, Yet Show Memory for the Location of Hidden Objects in a Nonsearch Task? *Developmental Psychology*, *34*(3), 441–453. http://doi.org/10.1037/0012-1649.34.3.441

Akhtar, N., Carpenter, M., & Tomasello, M. (1996). The Role of Discourse Novelty in Early Word Learning. *Child Development*, *67*(2), 635–645. http://doi.org/10.1111/j.1467-8624.1996.tb01756.x

Akhtar, N., Jipson, J., & Callanan, M. A. (2001). Learning words through overhearing. *Child Development*, *72*(2), 416–430. http://doi.org/10.1111/1467-8624.00287

Akhtar, N., & Tomasello, M. (1996). Two-year-olds learn words for absent objects and actions. *British Journal of Developmental Psychology*, *14*(1), 79–93. http://doi.org/10.1111/j.2044-835X.1996.tb00695.x

Aly, H., Hammad, T., Nada, A., Mohamed, M., Bathgate, S., & El-Mohandes, A. (2010). Maternal obesity, associated complications and risk of prematurity. *J Perinatol*, *30*(7), 447–451.

Ananth, C. V, Ananth, C. V, & Vintzileos, A. M. (2006). Epidemiology of preterm birth and its clinical subtypes. *The Journal of Maternal-Fetal & Neonatal Medicine*, *19*(12), 773–782. http://doi.org/10.1080/14767050600965882

Ananth, C. V, Getahun, D., Peltier, M. R., Salihu, H. M., & Vintzileos, A. M. (2006). Recurrence of spontaneous versus medically indicated preterm birth. *American Journal of Obstetrics and Gynecology*, *195*(3), 643–650. http://doi.org/http://dx.doi.org/10.1016/j.ajog.2006.05.022

Astington, J. W. E., & Baird, J. A. (2005). *Why language matters for theory of mind*. Oxford University Press.

Aylward, G. P. (2002a). Cognitive and neuropsychological outcomes: More than IQ scores. *Mental Retardation and Developmental Disabilities Research Reviews*, *8*(4), 234–240. http://doi.org/10.1002/mrdd.10043

Aylward, G. P. (2002b). Methodological issues in outcome studies of at-risk infants. *Journal of Pediatric Psychology*, *27*(1), 37–45.

Aylward, G. P. (2005). Neurodevelopmental outcomes of infants born prematurely. *Journal of Developmental and Behavioral Pediatrics*, *26*(6), 427–440. http://doi.org/10.1097/00004703-200512000-00008

Bakeman, R., & Adamson, L. B. (1984). Coordinating Attention to People and Ojects in Mother-Infant and Peer-Infant Interaction. *Child Development*, *55*(4), 1278–1289. http://doi.org/10.2307/1129997

Baldwin, D. A. (1993). Early Referential Understanding: Infants' Ability to Recognize Referential Acts for What They Are. *Developmental Psychology*, *29*(5), 832–843.

Baldwin, D. A. (2000). Interpersonal Understanding Fuels Knowledge Acquisition. *Current Directions in Psychological Science*, *9*(2), 40–45. http://doi.org/10.1111/1467-8721.00057

Baldwin, D. A., Markman, E. M., Bill, B., Desjardins, R. N., Irwin, J. M., & Tidball, G. (1996). Infants' Reliance on a Social Criterion for Establishing Word-Object Relations. *Child Development*, *67*(6), 3135–3153. http://doi.org/10.1111/j.1467-8624.1996.tb01906.x

Baldwin, D. A., & Moses, L. J. (2001). Links between Social Understanding and Early Word Learning: Challenges to Current Accounts. *Social Development*, *10*(3), 309–329. http://doi.org/10.1111/1467-9507.00168

Barrera, M. E., Rosenbaum, P. L., & Cunningham, C. E. (1987). Corrected and uncorrected Bayley scores: Longitudinal developmental patterns in low and high birth weight preterm infants. *Infant Behavior and Development*, *10*(3), 337–346. http://doi.org/10.1016/0163-6383(87)90021-x

Bates, E., Camaioni, L., & Volterra, V. (1975). The acquisition of performatives prior to speech. *Merrill-Palmer Quarterly*, *21*(3), 205–226.

Battaglia, F. C., & Lubchenco, L. O. (1967). A practical classification of newborn infants by weight and gestational age. *The Journal of Pediatrics*, *71*(2), 159–163. http://doi.org/http://dx.doi.org/10.1016/S0022-3476(67)80066-0

Bayley, N. (1993). *Bayley Scales of Infant Development. 2nd ed*. San Antonio, TX: Psychological Corp.

Bayley, N. (2006). *Technical Manual of the Bayley Scales of Infant and Toddler Development*. San Antonio, TX: Harcourt Assessment, Inc.

Beck, S., Wojdyla, D., Say, L., Betran, A. P., Merialdi, M., Requejo, J. H., … Look, P. F. A. Van. (2010). The worldwide incidence of preterm birth: a systematic review of maternal mortality and morbidity. *Bulletin of the World Health Organization*, *88*, 31–38.

Behne, T., Carpenter, M., & Tomasello, M. (2005). One-year-olds comprehend the communicative intentions behind gestures in a hiding game. *Developmental Science*, *8*(6), 492–499. http://doi.org/10.1111/j.1467-7687.2005.00440.x

Bhutta, A. T., Cleves, M. A., Casey, P. H., Cradock, M. M., & Anand, K. J. S. (2002). Cognitive and behavioral outcomes of school-aged children who were born preterm - A meta-analysis. *Jama-Journal of the American Medical Association*, *288*(6), 728–737.

Blondel, B., Macfarlane, A., Gissler, M., Breart, G., & Zeitlin, J. (2006). General obstetrics: Preterm birth and multiple pregnancy in European countries participating in the PERISTAT project. *BJOG: An International Journal of Obstetrics & Gynaecology*, *113*(5), 528–535. http://doi.org/10.1111/j.1471-0528.2006.00923.x

Bonin, M., Pomerleau, A., & Malcuit, G. (1998). A longitudinal study of visual attention and psychomotor development in preterm and full-term infants during the first six months of life. *Infant Behavior and Development*, *21*(1), 103–118. http://doi.org/http://dx.doi.org/10.1016/S0163-6383(98)90057-1

Bornstein, M. H. (2002). Parenting Infants. In M. H. Bornstein (Ed.), *Handbook of Parenting* (pp. 3–44). Mahwah, NJ, US: Lawrence Erlbaum Associates.

Bornstein, M. H., & Bornstein, L. (2008). Psychological stability. In W. A. J. Darity (Ed.), *International encyclopedia of social sciences. 2* (pp. 74–75). Detroit, MI: Macmillan Reference.

Boyle, E. M., Johnson, S., Manktelow, B., Seaton, S. E., Draper, E. S., Smith, L. K., … Field, D. J. (2015). Neonatal outcomes and delivery of care for infants born late preterm or moderately preterm: a prospective population-based study. *Archives of Disease in Childhood - Fetal and Neonatal Edition* , *100*(6), F479–F485. http://doi.org/10.1136/archdischild-2014-307347

Brooks, R., & Meltzoff, A. N. (2002). The importance of eyes: How infants interpret adult looking behavior. *Developmental Psychology*, *38*(6), 958–966. http://doi.org/10.1037/0012-1649.38.6.958

Brooks, R., & Meltzoff, A. N. (2005). The development of gaze following and its relation to language. *Developmental Science*, *8*(6), 535–543. http://doi.org/10.1111/j.1467-7687.2005.00445.x

Brugger, A., Lariviere, L. A., Mumme, D. L., & Bushnell, E. W. (2007). Doing the Right Thing: Infants' Selection of Actions to Imitate From Observed Event Sequences. *Child Development*, *78*(3), 806–824. http://doi.org/10.1111/j.1467-8624.2007.01034.x

Bruner, J. S. (1975). From communication to language—a psychological perspective. *Cognition*, *3*(3), 255–287. http://doi.org/http://dx.doi.org/10.1016/0010-0277(74)90012-2

Bruner, J. S. (1983). *Child's talk: Leaning to use language*. New York: Norton.

Butcher, P. R., Kalverboer, A. F., Geuze, R. H., & Stremmelaar, E. F. (2002). A longitudinal study of the development of shifts of gaze to a peripheral stimulus in preterm infants with transient periventricular echogenicity. *Journal of Experimental Child Psychology*, *82*(2), 116–140. http://doi.org/http://dx.doi.org/10.1016/S0022-0965(02)00006-1

Butterworth, G., & Jarrett, N. (1991). What minds have in common is space: Spatial mechanisms serving joint visual attention in infancy. *British Journal of Developmental Psychology*, *9*(1), 55–72. http://doi.org/10.1111/j.2044-835X.1991.tb00862.x

Callaghan, W. M., MacDorman, M. F., Rasmussen, S. a, Qin, C., & Lackritz, E. M. (2006). The Contribution of Preterm Birth to Infant Mortality Rates in the United States. *Pediatrics*, *118*(4), 1566–1573. http://doi.org/10.1542/peds.2006-0860

Caputo, D. V., Goldstein, K. M., & Taub, H. B. (1981). Neonatal compromise and later psychological development: A 10-year longitudinal study. In S. L. Friedman & M. Sigman (Eds.), *Preterm birth and psychological development*. New York: Academic.

Carmichael, S. L., & Abrams, B. (1997). A critical review of the relationship between gestational weight gain and preterm delivery. *Obstetrics & Gynecology*, *89*(5, Part 2).

Carmody, D. P., Bendersky, M., Dunn, S. M., DeMarco, J. K., Hegyi, T., Hiatt, M., & Lewis, M. (2006). Early risk, attention, and brain activation in adolescents born preterm. *Child Development*, *77*(2), 384–394.

Caron, A. J. (2009). Comprehension of the representational mind in infancy. *Developmental Review*, *29*(2), 69–95. http://doi.org/10.1016/j.dr.2009.04.002

Carpenter, M., Call, J., & Tomasello, M. (2005). Twelve- and 18-month-olds copy actions in terms of goals. *Developmental Science*, *8*(1), F13–F20. http://doi.org/10.1111/j.1467-7687.2004.00385.x

Carpenter, M., Nagell, K., Tomasello, M., Butterworth, G., & Moore, C. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development*, *63*(4), i–vi, 1-143.

Chabra, S. (2012). Concept of Gestational Age in "Completed Weeks": Lost in Translation. *Obstetrics & Gynecology*, *119*(1).

Chan, E., & Quigley, M. A. (2014). School performance at age 7 years in late preterm and early term birth: a cohort study. *Archives of Disease in Childhood - Fetal and Neonatal Edition*, (0), F1–F7. http://doi.org/10.1136/archdischild-2014-306124

Charman, T. (2003). Why is joint attention a pivotal skill in autism? *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *358*(1430), 315–24. http://doi.org/10.1098/rstb.2002.1199

Charman, T., Baron-cohen, S., Swettenham, J., Baird, G., Cox, A., & Drew, A. (2000). Testing joint attention, imitation, and play as infancy precursors to language and theory of mind. *Cognitive Development*, *15*(4), 481–498. http://doi.org/10.1016/s0885-2014(01)00037-5

Cheatham, C. L., Bauer, P. J., & Georgieff, M. K. (2006). Predicting Individual Differences in Recall by Infants Born Preterm and Full Term. *Infancy*, *10*(1), 17–42. http://doi.org/10.1207/s15327078in1001_2

Chomsky, N. (1965). *Aspects of the theory of syntax*. Cambridge: Multilingual Matters: MIT Press.

Chomsky, N. (1968). *Language and mind*. New York: Harcourt Brace.

Chu, S.-M., Tsai, M.-H., Hwang, F.-M., Hsu, J.-F., Huang, H., & Huang, Y.-S. (2012). The relationship between attention deficit hyperactivity disorder and premature infants in Taiwanese: a case control study. *BMC Psychiatry*, *12*(1), 85.

Chyi, L. J., Lee, H. C., Hintz, S. R., Gould, J. B., & Sutcliffe, T. L. (2008). School Outcomes of Late Preterm Infants: Special Needs and Challenges for Infants Born at 32 to 36 Weeks Gestation. *The Journal of Pediatrics*, *153*(1), 25–31. http://doi.org/10.1016/j.jpeds.2008.01.027

Clark, C. A. C., Woodward, L. J., Horwood, L. J., & Moor, S. (2008). Development of emotional and behavioral regulation in children born extremely preterm and very preterm: Biological and social influences. *Child Development*, *79*(5), 1444–1462.

Cohen, J. (1960). A Coefficient of Agreement for Nominal Scales. *Educational and Psychological Measurement*, *20*(1), 37–46. http://doi.org/10.1177/001316446002000104

Colombo, J. (2001). The development of visual attention in infancy. *Annual Review of Psychology*, *52*, 337–367. http://doi.org/10.1146/annurev.psych.52.1.337

Colombo, J., & Cheatham, C. L. (2006). The emergence and basis of endogenous attention in infancy and early childhood. In V. K. Robert (Ed.), *Advances in Child Development and Behavior* (Vol. Volume 34, pp. 283–322). JAI. http://doi.org/http://dx.doi.org/10.1016/S0065-2407(06)80010-8

Colombo, J., Freeseman, L. J., Coldren, J. T., & Frick, J. E. (1995). Individual differences in infant fixation duration: Dominance of global versus local stimulus properties. *Cognitive Development*, *10*(2), 271–285. http://doi.org/10.1016/0885-2014(95)90012-8

Committee on Fetus and Newborn American Academy of Pediatrics. (2004). Age Terminology During the Perinatal Period. *Pediatrics*, *114*(5), 1362–1364. http://doi.org/10.1542/peds.2004-1915

Conde-Agudelo, A., Rosas-Bermúdez, A., & Kafury-Goeta, A. (2006). Birth spacing and risk of adverse perinatal outcomes: A meta-analysis. *JAMA*, *295*(15), 1809–1823.

Cserjesi, R., Van Braeckel, K. N., Timmerman, M., Butcher, P. R., Kerstjens, J. M., Reijneveld, S. A., … Geuze, R. H. (2012). Patterns of functioning and predictive factors in children born moderately preterm or at term. *Developmental Medicine & Child Neurology*, *54*(8), 710–715. http://doi.org/10.1111/j.1469-8749.2012.04328.x

Cusson, R. M. (2003). Factors Influencing Language Development in Preterm Infants. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, *32*(3), 402–409. http://doi.org/10.1177/0884217503253530

D'Entremont, B., Hains, S. M. J., & Muir, D. W. (1997). A demonstration of gaze following in 3- to 6-month-olds. *Infant Behavior and Development*, *20*(4), 569–572. http://doi.org/10.1016/s0163-

6383(97)90048-5

da Costa Ribeiro, C., Abramides, D. V. M., Fuertes, M. G., Lopes dos Santos, P. N., & Lamônica, D. A. C. (2016). Receptive language and intellectual abilities in preterm children. *Early Human Development*, *99*, 57–60. http://doi.org/http://dx.doi.org/10.1016/j.earlhumdev.2016.03.011

Damasio, A. (2008). *Descartes' error: Emotion, reason and the human brain*. Random House.

Darlow, B. A., Horwood, L. J., Wynn-Williams, M. B., Mogridge, N., & Austin, N. C. (2009). Admissions of all gestations to a regional neonatal unit versus controls: 2-year outcome. *Journal of Paediatrics and Child Health*, *45*(4), 187–193. http://doi.org/10.1111/j.1440-1754.2008.01457.x

Daum, M. M., Ulber, J., & Gredeback, G. (2013). The Development of Pointing Perception in Infancy: Effects of Communicative Signals on Covert Shifts of Attention. *Developmental Psychology*, *49*(10), 1898–1908. http://doi.org/10.1037/a0031111

Davidoff, M. J., Dias, T., Damus, K., Russell, R., Bettegowda, V. R., Dolan, S., … Petrini, J. (2006). Changes in the Gestational Age Distribution among U.S. Singleton Births: Impact on Rates of Late Preterm Birth, 1992 to 2002. *Seminars in Perinatology*, *30*(1), 8–15. http://doi.org/http://dx.doi.org/10.1053/j.semperi.2006.01.009

De Barbaro, K., Johnson, C. M., & Deák, G. O. (2013). Twelve-month "social revolution" emerges from mother-infant sensorimotor coordination: A longitudinal investigation. *Human Development*, *56*(4), 223–248. http://doi.org/10.1159/000351313

De Groote, I., Roeyers, H., & Warreyn, P. (2006). Social-Communicative Abilities in Young High-Risk Preterm Children. *Journal of Developmental and Physical Disabilities*, *18*(2), 183–200. http://doi.org/10.1007/s10882-006-9011-y

de Jong, M., Verhoeven, M., & van Baar, A. L. (2012). School outcome, cognitive functioning, and behaviour problems in moderate and late preterm children and adults: a review. *Seminars in Fetal & Neonatal Medicine*, *17*(3), 163–169. http://doi.org/10.1016/j.siny.2012.02.003

De Schuymer, L., De Groote, I., Beyers, W., Striano, T., & Roeyers, H. (2011). Preverbal skills as mediators for language outcome in preterm and full term children. *Early Human Development*, *87*(4), 265–272. http://doi.org/10.1016/j.earlhumdev.2011.01.029

De Schuymer, L., De Groote, I., Desoete, A., & Roeyers, H. (2012). Gaze aversion during social interaction in preterm infants: A function of attention skills? *Infant Behavior and Development*, *35*(1), 129–139. http://doi.org/10.1016/j.infbeh.2011.08.002

Dehaene-Lambertz, G., Dehaene, S., & Hertz-Pannier, L. (2002). Functional Neuroimaging of Speech Perception in Infants. *Science*, *298*(5600), 2013 LP-2015.

Dehaene-Lambertz, G., Hertz-Pannier, L., & Dubois, J. (2006). Nature and nurture in language acquisition: anatomical and functional brain-imaging studies in infants. *Trends in Neurosciences*, *29*(7), 367–373. http://doi.org/10.1016/j.tins.2006.05.011

Delgado, C. E. F., Mundy, P., Crowson, M., Markus, J., Yale, M., & Schwartz, H. (2002). Responding to Joint Attention and Language Development: A Comparison of Target Locations. *J Speech Lang Hear Res*, *45*(4), 715–719. http://doi.org/10.1044/1092-4388(2002/057)

Delobel-Ayoub, M., Kaminski, M., Marret, S., Burguet, A., Marchand, L., N'Guyen, S., … Grp, E. S. (2006). Behavioral outcome at 3 years of age in very preterm infants: The EPIPAGE study. *Pediatrics*, *117*(6), 1996–2005. http://doi.org/DOI 10.1542/peds.2005-2310

Den Ouden, L., Rijken, M., Brand, R., Verloove-Vanhorick, S. P., & Ruys, J. H. (1991). Is it correct to correct? Developmental milestones in 555 "normal" preterm infants compared with term infants. *The Journal of Pediatrics*, *118*(3), 399–404. http://doi.org/10.1016/s0022-3476(05)82154-7

Desimone, R., & Duncan, J. (1995). Neural Mechanisms of Selective Visual Attention. *Annual Review of Neuroscience*, *18*(1), 193–222. http://doi.org/doi: 10.1146/annurev.ne.18.030195.001205

Diamond, A. (1985). Development of the ability to use recall to guide action, as indicated by infants' performance on AnotB. *Child Development*, *56*(4), 868–883. http://doi.org/10.1111/j.1467-8624.1985.tb00160.x

di Pellegrino, G., Fadiga, L., Fogassi, L., Gallese, V., & Rizzolatti, G. (1992). Understanding motor events: a neurophysiological study. *Experimental Brain Research*, *91*(1), 176–180. http://doi.org/10.1007/bf00230027

DiPietro, J. A., & Allen, M. C. (1991). Estimation of Gestational Age: Implications for Developmental Research. *Child Development*, *62*(5), 1184–1199. http://doi.org/10.1111/j.1467-

8624.1991.tb01599.x

Dunn, L. M., & Dunn, L. M. (1981). *Manual for the peabody picture vocabulary test-revised*. Circle Pines, MN: American Guidance Service.

Emery, N. J. (2000). The eyes have it: the neuroethology, function and evolution of social gaze. *Neuroscience & Biobehavioral Reviews*, *24*(6), 581–604. http://doi.org/http://dx.doi.org/10.1016/S0149-7634(00)00025-7

Engle, W. A. (2006). A Recommendation for the Definition of "Late Preterm" (Near-Term) and the Birth Weight–Gestational Age Classification System. *Seminars in Perinatology*, *30*(1), 2–7. http://doi.org/10.1053/j.semperi.2006.01.007

Engle, W. A. (2011). Morbidity and Mortality in Late Preterm and Early Term Newborns: A Continuum. *Clinics in Perinatology*, *38*(3), 493–516.

Engle, W. A., Tomashek, K. M., & Wallman, C. (2007). "Late-preterm" infants: a population at risk. *Pediatrics*, *120*(6), 1390–401. http://doi.org/10.1542/peds.2007-2952

Eryigit-Madzwamuse, S., & Wolke, D. (2015). Attention problems in relation to gestational age at birth and smallness for gestational age. *Early Human Development*, *91*(2), 131–138. http://doi.org/10.1016/j.earlhumdev.2015.01.004

Escobar, G. J., Clark, R. H., & Greene, J. D. (2006). Short-term outcomes of infants born at 35 and 36 weeks gestation: we need to ask more questions. *Seminars in Perinatology*, *30*(1), 28–33. http://doi.org/10.1053/j.semperi.2006.01.005

Escobar, G. J., McCormick, M. C., Zupancic, J. A. F., Coleman-Phox, K., Armstrong, M. A., Greene, J. D., … Richardson, D. K. (2006). Unstudied infants: outcomes of moderately premature infants in the neonatal intensive care unit. *Archives of Disease in Childhood - Fetal and Neonatal Edition*, *91*(4), F238–F244. http://doi.org/10.1136/adc.2005.087031

Fadiga, L., Fogassi, L., Pavesi, G., & Rizzolatti, G. (1995). Motor facilitation during action observation: a magnetic stimulation study. *Journal of Neurophysiology*, *73*(6), 2608–2611.

Farroni, T., Csibra, G., Simion, F., & Johnson, M. H. (2002). Eye contact detection in humans from birth. *Proceedings of the National Academy of Sciences* , *99*(14), 9602–9605. http://doi.org/10.1073/pnas.152159999

Farroni, T., Menon, E., & Johnson, M. H. (2006). Factors influencing newborns' preference for faces with eye contact. *Journal of Experimental Child Psychology*, *95*(4), 298–308. http://doi.org/10.1016/j.jecp.2006.08.001

Feldman, R., Eidelman, A. I., Sirota, L., & Weller, A. (2002). Comparison of skin-to-skin (kangaroo) and traditional care: Parenting outcomes and preterm infant development. *Pediatrics*, *110*(1), 16–26. http://doi.org/10.1542/peds.110.1.16

Fenson, L., Dale, P. S., Reznick, J. S., Thal, D. J., Bates, E., Hartung, J. P., … Reilly, J. S. (1993). *MacArthur communicative development inventories: user's guide and technical manual*. San Diego, CA: Singular Publishing.

Fernell, E., & Gillberg, C. (2012). Preterm birth, ADHD and the ESSENCE in adult psychiatry. *Acta Paediatrica*, *101*(12), e568–e569. http://doi.org/10.1111/apa.12026

Flom, R., Lee, K., & Muir, D. (2007). Gaze-following: Its development and significance. Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.

Foster-Cohen, S., Edgin, J. O., Champion, P. R., & Woodward, L. J. (2007). Early delayed language development in very preterm infants: Evidence from the MacArthur-Bates CDI. *Journal of Child Language*, *34*(3), 655–675. http://doi.org/10.1017/s0305000907008070

Frick, J. E., Colombo, J., & Saxon, T. F. (1999). Individual and developmental differences in disengagement of fixation in early infancy. *Child Development*, *70*(3), 537–548. http://doi.org/10.1111/1467-8624.00039

Gallese, V., Fadiga, L., Fogassi, L., & Rizzolatti, G. (1996). Action recognition in the premotor cortex. *Brain*, *119*(2), 593–609. http://doi.org/10.1093/brain/119.2.593

Garner, P. W., Landry, S. H., & Richardson, M. A. (1991). The development of joint attention skills in very-low-birth-weight infants across the first 2 years. *Infant Behavior and Development*, *14*(4), 489–495. http://doi.org/10.1016/0163-6383(91)90035-q

Gartstein, M. A., & Rothbart, M. K. (2003). Studying infant temperament via the Revised Infant Behavior Questionnaire. *Infant Behavior and Development*, *26*(1), 64–86. http://doi.org/10.1016/s0163-

6383(02)00169-8

Gestation-specific infant mortality, 2012. (2014). *Office for National Statistics, Cardiff ONS*.

Gliga, T., & Csibra, G. (2009). One-Year-Old Infants Appreciate the Referential Nature of Deictic Gestures and Words. *Psychological Science*, *20*(3), 347–353. http://doi.org/10.1111/j.1467-9280.2009.02295.x

Goldberg, S., & DiVitto, B. A. (2002). Parenting children born preterm. In M. H. Bornstein (Ed.), *Handbook of Parenting*. Mahwah, NJ, US: Lawrence Erlbaum Associates.

Goldenberg, R. L., Culhane, J. F., Iams, J. D., & Romero, R. (2007). Epidemiology and causes of preterm birth. *The Lancet*, *371*(9606), 75–84. http://doi.org/http://dx.doi.org/10.1016/S0140-6736(08)60074-4

Goldenberg, R. L., Culhane, J. F., Iams, J. D., & Romero, R. (2008). Preterm Birth 1 Epidemiology and causes of preterm birth, 75–84.

Gouyon, J.-B., Iacobelli, S., Ferdynus, C., & Bonsante, F. (2012). Neonatal problems of late and moderate preterm infants. *Seminars in Fetal and Neonatal Medicine*, *17*(3), 146–152. http://doi.org/http://dx.doi.org/10.1016/j.siny.2012.01.015

Gouyon, J.-B., Vintejoux, A., Sagot, P., Burguet, A., Quantin, C., Ferdynus, C., & Network, the B. P. (2010). Neonatal outcome associated with singleton birth at 34–41 weeks of gestation. *International Journal of Epidemiology*, *39*(3), 769–776. http://doi.org/10.1093/ije/dyq037

Gray, P. H., Edwards, D. M., O'Callaghan, M. J., & Gibbons, K. (2015). Screening for autism spectrum disorder in very preterm infants during early childhood. *Early Human Development*, *91*(4), 271–276. http://doi.org/10.1016/j.earlhumdev.2015.02.007

Griffiths, R. (1996). *The Griffiths mental development scales from birth to two years, manual, the 1996 revision*. Henley: Association for Research in Infant and Child Development, Test Agency.

Guarini, A., Sansavini, A., Fabbri, C., Alessandroni, R., Faldella, G., & Karmiloff-Smith, A. (2009). Reconsidering the impact of preterm birth on language outcome. *Early Human Development*, *85*(10), 639–645. http://doi.org/http://dx.doi.org/10.1016/j.earlhumdev.2009.08.061

Gultom, E., Doyle, L. W., Davis, P., Dharmalingam, A., & Bowman, E. (1997). Changes Over Time in Attitudes to Treatment and Survival Rate for Extremely Preterm Infants (23–27 Weeks' Gestational Age). *Australian and New Zealand Journal of Obstetrics and Gynaecology*, *37*(1), 56–58. http://doi.org/10.1111/j.1479-828X.1997.tb02218.x

Gurka, M. J., LoCasale-Crouch, J., & Blackman, J. A. (2010). LOng-term cognition, achievement, socioemotional, and behavioral development of healthy late-preterm infants. *Archives of Pediatrics & Adolescent Medicine*, *164*(6), 525–532.

Hack, M. (2012). Dilemmas in the Measurement of Developmental Outcomes of Preterm Children. *The Journal of Pediatrics*, *160*(4), 537–538. http://doi.org/http://dx.doi.org/10.1016/j.jpeds.2011.11.021

Halmøy, A., Klungsøyr, K., Skjærven, R., & Haavik, J. (2012). Pre- and Perinatal Risk Factors in Adults with Attention-Deficit/Hyperactivity Disorder. *Biological Psychiatry*, *71*(5), 474–481. http://doi.org/10.1016/j.biopsych.2011.11.013

Hamilton, A., Plunkett, K., & Schafer, G. (2000). Infant vocabulary development assessed with a British communicative development inventory. *Journal of Child Language*, *27*(3), 689–705.

Hamilton, B. E., Hoyert, D. L., Martin, J. A., Strobino, D. M., & Guyer, B. (2013). Annual Summary of Vital Statistics: 2010–2011. *Pediatrics*, *131*(3), 548–558. http://doi.org/10.1542/peds.2012-3769

Harel, H., Gordon, I., Geva, R., & Feldman, R. (2011). Gaze Behaviors of Preterm and Full-Term Infants in Nonsocial and Social Contexts of Increasing Dynamics: Visual Recognition, Attention Regulation, and Gaze Synchrony. *Infancy*, *16*(1), 69–90. http://doi.org/10.1111/j.1532-7078.2010.00037.x

Harijan, P., & Boyle, E. M. (2012). Health outcomes in infancy and childhood of moderate and late preterm infants. *Seminars in Fetal and Neonatal Medicine*, *17*(3), 159–162. http://doi.org/http://dx.doi.org/10.1016/j.siny.2012.02.002

Hayes, A. F. (2013). *Introduction to mediation, moderation and conditional process analysis*. New York, NY: The Guildford Press.

Heinonen, K., Eriksson, J. G., Lahti, J., Kajantie, E., Pesonen, A.-K., Tuovinen, S., … Raikkonen, K. (2015). Late Preterm Birth and Neurocognitive Performance in Late Adulthood: A Birth Cohort Study. *Pediatrics*, *135*(4), e818–e825.

Hendler, I., Goldenberg, R. L., Mercer, B. M., Iams, J. D., Meis, P. J., Moawad, A. H., … Sorokin, Y. (2005). The Preterm Prediction study: Association between maternal body mass index and spontaneous and indicated preterm birth. *American Journal of Obstetrics and Gynecology*, *192*(3), 882–886. http://doi.org/http://dx.doi.org/10.1016/j.ajog.2004.09.021

Hillemeier, M. M., Farkas, G., Morgan, P. L., Martin, M. A., & Maczuga, S. A. (2009). Disparities in the prevalence of cognitive delay: how early do they appear? *Paediatric and Perinatal Epidemiology*, *23*(3), 186–198. http://doi.org/10.1111/j.1365-3016.2008.01006.x

Hintz, S. R., Kendrick, D. E., Vohr, B. R., Poole, W. K., Higgins, R. D., & Natl Inst Child Hlth Human Dev, N. (2005). Changes in neurodevelopmental outcomes at 18 to 22 months' corrected age among infants of less than 25 weeks' gestational age born in 1993-1999. *Pediatrics*, *115*(6), 1645–1651. http://doi.org/10.1542/peds.2004-2215

Hitzert, M. M., van Geert, P. L. C., Hunnius, S., Van Braeckel, K. N. J. A., Bos, A. F., & Geuze, R. H. (2015). Associations between developmental trajectories of movement variety and visual attention in fullterm and preterm infants during the first six months postterm. *Early Human Development*, *91*(1), 89–96. http://doi.org/http://dx.doi.org/10.1016/j.earlhumdev.2014.12.006

Hollenbeck, A. R. (1978). Problems of reliability in observational research. In G. P. Sackett (Ed.), *Observing behavior Vol. 2: data collection and analysis methods* (pp. 79–98). Baltimore: University Park Press.

Hsu, H.-C., & Jeng, S.-F. (2008). Two-month-olds' attention and affective response to maternal still face: A comparison between term and preterm infants in Taiwan. *Infant Behavior and Development*, *31*(2), 194–206. http://doi.org/10.1016/j.infbeh.2007.10.008

Huddy, C. L. J., Johnson, A., & Hope, P. L. (2001). Educational and behavioural problems in babies of 32–35 weeks gestation. *Archives of Disease in Childhood - Fetal and Neonatal Edition*, *85*(1), F23–F28. http://doi.org/10.1136/fn.85.1.F23

Hunnius, S., Geuze, R. H., Zweens, M. J., & Bos, A. F. (2008). Effects of Preterm Experience on the Developing Visual System: A Longitudinal Study of Shifts of Attention and Gaze in Early Infancy. *Developmental Neuropsychology*, *33*(4), 521–535. http://doi.org/10.1080/87565640802101508

Hunter, L. a. (2009). Issues in Pregnancy Dating: Revisiting the Evidence. *Journal of Midwifery and Women's Health*, *54*(3), 184–190. http://doi.org/10.1016/j.jmwh.2008.11.003

Imafuku, M., Kawai, M., Niwa, F., Shinya, Y., Inagawa, M., & Myowa-Yamakoshi, M. (2016). Preference for Dynamic Human Images and Gaze-Following Abilities in Preterm Infants at 6 and 12 Months of Age: An Eye-Tracking Study. *Infancy*, *1*(17). http://doi.org/10.1111/infa.12144

Inder, T. E., Warfield, S. K., Wang, H., Hüppi, P. S., & Volpe, J. J. (2005). Abnormal Cerebral Structure Is Present at Term in Premature Infants. *Pediatrics*, *115*(2), 286–294. http://doi.org/10.1542/peds.2004-0326

Jandó, G., Mikó-Baráth, E., Markó, K., Hollódy, K., Török, B., & Kovacs, I. (2012). Early-onset binocularity in preterm infants reveals experience-dependent visual development in humans. *Proceedings of the National Academy of Sciences* , *109*(27), 11049–11052.

Jessen, S., & Grossmann, T. (2014). Unconscious discrimination of social cues from eye whites in infants. *Proceedings of the National Academy of Sciences*, *111*(45), 16208–16213. http://doi.org/10.1073/pnas.1411333111

Johnson, M. H. (2005). *Developmental cognitive neuroscience*. Oxford: Blackwell Publishing Ltd.

Johnson, M. H., & Morton, J. (1991). *Biology and cognitive development: The case of face recognition*. Oxford: Blackwell.

Johnson, S., & Marlow, N. (2011). Preterm Birth and Childhood Psychiatric Disorders. *Pediatric Research*, *69*(5, Part 2 of 2), 11R–18R.

Johnson, S., Matthews, R., Draper, E. S., Field, D. J., Manktelow, B. N., Marlow, N., … Boyle, E. M. (2015). Early Emergence of Delayed Social Competence in Infants Born Late and Moderately Preterm. *Journal of Developmental & Behavioral Pediatrics*, *36*(9).

Johnson, S., Slaughter, V., & Carey, S. (1998). Whose gaze will infants follow? The elicitation of gaze-following in 12-month-olds. *Developmental Science*, *1*(2), 233–238. http://doi.org/10.1111/1467-7687.00036

Johnson, S., & Wolke, D. (2013). Behavioural outcomes and psychopathology during adolescence. *Early Human Development*, *89*(4), 199–207. http://doi.org/http://dx.doi.org/10.1016/j.earlhumdev.2013.01.014

Kalia, J. L., Visintainer, P., Brumberg, H. L., Pici, M., & Kase, J. (2009). Comparison of Enrollment in Interventional Therapies Between Late-Preterm and Very Preterm Infants at 12 Months' Corrected Age. *Pediatrics*, *123*(3), 804–809.

Karmiloff-Smith, A. (2006). Modules, genes and evolution: what have we learned from atypical development? In Y. Munakata & M. H. Johnson (Eds.), *Processes of change in brain and cognitive development. Attention and performance XXI* (pp. 563–583). Oxford: Oxford University Press.

Karmiloff-Smith, A. (2007). Atypical epigenesis. *Developmental Science*, *10*(1), 84–88. http://doi.org/10.1111/j.1467-7687.2007.00568.x

Kern, S., & Gayraud, F. (2007). Influence of preterm birth on early lexical and grammatical acquisition. *First Language*, *27*(2), 159–173. http://doi.org/10.1177/0142723706075790

Klein, J. T., Shepherd, S. V, & Platt, M. L. (2009). Social attention and the brain. *Current Biology : CB*, *19*(20), R958-62. http://doi.org/10.1016/j.cub.2009.08.010

Kobayashi, H., & Kohshima, S. (2001). Unique morphology of the human eye and its adaptive meaning: comparative studies on external morphology of the primate eye. *Journal of Human Evolution*, *40*(5), 419–435. http://doi.org/http://dx.doi.org/10.1006/jhev.2001.0468

Kramer, M. S., Demissie, K., Yang, H., Platt, R. W., Sauvé, R., & Liston, R. (2000). The Contribution of Mild and Moderate Preterm Birth to Infant Mortality. *JAMA*, *284*(7), 843–849.

Kuzniewicz, M. W., Wi, S., Qian, Y., Walsh, E. M., Armstrong, M. A., & Croen, L. A. (2014). Prevalence and Neonatal Factors Associated with Autism Spectrum Disorders in Preterm Infants. *The Journal of Pediatrics*, *164*(1), 20–25. http://doi.org/http://dx.doi.org/10.1016/j.jpeds.2013.09.021

Kwon, S. H., Scheinost, D., Vohr, B., Lacadie, C., Schneider, K., Dai, F., … Ment, L. R. (2016). Functional magnetic resonance connectivity studies in infants born preterm: suggestions of proximate and long-lasting changes in language organization. *Developmental Medicine & Child Neurology*, *58*(4, SI), 28–34. http://doi.org/10.1111/dmcn.13043

Lamb, M. E., Morrison, D. C., & Malkin, C. M. (1987). The Development of Infant Social Expectations in Face-to-Face Interaction: A Longitudinal Study. *Merrill-Palmer Quarterly*, *33*(2), 241–254. http://doi.org/10.2307/23086332

Landis, R. J., & Koch, G. G. (1977). The Measurement of Observer Agreement for Categorical Data. *Biometrics*, *33*(1), 159–174. http://doi.org/10.2307/2529310

Landry, S. H. (1985). *The effect of joint attention interactions on the attending abilities of very low birth weight infants*. Dissertation Abstracts International.

Landry, S. H. (1986). Preterm infants' responses in early joint attention interactions. *Infant Behavior & Development*, *9*(1), 1–14.

Landry, S. H., Smith, K. E., Miller-Loncar, C. L., & Swank, P. R. (1997). Responsiveness and initiative: Two aspects of social competence. *Infant Behavior & Development*, *20*(2), 259–262.

Landry, S. H., Smith, K. E., MillerLoncar, C. L., & Swank, P. R. (1997). Predicting cognitive-language and social growth curves from early maternal behaviors in children at varying degrees of biological risk. *Developmental Psychology*, *33*(6), 1040–1053.

Landry, S. H., Smith, K. E., Swank, P. R., Assel, M. A., & Vellet, S. (2001). Does Early Responsive Parenting Have a Special Importance for Children's Development or Is Consistency Across Early Childhood Necessary? *Developmental Psychology*, *37*(3), 387–403.

Larroque, B., Ancel, P.-Y., Marret, S., Marchand, L., André, M., Arnaud, C., … Kaminski, M. (2008). Neurodevelopmental disabilities and special care of 5-year-old children born before 33 weeks of gestation (the EPIPAGE study): a longitudinal cohort study. *The Lancet*, *371*(9615), 813–820. http://doi.org/http://dx.doi.org/10.1016/S0140-6736(08)60380-3

Lee, E. S., Yeatman, J. D., Luna, B., & Feldman, H. M. (2011). Specific language and reading skills in school-aged children and adolescents are associated with prematurity after controlling for IQ. *Neuropsychologia*, *49*(5), 906–913. http://doi.org/http://dx.doi.org/10.1016/j.neuropsychologia.2010.12.038

Leekam, S., & Ramsden, C. (2006). Dyadic Orienting and Joint Attention in Preschool Children with Autism. *Journal of Autism and Developmental Disorders*, *36*(2), 185–197. http://doi.org/10.1007/s10803-005-0054-1

Lems, W., Hopkins, B., & Samsom, J. F. (1993). Mental and motor development in preterm infants: the issue of corrected age. *Early Human Development*, *34*(1–2), 113–123. http://doi.org/10.1016/0378-3782(93)90046-w

Lind, A., Korkman, M., Lehtonen, L., Lapinleimu, H., Parkkola, R., Matomäki, J., … The Pipari Study, G. (2011). Cognitive and neuropsychological outcomes at 5 years of age in preterm children born in the 2000s. *Developmental Medicine & Child Neurology*, *53*(3), 256–262. http://doi.org/10.1111/j.1469-8749.2010.03828.x

Lindström, K., Lindblad, F., & Hjern, A. (2011). Preterm Birth and Attention-Deficit/Hyperactivity Disorder in Schoolchildren. *Pediatrics*, *127*(5), 858–864.

Liu, L., Johnson, H. L., Cousens, S., Perin, J., Scott, S., Lawn, J. E., … Black, R. E. (2012). Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *The Lancet*, *379*(9832), 2151–2161. http://doi.org/http://dx.doi.org/10.1016/S0140-6736(12)60560-1

Lord, C., Risi, S., Lambrecht, L., Cook Jr., E., Leventhal, B., DiLavore, P., … Rutter, M. (2000). The Autism Diagnostic Observation Schedule—Generic: A Standard Measure of Social and Communication Deficits Associated with the Spectrum of Autism. *Journal of Autism and Developmental Disorders*, *30*(3), 205–223. http://doi.org/10.1023/A:1005592401947

Lowe, J., Duvall, S. W., MacLean, P. C., Caprihan, A., Ohls, R., Qualls, C., & Phillips, J. (2011). Comparison of Structural Magnetic Resonance Imaging and Development in Toddlers Born Very Low Birth Weight and Full-term. *Journal of Child Neurology*, *26*(5), 586–592. http://doi.org/10.1177/0883073810388418

Luciana, M. (2003). Cognitive development in children born preterm: Implications for theories of brain plasticity following early injury. *Development and Psychopathology*, *15*(4), 1017–1047M3–10.1017/S095457940300049X.

Luo, Y. (2010). Do 8-Month-Old Infants Consider Situational Constraints When Interpreting Others' Gaze as Goal-Directed Action? *Infancy*, *15*(4), 392–419. http://doi.org/10.1111/j.1532-7078.2009.00019.x

Luoma, L., Herrgård, E., Martikainen, A., & Ahonen, T. (1998). Speech and language development of children born at 32 weeks' gestation: a 5-year prospective follow-up study. *Developmental Medicine & Child Neurology*, *40*(6), 380–387. http://doi.org/10.1111/j.1469-8749.1998.tb08213.x

Madan, J., Chen, M., Goodman, E., Davis, J., Allan, W., & Dammann, O. (2009). Maternal obesity, gestational hypertension, and preterm delivery. *The Journal of Maternal-Fetal & Neonatal Medicine*, *23*(1), 82–88. http://doi.org/10.3109/14767050903258738

Madar, J., Richmond, S., & Hey, E. (1999). Surfactant-deficient respiratory distress after elective delivery at "term." *Acta Pædiatrica*, *88*(11), 1244–1248. http://doi.org/10.1111/j.1651-2227.1999.tb01025.x

Mangold. (2010). INTERACT Quick Start Manual V2.4. Mangold International GmbH (Ed.) www.mangold-international.com .

Markus, J., Mundy, P., Morales, M., Delgado, C. E. F., & Yale, M. (2000). Individual Differences in Infant Skills as Predictors of Child-Caregiver Joint Attention and Language. *Social Development*, *9*(3), 302–315. http://doi.org/10.1111/1467-9507.00127

Marlow, N., Wolke, D., Bracewell, M. A., & Samara, M. (2005). Neurologic and developmental disability at six years of age after extremely preterm birth. *New England Journal of Medicine*, *352*(1), 9–19.

McIntire, D. D., & Leveno, K. J. (2008). Neonatal Mortality and Morbidity Rates in Late Preterm Births Compared With Births at Term. *Obstetrics & Gynecology*, *111*(1), 35–41 10.1097/01.AOG.0000297311.33046.73.

Meltzoff, A. N. (2007). "Like me": a foundation for social cognition. *Developmental Science*, *10*(1), 126–134. http://doi.org/10.1111/j.1467-7687.2007.00574.x

Meltzoff, A. N., & Brooks, R. (2008). Self-experience as a mechanism for learning about others: a training study in social cognition. *Developmental Psychology*, *44*(5), 1257–65. http://doi.org/10.1037/a0012888

Mendive, S., Bornstein, M. H., & Sebastián, C. (2013). The role of maternal attention-directing strategies in 9-month-old infants attaining joint engagement. *Infant Behavior and Development*, *36*(1), 115–123. http://doi.org/http://dx.doi.org/10.1016/j.infbeh.2012.10.002

Mercer, B. M., Goldenberg, R. L., Moawad, A. H., Meis, P. J., Iams, J. D., Das, A. F., … McNellis, D. (1999). The Preterm Prediction Study: Effect of gestational age and cause of preterm birth on subsequent obstetric outcome. *American Journal of Obstetrics and Gynecology*, *181*(5), 1216–1221. http://doi.org/http://dx.doi.org/10.1016/S0002-9378(99)70111-0

Mewes, A. U. J., Hüppi, P. S., Als, H., Rybicki, F. J., Inder, T. E., McAnulty, G. B., … Huppi, P. S. (2006). Regional brain development in serial magnetic resonance imaging of low-risk preterm infants. *Pediatrics*, *118*(1), 23–33. http://doi.org/10.1542/peds.2005-2675

Moll, H., & Tomasello, M. (2004). 12- and 18-month-old infants follow gaze to spaces behind barriers. *Developmental Science*, *7*(1), F1–F9. http://doi.org/10.1111/j.1467-7687.2004.00315.x

Mondloch, C. J., Lewis, T. L., Budreau, D. R., Maurer, D., Dannemiller, J. L., Stephens, B. R., & Kleiner-Gathercoal, K. A. (1999). Face Perception During Early Infancy. *Psychological Science*, *10*(5), 419–422. http://doi.org/10.1111/1467-9280.00179

Moore, C. (2008). The Development of Gaze Following. *Child Development Perspectives*, *2*(2), 66–70. http://doi.org/10.1111/j.1750-8606.2008.00052.x

Moore, C., & Dunham, P. J. (1995). Joint attention: Its origins and role in development. Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Morales, M., Mundy, P., Delgado, C. E. F., Yale, M., Messinger, D., Neal, R., & Schwartz, H. K. (2000). Responding to Joint Attention Across the 6- Through 24-Month Age Period and Early Language Acquisition. *Journal of Applied Developmental Psychology*, *21*(3), 283–298. http://doi.org/http://dx.doi.org/10.1016/S0193-3973(99)00040-4

Morales, M., Mundy, P., & Rojas, J. (1998). Following the direction of gaze and language development in 6-month-olds. *Infant Behavior & Development*, *21*(2), 373–377. http://doi.org/10.1016/S0163-6383(98)90014-5

Moutquin, J. M. (2003). Classification and heterogeneity of preterm birth. *Bjog-an International Journal of Obstetrics and Gynaecology*, *110*, 30–33. http://doi.org/Doi 10.1016/S1470-0328(03)00021-1

Mundy, P. (2003). Annotation: The neural basis of social impairments in autism: the role of the dorsal medial-frontal cortex and anterior cingulate system. *Journal of Child Psychology and Psychiatry*, *44*(6), 793–809. http://doi.org/10.1111/1469-7610.00165

Mundy, P., Block, J., Delgado, C., Pomares, Y., Vaughan Van Hecke, A., Venezia Parlade, M., … Parlade, M. V. (2007). Individual Differences and the Development of Joint Attention in Infancy. *Child Development*, *78*(3), 938–954. http://doi.org/10.1111/j.1467-8624.2007.01042.x

Mundy, P., Card, J., & Fox, N. (2000). EEG correlates of the development of infant joint attention skills. *Developmental Psychobiology*, *36*(4), 325–338.

Mundy, P., Delgado, C., Block, J., Venezia, M., Hogan, A., & Seibert, J. (2003). A manual for the Abridged Early Social Communication Scales (ESCS). *Available through the University of Miami Psychology Department, Coral Gables, Florida*.

Mundy, P., Fox, N., & Card, J. (2003). EEG coherence, joint attention and language development in the second year. *Developmental Science*, *6*(1), 48–54. http://doi.org/10.1111/1467-7687.00253

Mundy, P., & Gomes, A. (1998). Individual differences in joint attention skill development in the second year. *Infant Behavior and Development*, *21*(3), 469–482. http://doi.org/http://dx.doi.org/10.1016/S0163-6383(98)90020-0

Mundy, P., & Jarrold, W. (2010). Infant joint attention, neural networks and social cognition. *Neural Networks*, *23*(8–9), 985–997. http://doi.org/10.1016/j.neunet.2010.08.009

Mundy, P., Sullivan, L., & Mastergeorge, A. M. (2009). A parallel and distributed-processing model of joint attention, social cognition and autism. *Autism Research*, *2*(1), 2–21. http://doi.org/10.1002/aur.61

Myatt, L., Eschenbach, D. A., Lye, S. J., Mesiano, S., Murtha, A. P., Williams, S. M., & Pennell, C. E. (2012). A Standardized Template for Clinical Studies in Preterm Birth. *Reproductive Sciences*, *19*(5), 474–82. http://doi.org/10.1177/1933719111426602

Neggers, Y., & Goldenberg, R. L. (2003). Some Thoughts on Body Mass Index, Micronutrient Intakes and Pregnancy Outcome . *The Journal of Nutrition* , *133*(5), 1737S–1740S.

Newson, J., & Newson, E. (1975). Intersubjectivity and the transmission of culture: On the social origins of symbolic functioning. *Bulletin of the British Psychological Society*, *28*, 437–446.

NHS Maternity Statistics – England, 2013-14. (2015). *Hospital Episode Statistics Analysis, Health and Social Care Information Centre*.

Nohr, E. A., Bech, B. H., Vaeth, M., Rasmussen, K. M., Henriksen, T. B., & Olsen, J. (2007). Obesity, gestational weight gain and preterm birth: a study within the Danish National Birth Cohort. *Paediatric and Perinatal Epidemiology*, *21*(1), 5–14. http://doi.org/10.1111/j.1365-3016.2007.00762.x

Oberman, L. M., Winkielman, P., & Ramachandran, V. S. (2007). Face to face: Blocking facial mimicry can selectively impair recognition of emotional expressions. *Social Neuroscience*, *2*(3–4), 167–178. http://doi.org/10.1080/17470910701391943

Odd, D. E., Emond, A., & Whitelaw, A. (2012). Long-term cognitive outcomes of infants born moderately and late preterm. *Developmental Medicine & Child Neurology*, *54*(8), 704–709. http://doi.org/10.1111/j.1469-8749.2012.04315.x

Oddie, S. J., Hammal, D., Richmond, S., & Parker, L. (2005). Early discharge and readmission to hospital in the first month of life in the Northern Region of the UK during 1998: a case cohort study. *Archives of Disease in Childhood* , *90*(2), 119–124. http://doi.org/10.1136/adc.2003.040766

Olafsen, K. S., Rønning, J. A., Kaaresen, P. I., Ulvund, S. E., Handegård, B. H., & Dahl, L. B. (2006). Joint attention in term and preterm infants at 12 months corrected age: The significance of gender and intervention based on a randomized controlled trial. *Infant Behavior and Development*, *29*(4), 554–563. http://doi.org/10.1016/j.infbeh.2006.07.004

Patra, K., Greene, M. M., Patel, A. L., & Meier, P. (2016). Maternal Education Level Predicts Cognitive, Language, and Motor Outcome in Preterm Infants in the Second Year of Life. *American Journal of Perinatology*, *33*(8), 738–744. http://doi.org/10.1055/s-0036-1572532

Peacock, J. L., Bland, J. M., & Anderson, H. R. (1995). Preterm delivery: effects of socioeconomic factors, psychological stress, smoking, alcohol, and caffeine. *BMJ*, *311*(7004), 531–535.

Peña, M., Arias, D., & Dehaene-Lambertz, G. (2014). Gaze Following Is Accelerated in Healthy Preterm Infants. *Psychological Science*, *25*(10), 1884, 1892. http://doi.org/10.1177/0956797614544307

Peña, M., Maki, A., Kovačić, D., Dehaene-Lambertz, G., Koizumi, H., Bouquet, F., & Mehler, J. (2003). Sounds and silence: An optical topography study of language recognition at birth. *Proceedings of the National Academy of Sciences* , *100*(20), 11702–11705. http://doi.org/10.1073/pnas.1934290100

Perra, O., & Gattis, M. (2010). The control of social attention from 1 to 4 months. *British Journal of Developmental Psychology*, *28*(4), 891–908. http://doi.org/10.1348/026151010x487014

Perra, O., & Gattis, M. (2012). Attention engagement in early infancy. *Infant Behavior and Development*, *35*(4), 635–644. http://doi.org/http://dx.doi.org/10.1016/j.infbeh.2012.06.004

Pignotti, M. S., & Donzelli, G. (2008). Perinatal Care at the Threshold of Viability: An International Comparison of Practical Guidelines for the Treatment of Extremely Preterm Births. *Pediatrics* , *121*(1), e193–e198. http://doi.org/10.1542/peds.2007-0513

Pollatsek, A., & Well, A. D. (1995). On the use of counterbalanced designs in cognitive research: A suggestion for a better and more powerful analysis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*(3), 785–794. http://doi.org/10.1037//0278-7393.21.3.785

Posner, M. I., Snyder, C. R., & Davidson, B. J. (1980). Attention and the detection of signals. *Journal of Experimental Psychology: General*, *109*(2), 160–174. http://doi.org/10.1037/0096-3445.109.2.160

Potijk, M. R., de Winter, A. F., Bos, A. F., Kerstjens, J. M., & Reijneveld, S. a. (2012). Higher rates of behavioural and emotional problems at preschool age in children born moderately preterm. *Archives of Disease in Childhood* , *97*(2), 112–117. http://doi.org/10.1136/adc.2011.300131

Potijk, M. R., de Winter, A. F., Bos, A. F., Kerstjens, J. M., & Reijneveld, S. A. (2015). Co-occurrence of developmental and behavioural problems in moderate to late preterm-born children. *Archives of Disease in Childhood*, (0), 1–6. http://doi.org/10.1136/archdischild-2015-308958

Putnam, S. P., Gartstein, M. A., & Rothbart, M. K. (2006). Measurement of fine-grained aspects of toddler temperament: The Early Childhood Behavior Questionnaire. *Infant Behavior and Development*, *29*(3), 386–401. http://doi.org/10.1016/j.infbeh.2006.01.004

Rabie, N. Z., Bird, T. M., Magann, E. F., Hall, R. W., & McKelvey, S. S. (2015). ADHD and developmental speech/language disorders in late preterm, early term and term infants. *Journal of Perinatology*, *35*(8), 660–664.

Reuner, G., Fields, A., Wittke, A., Löpprich, M., & Pietz, J. (2013). Comparison of the developmental tests Bayley-III and Bayley-II in 7-month-old infants born preterm. *European Journal of Pediatrics*, *172*(3), 393–400. http://doi.org/10.1007/s00431-012-1902-6

Reuner, G., Weinschenk, A., Pauen, S., & Pietz, J. (2014). Cognitive development in 7- to 24-month-old extremely/very-to-moderately/late preterm and full-term born infants: The mediating role of focused attention. *Child Neuropsychology*, (May 2015), 1–17. http://doi.org/10.1080/09297049.2014.899571

Reynell, J. K., & Gruber, C. P. (1990). *Reynell Developmental Language Scales*. Los Angeles: Western Psychological Services.

Ricciardelli, P., & Driver, J. (2008). Effects of head orientation on gaze perception: How positive congruency effects can be reversed. *Quarterly Journal of Experimental Psychology*, *61*(3), 491–504. http://doi.org/10.1080/17470210701255457

Rizzolatti, G., Fadiga, L., Gallese, V., & Fogassi, L. (1996). Premotor cortex and the recognition of motor actions. *Cognitive Brain Research*, *3*(2), 131–141. http://doi.org/10.1016/0926-6410(95)00038-0

Robson, K. S., & Moss, H. A. (1970). Patterns and determinants of maternal attachment. *The Journal of Pediatrics*, *77*(6), 976–985. http://doi.org/http://dx.doi.org/10.1016/S0022-3476(70)80080-4

Romeo, D. M., Di Stefano, A., Conversano, M., Ricci, D., Mazzone, D., Romeo, M. G., & Mercuri, E. (2010). Neurodevelopmental outcome at 12 and 18 months in late preterm infants. *European Journal of Paediatric Neurology*, *14*(6), 503–507. http://doi.org/10.1016/j.ejpn.2010.02.002

Romeo, D. M., Guzzardi, S., Ricci, D., Cilauro, S., Brogna, C., Cowan, F., … Mercuri, E. (2012). Longitudinal cognitive assessment in healthy late preterm infants. *European Journal of Paediatric Neurology : EJPN : Official Journal of the European Paediatric Neurology Society*, *16*(3), 243–7. http://doi.org/10.1016/j.ejpn.2011.07.012

Romeo, D. M., Ricci, D., Serrao, F., Gallini, F., Olivieri, G., Cota, F., … Mercuri, E. (2012). Visual function assessment in late-preterm newborns. *Early Human Development*, *88*(5), 301–305. http://doi.org/10.1016/j.earlhumdev.2011.08.024

Roos, E. M., McDuffie, A. S., Weismer, S. E., & Gernsbacher, M. A. (2008). A comparison of contexts for assessing joint attention in toddlers on the autism spectrum. *Autism*, *12*(3), 275–291. http://doi.org/10.1177/1362361307089521

Rose, S. A., Feldman, J. F., & Jankowski, J. J. (2001). Attention and recognition memory in the 1st year of life: A longitudinal study of preterm and full-term infants. *Developmental Psychology*, *37*(1), 135–151.

Rose, S. A., Feldman, J. F., & Jankowski, J. J. (2002). Processing speed in the 1st year of life: A longitudinal study of preterm and full-term infants. *Developmental Psychology*, *38*(6), 895–902. http://doi.org/10.1037//0012-1649.38.6.895

Rose, S. A., Feldman, J. F., & Jankowski, J. J. (2005). The structure of infant cognition at 1 year. *Intelligence*, *33*(3), 231–250.

Rose, S. A., Feldman, J. F., McCarton, C. M., & Wolfson, J. (1988). Information Processing in Seven-Month-Old Infants as a Function of Risk Status. *Child Development*, *59*(3), 589–603. http://doi.org/10.2307/1130559

Saigal, S., & Doyle, L. W. (2008). An overview of mortality and sequelae of preterm birth from infancy to adulthood. *The Lancet*, *371*(9608), 261–269. http://doi.org/http://dx.doi.org/10.1016/S0140-6736(08)60136-1

Sameroff, A. J., & Feil, L. (1985). Parental concepts of development. In I. E. Sigel (Ed.), *Parental Belief Systems: The Psychological Consequences for Children* (pp. 83–104). Hillsdale, NJ: Lawrence Erlbaum.

Samra, H. A., McGrath, J. M., & Wehbe, M. (2011). An Integrated Review of Developmental Outcomes and Late-Preterm Birth. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, *40*(4), 399–411. http://doi.org/10.1111/j.1552-6909.2011.01270.x

Samuelson, L. K., & Smith, L. B. (1998). Memory and Attention Make Smart Word Learning: An Alternative Account of Akhtar, Carpenter, and Tomasello. *Child Development*, *69*(1), 94–104. http://doi.org/10.1111/j.1467-8624.1998.tb06136.x

Sansavini, A., Guarini, A., Justice, L. M., Savini, S., Broccoli, S., Alessandroni, R., & Faldella, G. (2010). Does preterm birth increase a child's risk for language impairment? *Early Human Development*, *86*(12), 765–772. http://doi.org/http://dx.doi.org/10.1016/j.earlhumdev.2010.08.014

Sansavini, A., Guarini, A., Savini, S., Broccoli, S., Justice, L., Alessandroni, R., & Faldella, G. (2011). Longitudinal trajectories of gestural and linguistic abilities in very preterm infants in the second year of life. *Neuropsychologia*, *49*(13), 3677–3688.

http://doi.org/10.1016/j.neuropsychologia.2011.09.023

Sansavini, A., Savini, S., Guarini, A., Broccoli, S., Alessandroni, R., & Faldella, G. (2011). The effect of gestational age on developmental outcomes: a longitudinal study in the first 2 years of life. *Child: Care, Health and Development*, *37*(1), 26–36. http://doi.org/10.1111/j.1365-2214.2010.01143.x

Santos, I. S., Matijasevich, A., Silveira, M. F., Sclowitz, I. K. T., Barros, A. J. D., Victora, C. G., & Barros, F. C. (2008). Associated factors and consequences of late preterm births: results from the 2004 Pelotas birth cohort. *Paediatric and Perinatal Epidemiology*, *22*(4), 350–359. http://doi.org/10.1111/j.1365-3016.2008.00934.x

Scaife, M., & Bruner, J. S. (1975). The capacity for joint visual attention in the infant. *Nature*, *253*(5489), 265–266.

Seibert, J., Hogan, A., & Mundy, P. (1982). Assessing interactional competencies: The early social-communication scales. *Infant Mental Health Journal*, *3*(4), 244–258. http://doi.org/10.1002/1097-0355(198224)3:4<244::aid-imhj2280030406>3.0.co;2-r

Senju, A., & Csibra, G. (2008). Gaze Following in Human Infants Depends on Communicative Signals. *Current Biology*, *18*(9), 668–671. http://doi.org/10.1016/j.cub.2008.03.059

Shah, P. E., Robbins, N., Coelho, R. B., & Poehlmann, J. (2013). The paradox of prematurity: The behavioral vulnerability of late preterm infants and the cognitive susceptibility of very preterm infants at 36 months post-term. *Infant Behavior and Development*, *36*(1), 50–62. http://doi.org/http://dx.doi.org/10.1016/j.infbeh.2012.11.003

Shapiro-Mendoza, C. K., & Lackritz, E. M. (2012). Epidemiology of late and moderate preterm birth. *Seminars in Fetal and Neonatal Medicine*, *17*(3), 120–125. http://doi.org/http://dx.doi.org/10.1016/j.siny.2012.01.007

Shepherd, S. V, Klein, J. T., Deaner, R. O., & Platt, M. L. (2009). Mirroring of attention by neurons in macaque parietal cortex. *Proceedings of the National Academy of Sciences*, *106*(23), 9489–9494. http://doi.org/10.1073/pnas.0900419106

Smith, L. B. (2000). Learning how to learn words: An associative crane. In R. M. Golinkoff & K. Hirsh-Pasek (Eds.), *Becoming a word learner*. Oxford: Oxford University Press.

Smith, L. K., Draper, E. S., Manktelow, B. N., Dorling, J. S., & Field, D. J. (2007). Socioeconomic inequalities in very preterm birth rates. *Archives of Disease in Childhood - Fetal and Neonatal Edition* , *92*(1), F11–F14. http://doi.org/10.1136/adc.2005.090308

Smith, L., & Ulvund, S. E. (2003). The role of joint attention in later development among preterm children: Linkages between early and middle childhood. *Social Development*, *12*(2), 222–234.

Smyser, C. D., Inder, T. E., Shimony, J. S., Hill, J. E., Degnan, A. J., Snyder, A. Z., & Neil, J. J. (2010). Longitudinal Analysis of Neural Network Development in Preterm Infants. *Cerebral Cortex*, *20*(12), 2852–2862. http://doi.org/10.1093/cercor/bhq035

Sommerville, J. A., Woodward, A. L., & Needham, A. (2005). Action experience alters 3-month-old infants' perception of others' actions. *Cognition*, *96*(1), B1–B11. http://doi.org/http://dx.doi.org/10.1016/j.cognition.2004.07.004

Spittle, A. J., Treyvaud, K., Doyle, L. W., Roberts, G., Lee, K. J., Inder, T. E., … Anderson, P. J. (2009). Early Emergence of Behavior and Social-Emotional Problems in Very Preterm Infants. *Journal of the American Academy of Child & Adolescent Psychiatry*, *48*(9), 909–918. http://doi.org/10.1097/CHI.0b013e3181af8235

Spong, C. Y., Mercer, B. M., D'alton, M., Kilpatrick, S., Blackwell, S., & Saade, G. (2011). Timing of indicated late-preterm and early-term birth. *Obstetrics and Gynecology*, *118*(2 Pt 1), 323–33. http://doi.org/10.1097/AOG.0b013e3182255999

Striano, T., Henning, A., & Stahl, D. (2005). Sensitivity to social contingencies between 1 and 3 months of age. *Developmental Science*, *8*(6), 509–518. http://doi.org/10.1111/j.1467-7687.2005.00442.x

Striano, T., & Rochat, P. (1999). Developmental link between dyadic and triadic social competence in infancy. *British Journal of Developmental Psychology*, *17*(4), 551–562. http://doi.org/10.1348/026151099165474

Striano, T., & Stahl, D. (2005). Sensitivity to triadic attention in early infancy. *Developmental Science*, *8*(4), 333–343. http://doi.org/10.1111/j.1467-7687.2005.00421.x

Sucksdorff, M., Lehtonen, L., Chudal, R., Suominen, A., Joelsson, P., Gissler, M., & Sourander, A. (2015). Preterm Birth and Poor Fetal Growth as Risk Factors of Attention-Deficit/Hyperactivity

Disorder. *Pediatrics*, *136*(3), E599–E608. http://doi.org/10.1542/peds.2015-1043

Talge, N. M., Allswede, D. M., & Holzman, C. (2016). Gestational Age at Term, Delivery Circumstance, and Their Association with Childhood Attention Deficit Hyperactivity Disorder Symptoms. *Paediatric and Perinatal Epidemiology*, *30*(2), 171–180. http://doi.org/10.1111/ppe.12274

Talge, N. M., Holzman, C., Wang, J., Lucia, V., Gardiner, J., & Breslau, N. (2010). Late-Preterm Birth and Its Association With Cognitive and Socioemotional Outcomes at 6 Years of Age. *Pediatrics*, *126*(6), 1124–1131.

Tanis, J. C., Van Braeckel, K. N. J. A., Kerstjens, J. M., Bocca-Tjeertes, I. F. A., Reijneveld, S. A., & Bos, A. F. (2015). Functional Outcomes at Age 7 Years of Moderate Preterm and Full Term Children Born Small for Gestational Age. *The Journal of Pediatrics*, *166*(3), 552–558.e1. http://doi.org/http://dx.doi.org/10.1016/j.jpeds.2014.11.043

Telford, E. J., Fletcher-Watson, S., Gillespie-Smith, K., Pataky, R., Sparrow, S., Murray, I. C., … Boardman, J. P. (2016). Preterm birth is associated with atypical social orienting in infancy detected using eye tracking. *Journal of Child Psychology and Psychiatry*. http://doi.org/10.1111/jcpp.12546

Teune, M. J., Bakhuizen, S., Gyamfi Bannerman, C., Opmeer, B. C., van Kaam, A. H., van Wassenaer, A. G., … Mol, B. W. J. (2011). A systematic review of severe morbidity in infants born late preterm. *American Journal of Obstetrics and Gynecology*, *205*(4), 374.e1-374.e9. http://doi.org/http://dx.doi.org/10.1016/j.ajog.2011.07.015

The American College of Obstetricians and Gynecologists Committee on Obstetric Practice. (2013). Definition of term pregnancy. Committee Opinion No. 579. *Obstetrics & Gynecology*, *122*, 1139–1140.

Thompson, J. M. D., Irgens, L. M., Rasmussen, S., & Daltveit, A. K. (2006). Secular trends in socio-economic status and the implications for preterm birth. *Paediatric and Perinatal Epidemiology*, *20*(3), 182–187. http://doi.org/10.1111/j.1365-3016.2006.00711.x

Thorndike, R. L., Hagen, E. P., & Sattler, J. M. (1986). *Stanford-Binet intelligence scale*. Riverside Publishing Company.

Tomasello, M. (1988). The role of joint attentional processes in early language development. *Language Sciences*, *10*(1), 69–88. http://doi.org/http://dx.doi.org/10.1016/0388-0001(88)90006-X

Tomasello, M. (1992). The social bases of language acquisition. *Social Development*, *1*(1), 67–87. http://doi.org/10.1111/j.1467-9507.1992.tb00135.x

Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P. J. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 103–130). Hillsdale, NJ: Lawrence Erlbaum.

Tomasello, M. (1999). *The cultural origins of human cognition*. Harvard University Press.

Tomasello, M., & Carpenter, M. (2007). Shared intentionality. *Developmental Science*, *10*(1), 121–125. http://doi.org/10.1111/j.1467-7687.2007.00573.x

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and Brain Sciences*, *28*(5), 675–691. http://doi.org/doi:10.1017/S0140525X05000129

Tomasello, M., Carpenter, M., & Hobson, R. P. (2005). The Emergence of Social Cognition in Three Young Chimpanzees. *Monographs of the Society for Research in Child Development*, *70*(1), i-152. http://doi.org/10.2307/3701393

Tomasello, M., & Farrar, M. J. (1986). Joint Attention and Early Language. *Child Development*, *57*(6), 1454–1463. http://doi.org/10.2307/1130423

Tomasello, M., Hare, B., Lehmann, H., & Call, J. (2007). Reliance on head versus eyes in the gaze following of great apes and human infants: the cooperative eye hypothesis. *Journal of Human Evolution*, *52*(3), 314–320. http://doi.org/10.1016/j.jhevol.2006.10.001

Tomasello, M., & Rakoczy, H. (2003). What Makes Human Cognition Unique? From Individual to Shared to Collective Intentionality. *Mind & Language*, *18*(2), 121–147. http://doi.org/10.1111/1468-0017.00217

Torloni, M. R., Betrán, A. P., Daher, S., Widmer, M., Dolan, S. M., Menon, R., … Merialdi, M. (2009). Maternal BMI and preterm birth: A systematic review of the literature with meta-analysis. *The Journal of Maternal-Fetal & Neonatal Medicine*, *22*(11), 957–970. http://doi.org/10.3109/14767050903042561

Trevarthen, C. (1979). Communication and cooperation in early infancy: A description of primary intersubjectivity. In M. M. Bullowa (Ed.), *Before speech. The beginning of interpersonal communication* (pp. 321–347). New York: Cambridge University Press.

Triesch, J., Teuscher, C., Deák, G. O., Carlson, E., & Wolfgang, J. (2006). Gaze following : why (not) learn it ?, *2*, 125–147.

Ulvund, S. E., & Smith, L. (1996). The predictive validity of nonverbal communicative skills in infants with perinatal hazards. *Infant Behavior & Development*, *19*(4), 441–449. http://doi.org/10.1016/s0163-6383(96)90005-3

Vaish, A., Demir, Ö. E., & Baldwin, D. A. (2011). Thirteen- and 18-month-old Infants Recognize When They Need Referential Information. *Social Development*, *20*(3), 431–449. http://doi.org/10.1111/j.1467-9507.2010.00601.x

van de Weijer-Bergsma, E., Wijnroks, L., & Jongmans, M. J. (2008). Attention development in infants and preschool children born preterm: a review. *Infant Behavior & Development*, *31*(3), 333–351. http://doi.org/S0163-6383(08)00004-0 [pii] 10.1016/j.infbeh.2007.12.003

van Noort-van der Spek, I. L., Franken, M.-C. J. P., & Weisglas-Kuperus, N. (2012). Language Functions in Preterm-Born Children: A Systematic Review and Meta-analysis. *Pediatrics*, *129*(4), 745–754. http://doi.org/10.1542/peds.2011-1728

Voigt, B., Pietz, J., Pauen, S., Kliegel, M., & Reuner, G. (2012). Cognitive development in very vs. moderately to late preterm and full-term children: Can effortful control account for group differences in toddlerhood? *Early Human Development*, *88*(5), 307–313. http://doi.org/http://dx.doi.org/10.1016/j.earlhumdev.2011.09.001

Wang, M. L., Dorer, D. J., Fleming, M. P., & Catlin, E. A. (2004). Clinical Outcomes of Near-Term Infants. *Pediatrics*, *114*(2), 372–376.

Warneken, F., & Tomasello, M. (2007). Helping and Cooperation at 14 Months of Age. *Infancy*, *11*(3), 271–294. http://doi.org/10.1111/j.1532-7078.2007.tb00227.x

Waxman, S. R., & Gelman, S. A. (2009). Early word-learning entails reference, not merely associations. *Trends in Cognitive Sciences*, *13*(6), 258–263. http://doi.org/http://dx.doi.org/10.1016/j.tics.2009.03.006

Wilcox, A. J., Weinberg, C. R., & Basso, O. (2011). On the Pitfalls of Adjusting for Gestational Age at Birth. *American Journal of Epidemiology*, *174*(9), 1062–1068. http://doi.org/10.1093/aje/kwr230

Wilcox, T., Nadel, L., & Rosser, R. (1996). Location memory in healthy preterm and full-term infants. *Infant Behavior and Development*, *19*, 309–323. http://doi.org/10.1016/s0163-6383(96)90031-4

Williams, K. T. (1997). *Expressive Vocabulary Test*. Circle Pines, MN: American Guidance Service.

Wilson, S. L., & Cradock, M. M. (2004). Review: Accounting for prematurity in developmental assessment and the use of age-adjusted scores. *Journal of Pediatric Psychology*, *29*(8), 641–649. http://doi.org/DOI 10.1093/jpepsy/jsh067

Winstanley, A., & Gattis, M. (2013). The Baby Care Questionnaire: a measure of parenting principles and practices during infancy. *Infant Behavior & Development*, *36*(4), 762–75. http://doi.org/10.1016/j.infbeh.2013.08.004

Woodward, A. L. (2009). Infants' Grasp of Others' Intentions. *Current Directions in Psychological Science*, *18*(1), 53–57. http://doi.org/10.1111/j.1467-8721.2009.01605.x

Woodward, A. L., & Guajardo, J. J. (2002). Infants' understanding of the point gesture as an object-directed action. *Cognitive Development*, *17*(1), 1061–1084. http://doi.org/10.1016/s0885-2014(02)00074-6

Woythaler, M. A., McCormick, M. C., Mao, W.-Y., & Smith, V. C. (2015). Late Preterm Infants and Neurodevelopmental Outcomes at Kindergarten. *Pediatrics*, *136*(3), 424–431.

Woythaler, M. A., McCormick, M. C., & Smith, V. C. (2011). Late Preterm Infants Have Worse 24-Month Neurodevelopmental Outcomes Than Term Infants. *Pediatrics*, *127*(3), e622–e629. http://doi.org/10.1542/peds.2009-3598

Yang, S., Fombonne, E., & Kramer, M. S. (2011). Duration of gestation, size at birth and later childhood behaviour. *Paediatric and Perinatal Epidemiology*, *25*(4), 377–387. http://doi.org/10.1111/j.1365-3016.2011.01193.x

Yoder, P. J., & Warren, S. F. (1999). Facilitating Self-Initiated Proto-Declaratives and Proto-Imperatives in Prelinguistic Children with Developmental Disabilities. *Journal of Early Intervention*, *22*(4), 337–354. http://doi.org/10.1177/105381519902200408

Zegers-Hochschild, F., Adamson, G. D., de Mouzon, J., Ishihara, O., Mansour, R., Nygren, K., … Vanderpoel, S. (2009). International Committee for Monitoring Assisted Reproductive Technology (ICMART) and the World Health Organization (WHO) revised glossary of ART terminology, 2009∗. *Fertility and Sterility*, *92*(5), 1520–1524. http://doi.org/http://dx.doi.org/10.1016/j.fertnstert.2009.09.009

Zeitlin, J., Draper, E. S., Kollée, L., Milligan, D., Boerch, K., Agostino, R., … group, and the M. research. (2008). Differences in Rates and Short-term Outcome of Live Births Before 32 Weeks of Gestation in Europe in 2003: Results From the MOSAIC Cohort. *Pediatrics* , *121*(4), e936–e944. http://doi.org/10.1542/peds.2007-1620

Zeitlin, J., Szamotulska, K., Drewniak, N., Mohangoo, A. D., Chalmers, J., Sakkeus, L., … Group, T. E.-P. P. S. (2013). Preterm birth time trends in Europe: a study of 19 countries. *BJOG: An International Journal of Obstetrics & Gynaecology*, *120*(11), 1356–1365. http://doi.org/10.1111/1471-0528.12281

Zwicker, J. G., & Harris, S. R. (2008). Quality of life of formerly preterm and very low birth weight infants from preschool age to adulthood: A systematic review. *Pediatrics*, *121*(2), E366–E376. http://doi.org/10.1542/peds.2007-0169

Appendices

Appendix A - Cardiff Antenatal Inventory

Your Details

Baby's name: ______________________________ Male/Female

Name: ______________________________

Address: ______________________________

____

____

______________ Postcode: ______________

Telephone: ______________________________

E-mail: ______________________________

Date: ______________________________

This sheet will be detached; this means that your answers to the inventory will be anonymous. Your child's initials and date of birth will not be used to trace your answers but will be used to generate an anonymity code for you.

Your initials: __________ Your child's initials: _________

This Pregnancy

1) Standard prenatal care includes one introductory appointment, two scans in the hospital, and 10 appointments with a midwife in a GP surgery. During this pregnancy, was the prenatal care you received: (Please circle one)

   a. Standard

   b. More than standard

   c. Less than standard

   If you circled b or c, please provide a brief description of how and why your prenatal care differed from the standard prenatal care.

   ____

2) Did you experience any problems or complications during this pregnancy? Yes/No

   If yes, please circle any of the following relevant items:

   Uterine cramping, vaginal bleeding (spotting), or vaginal leakage of fluid; infections, rashes, fever over 101 degrees; ultrasound abnormalities detected; exposure to occupational, chemical, or other hazards; a serious accident such as a road traffic accident.

3) During this pregnancy, how often did you (please tick the most relevant box for each trimester: 1 – never, 2 – occasionally, 3 – usually, 4 - always):

	First Trimester				Second Trimester				Third Trimester			
	1	2	3	4	1	2	3	4	1	2	3	4
Eat a diet with a range of foods from each food group (including 5 portions of fruit and veg a day)	□	□	□	□	□	□	□	□	□	□	□	□
Drink caffeinated drinks in excess of three mugs of coffee, or six cups of teas, or eight cans of coke, or a combination of these	□	□	□	□	□	□	□	□	□	□	□	□
Drink more than two units of alcohol in one day	□	□	□	□	□	□	□	□	□	□	□	□
Smoke cigarettes	□	□	□	□	□	□	□	□	□	□	□	□
Have someone else in your household smoke cigarettes	□	□	□	□	□	□	□	□	□	□	□	□
Use recreational drugs	□	□	□	□	□	□	□	□	□	□	□	□

The Delivery

4) Did you experience any problems or complications during labour and delivery? Yes/No

If yes, please explain: ____

____

____

The information required to answer the next two questions will be included in the documents given to you when you were discharged from hospital.

5) At birth, what was your baby's:
   a. Gestational age? ____________ weeks
   b. Due date: __________________ Delivery Date: ____________ ___
   c. Weight? ____________________ grams
   d. Length? ____________________ cm

6) What were your baby's Apgar scores?
   a. 5 mins: _______________
   b. 10 mins: ______________

Previous Pregnancies

7) How many previous pregnancies have you had? ______________________

8) How many of those were:
   a. Full-term births (delivered after 37 completed weeks of gestation)? ______
   b. Preterm births (delivered before 37 completed weeks of gestation)? ______
   c. Stillbirths or miscarriages? ________
   d. Elective abortions? ________

9) How many siblings does your new baby have? __________

10) What are the age and gender of these siblings?

Sibling 1:	Male/female	Age: ____	Sibling 4:	Male/female	Age: ____
Sibling 2:	Male/female	Age: ____	Sibling 5:	Male/female	Age: ____
Sibling 3:	Male/female	Age: ____	Sibling 6:	Male/female	Age: ____

11) Do you have any reason to believe that your child may be at genetic risk for any physical or psychological difficulties (please circle one)?
Yes/No

If yes, please provide details: ____

____

____

Parenting Support

12) Have you taken any antenatal education classes? Yes/No

If yes, which class? ____

____

13) Do you feel you were getting the support and help you need as a parent?

□ Never □ Rarely □ Sometimes □ Usually □ Always

14) What are your plans for your baby's childcare over the coming year? Please provide an estimate of the number of days per week for each type of childcare you are anticipating using.

At home with one or both parents	__________	Half Day(s)	__________	Full Day(s)
At a childminder's house	__________	Half Day(s)	__________	Full Day(s)
At nursery or crèche	__________	Half Day(s)	__________	Full Day(s)

15) Using the 5-point scale below, rate the support you currently receive by each group of people/resources. For categories that include more than one person (for example,

friends and neighbours) enter the number that best represents the average helpfulness of that resource.

	Not used	Of little or no help		Moderately or occasionally helpful		Very helpful
	0	1	2	3	4	5
The child's father	□	□	□	□	□	□
My family and relatives	□	□	□	□	□	□
The family and relatives of the child's father	□	□	□	□	□	□
Health visitor/midwife/ services at your local surgery	□	□	□	□	□	□
Friends or neighbours	□	□	□	□	□	□
Organised groups including childcare, playgroups and classes	□	□	□	□	□	□
Books, magazines, newspapers	□	□	□	□	□	□

Demographic Information

	You	Baby's father
Age	______________________	______________________
Occupation	______________________	______________________
Marital Status	______________________	______________________
Ethnicity	______________________	______________________

16) What is your postcode? ______________________

17) Please check the item below that accurately describes the level of education currently attained (or equivalent) for you and the baby's father:

	You	**Baby's Father**
GCSE/key skills level 1 or 2/ NVQ level 1 or 2	□	□
A-level/key skills level 3/ NVQ level 3 or 4	□	□
Bachelors degree	□	□
Postgraduate qualification	□	□

18) Please circle the item below that accurately describes your family income.

   a. Less than £14,999
   b. £15,000 to £39,999
   c. Over £40,000

19) Which language is spoken most of the time in your house? _____________ ______

20) Which other languages will you or other caregivers speak with your child?

____

Appendix B - Demographic questions (administered at 13 and 18 months)

Reference number ________

Baby's initials ________ Mum's initials ________

1) What are your plans for your baby's childcare over the coming year? Please provide an estimate of the number of days per week for each type of childcare you are anticipating using.

At home with one or both parents	__________	Half Day(s)	__________	Full Day(s)
At a childminder's house	__________	Half Day(s)	__________	Full Day(s)
At nursery or crèche	__________	Half Day(s)	__________	Full Day(s)
Other:		Half Day(s)		Full Day(s)
______________________________	__________		__________	

2) Using the 5-point scale below, rate the support you currently receive by each group of people/resources. For categories that include more than one person (for example, friends and neighbours) enter the number that best represents the average helpfulness of that resource.

	Not used	Of little or no help		Moderately or occasionally helpful		Very helpful
	0	1	2	3	4	5
a. The child's father	☐	☐	☐	☐	☐	☐
b. My family and relatives	☐	☐	☐	☐	☐	☐
c. The family and relatives of the child's father	☐	☐	☐	☐	☐	☐
d. Health visitor/midwife/ services at your local surgery	☐	☐	☐	☐	☐	☐
e. Friends or neighbours	☐	☐	☐	☐	☐	☐
f. Organised groups including childcare, playgroups and classes	☐	☐	☐	☐	☐	☐
g. Books, magazines, newspapers	☐	☐	☐	☐	☐	☐

3)

	You	Baby's father
Age	______________________	______________________
Occupation	______________________	______________________
Marital Status	______________________	______________________

4) Please indicate how many years of formal education you completed

____

5) Please check the item below that accurately describes the level of education currently attained (or equivalent) for you and the baby's father.

	You	Baby's Father
a. GCSE/key skills level 1 or 2/ NVQ level 1 or 2	□	□
b. A-level/key skills level 3/ NVQ level 3 or 4	□	□
c. Bachelors degree	□	□
d. Postgraduate qualification	□	□

6) Please circle the item below that accurately describes your family income.

d. Less than £14,999   b. £15,000 to £39,999   c. Over £40,000

7) Which language is spoken most of the time in your house? ____________

Which other languages will you or other caregivers speak with your child?

____

Appendix C - Demographic, medical and language questions (administered at 24 months)

Thank you for agreeing to complete this questionnaire! It should take you about 30 minutes.

All data is confidential.

Please remember that your participation is voluntary and that you are free to withdraw at any time, without giving any reason.

By completing and returning this questionnaire you are consenting to participate.

Please provide:

Reference number (if known): ____________________________
Today's date: ____________________________
Your baby's date of birth: ____________________________
Your initials: ____________________________
Your baby's initials: ____________________________

General Information

Please fill in with some information about YOU:

age ____________________________

occupation ____________________________

years of formal education (starting from reception class) ____________________________

Please indicate YOUR marital status:

- ○ single
- ○ in a relationship
- ○ cohabiting
- ○ engaged
- ○ married
- ○ divorced
- ○ other

If you selected "other", please specify:

____

Please fill in with some information about THE CHILD's FATHER:

age ____________________________

occupation ____________________________

Please indicate THE CHILD's FATHER's marital status:

- ○ single
- ○ in a relationship
- ○ cohabiting
- ○ engaged
- ○ married
- ○ divorced
- ○ other

If you selected "other", please specify:

____

Please indicate the level of education completed by you and the child's father:

	You	Child's Father
a. GCSE/key skills level 1 or 2/ NVQ level 1 or 2	□	□
b. A-level/key skills level 3/ NVQ level 3 or 4	□	□
c. Bachelors degree	□	□
d. Postgraduate qualification	□	□

Any comments?

____

Please choose the item that accurately describes your family income:

a. Less than £14,999   b. £15,000 to £39,999   c. Over £40,000

Does your child have siblings?

If yes, please provide us information about their sex and current age.

sibling 1: sex and age ________________________

sibling 2: sex and age ________________________

sibling 3: sex and age ________________________

sibling 4: sex and age ________________________

sibling 5: sex and age ________________________

Any comments?

____

What are your weekly childcare plans for your child?
Please select half or full day for the appropriate option for each day.

	with one or both parents		with childminder		at nursery		other	
Monday	half day	full day	half day	full day	half day	full day	half day	full day
Tuesday	half day	full day	half day	full day	half day	full day	half day	full day
Wednesday	half day	full day	half day	full day	half day	full day	half day	full day
Thursday	half day	full day	half day	full day	half day	full day	half day	full day
Friday	half day	full day	half day	full day	half day	full day	half day	full day
Saturday	half day	full day	half day	full day	half day	full day	half day	full day
Sunday	half day	full day	half day	full day	half day	full day	half day	full day

If you selected “other”, please specify:

____

Medical Information

Has your child experienced any medical problems or complications in these first 2 years?

- O yes
- O no

If yes, please tick any of the following items and provide details below:

- O required surgery
- O visual complications
- O hearing complications
- O other diagnosis

details:

____

____

____

Did you and/or your child get admitted to hospital?

- O yes
- O no

If yes, please provide details:

____

____

____

Language Information

In the following questions you will be asked which language/s does your child hear in different situations and from different people.

To answer these questions you have to choose a percentage for each used language.

If your child hears English from all the people listed and in all the situations, you will want to choose "English, 100%" in all of them and leave blank the other languages, like this:

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
English	○	○	○	○	○	○	○	○	○	✓

If your child hears different languages from different people, you will want to choose the options that best describe your situation. For example, these questions could be completed like this:

Which languages are spoken AT HOME?
Please specify a percent of time for the used ones:

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
English	○	○	○	○	○	✓	○	○	○	○
Welsh	○	○	○	✓	○	○	○	○	○	○

Which languages do YOU speak with your child?
Please specify a percent of time for the used ones:

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
English	○	○	○	○	○	○	○	○	○	○
Welsh	○	○	○	○	○	○	○	○	○	✓

Which languages does the FATHER speak with your child?
Please specify a percent of time for the used ones:

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
English	○	○	○	○	○	○	○	○	○	✓
Welsh	○	○	○	○	○	○	○	○	○	○

Which languages are spoken AT HOME?
(i.e., between you and your partner, or other people, but not directly to your child)

Please specify a percent of time for the used ones:

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
English	○	○	○	○	○	○	○	○	○	○
Welsh	○	○	○	○	○	○	○	○	○	○
French	○	○	○	○	○	○	○	○	○	○
Italian	○	○	○	○	○	○	○	○	○	○
Lithuanian	○	○	○	○	○	○	○	○	○	○
Romanian	○	○	○	○	○	○	○	○	○	○
Dutch	○	○	○	○	○	○	○	○	○	○
Hungarian	○	○	○	○	○	○	○	○	○	○
Farsi	○	○	○	○	○	○	○	○	○	○
other	○	○	○	○	○	○	○	○	○	○

If you selected “other”, please specify:

____

Which languages do YOU speak with your child?
Please specify a percent of time for the used ones:

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
English	○	○	○	○	○	○	○	○	○	○
Welsh	○	○	○	○	○	○	○	○	○	○
French	○	○	○	○	○	○	○	○	○	○
Italian	○	○	○	○	○	○	○	○	○	○
Lithuanian	○	○	○	○	○	○	○	○	○	○
Romanian	○	○	○	○	○	○	○	○	○	○
Dutch	○	○	○	○	○	○	○	○	○	○
Hungarian	○	○	○	○	○	○	○	○	○	○
Farsi	○	○	○	○	○	○	○	○	○	○
other	○	○	○	○	○	○	○	○	○	○

If you selected “other”, please specify:

____

Which languages does the FATHER speak with your child?
Please specify a percent of time for the used ones:

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
English	○	○	○	○	○	○	○	○	○	○
Welsh	○	○	○	○	○	○	○	○	○	○
French	○	○	○	○	○	○	○	○	○	○
Italian	○	○	○	○	○	○	○	○	○	○
Lithuanian	○	○	○	○	○	○	○	○	○	○
Romanian	○	○	○	○	○	○	○	○	○	○
Dutch	○	○	○	○	○	○	○	○	○	○
Hungarian	○	○	○	○	○	○	○	○	○	○
Farsi	○	○	○	○	○	○	○	○	○	○
other	○	○	○	○	○	○	○	○	○	○

If you selected “other”, please specify:

____

Which languages do the SIBLINGS speak with your child?
(if your child does not have any sibling, please leave this blank)

Please specify a percent of time for the used ones:

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
English	○	○	○	○	○	○	○	○	○	○
Welsh	○	○	○	○	○	○	○	○	○	○
French	○	○	○	○	○	○	○	○	○	○
Italian	○	○	○	○	○	○	○	○	○	○
Lithuanian	○	○	○	○	○	○	○	○	○	○
Romanian	○	○	○	○	○	○	○	○	○	○
Dutch	○	○	○	○	○	○	○	○	○	○
Hungarian	○	○	○	○	○	○	○	○	○	○
Farsi	○	○	○	○	○	○	○	○	○	○
other	○	○	○	○	○	○	○	○	○	○

If you selected “other”, please specify:

____

Is your child exposed to a language other than English OUTSIDE THE HOME? If yes, please specify (i.e., language, with whom):

	with childminder	at nursery	with your relatives	with the father's relatives	with friends	other
English	○	○	○	○	○	○
Welsh	○	○	○	○	○	○
French	○	○	○	○	○	○
Italian	○	○	○	○	○	○
Lithuanian	○	○	○	○	○	○
Romanian	○	○	○	○	○	○
Dutch	○	○	○	○	○	○
Hungarian	○	○	○	○	○	○
Farsi	○	○	○	○	○	○
other	○	○	○	○	○	○

If you selected "other", please specify:

____

Which languages does your child speak?

	always almost always	sometimes	rarely
English	○	○	○
Welsh	○	○	○
French	○	○	○
Italian	○	○	○
Lithuanian	○	○	○
Romanian	○	○	○
Dutch	○	○	○
Hungarian	○	○	○
Farsi	○	○	○
other	○	○	○

If you selected "other", please specify:

____

Do you have any comments about this language section that you have just completed?

____

____

Appendix D - Medical status check (administered at 13 months)

Reference number _______

Baby's initials _______ Mum's initials ______

Baby's hospital number ____________ Mum's hospital number __________

Date of birth ___________________

Gestational age _________________

Date of admission (if different from DOB) ______________________

Weight at birth _____________________ gr.

Head circumference at birth ___________ cm.

Apgar scores ________ 1 min ________ 5 min ________ 10 min

Resuscitation yes no

In NNU yes no

Date of discharge ______________________

Weight at discharge ____________________ gr.

Head circumference at discharge __________ cm.

Appendix E - Administration Procedures and Behavioural Codes for the Shortened ESCS

All the tasks are described following the administration order, together with a list of the codes needed for each task. The codes followed by ^ have no duration: they refer to a single frame in the video. The key used in Interact is indicated in [square brackets].

1. **Response to Invitation Task with a hat**
   In this task the hat is placed directly in front of the child and the child is allowed to play with it for approximately 15 seconds. If the child uses the object in a socially conventional fashion (i.e., hat on head) the tester leans forward and shakes his or head gently while looking at the child's face and saying, " [child's name], Can I play?" This question is stated three times with a 2-second interval between repetitions, or until the child moves the hat toward the tester's head. If the child does not spontaneously use the object in a conventional fashion the tester should place the hat on the child (to demonstrate to the child what is socially expected) and then invite the child to play as stated above.

Child's (C) code	**Description**
Hat on E (RSI high) **[g]**	C puts hat on or towards E's head in response to invitation
Tease (ISI) **[C]**	C engages in a prohibited act while making eye contact (in general displaying positive affect toward E) (i.e., holding an object away from tester after a "give it to me" request; purposely throwing object across room)
Tease and Smile (ISI) **[V]**	C engages in a prohibited act while making eye contact AND smiling (in general displaying positive affect toward E) (i.e., holding an object away from tester after a "give it to me" request; purposely throwing object across room)

Experimenter's (E) code	**Description**
Hat start ^ **[a]**	E puts the hat on the table
Hat on child ^ **[s]**	E puts the hat on C's head (code when the hat is on the head – of course do not use if this doesn't happen, i.e. C doesn't stay still, C already did it him/herself)
Hat request **[d]**	E leans forward and asks to play with the hat; code until E brings the head up

2. **Object Spectacle Tasks with 1 wind-up toy (frog) and 1 hand-held toy (fish)**
   In each presentation the tester activates the toy on the table in front of, but out of reach of the child. The tester remains silent but attentive to the child while the toy is active to allow the child to initiate joint attention bids vis-à-vis the spectacle. However, if the child initiates a bid (e.g., alternates eye contact between the active object and tester), the tester should provide a natural but brief response (e.g., by smiling and nodding or by saying "mmm hmmm", or "Yes, I see!").The child may also make a bid to obtain the toy and the tester should respond to that bid by moving the toy within reach. If the toy ceases and the child has not bid for the toy, the tester should place the toy within reach of the child. The child is then allowed to play with the toy for approximately 10 seconds or until the child gives the toy to the tester. Each object spectacle is activated and presented to the child three times in a row

Follows Commands trials *should not be administered on the first presentation of a toy, however, to provide the child with an opportunity to give the toy spontaneously. If the child does not give the toy spontaneously on the second or third presentation of the object, the tester verbally requests the toy three times ("Give it to me!").*

Child's (C) code	**Description**
Eye to E + toy off (IBR low) **[Q]**	C makes eye contact with E while a toy is inactive, and s/he's not touching it OR after E has removed the toy from the child. Do not code eye contact elicited by movement or noise made by E
Eye to E + touch toy (IJA low) **[W]**	C makes eye contact with E while manipulating or touching an inactive toy. Use this code also if the child drops a toy off the table and then makes eye contact (if this is repeated more than once, then code as *Tease*).
Alternate eye E/toy (IJA low) **[E]**	C alternates a look between an active toy and E (typically when an object is active on the table or in the E's hands, but also recorded if C looks up to E after an object becomes active in own hands). Count each gaze between the toy and E as an *Alternate*. It can be coded up to 2secs after the toy stopped, if longer than that, then it's coded as *Eye to E + toy off*. [code the duration of the look to E]
Reach* (IBR low) **[R]**	C extends arm toward an object on E's side of the table. Code until C grasps object, retracts arm, or lays arm on table with hand closed for more than 2 seconds. Interruptions & re-initiations of a reach gesture with less than a 2secs interval are coded as one bid
Eye + Reach (IBR low) **[A]**	C combines eye contact with Reach. Eye contact may be a brief event superimposed on a longer period of reaching. They must be simultaneous at some point during bid
Pointing (IBR high) **[S]**	C point to indicate his/her desire for an inactive object or event. If a Point turns into a Reach or vice versa, only give credit to the Point. May be rated as occurring with or without eye contact. Reaching and verbalisations should help you in deciding that it's IBR rather than IJA. Write in the notes: if there is eye contact; pointing/open (to describe the hand position) and what C is pointing to.
Pointing (IJA high) **[D]**	C points to an active toy, or any other unobtainable object or event in the room (i.e., posters, cameras). May occur with or without eye contact. Write in the notes: if there is eye contact; pointing/open (to describe the hand position) and what C is pointing to.
Show toy (IJA high) **[F]**	C raises a toy toward E's face. The toy should be presented relatively still for a second or two. May be rated as occurring with or without eye contact (specify in the notes). Waving or shaking with a hand raised does not constitute a *Show*. (≠ from Give since typically C retracts the object if E attempts to take it)
Give (IBR high) **[Z]**	C pushes toy toward E, OR holds an object out towards E. May be rated as occurring with or without eye contact (specify in the notes)
Follow commands (RBR) ****[X]**	C responds to "give it to me" by giving the object back OR showing comprehension (e.g., shaking of head or by saying "no")
Tease (ISI) ** **[C]**	C engages in a prohibited act while making eye contact (in

	general displaying positive affect toward E) (i.e., holding an object away from tester after a "give it to me" request; purposely throwing object across room)
Tease and Smile (ISI) ** **[V]**	C engages in a prohibited act while making eye contact AND smiling (in general displaying positive affect toward E) (i.e., holding an object away from tester after a "give it to me" request; purposely throwing object across room)

* coding procedure different from the one in the manual, since the table is too small to follow the original procedure

** use just these three during the "toy request" task

Experimenter's (E) code	**Description**
Toy trial **[q]**	E operates one of the 4 small toys (frog, fish, caterpillar or clown). Code from when E has the toy in her hands (taking it from the box or C's hands or the floor) and for the whole time the toy is active until she puts it on the table in front of the child. Code for each of the 3 trials per toy
Toy request **[e]**	E administers the Follows Commands task (code from the beginning until 3secs after E stops talking / or when E gets the toy back)

3. **<u>Social Interaction Task singing "Itsy-bitsy spider"</u>**

Here the tester removes all toys from the table and begins the task by saying to the child "Let's play a game" or "Let's sing a song." Then the tester sings a few bars of a simple child song (e.g., "Baby bumble bee," or "Itsy-bitsy spider"). After approximately 10 seconds of song the tester gently runs his or her fingers across the table while softly saying "Whee," "Zipp," or "Bzzzz. The tester then returns his or her hand to the tester's side of the table and pauses, attending to the child for approximately 5 seconds. After the five second interval, or a child bid, the tester repeats the procedure of running his/her fingers across the table and touching or tickling the child and returning to a rest position. After a five second interval, or a child bid, this procedure is repeated a third time.

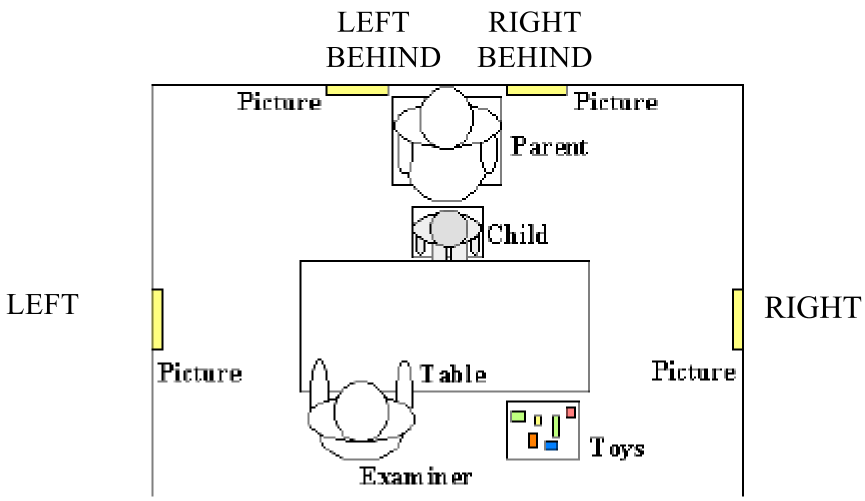
Child's (C) code	**Description**
Eye to E after tickle (RSI low) **[x]**	C makes eye contact with E <u>after</u> E has tickled C & paused before next tickle episode [in this case the length of the eye contact is unimportant]. If C initiates eye contact <u>during</u> the song or the tickle and it's maintained for 2 or more secs into the pause period, the code may be used.
Act after tickle (RSI low) **[c]**	C vocalises or bangs the table OR C reaches to E, after E has tickled the child
Eye + Act after tickle (RSI low) **[v]**	C combines "Eye to E after tickle" & "Act after tickle"
Initiates song/tickle (ISI) **[b]**	(after E has done at least one tickling) C makes eye contact & runs fingers across table. OR C makes tickle gesture. OR C claps. OR C sings.

Experimenter's (E) code	**Description**
Tickle **[m]**	E tickles C (code from when E puts the fingers on the table, until when she takes the hands away from C)

4. Gaze Following Task (p. 10) pointing to Left, Left-Behind, Right, Right-Behind

These trials must begin with the tester bringing the child's attention to her face. The child's attention can usually be directed by calling the child's name, tapping the table or gently touching the child, and then touching one's own nose.
The Gaze Following Task involves a sequence of the tester looking and pointing to the posters on the wall while emphatically stating the child's name.

The posters are identified from the experimenter's perspective:



Child's (C) code	**Description**
Pointing (IJA high) **[D]**	C points to a poster <u>before</u> E points to it, or any other unobtainable object or event in the room (i.e., posters, cameras). May occur with or without eye contact. <u>Write in the notes</u>: if there is eye contact; pointing/open (to describe the hand position) and what C is pointing to.
Pointing (IBR high) **[S]**	C point to indicate his/her desire for an <u>inactive</u> object or event. If a Point turns into a Reach or vice versa, only give credit to the Point. May be rated as occurring with or without eye contact. Reaching and verbalisations should help you in deciding that it's IBR rather than IJA. <u>Write in the notes</u>: if there is eye contact; pointing/open (to describe the hand position) and what C is pointing to.
Point in imitation **[8]**	C points to something after having witnessed E point to something
Follow pointing (RJA high) **[9]**	C turns eyes (and head if necessary) to look in the correct direction. Do not code if C was already looking in the direction of the point before the trial started.
Looking at wrong poster **[5]**	C looks at a poster, but not the one E just pointed to. <u>Write in the notes</u> which poster C is looking at (L, LB, R, RB).

Experimenter's (E) code	**Description**
Point to Left **[1]**	E points to the left poster (code from when E starts turning until when she is facing the child again)
Point to Left-Behind **[4]**	E points to the left-behind poster (code from when E starts turning until when she is facing the child again)
Point to Right **[3]**	E points to the right poster (code from when E starts turning until when she is facing the child again)

Point to Right-Behind **[6]**	E points to the right-behind poster (code from when E starts turning until when she is facing the child again)

5. **<u>Turn-Taking Task with a ball</u>**
   In these tasks the tester places either the toy car or ball within the child's easy reach and then the tester places his or her hands apart on the table in a posture ready to catch the ball or car if the child throws or rolls it to the. The tester should remain in this posture for about 10 seconds. If the child responds by throwing or rolling the ball or car to or away from the tester, the tester retrieves the ball and again rolls it to the child. This turn-taking activity continues until the child stops throwing or rolling the ball or car or the child has taken 12 turns. If the child does not initiate a turn-taking game the tester should request and/or retrieve the toy and roll it to the child while making an appropriate playful sound (e.g., "Brrrrrm," "Wheeeee," or "Zoom").

Child's (C) code	**Description**
Initiates turn-taking (ISI) **[l, small L]**	[After C receives the ball from E the first time] C rolls/push the ball back to E (just if it's rolling it on the table, or with a clear intention of giving it to E).
Maintains turn-taking (RSI high) **[h]**	[After E rolls the ball back to C] C rolls the ball back to E (just if it's rolling it on the table, or with a clear intention of giving it to E). If C has a double turn (i.e., the ball goes on the floor and the mums returns it to C) all of this counts as one turn.
Pointing (IJA high) **[D]**	C points to an <u>active</u> toy, or any other unobtainable object or event in the room (i.e., posters, cameras). May occur with or without eye contact. <u>Write in the notes</u>: if there is eye contact; pointing/open (to describe the hand position) and what C is pointing to.
Pointing (IBR high) **[S]**	C point to indicate his/her desire for an <u>inactive</u> object or event. If a Point turns into a Reach or vice versa, only give credit to the Point. May be rated as occurring with or without eye contact. Reaching and verbalisations should help you in deciding that it's IBR rather than IJA. <u>Write in the notes</u>: if there is eye contact; pointing/open (to describe the hand position) and what C is pointing to.

Experimenter's (E) code	**Description**
Ball start ^ **[j]**	E puts the ball in front of C
Ball roll **[k]**	E rolls the ball to C – from when E takes the ball until when this is near to C (therefore including if E touches it again to stop it)

6. **Object Spectacle Tasks with 1 wind-up toy (caterpillar) and 1 hand-held toy (clown)**

7. **Social Interaction Task**

8. **Gaze Following Task pointing to Right, Right-Behind, Left, Left-Behind**

Appendix F - Language characteristics of the sample

The two samples were both heavily bilingual, as is common in Wales (see Appendices B and C for inventories used to collect this data). In the preterm sample 17 (40%) participants indicated a bilingual environment, while 26 (60%) a monolingual one; in the term sample 32 (48%) participants responded as bilingual, while 35 (52%) as monolingual. Samples were therefore not significantly different in this aspect, $\chi^2(1, N = 110) = 0.72$, $p = .436$. Welsh was the most common second language (sometimes indicated as "occasional"), but also Chinese, Chichewa, Filipino, Spanish, French, Romanian, Farsi and German were included in the responses.

For the preterm sample, the majority of the participants (N = 40; 93%) spoke English as first language, one had English and Welsh as joint first languages, one had Welsh and one had Lithuanian. For the term sample, English was again the most common first language (N = 62; 92%), while the most used language in the house for the remaining families were joint English and Welsh (N = 1), Welsh (N = 1), Italian (N = 1), Dutch (N = 1) or French (N =1). For all the families who did not have English as first language, it was indicated as a second language.

As partially mentioned in section 2.5.2, some participants showed conditions affecting language performance. One participant born at term (GA 37^{+1}) was diagnosed at around 1 year with very mild cerebral palsy and at the 2 years questionnaires reported an expressive vocabulary of around 20 words only intelligible by the family. When contacted for the 2 years questionnaires two of the term born participants (GA 39^{+6}, 41^{+3}) reported delayed language development and got referrals for additional support. Again in occasion of the 2 years questionnaires, one term born participant (GA 39^{+5}) reported temporary deafness for 4 months after severe and recurrent ear infections and another (GA 40^{+1}) had some concerns due to muffled speech and asked for a referral.

Appendix G - Scores of the Bayley Scales

The third edition of the Bayley Scales (Bayley, 2006) is a very widely used standardised measure of infants and toddlers' development, divided in three parts: cognitive, language and motor scales. In the Special Delivery study, only the Cognitive Scale was administered. This scale is designed to "assess sensorimotor development, exploration and manipulation, object relatedness, concept formation, memory and other aspects of cognitive processing" (Bayley, 2006, p. 3). Most of the BSID-II Mental Scale (MDI; Bayley, 1993) items were retained for the third version, revising or rewriting the items relying too much on receptive language or fine motor ability, in order to strengthen the uniqueness of the cognitive scale (Bayley, 2006).

The raw score obtained by each participant on the Cognitive Scale is simply the total number of passed tasks. The composite score is a norm-referenced score scaled to a metric, ranging from 40 to 160, with a mean of 100 and a standard deviation of 15 (Bayley, 2006).

For each participant, scores were calculated both considering the chronological age and the age corrected for prematurity. All participants were tested at 18 months chronological age from the "J" starting point, which was intended for infants from 13 months and 16 days to 16 months and 15 days, so that all participants would be included given the lower gestational age (and therefore corrected age) of the preterm sample.

Preterm infants had lower raw and composite scores than term peers relative to chronological age, but had similar results based on the composite scores relative to age corrected for prematurity, with medium effect sizes (see Table 2.5). There was therefore a difference between samples when considering preterm infants' scores based on chronological age, but no difference when considering the corrected age. These results were in line with the most common findings in the literature (i.e., Bonin et al., 1998; Romeo, Guzzardi, et al., 2012).

Table 2.5
Performance on the Bayley Cognitive Scale at 18 months of age.

	Preterm sample	Term sample	Difference between samples
	M (*SD*)	*M* (*SD*)	
Raw scores	49.19 (3.07)	52.02 (3.51)	$t(90) = 3.95$, $p < .001$, $r = .38$
Composite scores for chronological age	92.22 (7.02)	98.66 (9.41)	$t(90) = 3.52$, $p = .001$, $r = .35$
Composite scores for corrected age	98.47 (8.35)	97.86 (8.89)	$t(90) = -0.33$, $p = .741$, $r = .03$

Note. Data were missing for 11 term and 7 preterm infants.