Explaining the Influence of Younger Siblings on Firstborns' Understanding of Minds in Middle Childhood: A Longitudinal Investigation of the Mother-Firstborn Relationship

AMY LOUISE PAINE

A thesis submitted to the School of Psychology, Cardiff University, in partial fulfilment of the requirement for the degree of

Doctor of Philosophy

July 2017

Under the supervision of

Professor Dale Hay

School of Psychology

Cardiff University

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This thesis is dedicated to the families who took part in the Cardiff Child Development Study.

Acknowledgements

Firstly, I would like to thank the funders of the Cardiff Child Development Study, the Medical Research Council (MRC), Medical Research Foundation and Waterloo Foundation, and the participating families who so generously gave their time to this study. Thank you to the School of Psychology, Cardiff University, for my funding to complete this thesis. I would like to extend my gratitude to my supervisory team, Professor Dale Hay and Dr Catherine Jones. Dale, thank you so much for this opportunity, for your words of wisdom, for challenging me and encouraging me to approach my work with curiosity and creativity. Catherine, thank you for all your kind words, invaluable advice and for being a mentor to me for the last 4 years.

Thank you to all the members of the Cardiff Child Development Study team, both past and present. It has been a privilege to work in a team of such dedicated, kind people. I would like to thank Rhiannon, for your incredible support all the way through and for your suggestions at the final stages. Thank you, Vikki, for showing me the ropes at the start, Jo, for the best fun on our testing visits, and Jess W., for your calming presence and hugs. Thanks also to Cerith, Nina, and Charli for your support, Holly, for reliability coding, and Oliver, for your statistics advice. A huge thank you also goes to Salim, for all the above, but mainly for keeping me laughing along the way. I feel very lucky to have shared this journey with one of my best friends.

Thank you to all my friends and family for supporting me. Thanks, Ffion, Manon and Kathryn, for cheering me on. To my two best friends in the world, Mum and Dad, thank you for all your love, reassurance and unwavering belief that I can do anything I put my mind to.

Last, but certainly not least, thank you Arjen, for being the person who knows me best, believes in me the most, and is there for me always.

Contributions to the Cardiff Child Development Study

The Cardiff Child Development Study (CCDS) was the source of data for all empirical chapters in this thesis. The CCDS is a prospective longitudinal study that investigates children's early social development in a nationally representative sample of mothers and their firstborn children. Recruitment for this study started in 2005, and data collection took place in pregnancy (Wave 1) and at 6, 12, 21, and 33 (Waves 2 – 5 respectively) months postpartum. The final assessments took place when the children reached 6.5 to 7.5 years of age (Wave 6); the last stage of assessment finished in the summer of 2015. Full details of the CCDS are described in Chapter 2 of this thesis. In this section I will describe my contribution to this study since I joined the study in 2012 and commenced by PhD research in 2013.

I joined the study as an undergraduate in the summer of 2012 to complete a Cardiff Undergraduate Research Opportunities Programme. During this 8-week placement, I coded tasks administered during the late infancy assessment: 100% of the causal understanding task and 100% of real-time coding of the joint attention task. I also created a coding scheme to measure affect in mother-child interactions at the early infancy assessment. I coded 100% of these interactions and this was used for publication (Perra, Paine & Hay, under review; Perra, Phillips, Fyfield, Waters, & Hay, 2015). Following the summer placement, during my undergraduate project I coded 23.6% of the reliability for the peer interaction task at the late toddler assessment using the Peer Interaction Coding Scheme.

During my PhD research, I assisted with data collection for the middle childhood wave of assessment. This involved administering a battery of social, emotional and cognitive assessments with 6- to 7-year-old children and additional assessments with their younger siblings in the home over two 2-hour visits. I attended a number of data collection visits to administer tasks with the younger sibling, before training as a child tester. As a child tester, I

administered child assessments for 42 of the 233 (18.0%) families visited in the home at the middle childhood assessment. This equated to approximately 70 visits and 140 hours of child testing.

In terms of data coding for this thesis, I transcribed and coded 100% of the false belief task from the middle childhood wave of assessment (Chapters 3, 5 and 6). I coded 60% of the British Picture Vocabulary Scale, the verbal IQ childhood assessment (Chapters 3, 5 and 6). I transcribed 100% of mother-child interactions with the teddy puzzle at the toddlerhood assessment (Chapters 4 and 6), and 100% of mother-child interactions with the Etch-a-Sketch at the middle childhood assessment (Chapters 4, 5 and 6). I coded 100% of maternal use of internal state language from the early infancy, toddlerhood and middle childhood mother-child interaction transcripts (Chapters 4, 5 and 6). I also produced 100% of the standardised scores for the Wechsler Test of Adult Reading, the assessment for caregivers' productive language at the middle childhood assessment. In collaboration with a colleague I constructed the executive function variables from the middle childhood assessments from the raw datasets (Chapters 3, 5 and 6). We created a CCDS executive function manual to complement the Amsterdam Neuropsychological Tasks manual (de Sonneville, 2011).

In addition to the data collection and observational coding for this thesis, I have been involved in a number of additional projects with the CCDS during my PhD research. I coded 31.3% of children's interactions with familiar peers at the toddlerhood assessment using the Peer Interaction Coding System (PICS), and coded 100% of children's use of internal state language at the early childhood free play assessment and at the middle childhood mother-child interaction assessment. I have collaborated with other teams to adapt the GESU (Pawlby & Schmücker, 1991); a coding scheme for the cooperation Etch-a-Sketch task, adapted the PICS coding scheme for the 'Bop it!' caregiver-/sibling-child interaction task and created coding schemes for the battery of other social understanding tasks administered at the

middle childhood assessment. I have collaborated with colleagues by coding for other postgraduate students' projects, including 10% of reliability coding of immersion during the video game administered at the childhood assessment, and 25% of episodes of conflict, cooperation and cooperative pretence during free play at the early childhood assessment (Robinson, Howe, Paine, Fyfield, & Hay, in preparation).

Following completion of the middle childhood wave of data collection, I contacted families to collect missing sibling questionnaires over the telephone and entered all sibling questionnaire data into SPSS. I also completed audits of data collected at the middle childhood assessment. I led the debriefing of all CCDS families following the latest wave of assessment, managed two location moves of all CCDS confidential data and equipment, and recruited volunteers and organised booths to promote the CCDS at public engagement events. I have trained and mentored volunteers, summer placement students, as well as final year project students.

Dissemination of Findings

The work presented in this thesis has been disseminated at conferences and submitted to journals for publication. Chapter 3 of this thesis was presented at the 2016 British Psychological Society (BPS) Developmental Section Conference in Belfast, Ireland on the 14th September 2016. An earlier version of the chapter was also presented at the IMPRS Workshop: Perspectives on the ontogeny of mutual understanding, at the Max Plank Institute for Psycholinguistics in Nijmegen, The Netherlands on the 1st October 2015. Chapter 3 has also been revised and accepted for publication in the Journal of Experimental Child Psychology. Findings from Chapter 4 are to be presented at the 2017 British Psychological Society (BPS) Developmental Section Conference in Stratford-upon-Avon, England, on the 15th September 2017. An earlier version of Chapter 5 was presented at the International Society for Studies in Behavioural Development conference in Vilnius, Lithuania, on the 12th July 2016. Finally, an earlier version of Chapter 6 was presented at the 2015 Society for Research in Child Development Biennial Meeting in Philadelphia, Pennsylvania, USA, on the 20th March 2015.

Summary

This thesis focuses on the influence of younger siblings on firstborns' understanding of minds in middle childhood. This topic was investigated in the context of the Cardiff Child Development Study (CCDS): a prospective longitudinal study of firstborn children and their families living in Wales, UK. As reported in Chapter 3, presence of a younger sibling resulted in an advantage on a second-order false belief task at 7 years of age. However, this advantage was only true for firstborns who experienced the birth of a sibling after their second birthday. It was hypothesised that the positive contribution of a younger sibling is mediated by changes to features of mother-firstborn conversation in dyadic interactions.

To test this hypothesis, in Chapter 4 I described an expanded internal state language coding scheme for analysing mothers' speech at 6 months, 21 months and 7 years. Mothers' references to their 7-year-olds' cognitive states positively predicted understanding of second-order false belief. As reported in Chapter 5, mothers who had a second child referred to cognitive states more than those with one child in middle childhood. Mothers' variety of references to cognitive states partially mediated the association between presence of a sibling and firstborns' understanding of second-order false belief.

In Chapter 6, I investigated the families who experienced the birth of an early arrival younger sibling. Early arrival siblings were predicted by mothers' symptoms of conduct disorder. Mothers who had an early arrival sibling present by 21 months referred to cognitive states less than mothers who did not.

The findings in this thesis contribute to knowledge about the influence of younger siblings on the child's development of theory of mind. The findings demonstrate the importance of examining how the arrival, and timing of arrival, of a younger sibling affects the dynamics of children's other close relationships that influence children's developing understanding of minds.

CHAPTER 1

Introduction

1.1 Introduction to the Thesis

Most children in the UK grow up with at least one brother or sister; 80% of children in Western families have a sibling (Volling, 2012). Siblings provide children with a unique opportunity to learn about themselves and about others; it has been suggested that siblings provide an important context for the development of theory of mind (Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991). While there is mounting evidence that older siblings positively foster children's understanding of minds, it is unclear if children with younger siblings experience the same advantage (Ruffman, Perner, Naito, Parkin, & Clements, 1998). The first aim of this thesis is to explore the influence of younger siblings on measures of firstborns' theory of mind, with the view to then investigate processes by which younger sibling influence may occur. This will be addressed in the context of the Cardiff Child Development Study (CCDS); a prospective longitudinal study of firstborn children from a community sample living in South Wales, United Kingdom.

This introductory chapter will review what is known about the influence of siblings on theory of mind in the literature thus far. I will consider early research, predominantly

conducted by Judy Dunn and her colleagues in the 1980s and early 1990s that explored processes by which siblings may foster children's understanding of minds. I will consider how these processes may be dependent on aspects of sibling relationship structure, such as gender composition, birth interval and birth order.

1.2. Theory of Mind

1.2.1 Defining 'theory of mind'

Navigation through the complexities of our social worlds requires understanding of our own inner states and those of other people. As children develop, they increasingly understand others as beings with minds: with beliefs, desires, intentions and emotions. Such understanding is essential for children to successfully comprehend, interpret, predict and manipulate the behaviour of those around them. The ability to understand the psychological world has been coined *theory of mind* (Premack & Woodruff, 1978), which is defined as the "…understanding of mental states, what we know or believe about thoughts, desires, emotions, and other psychological entities both in ourselves and in others" (Miller, 2009, p. 749). Theory of mind is also referred to as *belief-desire psychology* (Wellman & Banerjee, 1991), *folk psychology* (Stitch & Nichols, 1995), *commonsense psychology* (Forguson & Gopnick, 1988) *mindreading* (Whiten, 1991) and more broadly within *social cognition* (Hala, 1997) and *social understanding* (Carpendale & Lewis, 2004).

1.2.2 Measuring developments in children's theory of mind

Theory of mind has been demonstrated to be a multifaceted construct, characterised by a series of multiple concepts that develop over time (Wellman & Liu, 2004). As such, a number of measures have been designed to tap different aspects of theory of mind at each phase in development. Sharp, Fonagy and Goodyer (2008) provide an overview of the social cognitive constructs typically measured from infancy to adolescence (Figure 1.1).

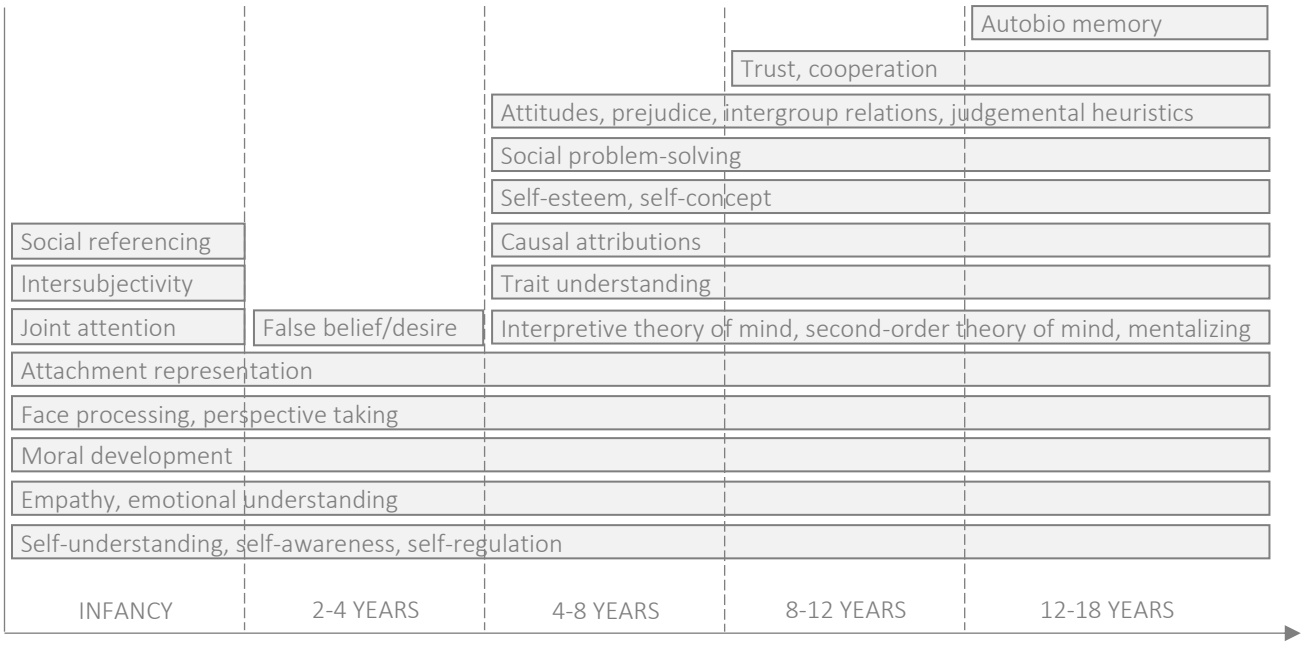

Figure 1.1 Sharp and colleagues' (2008) map of social cognitive constructs most commonly examined in relation to children's normative development[1].

Of these constructs, children's ability to understand beliefs to be changeable, fallible, and possibly contradictory to their own has been amongst the most intensively studied attainments within the theory of mind literature (Hughes, 2016). Such understanding of belief has been exemplified by philosopher Dennett (1978), who highlighted children's understanding of fallibility of belief by their reactions to a traditional Punch and Judy show. Children will laugh and squeal while Punch throws a box off a cliff; to Punch's knowledge, Judy is inside the box; however unbeknownst to Punch, Judy already escaped. Children's joyous reactions to this show, Dennett wrote, is "…overwhelmingly good evidence that they understand… that Punch is acting on a mistaken belief" (p.4, Figure 1.2).

[1] Figure 1.1 shows social cognitive constructs commonly measured at each phase of development. This does not represent the sequence of development of these constructs, nor is this list exhaustive of all constructs that have been measured in relation to theory of mind. For more information regarding sequences of development, see Wellman (2002) and Wellman & Liu (2004).

Figure 1.2 Punch and Judy illustration from The Nursery Rhymes of England.

Children's understanding of such mistaken beliefs, or *false beliefs*, is widely used as an indicator of theory of mind. The false belief task (also known as *unexpected transfer* or *unexpected location* task) was introduced by Wimmer and Perner (1983) as a simpler alternative to Premack and Woodruff's (1978) deception task used to investigate understanding of mind in chimpanzees. In a typical story for a false belief task, a protagonist places an object in a specific location, only to have it moved by another character to another location in their absence. Following the story, children are asked questions to ascertain whether they have a representation of a mistaken belief; in their attribution of the protagonist's belief, or in their prediction of the protagonist's behaviour. The most common variation of the *unexpected transfer* or *unexpected location* false belief task is depicted in Figure 1.3, the Sally-Anne task (Baron-Cohen, Leslie, & Frith, 1985).

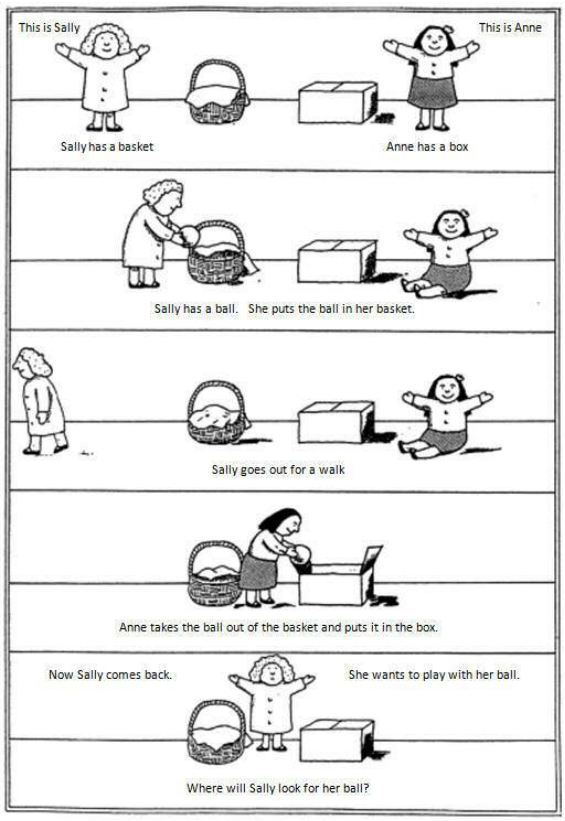

Figure 1.3 Baron-Cohen, Leslie and Frith (1985) illustration of Sally-Anne false belief task.

The false belief task is not without its criticisms as a fairly narrow measure that, due to its linguistic complexity, may somewhat underestimate children's understanding of minds (for a review, see Bloom & German, 2000). However, in a meta-analysis by Wellman, Cross and Watson, (2001), the false belief task was demonstrated to be a robust measure of theory of mind. Despite variations in task, the developmental trajectory of this attainment remained the same. Additionally, children's responses had a consistency of 84% from first to second responses. The reliability and validity of the false belief task is demonstrated further in a review by Devine and Hughes (2016). Indeed, the classic false belief task is still commonly used in recent work (for example see Devine, White, Ensor & Hughes, 2016).

1.2.3 Individual differences in theory of mind

Although numerous studies have demonstrated that the majority of children succeed in such false belief tasks by the fourth year of life (Astington & Gopnick, 1991; Perner,

Leekam, & Wimmer, 1987), it has been indicated that there are marked individual differences in the age at which children succeed in the false belief task, ranging from 3 to 5 years (Jenkins & Astington, 1996). As such, a considerable body of research has accumulated exploring individual differences in typical development of theory of mind, and three contributing factors have been identified (Slaughter & Repacholi, 2003). Firstly, research investigating *cognitive constructs* have identified language (Milligan, Astington, & Dack, 2007) and executive function (Carlson & Moses, 2001) as particularly important sources of individual difference in children's false belief understanding. Secondly, a sophisticated understanding of mental states has been linked to various *social outcome measures*, including more positive interactions among peers (Cutting & Dunn, 1999), improved conversations (Dunn, 1994) and improved teacher ratings of social competence (Lalonde & Chandler, 1995; Watson, Nixon, Wilson, & Capage, 1999). The third and final factor most relevant to this thesis is *family influence.*

1.3 Family Influences on Theory of Mind

The examination of family influence in relation to theory of mind has been pivotal in the long-standing debate regarding how children develop understanding of the minds of themselves and of others. Most broadly, this debate concerns whether understanding of minds results from individual cognitive growth, or from socialisation (for a review, see Carpendale & Lewis, 2004). While some theorists have proposed that theory of mind is essentially a maturational process (Leslie, 1994), there is a growing body of research that has demonstrated the importance of children's social worlds on their understanding of minds. Prominent accounts such as the 'theory theory' (Wellman, 1990) and 'simulation theory' (Harris, 1991) propose that children's social environments have a triggering role in children's theory of mind development. Yet research showing associations between children's understanding of minds and various aspects of their socialisation history has emphasised that

children's emerging understanding of minds must be understood within the context of social interaction (Dunn, 1994). Indeed, features of children's relationships with their mothers and fathers (Miller, 2016), other kin (Lewis, Freeman, Kyriakidou, Maridaki Kassotaki, & Berridge, 1996) and peers (Slaughter, Dennis, & Pritchard, 2002) have all been found to influence children's developing theories of mind. Such research has led to increasing consensus that understanding of minds develops within triadic interactions between children, interactional partners and the environment (for a review see Carpendale & Lewis, 2006).

1.3.1 The influence of siblings on theory of mind

The influence of siblings on children's understanding of minds is of particular interest in the theory of mind literature. Not only did research identifying that siblings may foster children's understanding of minds initiate the flurry of work examining social influences on theory of mind, but sibling relationships are of particular interest in terms of their universality and uniqueness. Most children in the UK grow up with at least one brother or sister (Office for National Statistics, 2013a), and for many the sibling relationship is the most long-term of relationships in the lifespan. The sibling relationship can be characterised by enduring closeness, play and cooperation, as well as extreme conflict and rivalry, and as such provides a unique opportunity for children to learn about themselves and about others (Dunn, 1994; Hughes, 2011).

The influence of siblings on the development of theory of mind has predominantly been explored in terms of sibling relationship factors, such as sibling presence, number, gender and timing of arrival. Another branch of research has focused on the relationship between theory of mind and characteristics of the sibling relationship itself. Interestingly, it was the latter association that was first explored, in a forward-thinking body of work by Judy Dunn and colleagues, who noted a positive relationship between sibling cooperation at 33 months and performance on a false belief task 7 months later (Dunn, Brown, Slomkowski, et

al., 1991). This was followed by a pivotal study by Perner, Ruffman and Leekam (1994), who demonstrated that both older and younger siblings foster children's false belief understanding, reporting that every addition of a sibling in the home provided the same advantage as 6 months of development.

1.3.2. How might a sibling foster a child's theory of mind?

These pivotal studies by Judy Dunn and Josef Perner and their colleagues (1991; 1994) support the suggestion by Piaget (1959) that siblings facilitate cognitive change through discussion and reflection. This position was expanded by Dunn (1994), in her proposal that siblings may influence theory of mind through a) talk about causality and internal states; b) management of conflict; c) joint play; d) shared jokes; and e) reasoning about moral issues. The subsequent sections will briefly summarise each of these processes.

1.3.2.1 Talk about causality and internal states. Over the second and third years of life, children talk increasingly about the causes of individuals' behaviour (Dunn & Brown, 1993), and such conversations are positively associated with children's understanding of false belief (Dunn, Brown, Slomskowski, et al., 1991). Talk about causality refers to two events or states that have a conditional relationship, such as, "Don't jump – you'll hurt yourself!" (Dunn, Brown, Slomskowski, et al., 1991, p. 450). From the ages of 33 to 40 months, talk about causality becomes equally common with both mother and sibling, and additionally increasingly shifts focus from overt behaviour to internal states.

References to inner states, such as feelings, desires and cognitions, have also been observed in children as early as the end of the second year of life (Bretherton, McNew, & Beeghly-Smith, 1981). Children's production of, and exposure to, internal state language with various interlocutors has been associated with children's false belief understanding (Dunn, Brown, Slomkowski, et al., 1991; Ruffman, Slade, & Crowe, 2002; see also Chapter 4 for a review). The sibling relationship has been shown to become an increasingly rich context

for children to have conversations about their own inner states and the inner states of others. In Brown and Dunn's early research (1991, 1992), it was found that as children develop, they increasingly discuss internal states with their siblings, and by 47 months of age, children discuss inner states with their siblings and friends more so than they do with their mothers (Brown, Donelan-McCall, & Dunn, 1996). Additionally, children's discussions about internal states with siblings concern the inner states of both children, rather than the inner states of the child only; which tends to be the focus within mother-child interactions (Dunn & Kendrick, 1982a). Therefore, in the context of sibling interactions, children are more likely to hear about the internal states of others.

Children's discussion of internal states with their siblings is positively related to measures of theory of mind; including emotion understanding (Dunn, Brown, & Beardsall, 1991), perspective taking (Howe & Ross, 1990) and false belief understanding (Brown et al., 1996). It has been found, however, that children's use of internal state language is dependent on context; namely, that such conversations occur most often during conflict and play (Howe, 1991).

1.3.2.2 Management of conflict. Children's mind-understanding has been demonstrated to be fostered by positive sibling interactions (Dunn, Brown, Slomkowski, et al., 1991; Howe & Ross, 1990). However, family conflict may also provide an important context for the development of theory of mind. Family disputes involving young children have been found to be extremely common (Dunn, 1994), and the sibling relationship is one that is often characterised by intense conflict. Unlike relationships with peers, the permanence and intimacy of sibling relationships affords children the opportunity to test the boundaries of conflict without jeopardizing the relationship (Hughes, 2011).

Episodes of sibling conflict may foster theory of mind as they tend to be rich in talk about causality and internal states (Dunn & Brown, 1993; Dunn & Brown, 1994; Howe,

1991) which, as previously discussed, is related to children's understanding of false belief. Within sibling conflict, children are more likely to talk about feeling states, such as, "… *you drive me mad!* I'm really *angry!* Leave me alone!" (Howe, 1991, p. 1506), bringing children's attention to their own thoughts, feelings and intentions. In addition, children's arguments may also highlight how their own inner states contrast with the states of their interactional partner. This is demonstrated again, in an example from Howe (1991), in an example of one child's references to contrasting inner states as a younger sibling attempts to knock down a tower of blocks, "Don't do that! *I want to make it higher.*" (p. 1506).

Within their arguments, children have the opportunity to discuss their contrasting points of view, and may also attempt to reconcile their differences. The nature of how children reconcile or negotiate their disputes with their siblings has been found to be related their false belief understanding (Foote & Holmes-Lonergan, 2003). Namely, children's use of *other-oriented arguments* (Dunn, 1994) take into account the inner states of the interactional partner, such as "She said we have to play together. Let's finish the building, then we'll play with that." (Foote & Holmes-Lonergan, 2003, p. 58). Such negotiation strategies have been found to foster children's false belief understanding, over use of *self-oriented arguments*, which focus on the child's self-interest, for example, "I chose the horse first." (Foote & Holmes-Lonergan, 2003, p. 57). Indeed, sibling dyads who do not argue have been found to score lower on false belief tasks (Foote & Holmes-Lonergan, 2003), suggesting that negotiating conflict is an important context for the development of theory of mind.

1.3.2.3 Joint play. Leslie (1987) argued that pretend play requires similar understanding as that required for understanding of minds. In a pretend play scenario, an alternate reality is separated, or *decoupled*, from literal reality itself. An example of this could be a child playing with a toy banana, not as a food object, its *primary representation*, but a telephone, its *secondary representation*. This *metarepresentational* ability required for

pretend play is thought to mirror that required for the understanding of minds, in the understanding that the inner states can contradict reality and one's own inner states, and thus may be an indicator of a child's social understanding (Leslie, 1988).

Children's propensity to pretend play generally, and with siblings, is associated with measures of children's theory of mind (Youngblade & Dunn, 1995). Children's sibling relationships are of particular interest in the pretend play literature, as it has been demonstrated that siblings tend to be children's preferred partners for engaging in pretend play (Farver & Wimbarti, 1995; Youngblade & Dunn, 1995). This may be due to their shared experiences of family life and the intimacy of the sibling relationship giving freedom to express themselves (Hughes, 2011). Additionally, the nature of siblings' participation in pretend play tends to differ from that of the caregiver, in that siblings participate beyond commentary, but as actors themselves within the pretend play scenario (Dunn & Dale, 1984).

There are many aspects of pretend play with siblings that may be important for children's developing understanding of minds. Pretend play, like conflict, is another context rich in internal state language. Children refer to internal states in their invitations to commence play, in their construction of shared meaning, negotiation of roles and enactments in the play scenario, in addition to managing their disputes when faced with conflicting ideas. These references to inner states during pretend play are well illustrated in an excerpt of a play session with a female sibling dyad from Hughes (2011, p. 109, names removed, italics added). In this play scenario, one child attempts to imprison her sister behind a pot plant:

Child:	Boba, *pretend* you are a baddy and I'll catch you. Come on Boba. You are a baddy and you fight me and I catch you up.
Child:	Boba, don't. Do this.
Child:	Will you just put that on there? [Putting a handcuff on sibling's wrist]. Make a fist. OK you need to [speech unintelligible] and I'll take you into prison. Now stay in there for the night. Get in Boba. Get into that little space.
Sibling:	Getting in it.

1.3.2.4 Shared jokes. Children's jokes and shared humour with their interactional partners may also reveal a great deal about what children understand about their social world. From as early as 14 months, children have been observed to laugh at *discrepant events*, if people or objects behave in unusual or unexpected ways. In the second year of life, children increasingly laugh at behaviour that is considered forbidden, as well as people's mistakes and misfortunes. Children's emerging verbal ability also leads to play with language, by joking, teasing and stating deliberate falsehoods (Dunn, 1988). Children's laughter at such events demonstrates children's emerging understanding of the world; in that the source of humour often results from events that violate what is known about reality.

Joking between siblings is particularly important in this context, given that the sources of laughter within sibling interactions often differ from that they share with their caregiver (Dunn, 1994). Children's jokes with their siblings often focus on what is forbidden, insulting or disgusting, often in repetitive conversational turns, exemplified by Dunn (1988, p. 157):

Sibling:	Piggyface!
Child:	Piggyface!
Sibling to observer:	I'm not allowed to say Piggyface at school.
Child to observer:	My mum doesn't let me say Piggyface.
Child to sibling	Mr. Piggyface! Mr. Piggyface!
Sibling:	No, not Piggyface.
Child:	Mr. Piggyface!
Sibling:	You said Piggyface!
Child:	Mr. Piggyface!

The differences in the nature of shared jokes within mother-child interaction and sibling-child interaction demonstrates that children come to know what specific individuals may (and may not) find amusing (Dunn, 1994), which may foster children's developing theory of mind. Indeed, children who are frequent jokers within interactions have been found to have an advantage on false belief tasks (Woodworth, 1993, as cited in Dunn, 1994).

1.3.2.5 Reasoning about moral issues. Understanding feelings and intentions of others is thought to be fostered by children's experiences of moral transgressions (Carpendale & Lewis, 2006). Indeed, children's appropriate responses to moral transgressions is positively correlated with children's false belief understanding (Baird & Astington, 2004). Like children's theory of mind, children's understanding of issues such as rule-breaking, harming others and teasing, as well as events that highlight responsibility, justice and kindness to others, are thought to be fostered within children's social interactions (for a review, see Dunn, 2013). This reflects Piaget's (1932) original argument that children's experiences with other children, namely their cooperation and conflict, are particularly important for moral development.

Children's causal talk concerning social norms and rules with their siblings increases in frequency as they develop (Dunn, 1994), and most sibling conflicts concern moral issues

(Recchia & Howe, 2009), with 50% of young children's disputes being centred on issues such as rights and possession (Dunn & Munn, 1987). Children's arguments concerning social rules can lead to justifications for their actions, and within these types of disputes, children often refer to feeling states (Dunn & Munn, 1987). In addition to episodes of conflict, is it also possible that theory of mind is fostered within children's exploration of moral issues within pretend play. For example, their construction of dramatic narratives may include moral transgressions (Dunn, Cutting, & Demetriou, 2000).

1.3.3 Might siblings indirectly facilitate theory of mind?

It is also argued that children may benefit from a sibling by observing their interactions with their caregiver (Hughes & Leekam, 2004). Children have been found to closely monitor conversation and expression between their mother and sibling (Dunn & Kendrick, 1982a; Dunn & Shatz, 1989), and as such, children have more opportunity to make sense of interactions between others. For example, mothers' styles of interacting with siblings, such as frequent controlling behaviour, have been associated with children's understanding of minds (Dunn, Brown, Slomkowski, et al., 1991). Additionally, children with siblings are more likely to hear more internal state language within the home (Jenkins, Turrell, Kogushi, Lollis, & Ross, 2003). Such mother-sibling conversations expose children to conversations regarding other individuals' internal states, as prior to siblinghood, mothers' utterances regarding internal states focus predominantly on those of the child (Dunn & Kendrick, 1982a). Indeed, children who grow up in families where talk about feelings is frequent do well in measures of theory of mind (Dunn, Brown, & Beardsall, 1991).

In addition to eavesdropping on mother-sibling interactions, children may also experience sibling influence on theory of mind indirectly via maternal involvement in interactions between siblings. One possibility is that theory of mind is fostered in caregivers' efforts to manage conflict between siblings. Mothers become involved in over half of

children's episodes of conflict with their siblings, and such interventions often include references to rules and internal states (Dunn & Munn, 1986), such as, "She didn't *know* I had promised it to you." (Dunn, Brown, Slomkowski, et al., 1991, p. 1363, italics added). Although maternal intervention in sibling conflicts has been linked with longer duration of conflict between siblings and more physical aggression, it has also been linked with more mature conflict management and moral sensibility by children (Dunn & Munn, 1986; Dunn, Brown, & Maguire, 1995).

Though previous work has focused on how the arrival of a sibling may change children's conversational climates, in the conversations that they overhear (Hughes & Leekam, 2004), and in the triadic interactions they take part in with their caregiver (Dunn, Brown, Slomkowski, et al., 1991; Dunn & Kendrick, 1982a), few studies have explored changes in dyadic mother-child interactions before and after the arrival of a sibling. In order to examine the processes by which siblings indirectly influence children's theory of mind via the caregiver, more research must examine the changes in mother-child dyadic interactions (Carpendale & Lewis, 2004). This therefore, will be the focus in the examination of processes within this thesis.

1.3.4 Quality of sibling relationship

It is suggested that the processes by which siblings may influence children's developing theories of mind, described in sections 1.3.2 and 1.3.3, may be moderated by the quality of the sibling relationship. Cooperative sibling interactions have been associated with children's false belief performance (Dunn, Brown, Slomkowski, et al., 1991) and sibling relationships that are characterised by harmonious, warm, friendly interactions have been found to be conducive to more frequent conversations about internal states and pretend play, as well as more constructive styles of conflict and mature moral sensibility (Brown et al., 1996; Cutting & Dunn, 2006; Dunn, et al., 1995; Foote & Holmes-Lonergan, 2003).

Conversely, destructive sibling relationships, characterised by high emotional intensity, aggression and antagonism are associated with poor performance on measures of theory of mind (Song, Volling, Lane, & Wellman, 2016).

Additionally, evidence suggests that the influence of caregivers' interventions within children's sibling interactions may also be explained by sibling relationship quality. For example, Recchia and Howe (2009) showed that when sibling relationship quality is high, mothers' intervention strategies such as encouraging joint perspective-taking was linked to corresponding use of such strategies by children, but this association was weaker when sibling relationship quality was poor. It is possible that when in positive sibling relationships, children are more motivated to resolve their conflicts in positive ways, which in turn may foster their understanding of minds.

1.3.5 The importance of relationship structure

The processes summarised in the preceding sections represent an important step in understanding how siblings may foster children's understanding of minds. However, a disproportionate number of studies investigating such processes focus on the influence of an older sibling, and often do not specify other important factors such as other positions in birth-order, age-spacing and gender composition, factors known as *biosocial structure* or *sibling constellation factors* (Buhrmester, 1992). Given that research has demonstrated that sibling constellation factors affect aspects of socioemotional characteristics of the sibling relationship (Buhrmester, 1992), it is possible that the processes by which siblings influence theory of mind specified by Dunn (1994) may be dependent on features of sibling constellation.

1.3.5.1 Gender composition of siblings. Some studies have documented that children with opposite-gender siblings demonstrate better performance on theory of mind tasks (Carlson & Moses, 2001; Cassidy, Fineberg, Brown, & Perkins, 2005). Opposite-gender

siblings may be most beneficial in fostering understanding of minds as they expose children to diverse perspectives, play styles and preferences that differ from their own (Kennedy, Lagattuta, & Sayfan, 2015). Opposite-gender sibling relationships are also characterised by more conflict (Dunn & Kendrick, 1982a), and therefore may provide more opportunities for children to navigate opposing points of view.

While these studies have noted that opposite-gender siblings appear most facilitative of theory of mind, other work has suggested the same for same-gender siblings (Kennedy et al., 2015). Research from the literature on peer relationships has demonstrated that children prefer to interact within same-gender dyads (Maccoby, 1990). Same-gender sibling relationships have been found to be characterised by more play, conversation, positivity and intimacy than opposite-gender sibling relationships (Burhmester, 1992; Dunn & Kendrick, 1981; Dunn, 1983; Kim, McHale, Osgood, & Crouter, 2006). It may be that same-gender siblings positively influence theory of mind via quality of relationship.

1.3.5.2 Age spacing of siblings. Another sibling constellation feature of sibling relationships that may affect the degree to which siblings influence children's theory of mind is birth interval. Peterson (2000) investigated the possibility that there are minimum and maximum age boundaries within which siblings foster theory of mind, demonstrating that children with very young siblings (< 12 months) or older siblings (> 12 years) do not show an advantage in measures of theory of mind over only children. While very young siblings lack the ability to engage in relevant interactions that foster theory of mind, older siblings may choose not to, in being aloof to childish interactions or by adopting a more parent-like role. This work highlighted that having a sibling with whom a child can engage in play, conflict and conversations in childish ways may be key to the sibling effect on children's theory of mind.

The experience of having a twin provides no advantage in measures of theory of mind (Cassidy et al., 2005); therefore, in common with widely-spaced birth intervals, siblings born within very narrow birth intervals may similarly not facilitate children's theory of mind. It has been argued that the sibling effect may only occur when the sibling provides children with exposure to a *different* mind; this is corroborated by evidence demonstrating that having both older and younger siblings may be of most benefit by exposing children to a wider variety of minds (Peterson, 2000). It is also possible that a twin may affect the mother-child relationship. Evidence has demonstrated that the stress and demands of having twins has been associated with less "…strong, elaborated, communicative interaction" (Thorpe, Rutter, & Greenwood, 2003, p. 346). It then seems plausible that children born within a very short interval may similarly not provide children with the sibling advantage.

1.3.5.3 Birth order

1.3.5.3.1 Older siblings. Of the aspects of sibling constellation that have been investigated, birth order has by far received the most research interest. Following initial studies that older and younger siblings increase the likelihood of passing false belief tasks (Jenkins & Astington, 1996; Perner et al., 1994) a reanalysis and extension of the pivotal study by Perner and colleagues (1994) was conducted (Ruffman et al., 1998). When the influence of number of older and younger siblings were entered into the sample model whilst controlling for age, only older siblings were found to positively influence children's false belief performance. Since this study, preschoolers with older siblings have been found to outperform those with younger siblings and without siblings on theory of mind measures in a number of studies (Farhadian et al., 2010; Jenkins & Astington, 1996; Kennedy et al., 2015; Lewis et al., 1996; McAlister & Peterson, 2007, 2013; Ruffman et al., 1998).

One explanation for this finding has been coined the *apprenticeship hypothesis* (Lewis et al., 1996), proposing that interactions with more skilled partners, such as older

siblings, fosters children's understanding of minds. With their experience and more advanced metacognitive skills, older siblings may play an important role in helping their younger siblings to become more proficient in their understanding of internal states (Ruffman et al., 1998). Older children may be better able to teach skills to their younger sibling (Azmitia & Hesser, 1993; Dunn & Kendrick, 1982a) as well as engage their younger sibling in more sophisticated pretend play (Farver & Wimbarti, 1995) and conversations about internal states (Jenkins et al., 2003).

This reflects a Vygotskian perspective (Vygotsky, 1978), which proposes that understanding of minds is the product of the child's engagement with other people in their social environment through the use of *cultural tools*, stimuli passed down through generations that act as a means to achieve goals and consequently facilitate cognitive development. As well as physical objects, these can include psychological tools such as language, values, skills and symbols. Cultural tools are used within social interactions between children and other individuals in their environment, which, when occurring with a more knowledgeable other, enables the knowledgeable other to *scaffold* the interaction with the child. By providing a framework to guide the interaction with the child, be it in a game, task or in conversation, more knowledgeable others can guide children's active participation to reach higher levels of cognitive functioning. Vygotsky described this range of performance, between what children can do alone, and what their more knowledgeable other can support them to achieve, as the *Zone of Proximal Development* (Vygotsky, 1978) (see Figure 1.4).

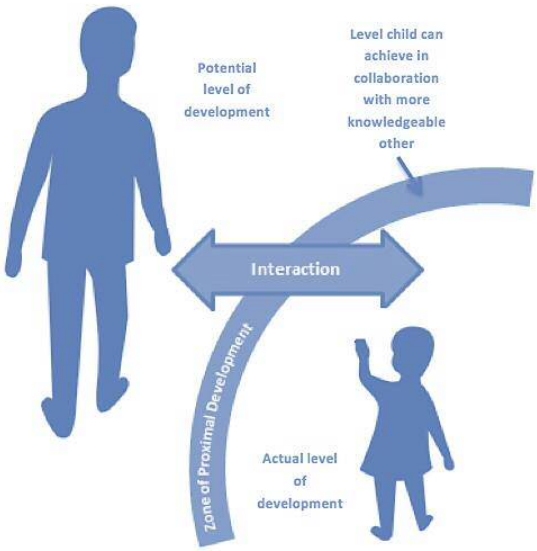

Figure 1.4 Illustration of the Zone of Proximal Development.

Older siblings may be particularly efficacious for children's understanding of minds in the context of pretend play and through their use of internal state language. Children with older siblings have been found to use more sophisticated play strategies, whereas their firstborn counterparts are less successful at creating shared meanings in play (Howe, Petrakos, & Rinaldi, 1998; Howe, Petrakos, Rinaldi, & LeFebvre, 2005). It is thought that younger siblings may become involved in more sophisticated and complex play scenarios by the older siblings scaffolding, through the use of "…verbal suggestions, hints, strategies, extensions, or… physical gestures." (Howe et al., 2005, p. 785).

An alternative explanation focuses on observational learning, proposing that the sibling advantage comes about through the younger child's observation of the older sibling's interactions with the caregiver (Dunn & Kendrick, 1980). Children may particularly benefit from observing interactions between an older sibling and a caregiver, as this exposes children to more sophisticated forms of internal state language (Jenkins et al., 2003). This may foster children's understanding of minds by promoting children's understanding and generation of

such terms, which is positively associated with false belief performance (Ruffman et al., 2002).

1.3.5.3.2 Younger siblings. While it is well established that older siblings foster children's understanding of minds, the influence of younger siblings on theory of mind remains unclear. A number of studies have indicated that younger siblings foster children's theory of mind (Jenkins & Astington, 1996; Kennedy et al, 2015; McAlister & Peterson, 2007; Perner et al., 1994; Peterson, 2000; Shahaeian, Nielsen, Peterson, & Slaughter, 2014). Some studies have found no effect of younger siblings on theory of mind measures (Farhadian et al., 2010, Ruffman et al., 1998; Shahaeian, 2015) and one study found that younger siblings have a negative effect on theory of mind performance (Wright & Mahford, 2012).

Although children with younger siblings may not benefit from scaffolding of higher-level pretend play and internal state language like those with older siblings (Howe et al., 1998, 2005; Jenkins et al., 2003), it may be that *being* the older sibling with the opportunity to teach a younger sibling such skills may also be beneficial (Dunn & Dale, 1984; Zajonc & Markus, 1975). Strauss, Ziv, and Stein (2002) emphasised the relationship between teaching and theory of mind; that teachers must understand the learners' knowledge - whether it is absent, partial, or mistaken - in comparison to their own knowledge. Firstborn siblings have been found to adjust teaching strategies to suit the abilities of their younger siblings (Pérez-Granados & Callanan, 1997), and adopting various teaching strategies has been found to be positively associated with measures of children's theory of mind (Davis-Unger & Carlson, 2008).

First and second-born children are born into very different family circumstances, and it may be the firstborn's transition from only child to siblinghood that impacts on children's understanding of minds. The changes that the arrival of this new family member brings to a

firstborn's world have thus far not been investigated within the context of children's developing theories of mind (Volling, 2012). Therefore, to some extent we can only speculate how the transition to siblinghood may impact children's understanding of minds.

The majority of children make the transition to siblinghood between the ages of 2 and 3 (Baydar, Greek, & Brooks-Gunn, 1997), at the time when children's understanding of minds is thought to emerge (Wellman, 2002). Therefore, the arrival of a new baby may play an important role during a time when children are increasingly thinking of themselves and others with minds. One such way the arrival of a new baby may foster children's understanding of minds is by triggering changes to the family conversational climate. Dunn and Kendrick (1982a) studied mother-child conversations before and after the arrival of a sibling and noted that prior to the birth, the majority of mothers' references to internal states referred to those of the child's. Mothers' references to the inner states of others, however, increased upon arrival of the sibling, due to references to the sibling's inner states. Not only were mothers observed to frequently discuss the infant's inner states with their firstborn, but much of their speech directed to the infant concerned their inner states: "Are you *hungry*?"; "Are you *starving*?"; "Oh you're not getting *hiccups* are you? Silly fool!" (p 76, italics added), which are also likely to be overheard by the firstborn.

Dunn and Kendrick have also observed changes in firstborns' speech upon arrival of a sibling. Firstborns were found to use more internal state language, predominantly in their discussions about their siblings' internal states. Additionally, firstborns were observed to use *infant-directed speech* when talking directly to their siblings (Dunn & Kendrick 1982a; 1982b). Dunn and Kendrick also noted that firstborns showed particular interest in the physical manifestation of their younger siblings' inner states (1982a, p.77, italics added):

Child:	Brenda *crying*.
Mother:	Mm.
Child:	Why?
Mother:	‘Cause you woke her up this morning.

Children’s interest in the reasons *why* their younger sibling may behaving in a certain way, in addition to appropriate use of infant directed speech, suggests an understanding of the infant as a person with a mind (Dunn & Kendrick, 1982a), and is also suggestive of their ability to differentiate between the cognitive status of infants and other family members (Dunn & Kendrick, 1982b).

However, some studies have suggested that younger siblings do not influence children’s understanding of minds (Ruffman et al., 1998) or may even hinder theory of mind development (Wright & Mahford, 2012). It is possible that younger siblings do not foster children’s understanding of minds, as the processes described in section 1.3.2 may require a certain degree of cognitive maturity. Alternatively, the lack of influence, or indeed hindering effect of younger siblings may result from negative outcomes related to the arrival of the second child. Negative reactions from children upon the arrival of a second-born are common (Volling, 2012), so much so that Winnicott (1964) described this as normative, “It is so usual to be called normal when a child is upset at a new one.” (p.133). Indeed, the majority of children experiencing the arrival of a sibling show emotional upset, in their display of regressive behaviour, anxiety, and confrontational behaviour (Volling, 2005). This, coupled with the new infant placing increased demands on the caregivers’ time, may be responsible for resulting decreases in mother-firstborn positive affection, play, responsiveness and verbalisations upon arrival of a second child (Baydar et al., 1997; Dunn & Kendrick, 1980, 1982; Field & Reite, 1984; Kendrick & Dunn, 1982). It is also possible that parents’ explanations to their firstborn children are frequently interrupted due to the demands of the younger sibling (Wright & Mahford, 2012).

1.4 Summary of Chapter

Children's understanding of minds is crucial to understanding the many complexities of their social worlds. It is argued that children come to understand the minds of themselves and of others through their social interactions; this chapter has reviewed the unique contribution made by siblings. Sibling relationships provide a rich context for developing an understanding of minds, from discussion about internal states, to humour, pretend play and conflict. However, this review has also highlighted the need to develop our understanding of such processes within the context of children's sibling constellation factors, whilst considering their other close relationships, such as the mother-child dyad. Rather than simply understanding how children develop their knowledge of minds within the child-sibling dyad or the parent-child dyad, it is essential to understand the social influences on the development of theory of mind within the context of family life.

I have identified one main inconsistency within the literature concerning sibling influences on children's theory of mind. Despite the positive influence of older siblings being well-established, it is unclear whether younger siblings foster, hinder, or do not influence theory of mind development at all. Given that many studies examining processes by which siblings influence theory of mind have focused on older sibling influence and very little research has been conducted regarding how sibling arrival may affect children's theory of mind, this presents a clear issue that warrants further investigation.

The questions raised in this thesis will be explored within the context of the Cardiff Child Development Study (CCDS). Because the CCDS is the source of data for all empirical chapters in this thesis, Chapter 2 will outline its general method. Following this, the first question that will be addressed in this thesis is:

1.4.1 Why might the findings regarding younger sibling influence on theory of mind be so inconsistent?

Prior to further investigation into the influence of younger siblings on theory of mind, it is first necessary to explore why there may be such inconsistency within this literature. This will be addressed in Chapter 3, in a close examination of this body of work to identify theoretical and methodological flaws that must be addressed in future study of this relationship. This will include further consideration of family structure, as well as issues of sample sizes and inclusion of relevant correlates of theory of mind in the existing literature. This will then be taken into consideration in the next question:

1.4.2 Do younger siblings, like older siblings, foster children's theory of mind?

As we have seen, the role of younger siblings in the development of theory of mind is controversial. It is unclear whether experience with younger as well as older siblings fosters theory of mind. Following the critique of the literature, Chapter 3 will then proceed to establish whether there is a relationship between the presence of younger siblings in the home and theory of mind in a community sample of firstborn children and their families, whilst addressing issues with the existing literature.

CHAPTER 2

The Cardiff Child Development Study: General Method

2.1 Introduction

The present chapter outlines the methods used in the Cardiff Child Development Study (CCDS), which provided the data used in all chapters of this thesis. This chapter describes the general design, participants' recruitment and demographic information, the procedure and measures used in the CCDS.

2.2 General Method

2.2.1 Design

The Cardiff Child Development Study (CCDS) is a prospective longitudinal cohort design that investigates children's early social development in a nationally representative sample of mothers and their firstborn children. Mothers were recruited during the pregnancy of their first child and data collection took place in pregnancy (Wave 1) and at 6, 12, 21, 33 and (Waves 2 – 5 respectively) months postpartum. The final assessments took place when the children were between 6.5 and 7.5 years of age (Wave 6). The CCDS was funded by the UK Medical Research Council (MRC) Grants G0400086 and MR/J013366/1 and grants from the Medical Research Foundation and Waterloo Foundation. Ethical approval was obtained

for the procedures from the NHS Multi-Centre Research Ethics Committee and the Cardiff University School of Psychology Research Ethics Committee.

2.2.2 Participants

2.2.2.1 Recruitment. Three hundred and thirty-two primiparous women and their partners were recruited from 1st November 2005 to 31st July 2007 from National Health Service (NHS) antenatal clinics in hospitals and GP surgeries in Cardiff and The Vale University Health Board, and the Gwent Healthcare Trust, UK. These areas were selected to provide a diverse sample of families. Further representativeness was enabled by midwifery teams granting the recruitment team access to antenatal clinics for specialist medical problems, and to outreach services for vulnerably housed individuals. A recruitment DVD was made to inform the midwifery teams of the procedures of the study.

Trained researchers approached expectant mothers and their families in the hospital or clinics, with the guidance of receptionists indicating who might be primiparous women suitable for the study. The families were given a brief explanation of the study and what participation would involve, and interested families were shown the recruitment DVD and provided with a leaflet, and their contact details were recorded. Within two weeks of the initial contact, the project administrator contacted the families to provide further information. Families willing to participate had their first appointment booked during the 3rd trimester of the pregnancy, which became Wave 1 of the CCDS. Translators were employed for families whose native language was not English or Welsh, or for participants who had impaired hearing. No inclusion criteria were required for this study, except in the case of miscarriage or infant death.

2.2.2.2 Sample. The full CCDS sample is used in the investigation in Chapter 4; however, in the remaining chapters a subsample of the CCDS is used, as younger siblings are the focus of this thesis. In this context, younger siblings are defined as full, step-, half- or

adopted younger siblings who are living in the same home as the firstborn child. Therefore according to this definition, children with an older half- or step-sibling, a twin, or a younger sibling out of the home were excluded from the samples used in Chapters 3, 5 and 6 of this thesis (Figure 2.1), resulting in a *younger sibling study sample* of 269 (81.0%) families included in these chapters.

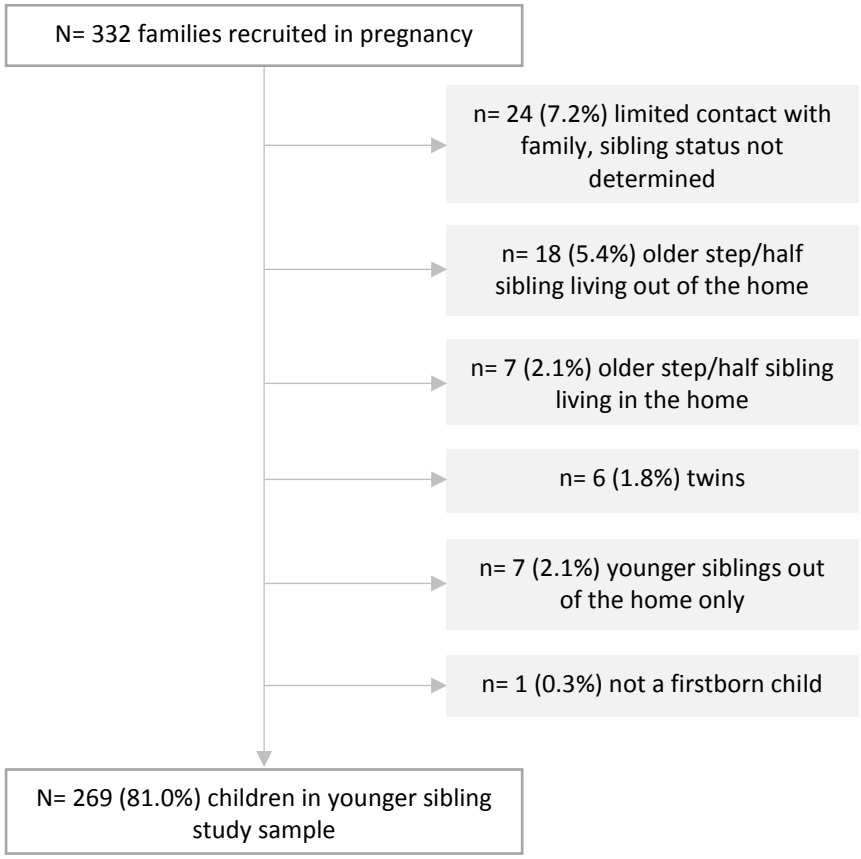

Figure 2.1 Derivation of younger sibling study sample used in Chapters 3, 5 and 6 of this thesis.

By the time that the firstborn children were 7 years of age (Wave 6), 196 (72.9%) of firstborn children in the younger sibling study sample had at least one younger sibling living in the home. One hundred and fifty-five (57.6%) children had one younger sibling, 34

(12.6%) had two younger siblings, and seven (2.6%) had three younger siblings. Figure 2.2 shows the full breakdown of these groups.

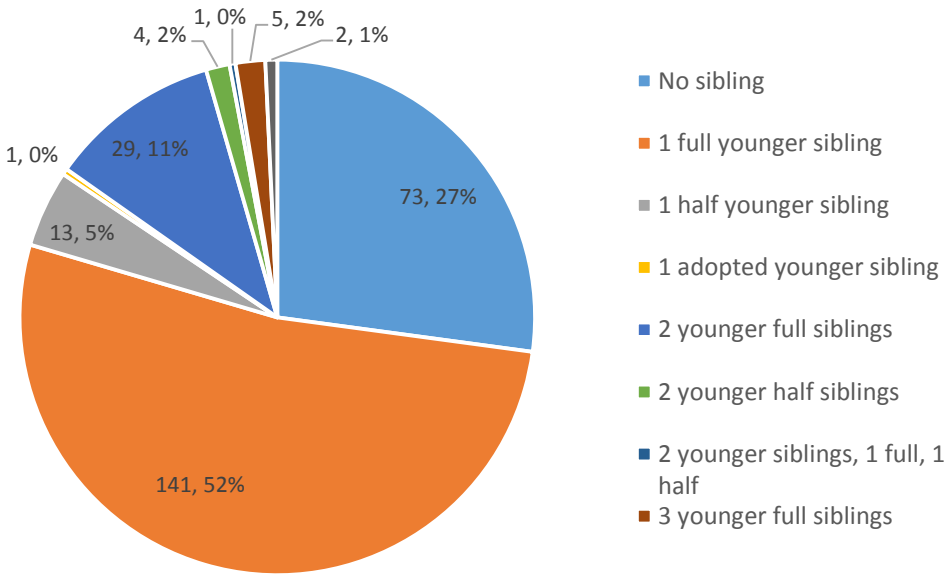

Figure 2.2 Percent of siblings living in the home by the time of the middle childhood assessment.

In this thesis, characteristics of firstborns' closest in age younger sibling are investigated. Birth dates were available for 268 (99.6%) closest in age younger siblings, and gender was known for 267 (99.3%) closest in age younger siblings. Of the children with younger siblings, the mean age at arrival of the next in age younger sibling was 35.25 months (*SD* = 16.23). One hundred and three (53.1%) closest in age siblings were female and 91 (46.9%) were male. One hundred and four (53.6%) firstborns were in a same-gender sibling dyad with their closest in age younger sibling, and 90 (46.4%) were in an opposite gender sibling dyad. Table 2.1 shows the number of children per gender composition between the firstborn child and their closest in age younger sibling.

Table 2.1

Gender compositions of firstborn children and their closest in age younger siblings.

		Closest in age younger sibling gender	
		Male	Female
Firstborn gender	Male	53 27.3%	52 26.8%
	Female	38 19.6%	51 26.3%

2.2.2.3 Demographic characteristics. The sample of participants who took part in the CCDS has been shown to be nationally representative, as it did not significantly differ on sociodemographic characteristics of firstborn children in the nationally representative sample in the Millennium Cohort Study (for more details see Hay et al., 2014). The full sample characteristics and the characteristics of the sibling subsample are presented in Table 2.2. The demographic characteristics of the participants were collected during interviews and questionnaires during the prenatal assessment (Wave 1), with the exception of maternal and paternal age at first birth, which were calculated using the infant's date of birth during the early infancy telephone calls to book Wave 2 appointments. The Standard Occupational Classification 2000 (SOC2000; Elias, McKnight & Kinshott, 1999) was used to determine occupational status of mothers. This was based on the highest ranked employment that the mother ever had at entry into the study. A dichotomous variable was created using mothers' highest rank of employment on the SOC2000 six-category scale to categorise individuals as working class or middle class.

Information provided about maternal educational attainment was also dichotomised to indicate whether mothers had achieved the minimum level of qualifications required for the completion of secondary education in the United Kingdom (5 General Certificate of Secondary Education examinations grade A*- C or equivalent). It was also ascertained as to

whether mothers identified that they were in a stable partnership with the baby's father and marital status was also dichotomised.

In this thesis, the child's exposure to socioeconomic adversity was indexed by these sociodemographic risk variables. All these items were categorical; therefore a principal components analysis based on the polychoric correlation matrix confirmed that all these items contributed to a single component, which explained approximately 77% of the shared variance in these risk indicators. Summary scores derived from this PCA measured the family's exposure to socio-economic adversity (Perra, Phillips, Fyfield, Waters, & Hay, 2015).

Table 2.2

Demographic information for full CCDS sample and the younger sibling study sample.

	Total sample (Chapter 4) ***N* = 332**	**Younger sibling study sample (Chapters 3, 5 and 6)** ***N* = 269**
Age at first birth *(mean)*		
Mother	28.15 *(SD 6.35, range 16.09 - 42.99)*	28.41 *(SD 6.21, range 16.09 – 42.18)*
Father	30.81 *(SD 6.82, range 15.62 – 30.81)*	31.11 *(SD 6.63, range 16.50 – 56.67)*
Social class *(%)*		
Middle class	50.9	54.3
Working class	49.1	45.7
Mother's education *(%)*		
No qualifications	5.1	4.8
Less and 5 GCSEs A*= C/Basic e.g. key skills, NVQ, NNEB	16.6	16.7
5+ GCSEs A*-C or GNVQ higher level	13.9	11.5
A-levels A*-E/BTEC/HNC	11.7	11.2
Undergraduate degree (BA or BSc)/HND	28.0	27.1
Postgraduate degree e.g. MSc, MD, PhD, PG Cert	24.7	28.6
Relationship status at the child's birth *(%)*		
Married	50.3	55.8
Cohabiting	33.7	29.4
In a relationship but not living together	6.3	5.2
Single	9.6	9.7
Ethnicity *(%)*		
British	92.7	92.2
Non-British	7.3	7.8
Firstborn child gender *(%)*		
Male	56.8	55.8
Female	43.2	44.2
Adversity score *(mean)*	.00 *(SD .99, range -.95 – 2.51)*	-.06 *(SD 1.02, range -.95 – 2.51)*

Note. The $N = 269$ younger sibling study sample used in this thesis was not significantly different from the original $N = 332$ recruited.

2.2.3 Procedure

The CCDS procedures involved combinations of interview, questionnaire and observational methods at each wave. Waves 1, 2, 4 and 6 took place in the participants' homes, and at Waves 3 and 5, the participants were invited to a purpose-designed laboratory at Cardiff University. Figure 2.3 provides an overview of the study; the darker shaded areas of the figure highlight waves of assessment that were investigated in this thesis. The following sections provide explanation of specific procedural details of each wave of interest in this thesis. The additional waves that were not investigated are also described to provide the full context of this longitudinal study.

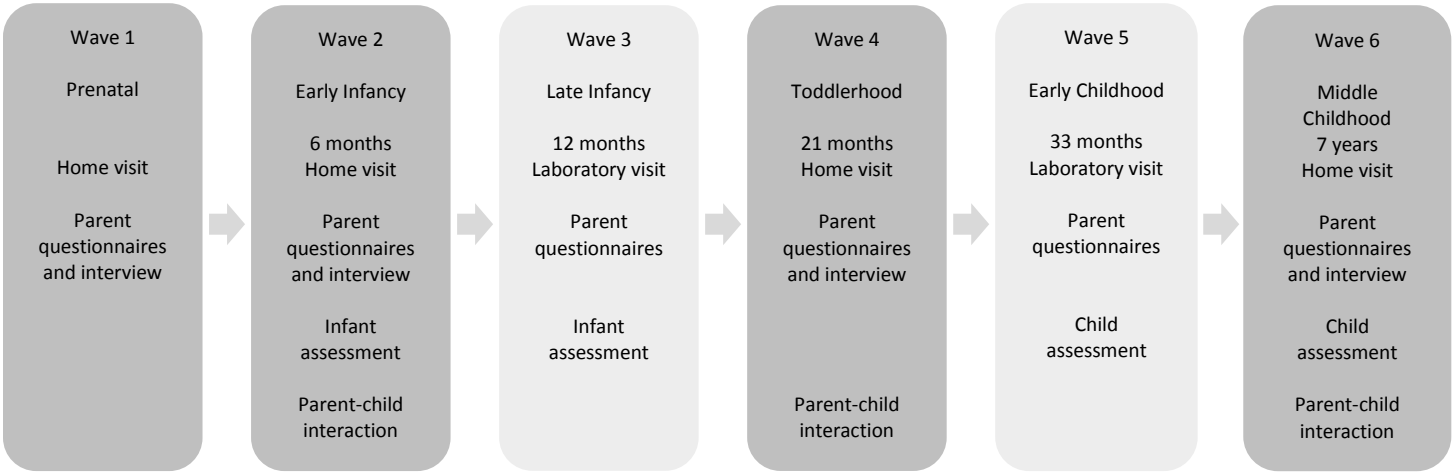

Figure 2.3 Overview of the procedure in the CCDS.

2.2.3.1 Wave 1: Prenatal home visit. Mothers and fathers were interviewed in their homes by CCDS research assistants during the third trimester of the pregnancy. Where possible, the mothers and fathers were interviewed at the same time in different rooms. Otherwise, efforts were made to arrange the interviews to take place separately. The interviews included a psychiatric assessment of symptoms of psychopathology using the Schedules for Clinical Assessment in Neuropsychiatry (SCAN; Wing et al., 1990), as well as employment history, sociodemographic information, social support networks and family history of mental health problems. Following the interview, questionnaires that measured

demographic variables, lifestyle, general health, relationship quality, fertility history and behavioural history were given to both parents to complete and return to the university at their convenience. A remuneration of a £20 gift voucher was given to the family upon completion of the visit.

2.2.3.2 Wave 2: Early infancy home visit. Families were visited in the home by research assistants when the infant was 6 months old (mean age was 6.64 months). The home visit took approximately two hours and during that time the mothers were again interviewed using the SCAN to assess their mental health since the prenatal home visit (Wave 1). They were also asked questions regarding their experience of labour, obstetric complications, and any changes in general lifestyle arrangements and their social network. The infant was filmed during a 25 minute assessment where various social, emotional and cognitive tasks were administered, including several parent-child interaction tasks. A questionnaire battery was also administered to mothers, fathers and, where possible, another significant person in the infant's life (such as a close family member or friend). Mother and father questionnaires included questions regarding their health, lifestyle, life events, relationships, family structure and their infant's behaviour. Upon completion of the assessments, a remuneration of a £20 gift voucher was given to the family.

2.2.3.3 Wave 3: Late infancy laboratory visit. Families were invited to the laboratory to attend a simulated birthday party at the School of Psychology, Cardiff University, when the children were approaching their first birthday (mean age was 12.84 months). Where possible, three participating families would attend the laboratory on the same afternoon. The infants, accompanied by their caregivers would first complete assessments in individual rooms. The infants were assessed using various social, emotional and cognitive tasks, and the accompanying caregiver would complete a battery of questionnaires regarding their infant's behaviour. Following this, all the families were observed together during a

simulated birthday party, which took place in a family room decorated to resemble a living room. A researcher joined the party dressed as a 'birthday lady' in a princess costume and administered a 'teddy bear's picnic', during which another researcher dressed in a teddy bear costume would enter the room and join the party (for details see Hay et al., 2016). After the 'teddy bear's picnic', the families were left alone and asked to proceed as they normally would at a birthday party with other families, and the infants were observed for 20 minutes of free play. At the end of the session, children were invited to select a gift-wrapped book from a lucky dip in a box of balls, and a remuneration of a £20 gift voucher was given to the family.

2.2.3.4 Wave 4: Toddler home visit. Families were visited in the home by two research assistants for approximately two hours when the child was approximately 18 months old (mean age was 20.59 months). First, the mothers were briefly interviewed regarding their current circumstances. In the second half of the visit, the participating family was asked to invite a familiar and similarly-aged friend of the toddler to their home. The children were provided with a miniature toy kitchen and a wooden shape sorter cube toy, and observed for 45 minutes of free play where they could play with these or their own toys as they normally would. The play session ended with a lucky dip present, such as felt pens, for both children. The participants were provided with questionnaires for the mother and father regarding their health, lifestyle, life events, relationships, family structure and their toddler's behaviour. A questionnaire battery was also completed by another significant person in the child's life. A remuneration of a £20 gift voucher was given to the family at the end of the session.

2.2.3.5 Wave 5: Early childhood laboratory visit. Families were invited to the laboratory to attend a simulated birthday in the laboratory when the children were 33 months old (mean age was 33.60). Where possible, three participating families would attend the laboratory on the same afternoon. First, the children took part in various cognitive, social and

emotional assessments in separate rooms, accompanied by their caregivers. Due to a paucity of developmentally appropriate tasks for this age, there was no theory of mind assessment at this wave of data collection. Following these assessments, the families were observed during another simulated birthday party, identical to that of Wave 3. A questionnaire battery was also given to the mother and father, and a third significant person in the child's life, to be completed before, during or after the laboratory visit. At the end of the session, the children were invited to select a gift-wrapped book from a lucky dip in a box of balls, and a remuneration of a £20 gift voucher was given to the family.

2.2.3.6 Wave 6: Middle childhood home visit. Families were visited in the home by 2 or 3 research assistants for two 2-hour sessions (mean age 83.28 at session 1, 83.87 at session 2). During the first session, the primary caregiver (typically the mother) would complete a Preschool Age Psychiatric Assessment (PAPA) with a trained research assistant (Egger & Angold, 2004). In the second visit, the same research assistant administered a SCAN interview with the caregiver, as well as additional questions to gain updates on the family lifestyle arrangements and social network. Where possible, these interviews would take place in a separate room from the child. During these interviews, the child completed various cognitive, social and emotional assessments in a quiet space with a second trained research assistant. Where required, a third research assistant would attend to keep any younger siblings occupied and away from the child testing and mother-child interaction tasks. They were also administered a free play task with a tea set. At the end of each session, the child and caregiver would take part in some family games, including a 'Bop it' and 'Etch-a-Sketch' toy, and dressing up. In games of 'I-Spy' and 'Simon Says', the whole family was encouraged to join in. A questionnaire battery was also provided during the visit to mothers and fathers and, where possible, a significant person in the infant's life (such as a close family member or friend) and teachers. Mother and father questionnaires included questions

regarding their health, lifestyle, life events, relationships, family structure and their child's behaviour. A remuneration of £20 was given to the caregiver and a book voucher of £10 to the child at the end of the session.

CHAPTER 3

"Because she thinks Nick has no idea that she's put the teddy in the cupboard."

Younger Sibling Influence on 7-year-olds' Understanding of Second-order False Belief[2]

3.1 Introduction

The contribution of younger siblings to children's developing understanding of minds has remained unclear, as evidence regarding their influence on measures of theory of mind has been mixed (Jenkins & Astington, 1996; Kennedy et al, 2015; McAlister & Peterson, 2007; Perner et al., 1994; Peterson, 2000, Shahaeian et al., 2014; Calero, Semelman, Salles, & Sigman, 2013; Farhadian et al., 2010, Ruffman et al., 1998; Shahaeian, 2015; Wright & Mahford, 2012). In Chapter 1, I reviewed ways in which siblings may influence children's developing theories of mind. Chapter 1 also considered how these processes may differ according to structural features of the sibling relationship, such as birth order. To establish whether younger siblings foster children's understanding of minds, it is first important to understand why evidence has remained so mixed in this investigation. First, this issue will be

[2] The findings reported in this chapter are in press in the Journal of Experimental Child Psychology.

explored in a critique of this literature with the aim to identify any limitations that must be addressed in future research. Following this, the influence of younger siblings on children's understanding of minds will be examined in the CCDS dataset whilst taking those issues into account.

Studies that have explored features of sibling constellation factors in relation to children's understanding of minds, as assessed using false belief tasks, are presented in Table 3.1. Only studies that assessed theory of mind using false belief tasks were included for comparability with the work presented in this thesis. The literature search for this investigation was conducted using MEDLINE, PsychINFO, PubMED and Web of Science databases, with search terms including combinations of *theory of mind, social understanding, [first-order, second-order, primary, secondary] false belief, sib [-ling, -ship, -linghood] and family*. The search included an examination of reference lists in relevant articles and of publication lists of authors within the field. Relevant journals that had been identified as publishing relevant articles within the last 5 years were also manually searched to check for studies that included siblings as a covariate whilst investigating other sources of individual difference in false belief performance. These included *Journal of Experimental Child Psychology, Child Development, British Journal of Developmental Psychology* and *Infant and Child Development*.

3.1.1 Limitations of past research

3.1.1.1 Focus on preschool years. Given that children typically pass the standard false belief task between the ages of 3 and 5, most work exploring individual differences in children's theory of mind has focused on the preschool years (Wellman et al., 2001). As such, the two streams of work reviewed in Chapter 1, one concerning sibling relationship structure and the other processes of sibling influence, focused on developments in the preschool years. However, this vast literature does not represent the entire developmental picture insofar as

children's understanding of minds continues to develop throughout middle childhood (Miller, 2012). The paucity of research concerning theory of mind in middle childhood thus far means there is scope to explore sources of individual differences in children's theory of mind beyond the preschool years (Hughes, 2016).

For the very few studies that have explored the influence of siblings in samples of older children, the findings have, as in the preschool literature, remained mixed (see Table 3.1). Two recent studies have reported no effect of siblings on higher-order measures of theory of mind (Calero et al., 2013; Miller, 2013). It is possible that this work corroborates studies conducted with preschoolers, suggesting that younger siblings do not foster children's understanding of minds across different phases of development (Farhadian et al., 2010, Ruffman et al., 1998; Shahaeian, 2015). It is also possible that any advantage of younger siblings in the preschool years may disappear on account of children starting school and spending more time amongst non-familial adults and peers rather than their family members (Lagattuta et al., 2015; Larson & Verma, 1999).

In another sample, however, it has been reported that both older siblings and same-gender younger siblings facilitate performance on measures of theory of mind in middle childhood (Kennedy et al., 2015). It is possible that any younger sibling advantage in middle childhood represents 'residual' effects of younger siblings in the preschool years, or it may be that younger siblings foster children's understanding of minds in middle childhood as they gradually become more proficient play-mates. Not only do children increase the amount of time spent playing with their younger siblings as they get older (Brown & Dunn, 1992), but older sibling dyads also engage in more sophisticated interactions that may foster theory of mind; for example, older sibling dyads' pretend play is characterised by more negotiation and creation of roles and shared meaning (Howe et al., 1998, 2005). It has been argued that younger siblings may become more important in fostering children's understanding of minds

in middle childhood, as younger siblings may have to reach a certain threshold in age to provide an advantage. This has been coined the *age threshold model* (Kennedy et al., 2015). As such, it is possible that null findings regarding younger sibling advantage in middle childhood are due to the younger siblings being too young to provide any advantage. Certainly, more research is warranted to establish younger sibling influences on theory of mind in middle childhood (Lagattuta et al., 2015).

A focus on children in the middle childhood years would require use of higher-order false belief tasks; second-order false belief has been suggested to be an age-appropriate task to explore theory of mind in samples with older children (Perner & Wimmer, 1985) and has already been used by Miller (2013) to investigate the influence of siblings on theory of mind in older children. Whereas first-order false belief tasks typically assess the mistaken knowledge of one character in a story, second order false belief tasks add an additional element to the narrative. Where first-order false belief tasks typically assess children's understanding of one character's belief, a second-order task assesses whether children understand that a character can have a mistaken belief about another character's belief. Between the ages of 6 and 7 years, some children are successful at passing this higher-order test of theory of mind (Perner & Wimmer, 1985); thus, this extended task is a more developmentally appropriate indicator of theory of mind for this age range.

3.1.1.2 Sampling issues. It has also been argued that null findings in terms of younger sibling influence on measures of theory of mind may be due to small sample sizes (Lagattuta et al., 2015). This is a problem in studies investigating this relationship in both the preschool and the middle childhood literatures; although overall sample sizes may be acceptable, when participants are divided into subgroups according to sibling constellation factors, cell sizes often become small (see Table 3.1). To detect medium to large effect sizes, group comparisons with approximately 30 participants per cell should lead to 80% power (Cohen,

1988). Certainly, it has been recommended that cell sizes should be no lower than seven (Wilson van Voorhis & Morgan, 2007). This is a problem for many studies within this literature, particularly in studies exploring children's theory of mind in middle childhood (e.g., Miller, 2013). It is possible that inadequate sample sizes could lead to failure in detecting sibling influences on measures of theory of mind (or *type II error*). To tease apart the benefits of particular kinds of sibling constellations with sufficient power, a larger scale study is required (Cassidy et al., 2005).

These small subsamples are a particular issue for 'only child' groups in this research (Miller, 2013; Peterson & Slaughter, 2003; Shahaeian et al., 2014). This not only leads to a decrease in power to detect an advantage in having a sibling over none, but also leads to samples that have a very high proportion of children who have siblings (in some studies over 90%). Given that 80% of children in Western families have a sibling (Volling, 2012), these samples with disproportionate numbers of children with siblings cannot be regarded as representative.

Additionally, many of these studies are not representative of the general population, with participants often recruited from two-parent intact families living in middle-class, well-educated affluent areas (Cutting & Dunn, 1999). Given that family background is associated with children's false belief understanding (Cutting & Dunn, 1999), questions of sibling influence on children's mind understanding should be asked within a more representative community sample (Cole & Mitchell, 2000).

3.1.1.3 Identifying correlates. The preschool literature has highlighted correlates that need to be accounted for in studies of sibling influence on theory of mind. Passing first-order false belief is related to the child's age (Wellman et al., 2001), language ability (Astington & Jenkins, 1999), sociodemographic risk factors (Cutting & Dunn, 1999; Cole & Mitchell, 2000) and executive function (Devine & Hughes, 2014). Like the first-order false belief

literature, children's age has been found to be positively associated with passing second-order false belief. In Perner and Wimmer's (1985) original studies, it was identified that some 6-year-olds and most 7- to 8-year-olds pass second-order false belief problems. However, given the paucity of research regarding children's understanding of minds in middle childhood, the extent to which other factors are associated with passing second-order false belief is not yet clear.

It is plausible that language would influence children's second-order false belief performance as these stories are linguistically complex. These stories also require children to retain information in their *working memory*, and when responding to test questions, could require *inhibition* of an immediate prepotent response of the child's understanding of reality, as opposed to the mistaken reality of the characters (Miller, 2012). Evidence has suggested that second-order false belief understanding, like first-order, is positively associated with children's language and executive function competence (Astington, Pelletier, & Homer, 2002; Lagattuta, Sayfan, & Blattman, 2010; Lagattuta, Sayfan, & Harvey, 2014; Perner, Kain, & Barchfield, 2002). However, when examined together, one study found that executive function was positively associated with second-order false belief when age was controlled, but not when language ability was controlled (Hasselhorn, Mahler, & Grube, 2005).

In studies of sibling influences on theory of mind, the child's age, sociodemographic risk, language and executive function have rarely been controlled in a single study (see Kennedy et al., 2015; Miller, 2013). Prior to an analysis of sibling influences on children's understanding of second-order false belief, it will be essential first to examine the correlates that must be controlled. Although known correlates of first-order false belief may also be relevant for second-order false belief, this has not yet been fully established (Miller, 2012). It has been argued that some of these factors, such as executive function, may be most

important during early development of theory of mind, yet after reaching a certain threshold in these skills, these relationships may attenuate or disappear by middle childhood (Lagattuta et al., 2015).

3.1.2 Research questions

Chapter 1 highlighted an issue of inconsistency in the preschool theory of mind literature regarding the influence of younger siblings on children's developing theories of mind. Three possibilities for this inconsistency are explored in this chapter. Firstly, the effects of younger siblings may be somewhat confounded by their age, and the influence of younger siblings may be better detected beyond the preschool years. Secondly, the samples used to explore these questions may have lacked sufficient power to detect smaller effects of younger siblings. Finally, correlates of theory of mind such as age, sociodemographic risk, language and executive function have rarely all been controlled within a single study. In summary, the primary question this chapter will answer is:

3.1.2.1 Does the presence of younger siblings influence children's ability to pass a second-order false belief task? This chapter will examine the influence of younger siblings on children's understanding of second-order false belief in middle childhood. This will be conducted within the context of the Cardiff Child Development Study (see Chapter 2), a moderately sized, representative community sample of firstborn children and their families. A subsidiary question that must be asked as a prerequisite to this investigation is:

3.1.2.2 What are the correlates of passing the second-order false belief task? I will also explore the influence of potential correlates of second-order false belief identified in the literature; age, sociodemographic risk, language, working memory and inhibitory control. Relevant correlates will be brought forward into a final investigation of sibling constellation factors including younger sibling presence, gender composition and birth interval on children's understanding of second-order false belief.

Table 3.1

Methods and measures used in previous research examining the influence of siblings on false belief tasks.[3]

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
Calero, Salles, Semelman, & Sigman (2013)	76	Not specified	Range 61 - 103 mean 86.5	Cross-sectional	Six ToM tasks: Diverse desires, diverse beliefs, knowledge access, contents false belief, explicit false belief, belief vs emotion (Wellman & Liu, 2005).	ToM tasks presented in novel computer format. Found sequential progression through Wellman and Liu's suite of ToM tasks in 6-8 year olds.	No effect of sibling amount or birth order was found on ToM performance.
Cassidy, Fineberg, Brown, & Perkins (2005)	72	16 no siblings 25 w/ siblings 31 identical and fraternal twins	Mean 47.8	Cross-sectional	Three FB tasks: One change location story, 2 unexpected contents	Twins were better able to answer FB questions involving their twin than FB questions involving a friend.	The sibling group had higher ToM scores than the no sibling group and the twin only group. Twins who had another sibling also performed better than these two groups. When sibling constellations were scored according to variety (e.g. only children 0, children with a younger and an older sibling 2) sibling variety positively explained 12% of the variance in ToM score. Children with a sibling of opposite gender had higher ToM scores than those with a matched gender sibling.

[3] *FB*, False belief; *ToM*, Theory of Mind.

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
Cole & Mitchell (2000) Study 1	119	25 no siblings 19 had older and younger siblings (range 2 – 6) 47 had older siblings only (range 1 - 4) 28 had younger siblings only (range 1 – 3)	Nursery group range 37 – 48 mean 44.2 Reception group range 48 – 61 mean 55.9	Cross-sectional (2 phases)	Three ToM tasks: x2 Deceptive box and 1 appearance reality Post hoc, unexpected transfer FB task included	Sample drawn from community rated high on Townsend Deprivation Scale (TDS). Four months after 1st testing, 93 children from original sample given FB unexpected transfer task. Executive function also measured.	No significant differences were found between sibling groups (younger sibling, older sibling, both or no sibling) in individual social understanding measures. No significant differences between sibling groups detected when ToM tests were combined into a single score.
Cole & Mitchell (2000) Study 2	71	12 only children 31 had older siblings 10 had younger siblings 9 had both older and younger siblings	Range 47 – 68 mean 63	Cross-sectional	Six ToM tasks: x2 unexpected transfer, x2 deceptive box self-belief x2 deceptive box other belief	Executive function also measured.	There was a tendency for children with younger siblings to fail more deceptive box tasks, but no significant correlation between siblings and ToM tasks found. No significant differences between sibling groups when socio-economic status was taken into account.
Cutting & Dunn (1999)	128		Range 41.9 – 57.6 mean 49.9	Cross-sectional	Eight FB tasks: x4 unexpected location stories, x2 unexpected identity questions, x2 FB tasks. Emotion understanding tasks: affective labelling task and affective perspective taking task.	Diverse sample. Positivity and negativity of target child's relationship with closest in age sibling also assessed.	No significant correlation between number of siblings and false belief or emotion understanding. No effect of older and younger siblings. Positivity and negativity in target child's relationship with closest in age sibling was also unrelated to false belief and emotion understanding scores.

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
Farhadian et al. (2010)	163	103 first born 63 second born 88 no sibling 62 1 sibling 13 2+ siblings	Range 43 - 66 mean 54.4	Cross-sectional	Three ToM tasks: Two change of location stories and 1 change of content task	Sample of children from Iran.	Children with an older sibling showed better performance on ToM tasks than those with no siblings when controlling for age and verbal ability. No significant differences found in ToM scores according to number of siblings in the family. No significant difference in ToM scores between children with older or younger siblings. Children with an older brother showed an advantage in ToM performance over children with an older sister.
Jenkins & Astington (1996)	68	22 no sibling 32 1 sibling 13 2 siblings 1 3 siblings 38 first-born 24 second-born 5 third-born 1 forth-born	Range 35 – 65 Mean 49.2	Cross-sectional	Four FB tasks: Two change location stories, 1 unexpected contents, 1 unexpected picture task	Verbal and non-verbal memory did not predict FB performance when age and language ability were taken into account.	Family size significantly and positively predicted FB performance, when controlling for age, language and birth order. Sibling effect more pronounced for children with lower levels of language ability. No significant effect of birth order when controlling for age and language ability, suggesting it does not matter whether the siblings are older or younger. Also found it does not matter how close the siblings are in age to the target child.

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
Kennedy, Lagattuta, & Sayfan (2015)	192	3.1% no siblings 48.7% 1 sibling 38.7% 2 siblings 9.4% 3+ siblings When separated by age, 56.3% older siblings 58.4% younger siblings 9.5% same age siblings 20.5% both older and younger siblings	65 children range 48.5 – 71.4 mean 59.8 62 children range 72.4 – 95.4 mean 84 65 children range 96.1 – 138.7 mean 108.5	Cross-sectional	Interpretive ToM task (IToM)	-	A number of sibling composition variables were positively correlated with IToM scores, including number of siblings, number of older siblings, number of female siblings and number of same-gender siblings. When age and executive function (inhibitory control and verbal working memory) were controlled, number of older siblings explained a significant amount of the variance of IToM tasks, as did having a same-gender sibling, regardless of whether they were older or younger.
Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki, & Berridge (1996) Study 1	82	Mean number of older siblings .87, of younger siblings .43	16 children mean 40 26 children mean 45 28 children mean 49 12 children mean 57	Cross-sectional	Three ToM tasks: The deceptive box test, the unexpected transfer test and the deceptive object task.	Sample of children from Greece. Also examined number of adult and child kin living in close proximity.	Demonstrated that number of older siblings and number of younger siblings significantly predicted towards children's total ToM score. Children with no siblings scored significantly lower on ToM than children with a younger sibling, children with an older sibling, and children with both an older and a younger sibling.

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki, & Berridge (1996) Study 2	100	Mean number of older siblings .95, of younger siblings .31	26 children mean 38.5 24 children mean 44 36 children mean 51 14 children mean 58	Cross-sectional	Three ToM tasks: The deceptive box test, the unexpected transfer test and the deceptive object task.	Sample of children from Cyprus. Also examined number of adults and children interacted with recently.	Number of older siblings was positively associated with ToM score. There were significant differences between ToM scores between children with no sibling, and older sibling and both older and younger sibling groups. Yet when controlling for age, only 'number of adults interacted with the day before' and 'number of older children interacted with the day before' predicted higher ToM scores.
McAlister & Peterson (2007)	63	10 no siblings 33 1 sibling 17 2 siblings 3 3 siblings	At time 1 mean 50 At time 2 mean 64	Longitudinal	ToM tests at time 1: changed location FB test, unexpected contents FB test. Two pretend representation tests. ToM tests at time 2: changed location FB task, emotion FB task and appearance-reality tasks	Australian sample	At time 1, children with 2 or 3 siblings scored significantly above children without siblings, and children with just 1 sibling did not differ from either group. This was the same at time 2. At time 1, higher number of siblings significantly predicted better ToM scores when age and verbal IQ were controlled. At time 2, number of siblings significantly predicted better ToM scores, when age, verbal IQ and ToM scores at time 1 were controlled.

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
McAlister & Peterson (2013)	157	85% (133) lived with at least 1 child-aged sibling at time 1, 15% (24) had no child-aged sibling access (21 with no sibling, 3 with preverbal infant sibling)	At time 1 mean 50 At time 2 mean 62	Longitudinal	ToM tasks at time 1: Unseen displacement, misleading container, appearance-reality and pretend play. ToM tasks at time 2: real-apparent emotion, emotion-based false belief, unseen displacement and appearance-reality.	Australian sample Executive function measured.	Number of siblings was found to be positively associated with ToM scores at time 1 and time 2, when the effects of age and language ability were controlled. Mere presence of a sibling was a significant predictor of ToM scores at time 1 and time 2, where only-children scored lower than children with a sibling present. In a comparison of children with siblings, those with 3 or more siblings outperformed children with 1 or 2 siblings. There was no significant difference between children who were youngest children, middle children or eldest children. When age, language ability, ToM performance at time 1 and executive function at time 1 were controlled, number of child siblings was a significant predictor of time 2 ToM performance, above all other variables.
Miller (2013)	70	4% 0 siblings 48% 1 sibling 37% 2 siblings 10% 3 siblings 2% 5 siblings (older/younger not specified)	34 kindergarteners mean 72 36 first-graders mean 84	Cross-sectional	Four second-order false belief stories	First study of sibling effect on second-order understanding.	Non-significant correlation between number of siblings and second-order FB performance. No evidence for a sibling effect. Examination of older vs younger siblings also did not show sibling effect.

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
Miller (2013)	55	10 no siblings 28 1 sibling 11 2 siblings 4 3 siblings 1 4 siblings 1 5 siblings (older/younger not specified)	Mean 72	Cross-sectional	Three second-order false belief stories, one standard location change, and 2 including element of deception.	-	Non-significant correlation between number of siblings and second-order FB performance. No significant difference between children with or without a sibling.
Perner, Ruffman, & Leekam (1994) Study 1	76	22 no siblings 42 1 sibling: 18 older sibling 23 younger sibling 1 twin 11 2 siblings 4 middle children 6 with older siblings 1 with 1 older sibling and a twin	Range 37 – 57	Cross-sectional	One FB story, half the children received an unexpected change story, the other half had a misinformation story.	-	Number of siblings had a significant positive effect on children's understanding of false belief. Children who had 2-3 siblings were shown to have the same magnitude of improvement as children from 3 to 4 years of age.
Perner, Ruffman, & Leekam (1994) Study 2	42	All children had exactly 1 sibling 15 with an older sibling, 27 with a younger sibling	Range 38 – 69 mean 58	Cross-sectional	Six FB unexpected change stories.	-	When controlling for age, no additional sibling factors introduced in this second study were significant; sibling's age, and the difference in age between target child and sibling, and the interaction between the two, did not predict target children's passing of false belief.

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
Peterson (2000) Study 1	98	12 with no siblings 45 eldest children with at least 1 sibling 35 with 1 sibling 10 with 2 siblings 41 youngest children 22 with 1 sibling 14 with 2 siblings 5 with 3-4 siblings	Range 46 – 69 mean 58	Cross-sectional	Two trials of change location FB task	Australian sample	Mean FB scores differed according to sibling groups. Children with no siblings scored lower than eldest children with siblings and youngest children with siblings. The latter groups did not significantly differ in terms of FB scores. There were no significant differences between sibling-present groups according to number of siblings (no differences between children's FB scores with 1, 2, or 3+ siblings).
Peterson (2000) Study 2	167	14 with no siblings 7 with 1 infant sibling 29 1 younger sibling 7 2 younger siblings 35 with 1 older and 1 younger sibling 11 with multiple older or younger siblings 54 with older siblings 10 twins	Range 43 – 68 mean 56	Cross-sectional	Two trials of change location FB task as in study 1. Additionally an unexpected contents FB task.	Australian sample	There was a significant difference between sibling groups according to their total FB scores. Children with mature (teen or adult) older siblings scored lower than children who had a child-aged older sibling. Children with an infant sibling (< 12 months) performed no better than only children. These two groups scored significantly lower than sibling groups who had at least one older or younger child-aged sibling. Sibling variety (SV) scores were coded (no siblings = 0, 1 older 1 younger sibling = 2), and SV scores were positively associated with total FB scores, and significantly predicted with controlling for age and language ability. Number of older/younger siblings was not significant when added into the model.
Peterson & Slaughter (2003) Study 1	61	6 with no siblings 24 with 1 sibling 25 with 2 siblings 6 with 3+ siblings (older/younger not specified)	Range 48 – 67 mean 57.8	Cross-sectional	Two trials of change location FB task.	Measured mother's use of mental state language and conversational preferences.	Children's FB scores were not significantly associated with number of siblings.

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
Ruffman, Perner, Naito, Parkin, & Clements (1998) Study 1	78	22 no siblings 42 1 sibling: 18 older sibling 23 younger sibling 1 twin 11 2 siblings 4 middle children 6 with older siblings 1 with 1 older sibling and a twin	Range 37 – 57	Cross-sectional	One FB story, half the children received an unexpected change story, the other half had a misinformation story.	Data used in this study was the same from that of Perner, Ruffman & Leekam (1994, Study 1)	Found that when 'family size' variable was replaced with 'number of younger siblings' and 'number of older siblings' variables, When controlling for age, only number of older siblings significantly predicted FB understanding and number of younger siblings did not.
Ruffman, Perner, Naito, Parkin, & Clements (1998) Study 2	56	Not specified	19 mean 54 17 mean 69 20 mean 79	Cross-sectional	Four FB tasks, unexpected contents.	Sample drawn from lower social classes to recruit children who would be late in developing social understanding.	When controlling for age, there was a significant effect of number of older siblings on total FB scores, but number of younger siblings did not approach significance.
Ruffman, Perner, Naito, Parkin, & Clements (1998) Study 3	116	Not specified	73 mean 46 43 mean 48	Group comparison	Two FB stories change location enacted in a cartoon video.	Compared the effect of siblings for younger and older children.	When controlling for age, neither number of older nor number of younger siblings significantly predicted FB scores. When target children were split into younger and older groups, an interaction was found between age group and number of older siblings, where the effect of older siblings on FB performance was significantly greater in the older age group. When looking at just the older group of target children, only number of older, not younger siblings significantly predicted better FB scores, and when language was controlled.

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
Ruffman, Perner, Naito, Parkin, & Clements (1998) Study 4	214	Not specified	48 mean 42 71 mean 53 95 mean 67	Cross-sectional	One FB change location story. Four source tasks, 2 'see' and 2 'feel' tasks.	Sample of children from Japan.	For the whole sample, when age and verbal mental age were controlled, number of older siblings significantly predicted FB performance and number of younger siblings did not. No difference for sibling gender, but same-gender siblings did slightly worse than opposite-gender siblings. There was no sibling effect on children's performance in the source tasks.
Ruffman, Perner, & Parkin (1999)	64	Mean number of younger siblings 0.27, mean number of older siblings 0.53.	23 mean 43.1 41 mean 53.3	Cross-sectional	2 FB stories	Some participants were drawn from Ruffman et al. (1998).	Number of older siblings positively correlated with belief understanding. This remained when controlling for mental state language, child age, verbal mental age, time spent with the mother and number of younger siblings.
Shahaeian (2015)	142	High SES mean number of siblings 1.2 Low SES mean number of siblings 1.3 Non-urban mean number of siblings 3.0	Mean 57.8 33 high SES children mean 56.9 37 low SES children mean 59.1 72 non-urban children mean 57.6	Group comparison	ToM scale, including diverse desires, knowledge access, diverse beliefs, false belief and hidden emotions. Three FB tests: change of location, surprise contents and emotion false belief task. Three tests of diverse beliefs.	A comparison of children from high SES, low SES and rural families from Iran.	There were no differences between the high SES, low SES and rural children in their ToM scores, so examined as a whole. There were no significant correlations between number of siblings, number of older siblings and younger siblings and number of people living in the home with any of the ToM measures.

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
Shahaeian, Nielsen, Peterson, & Slaughter (2014)	164	80 Iranian children: 39% (30) no siblings 36% (29) 1 sibling 2% (2) 2 siblings 0% (0) 3+ siblings 22% (18) missing information 84 Australian children 7% (6) no siblings 58% (48) 1 sibling 28% (23) 2 siblings 6% (5) 3+ siblings 1.2% (1) missing information (older/younger not specified)	Iranian children mean 74.8 Australian children mean 73.5	Multicultural group comparison	6 ToM tasks: Diverse desires, diverse beliefs, knowledge access, false belief, hidden emotion and sarcasm tasks.	No difference between Iranian and Australian children on overall ToM scores, but some task-specific differences. Range number of siblings varied between cultures which may explain results.	Number of child-aged siblings positively associated with performance on overall ToM score for Australian children, but not for Iranian children.
Taylor & Carlson (1997)	152	80% of children had 1 or 2 siblings.	57 mean 43.2 95 mean 52.8	Cross-sectional	Appearance-reality tasks, false belief and representational change tasks, interpretative diversity task	Children's engagement in fantasy/pretence was associated with ToM performance.	Children with two siblings outperformed children with one sibling on FB performance.

Author	N	Sibling constellation	Age (months)	Design	Measures of theory of mind	Other details	Results
Wright & Mahford (2012)	114	For all groups, mean number of younger siblings .63 Mean number of older siblings .99 Mean number of both older and younger siblings 1.61	18 mean 44.4 33 mean 58 41 mean 67.9 22 mean 78.4	Cross-sectional	Two FB change location tasks and an unexpected contents 'smarties' task.	-	A significant positive association was found between number of older siblings and ToM performance. Number of younger siblings was negatively associated with ToM performance although did not reach significance. When target child age, memory, play opportunities with nuclear and extended family, and friends and home and school were entered into a model, number of older siblings did not significantly predict towards ToM scores, but number of younger siblings had a negative effect on ToM scores that trended towards significance.

3.2 Method

The analyses presented in this chapter are based on Waves 1 and 6 of the Cardiff Child Development Study (Figure 3.1). A full description of the younger sibling study sample and study design and procedure at each wave of assessment is presented in Chapter 2.

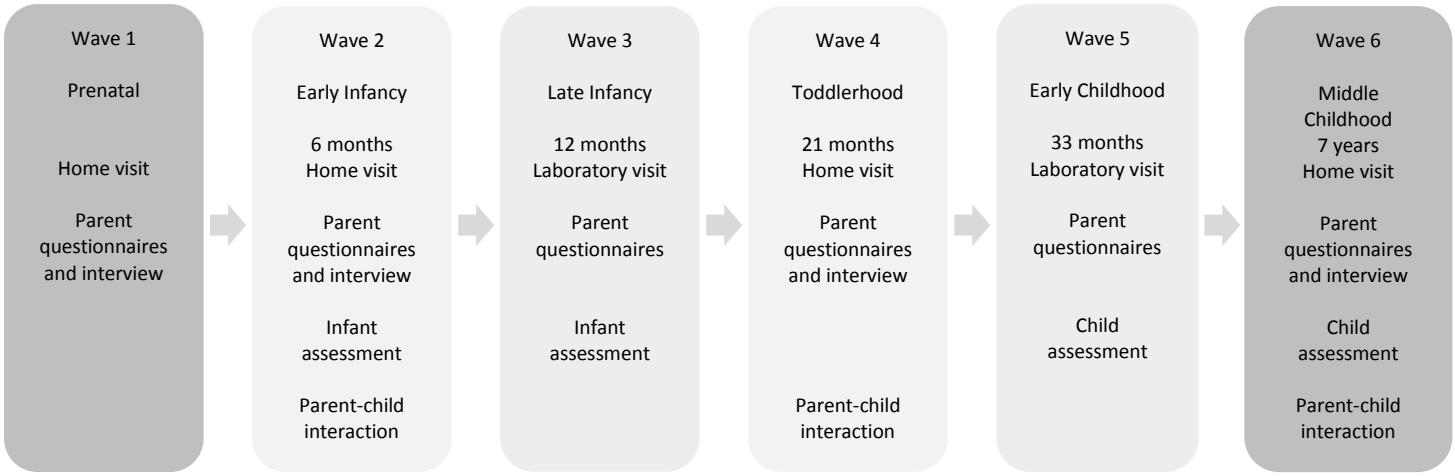

Figure 3.1 CCDS waves used in the present chapter.

3.2.1 Participants

Of the 269 children in the younger sibling study sample, 244 (90.7%) were assessed at age 6 and 229 (85.1%) were directly observed in the home. Figure 3.2 shows the progression of the younger sibling study sample to the data available for use in the present analysis.

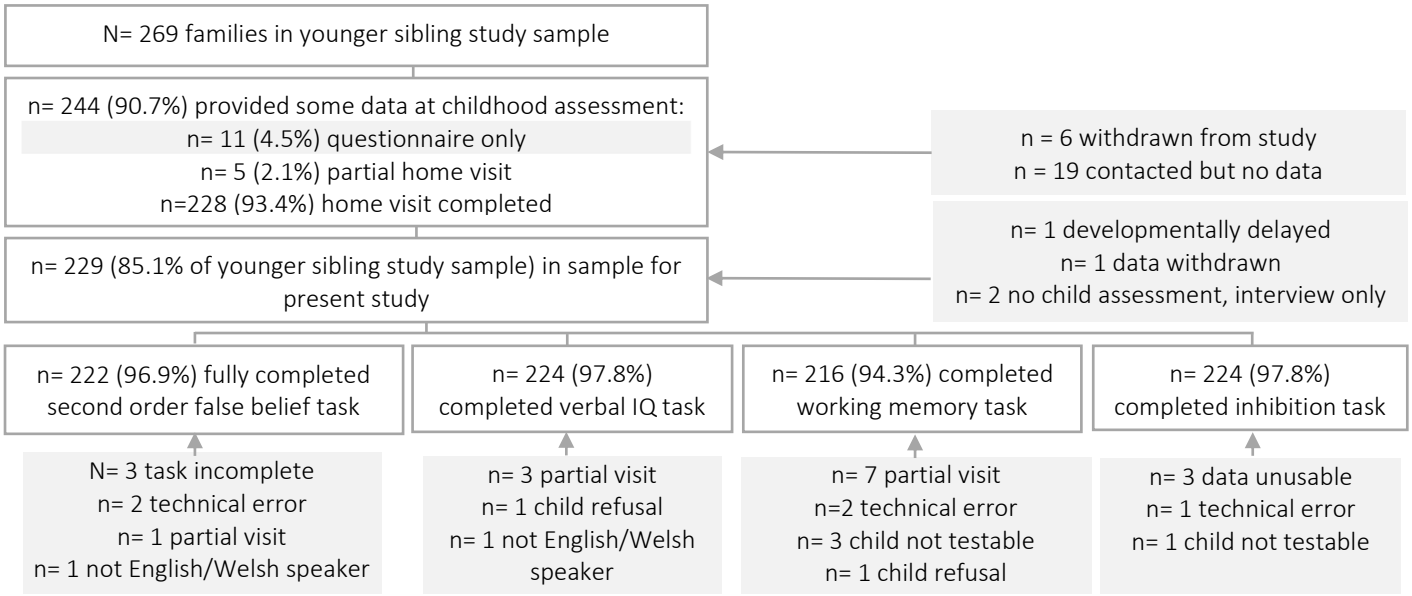

Figure 3.2 Derivation of the sample.

The participants' mean age at the time of testing was 83.20 months (range 67 to 104 months, *SD* = 4.59). The *N* = 229 in the present study was not significantly different from the original *N* = 332 recruited in terms of sociodemographic risk.

Of the 229 children in the present study, 75.1% of children had at least one younger sibling living in the home. Of these, 133 (58.1%) had 1 sibling, 32 (14.0%) had 2 siblings, and 7 (3.1%) had 3 siblings. The mean age of the closest in age younger sibling at the time of the middle childhood assessment was 47.8 months (SD = 16.5).

Of the children with siblings, 90 (52.3%) closest in age siblings were female and 81 (47.7%) were male. Ninety-one children (52.9%) were in a same-gender sibling dyad, and 81 (47.1%) were in an opposite-gender sibling dyad. Table 3.2 shows the number of children per gender composition between the firstborn child and their closest in age younger sibling.

Table 3.2

Gender compositions of firstborn children and their closest in age younger siblings.

		Closest in age younger sibling gender	
		Male	Female
Firstborn gender	Male	47 27.3%	46 26.7%
	Female	35 20.3%	44 25.6%

The firstborn children entered siblinghood at a mean age of 35.7 months (*SD* = 16.8). To investigate the influence of sibling birth interval, children were grouped according to the interval between the firstborn and second born sibling birth. Children who entered siblinghood at the first quartile (≤ 24 months) were categorised as having an *early arrival sibling* (n = 45, 19.7%), children who entered siblinghood at the fourth quartile (≥ 43 months)

were categorised as having a *later arrival sibling* (n = 44, 19.2%), and children with a sibling arriving between these quartiles were categorised as having an *average arrival sibling* (n = 83, 36.2%).

Table 3.3 shows the breakdown of the early, average and later arrival sibling groups according to the firstborns' relationship to the closest in age younger sibling. There was no significant difference in relationship according to the sibling arrival groups χ^2 (4) =8.46, p <.07.

Table 3.3

Timing of younger sibling arrival groups and relationship to firstborn child.

		Sibling arrival group		
		Early	Average	Late
Sibling relationship to firstborn	Full	42 (27.6%)	76 (50.0%)	34 (22.4%)
	Half	3 (15.8%)	7 (36.8%)	9 (20.5%)
	Adopted	0 (0.0%)	0 (0.0%)	1 (100.0%)

3.2.2 Measures

3.2.2.1 Second-order false belief task. This age-appropriate task was adapted from the second-order belief paradigms used by Coull, Leekam, and Bennett (2006) and Perner and Wimmer (1985). Each child was told a story enacted with plastic Playmobil® figures by the experimenter, with the experimenter acting the story out by moving the Playmobil figures. The protagonist was gender-matched to the participant, a figure named Nick for boys and Kate for girls. The sibling was gender-matched to the participant's closest-in-age younger sibling. The sibling figures were both called Alex. In cases where the focal child had no siblings, the sibling character's gender was randomly selected. The mother figure was referred

to as ‘Mum’ (Figure 3.3). The setup of the characters and the sequence of events is illustrated in Figure 3.4. The false belief story is shown in Table 3.4.

Figure 3.3. Playmobil characters used in the false belief story. *Front row, left to right:* Nick, Kate, Alex and Alex. *Back row:* Mum.

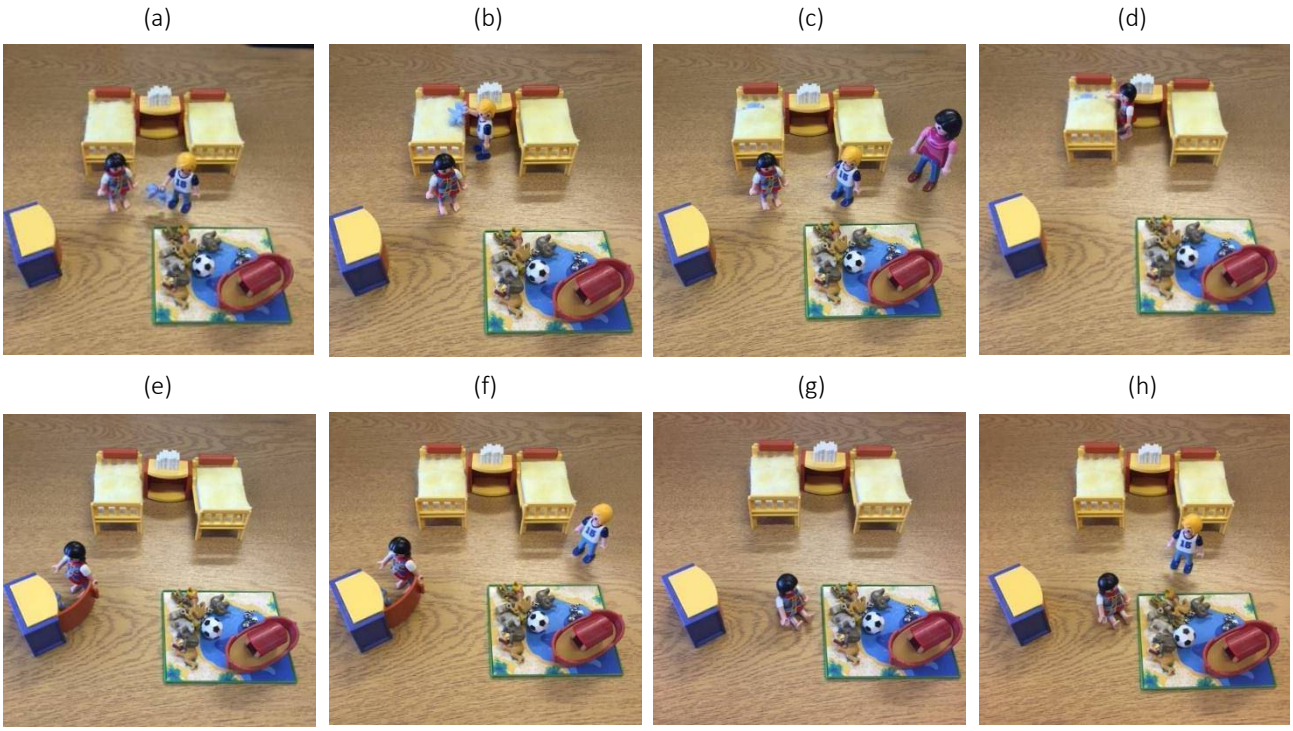

Figure 3.4 False belief story with Playmobil®. Labels (a) to (h) correspond to false belief story in Table 3.4.

Table 3.4

The false belief story used to assess children's understanding of second-order false belief.

It's almost bedtime. Nick has had his special teddy for a very long time. He likes to have it nearby when he goes to sleep (a). So he tucks the teddy in his duvet in the bed (b). Mum comes into the room and asks Nick to brush his teeth (c). Alex sees Nick leave and runs to get the teddy (d) to hide it in the cupboard (e). But Nick comes back, and stands in the doorway and sees Alex hiding the teddy in the cupboard (f). But, Alex doesn't see Nick. Nick goes away again, and Alex goes back to playing (g). Nick comes back in and says, "I want my teddy!" (h)
Test questions:
1. Mental state: Where does Alex think Nick will look for the teddy?
2. Justification: Why does Alex think that Nick will look for the teddy in the _____?
Comprehension questions:
3. Does Nick know that the teddy is in the cupboard?
4. Does Alex know that Nick saw him/her hide the teddy?
5. Where will Nick look for the teddy?

Note. This is an example of the story for male participants, whereby the protagonist was gender matched and named 'Nick'. The protagonist for female participants was named 'Kate'. Labels (a) to (h) correspond with images of false belief story depicted in Figure 3.4.

Pathways to passing or not passing this task are shown in Figure 3.5. Children's responses to the test questions were transcribed from video records of the task, and then coded from transcripts using the recommendations of Coull and colleagues (2006). Children were classified as passing second-order false belief if they correctly answered the first location question and with an appropriate justification (see Appendix I), and as passing second-order false belief with full comprehension if they additionally correctly answered the additional comprehension questions. An independent observer coded transcripts for 32.9% of the participants and established excellent agreement for passing second-order false belief (κ = 1.00) and for whether justifications were appropriate or inappropriate (κ = 1.00). There was also very good agreement for appropriate and inappropriate justification codes, where the Kappa coefficients were .89 and .79 respectively.

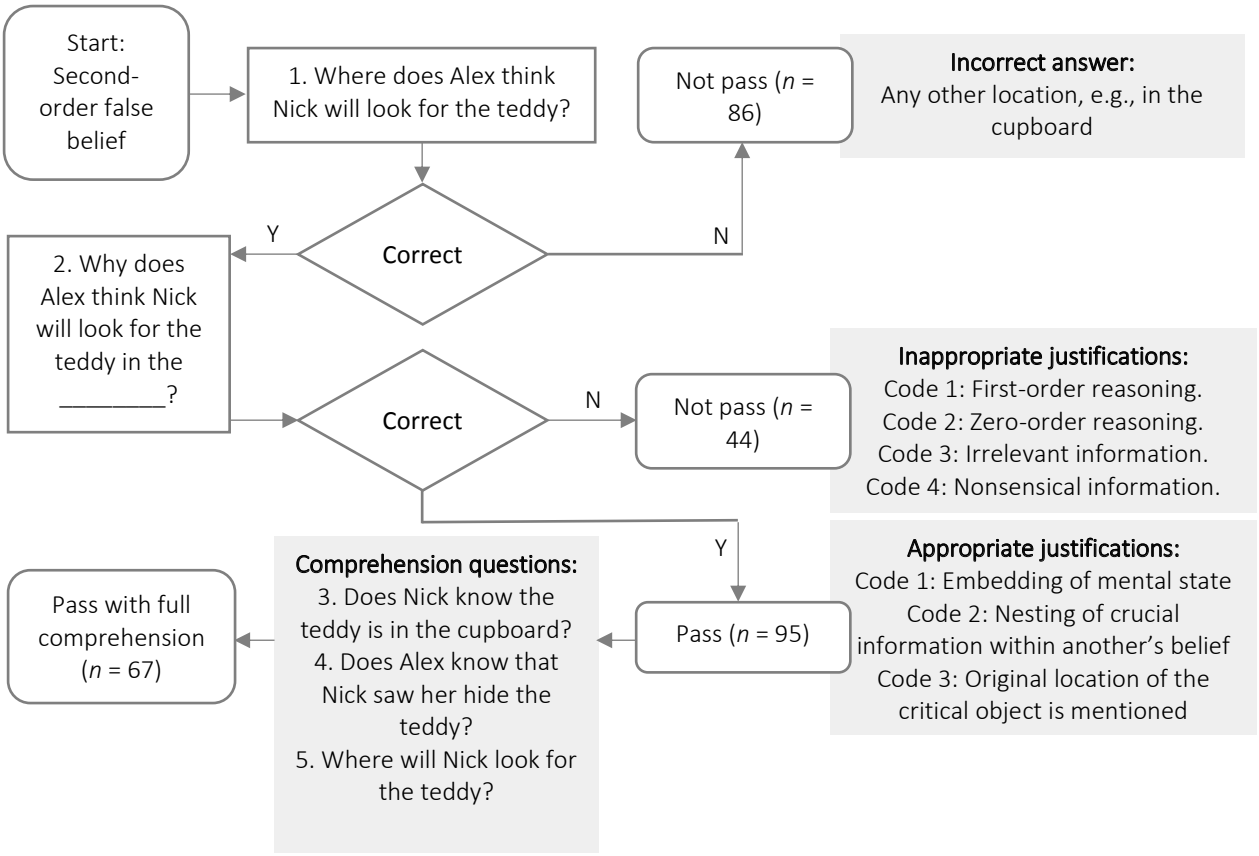

Figure 3.5 Flow diagram displaying pathways to passing and not passing second-order false belief in the false belief story.

3.2.2.2 Sociodemographic risk. See Chapter 2, section 2.2.2.3, page 30.

3.2.2.3 Verbal IQ. Each child's vocabulary knowledge was assessed using the British Picture Vocabulary Scale (BPVS; Dunn, Dunn, Whetton, & Pintillie, 1982). Each child's verbal IQ was calculated by age-normalising the data to produce a standardised score. The mean score for verbal IQ was 99.54 (*SD* = 11.99), and the average age children in the sample were equivalent to was 84.14 months (*SD* = 14.66) and ranged from 49 to 150 months.

3.2.2.4 Executive Function. Cognitive function was assessed using tasks from the Amsterdam Neuropsychological Tasks (ANT) (de Sonneville, 1999). The ANT has been proven to be a well-validated and sensitive instrument to evaluate executive functioning in population-based (Brunnekreef et al., 2007) and clinical samples (Rommelse et al., 2008). The

tasks were presented on a laptop and children made responses using a mouse. For each task, the experimenter gave verbal instructions whilst showing examples. Following this children were given a practice trial before starting the test trials.

The Response Organisation Objects (ROO) task was used to measure *response inhibition* via children's reaction times to stimuli. Children were asked to hold the mouse with a forefinger of each hand on each button of the mouse. In Part 1, (compatible condition), the children were presented with a fixation cross in the middle of the screen, and were asked to respond to a red ball appearing on either side of the cross by clicking the same side of the mouse to which the ball appeared. In Part 2 (incompatible condition), the children were presented with a white ball on the screen. Children were instructed to click the opposite side of the mouse according to the position of the ball. Response inhibition was operationalised as the difference between children's mean reaction speed times (M = 314.32, SD = 195.65) in milliseconds between the compatible (Part 1) and incompatible (Part 2) tasks.

The Visuo-Spatial Sequencing (VSS) task was used to measure visuo-spatial *working memory*. In this task children were presented with a grey square containing 9 circles symmetrically positioned in a 3x3 matrix on a computer screen. After a beep, a sequence of circles was pointed at by a computer animated hand, and after the sequence the children took control of the mouse to replicate the sequence of circles. The test consisted of 24 trials, and gradually increased in difficulty in the number of targets and complexity of the sequence. Working memory was assessed using the total number of correct targets in the correct order, with a total of 100 possible correct targets. The mean score for correct targets in the correct order was 67.24 (SD = 17.94).

Full details of the tasks are available in the official ANT manual (de Sonneville, 1999). A compilation of the descriptions of the tasks, instructions for administration and details of the construction of data sets and variables specific to the Cardiff Child Development

Study is also available in the CCDS ANT Manual. Sections of this manual for the tasks used in the present study are available in Appendix II.

3.3 Results

Correlations, means and standard deviations for all variables of interest are presented in Table 3.5. Prior to investigating the influence of siblings on the false belief task, children's overall performance on the second-order false belief task is described, and the subsidiary question regarding the correlates of the false belief questions is addressed.

3.3.1 Children's understanding of second-order false belief.

Correlations, means and standard deviations for all variables of interest are presented in Table 3.5. Ninety-five children (42.8%) passed the initial location question and provided an appropriate justification, and 67 (30.2%) additionally passed the second-order false belief comprehension questions (Figure 3). Supplementary descriptive data are presented in Appendix I. These two levels of passing second-order false belief were positively correlated (Table 3.5). Younger sibling constellation factors were only associated with passing second-order false belief with full comprehension (Table 3.5). Therefore, the subsequent analyses focus on children's full comprehension of second-order false belief. Prior to investigating the influence of siblings on this measure of false belief understanding, a preliminary investigation of its correlates was conducted.

Table 3.5

Intercorrelations among all variables of interest.

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Presence of a sibling in the home	-											
2. Number of siblings living in the home	.77**	-										
3. Gender composition of siblings	.[a]	.04	-									
4. Timing of sibling arrival	.[a]	-.33**	.09	-								
5. Firstborn age at false belief tasks	.10	.03	-.03	.22**	-							
6. Firstborn gender	.03	.06	-.05	-.03	.01	-						
7. Second-order false belief	.09	.07	.03	-.03	.04	.10	-					
8. Second-order false belief conservative	.10*	.10	.05	.02	.06	.12	.76**	-				
9. Sociodemographic risk	-.09	-.01	.02	.15*	.25**	-.11	-.18**	-.18**	-			
10. Verbal IQ	-.01	-.05	.02	-.12	-.23**	.07	.24**	.23**	-.47**	-		
11. Response inhibition	-.15*	-.15*	-.04	.13	-.12	.15*	-.07	-.04	-.07	-.01	-	
12. Working memory	-.02	.02	-.05	.07	.21**	.16*	.09	.09	-.24**	.32**	-.17*	-
Mean	.75	.95	.47	35.68	83.20	.45	.43	.30	-.13	99.54	314.32	67.24
SD	.43	.71	.60	16.84	4.59	.50	.50	.46	.97	11.99	195.65	17.94

Note. Associations between dichotomous variables were tested by Kappa coefficients.

*p <.05. **p <.001.

[a]correlation not computed as one variable is constant.

3.3.2 What are the correlates of second-order false belief understanding?

Examination of the correlation matrix (Table 3.5) and of collinearity statistics established no issues with collinearity amongst predictor variables (VIF < 10, Tolerance > .20) (Menard, 1995; Myers, 1990). Verbal IQ and sociodemographic risk were significantly associated with passing second-order false belief questions with full comprehension, where higher verbal IQ scores were associated with better performance, and higher sociodemographic risk scores with lower performance. No relationship was detected between either children's response inhibition or working memory and children's performance on second-order false belief with full comprehension, nor was a relationship detected between age at the time of testing and second-order false belief (Table 3.5). However, in view of earlier research suggesting that individual differences in performance on false belief tasks exist across different ages (Wellman, Cross, & Watson 2001), age was included in the subsequent logistic regression.

In a logistic regression these potential confounds accounted for 11% of the variance in second-order false belief with full comprehension, χ^2 (3) =18.45, p <.001, Nagelkerke R^2 =.11. Children who were older at the time of testing, Wald statistic = 4.21, p <.05, OR = 1.08, 95% CI(1.00-1.16), and those with higher verbal IQ scores, Wald statistic = 7.17, p <.01, OR = 1.04, 95% CI(1.01-1.07), performed significantly better on second-order false belief; age and verbal IQ were therefore used as covariates in the subsequent analysis.

3.3.3 Do younger siblings influence firstborn's second-order false belief understanding?

Sibling variables were only associated with passing second-order false belief with full comprehension (Table 3.5). Therefore, all subsequent analyses in this chapter and throughout this thesis focus on firstborns' passing of the full sequence of second order questions with full comprehension. There was no significant association between number of siblings living in the

home and second-order false belief performance (Table 3.5). Therefore, all subsequent analyses explore sibling constellation factors related to the closest in age sibling.

3.3.3.1 Sibling presence in the home. To test for variations in second-order false belief as a function of presence or absence of siblings in the home, the sample was divided into two groups. Preliminary analyses showed no differences between the groups in ratio of males to females, firstborn mean age, sociodemographic risk, verbal IQ, and working memory. Children with siblings in the home performed better on the response inhibition task $t(222) = 2.03$, $p < .05$ (Table 3.6). A significant difference was detected between the two sibling groups in their passing of the second-order false belief task with full comprehension $\chi^2 (1) = 5.00$, $p < .05$, $OR = 2.33$, 95% CI (1.10 – 4.97), where children with a sibling had a twofold advantage on the second-order false belief task (Figure 3.6).

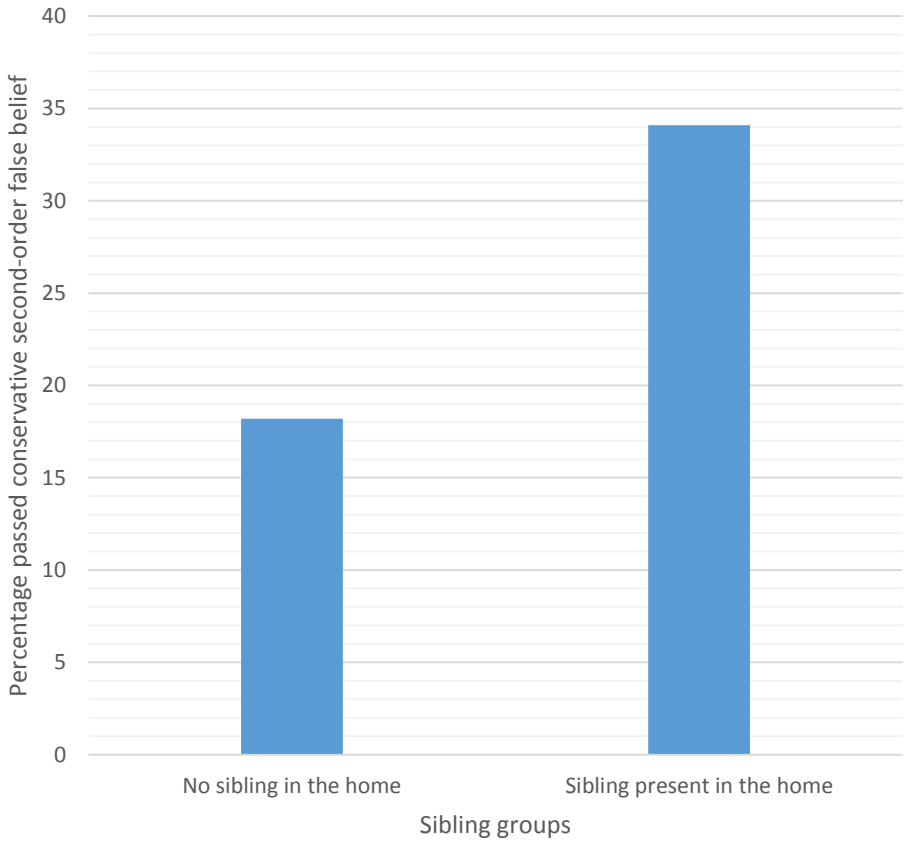

Figure 3.6 Percentage of children who passed the second-order false belief task with full comprehension according to sibling presence groups.

Table 3.6

Means and standard deviations of all variables of interest for sibling groups.

Variable	Sibling presence groups				Sibling arrival groups							
	No younger sibling present in the home		Younger sibling present in the home		Early arrival younger sibling		Average arrival younger sibling		Later arrival younger sibling		Average to later arrival younger sibling	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Firstborn age at false belief tasks	82.44	3.91	83.45	4.78	82.67	5.29	83.05	3.79	85.02	5.57	83.74	4.57
Firstborn gender	.42	.50	.46	.50	.42	.50	.48	.50	.45	.50	.47	.50
Second-order false belief	.33	.47	.46	.50	.39	.49	.55	.50	.37	.49	.49	.50
Second-order false belief full comprehension	.18	.39	.34	.48	.25	.44	.41	.50	.30	.46	.37	.49
Sociodemographic risk	.03	.95	-.19	.98	-.19	1.07	-.38	.82	.19	1.06	-.18	.95
Verbal IQ	99.78	12.54	99.46	11.85	99.18	11.91	101.37	11.92	96.23	11.18	99.56	11.88
Response Inhibition	366.29	230.11	297.40	180.60	317.48	175.05	267.18	148.92	334.49	229.62	290.34	182.69
Working Memory	67.73	18.50	67.09	17.82	64.20	19.44	69.29	16.12	66.00	18.93	68.14	17.15

In a logistic regression analysis (Table 3.7), the covariates were entered into the first step of the model, which accounted for 9% of the variance in second-order false belief χ^2 (2) = 15.07, p <.001, Nagelkerke R^2 = .09. At the second step, presence of a younger sibling accounted for significant additional variance in passing second-order false belief χ^2 (1) = 4.97, p <.05, and the overall model remained significant χ^2 (3) = 19.98, p < .001, Nagelkerke R^2 = .12. Within this model verbal IQ remained a significant predictor of second-order false belief performance. Children with a younger sibling present in the home were over twice as likely as children without siblings to pass second-order false belief with full comprehension, Wald statistic = 4.53, p <.05, *OR* = 2.35, 95% CI(1.07–5.15).

Table 3.7

Logistic regression of presence of a younger sibling in the home, firstborn age and verbal IQ as predictors of passing second-order false belief with full comprehension.

Variable	R^2	*B*	*SE*	Wald χ^2	*eβ*	95% CI for OR
Step 1	.09***					
Constant		-10.91	3.61	9.12	.00	
Firstborn age		.06	.04	2.86	1.06	.99 – 1.14
Verbal IQ		.05***	.01	12.68	1.05	1.02 – 1.08
Step 2	.12***					
Constant		-11.47	3.70	9.59	.00	
Firstborn age		.06	.04	2.45	1.06	.99 – 1.14
Verbal IQ		.05***	.02	13.00	1.05	1.02 – 1.08
Presence of a younger sibling in the home		.85*	.40	4.53	2.35	1.07 – 5.15

Note. The table presents the total R^2 Nagelkerke statistic.

N = 219.

ŧp <.10. *p < .05. **p <.01. ***p <.001.

3.3.3.2. Gender composition. Gender composition was examined in two ways; same-gender and opposite gender dyads were investigated, then all four possible gender

compositions: older female-younger female; older female-younger male; older male-younger male; and older male-younger female were explored. Preliminary analyses showed no differences between the groups in ratio of males to females, firstborn mean age, sociodemographic risk, verbal IQ, and working memory or inhibition across all the groups. No associations were detected between gender compositions of sibling dyads and second-order false belief.

3.3.3.3. Birth interval. Although no association was detected between timing of sibling arrival and second-order false belief understanding (Table 3.4), the four sibling arrival groups: no sibling, early-, average- and later arriving sibling groups were investigated. Preliminary analyses showed no differences between these groups in ratio of males to females, verbal IQ and working memory. Significant differences were detected between groups in sibling age $F(3,224) = 3.16$, $p < .05$, sociodemographic risk $F(3,225) = 4.13$, $p < .01$ and ANT inhibition scores $F(3, 220) = 3.12$, $p < .05$. Post hoc tests were selected in accordance with results from tests for homogeneity of variances. Games-Howell post hoc tests indicated that children in the later arrival sibling group were older than those in the no sibling group, and children with an average arriving sibling performed better on the inhibition task than those without a sibling ($ps < .05$). A Tukey post hoc test indicated that children with an average arriving younger sibling had lower sociodemographic risk than those with a later arriving sibling ($p < .01$). A significant difference was detected between the four sibling groups in their passing of the second-order false belief task with full comprehension $\chi^2 (3) = 8.97$, $p < .05$ (Figure 3.7).

This finding was explored further whilst controlling for covariates of second-order false belief. As later arriving siblings did not significantly differ from average arriving sibling group in performance on passing second-order false belief with full comprehension, these were collapsed into one 'average to later' sibling arrival group. There were no significant

differences between the groups in ratio of males to females, firstborn mean age, sociodemographic risk, verbal IQ, and working memory or inhibition when these groups were collapsed (see Table 3.5).

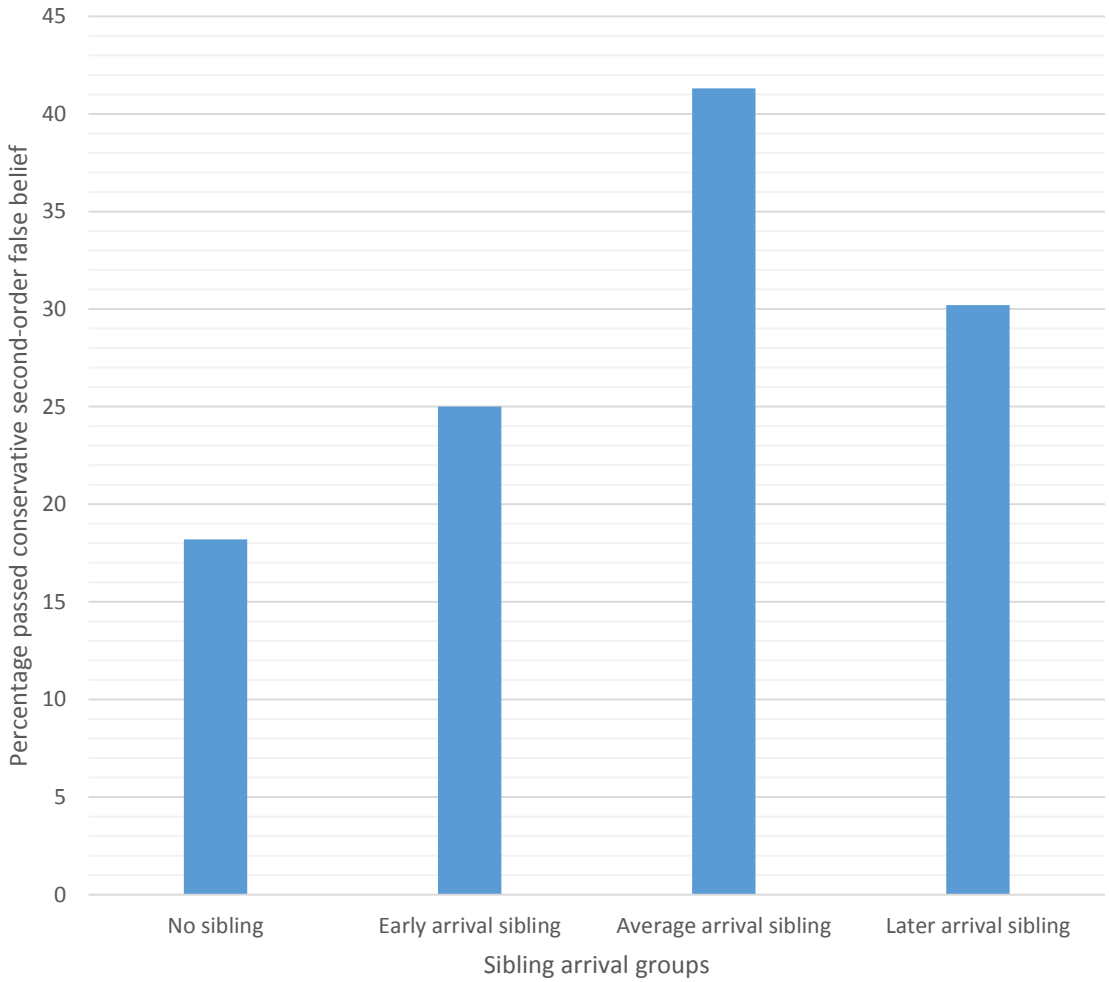

Figure 3.7 Percentage of children who passed the second-order false belief task with full comprehension according to sibling arrival groups.

The three remaining sibling status groups were dummy coded with the no sibling group assigned as the reference category in a logistic regression. Covariates (age and verbal IQ) were entered into the first step of the logistic regression model. When entered into the model at the second step, early arrival of a younger sibling and average to later arrival of a younger sibling accounted for a significant step when entered into the model, accounting for

an additional 4% of the variance in second-order false belief with full comprehension, χ^2 (2) = 6.57, p <.05. The overall model remained significant χ^2 (2) = 21.57, p < .001, Nagelkerke R^2 = .13. The early arrival of younger siblings did not predict firstborns' passing of second-order false belief with full comprehension; however, average to later arrival siblings conveyed a significant advantage, Wald statistic = 5.63, p <.05, *OR* = 2.66, 95% CI(1.19–5.96) (Table 3.8).

Table 3.8

Logistic regression of dummy coded sibling status groups, firstborn age and verbal IQ as predictors of passing second-order false belief with full comprehension.

Variable	R^2	*B*	*SE*	Wald χ^2	*eβ*	95% CI for OR
Step 1	.09***					
Constant		-10.91	3.61	9.12	.00	
Firstborn age		.06	.04	2.86	1.06	.99 – 1.14
Verbal IQ		.05***	.01	12.68	1.05	1.02 – 1.08
Step 2	.13***					
Constant		-10.87	3.71	8.58	.00	
Firstborn age		.05	.04	1.86	1.05	.98 - 1.13
Verbal IQ		.05	.02	12.87	1.05	1.02 - 1.08
Early arrival younger sibling		.46	.51	.82	1.59	.58 - 4.34
Average to Late arrival younger sibling		.98*	.41	5.63	2.66	1.19 - 5.96

Note. The table presents the total R^2 Nagelkerke statistic.

N = 219.

ŧp <.10. *p < .05. **p <.01. ***p <.001.

3.4 Discussion

3.4.1 Sibling influences on children's understanding of second-order false belief

When predictors of second-order false belief understanding were controlled, children with a younger sibling present in the home were twice as likely to succeed on a second-order

false belief task with full comprehension. In a closer examination of sibling constellation factors, it was established that this sibling advantage is only the case for firstborns who did not experience the early arrival of a sibling. This finding stands in contrast to the first study of sibling effects on second-order false belief tasks, which found no effect (Miller, 2013), but is consistent with previous research showing that presence of a younger sibling in the home is advantageous for theory of mind (Perner et al., 1994; Lewis et al., 1996; Peterson, 2000). In contrast to earlier work (Kennedy et al., 2015), the younger sibling's influence on a higher-order theory of mind task in this sample was not limited to same-gender siblings. Although the effects reported in this study were not large, it is important to note that the sample size used in the present study provided sufficient power to enable detection of such small to moderate effects.

There are various mechanisms whereby younger siblings could facilitate their older sibling's false belief understanding; see Chapter 1. These included engaging in joint pretence (Youngblade & Dunn, 1995), sharing knowledge through teaching (Zajonc & Markus, 1975; Azmitia & Hesser, 1993) and engaging in conflict and resolution (Dunn, 1994; Foote & Holmes-Lonergan, 2003).

Siblings may also foster children's understanding of false belief indirectly, by triggering changes in parent-firstborn interactions (Carpendale & Lewis, 2006). Many parental characteristics and features of parent-child interaction have been explored in relation to children's development of theory of mind (Miller, 2016) such as attachment quality, general parenting style, warmth and affection (Arranz, Artamendi, Olabarrieta, & Martin, 2002; Ruffman, Slade, Devitt, & Crowe, 2006; Steele, Steele, Croft, & Fonagy, 1999). Children's conversational environments have been the focus of numerous studies, where perhaps the most robust associations in this area have been identified between maternal internal state language and children's performance on theory of mind tasks (see Harris, de

Rosnay, & Pons, 2005; de Rosnay & Hughes, 2006). Given that the arrival of a sibling has been found to be associated with changes in maternal internal state language use (Dunn & Kendrick, 1982a), it is possible that younger sibling influences on false belief understanding are mediated by maternal internal state language.

The experience of the arrival of a sibling early in development however, does not appear to provide a similar advantage brought about by a younger sibling. The first two years of life represent an important time period in theory of mind development, which features evidence of consciousness, pretence and the use of lexical terms for mental states (Astington, Harris, & Olson, 1988; Bartsch & Wellman, 1995). It is possible that transition to siblinghood during this time may disrupt this process.

3.4.2 Correlates of second-order false belief

Children who experienced socioeconomic adversity performed less well on the second-order false belief task; however, this association did not remain significant when accounting for age and verbal IQ. This finding stands in contrast to previous research (Cutting & Dunn, 1999; Cole & Mitchell, 2000), perhaps because this study took into account a number of dimensions of sociodemographic risk beyond occupational class or income. Although a number of sociodemographic risk factors have been found to be associated with theory of mind, such as income, maternal education (Andersson, Sommerfelt, Sonnander, & Ahlsten, 1996), and parental occupational class (Cutting & Dunn, 1999), these factors are rarely all controlled in a single study (Pears & Moses, 2003).

Although the effects reported in this study were not large, it is important to note that the sample size used in the present study provided sufficient power to enable detection of such small to moderate effects. Thus, the absence of an association with children's executive function abilities in this sample is noteworthy, given that there was sufficient power to detect such an effect. Although executive function abilities and first-order false belief understanding

have been found to be positively related (Carlson, Moses, & Breton, 2002), a finding replicated in the present study, there has not been consistent evidence for a correlation between executive function and performance on second-order false belief tasks (for a review, see Miller, 2009). This may indicate that second-order false belief is predominantly a social rather than a cognitive advance. Alternatively, it may be that the non-verbal measures used in this study to assess executive function may not be comparable to other verbal measures of inhibition and working memory, such as Bear/Dragon 'Simon Says'-type inhibition tasks or word/digit span working memory tasks (Carlson, Moses & Breton, 2002). Before a more definitive conclusion can be made, replication of this finding using other executive function tasks is warranted.

3.4.3 Limitations of the study

The findings must be interpreted with some caution. Data collection took place in the family homes; therefore the assessment of false belief is likely to be influenced by situation-specific influences, such as distractions within the home environment. This situational factor as well as the broader nature of the community sample may explain why fewer children passed first- and second-order false belief than previously reported in the literature. However, the use of home visits may also have led to the inclusion of more families than would have otherwise been unable to participate in such a study. Further research might be advised to conduct similar assessments in a more controlled environment, such as in a laboratory or school setting, which may reduce situational influences that increase measurement error.

3.4.4 Chapter summary and next directions in the thesis

The finding that the presence of a younger sibling in the home facilitated false belief understanding draws attention to the contribution of the sibling relationship to social cognitive development in middle childhood. Taken together with evidence from the vast literature on first-order false belief understanding, the findings contribute to knowledge about the influence

of younger as well as older siblings on the child's development of a theory of mind. In the next stage of this thesis, I will examine mothers' references to internal states as a mediator of younger sibling influence on children's understanding of second-order false beliefs. For this investigation to take place, Chapter 4 will first review theoretical and methodological issues of studying maternal internal state language. In Chapter 5, maternal references to internal states will be tested as a potential mediator of the sibling effect on children's second-order false belief understanding.

In the present chapter, younger siblings were found to foster children's performance on the second-order false belief task; however, this was not the case for firstborns who experienced the early arrival of a sibling. Chapter 6 will focus on the early arrival younger sibling group with the aim to discover why these younger siblings did not provide an advantage in children's understanding of minds. This will include a review of family characteristics associated with rapid subsequent childbearing and an exploration of the effects rapid sibling arrival may have on mother-child interaction.

CHAPTER 4

"What's that, what have you seen, nosy parker?"

Mothers' Use of Internal State Language: Associations with Children's Understanding of False Belief and Methodological Considerations

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4.1 Introduction

In this thesis thus far, it has been demonstrated that younger siblings foster firstborns' understanding of higher-order understanding of minds in middle childhood. In Chapter 3, the presence of a younger sibling in the home was found to result in a two-fold advantage in children's performance responding to second-order false belief questions. It was hypothesised that this association may be explained in part by changes in mothers' use of internal state language towards the firstborn child upon the arrival of a younger sibling. In the present chapter, I will review the relationship between mothers' use of internal state language and children's understanding of minds. I will also highlight methodological issues that must be taken into consideration when studying maternal use of internal state language. This will take place in preparation for testing the contribution of both mothers' use of internal state language and presence of a younger sibling on firstborns' second order false belief understanding in Chapter 5.

4.1.1 Mothers' use of internal state language: Associations with children's false belief understanding

A recently growing body of work within the theory of mind literature has focused on the association between children's conversational environments and their emerging understanding of minds. This line of enquiry is reminiscent of Vygotsky's (1978) *interactionist-dialectical* (p. 124) approach in explaining the development of social understanding. As highlighted in section 1.3.5.3.1 of Chapter 1 (page 18), Vygotsky theorised that conversation is a 'tool' that facilitates children's understanding of minds, by the sharing of experience, memories and meaning to reach mutual understanding (see also *Zone of Proximal Development,* Figure 1.4 in Chapter 1, page 20). In the revival of this work, research has explored the features of parental discourse that may foster children's understanding of minds. Although some work has explored features of paternal speech (LaBounty, Wellman, Olson, Lagattuta, & Liu, 2008), most studies have focused on mothers' speech, including talk about causality (Dunn, Brown, Slomkowski, et al., 1991), elaborative discourse (Garner, Jones, Gaddy, & Rennie, 1997; Laible, 2004), as well as conversations about, and sensitivity to, internal states (Ruffman et al., 2002).

Internal state language encompasses references to an individual's internal, mental worlds, and in the literature is also referred to as *mental state language, language of mind* and *metacognitive language* (see de Rosnay & Hughes, 2006, see also section 1.3.2.1 of Chapter 1, page 8). The majority of studies focus on mothers' speech about desires, emotions, cognitions, and in the infancy literature, perception, as examples of internal state language (Table 4.1). Although few studies have explored the relationship between mothers' use of internal state language and children's understanding of minds in middle childhood, this association has been well-established in studies of mothers and their preschool-aged children. This feature of language has been associated with children's emotion understanding (Dunn,

Brown, & Beardsall, 1991; Taumoepeau & Ruffman, 2006, 2008), children's own use of internal state language (Jenkins et al., 2003; Garner et al., 1997; Moore, Furrow, Chiasson, & Patriquin, 1994) as well as performance on false-belief tasks (Ruffman et al., 2002, 2006; Symons, Peterson, Slaughter, Roche, & Doyle, 2005). Caregivers' internal state language has been consistently found to relate to children's understanding of minds; this is demonstrated in Table 4.1, where the majority of studies have reported positive associations between features of mothers' internal state language and children's understanding of false belief.

The majority of studies investigating mothers' use of internal state language and children's understanding of false belief have focused on the frequency of references to emotions, desires and cognitions (de Rosnay & Hughes, 2006). This investigation was initiated by the seminal work of Judy Dunn and colleagues, who coded from transcripts of over two hours of video footage with 33-month-olds. In their work, Dunn and colleagues identified a link between maternal discourse about feeling states at 33 months and children's success on false belief 7 months later (Dunn, Brown, Slomkowski, et al., 1991). Following this landmark study, mothers' references to emotions (e.g. "happy", "sad", "angry", "scared") and references to desires (e.g. "want", "wish", "like", "hope") also predicted children's understanding of false belief in cross-sectional studies (Adrian, Clemente, Villanueva, & Rieffe, 2005; Racine, Carpendale, & Turnball, 2007; Symons, Fossum, & Collins, 2006).

Nevertheless, when taken together, mothers' references to cognitions (e.g. "think", "know", "believe", "guess", "figure") have emerged as perhaps the most consistent predictor of children's understanding of false belief (Adrian et al., 2005). The frequency of mothers' use of cognitive terms has been associated with children's passing of false belief tasks (Adrian et al., 2005; Ensor & Hughes, 2008; Ruffman et al., 2002), and such references have remained significant predictors of children's false belief understanding, even when children's early false belief performance is controlled (Ensor, Devine, Marks, & Hughes, 2014).

Table 4.1

Methods and measures used in previous research examining the association between caregivers' use of internal state language and children's false belief understanding.[4]

Author	Age of children	N	Study Design	Child theory of mind outcome measure	Parent-child interaction assessment	Internal state language coded	Summary of findings
Adrian, Clemente, Villanueva, & Rieffe (2005)	48 – 60 months	34	Cross-sectional	False belief	Wordless picture book	Cognition Emotion Desire Perception	Frequency and variety of cognitive terms and frequency of emotion terms predicted false belief.
Dunn, Brown, Slomkowski, Tesla, & Youngblade (1991)	T_1: 33 months T_2: 40 months	50	Longitudinal	False belief Emotion understanding	2 x 75 minute natural home observation	Emotions Preferences	Child's participation in family discourse about feelings and causality were associated with understanding of feelings and false belief.
Ensor & Hughes (2008)	T_1: 29 months T_2: 41 months T_3: 50 months	120	Longitudinal	False belief battery Emotion understanding	30 minute natural home observation	Cognition Emotion Desire	Mothers' cognitive references were associated with children's social understanding; however this did not remain a predictor when covariates (including mothers' connected turns) were controlled. 'Connectedness' found to have moderating effect, mothers' mental state language strongest predictor in connected turns.

[4] Studies were included in Table 4.1 if they had assessed caregivers' internal state language and children's false belief understanding in community samples of infants, toddlers and children.

Ensor, Devine, Marks, & Hughes (2014)	T_1: 28 months T_2: 40 months T_3: 78 months T_4: 111 months	105 (to age 6) 77 (to age 10)	Longitudinal	False belief battery Strange stories	30 minute natural home observation (T_1) Wordless picture book (T_3)	Cognition Emotion Desire	Mothers' references to cognition at T_1 predicted children's performance on FB at T_2 and strange stories at T_3, even when controlling for children's FB performance at T_1.
Howard, Mayeux, & Naigles (2008)	36 – 48 months	60	Cross-sectional	False belief battery Mental verb understanding	30 mins natural observation Semi-structured memory game	Cognition	Children's mental verb understanding was facilitated by mothers' questions including mental verbs and mothers' references to others rather than self. Mothers' use of 'know' and 'remember' but not 'think' in single-clause utterances predicted children's false belief performance.
LaBounty, Wellman, Olson, Lagattuta, & Liu (2008)	T_1: 41 months T_2: 69 months	106	Longitudinal	False belief battery Desire understanding Emotion understanding	Wordless picture book	Cognition Desire Emotion	Mothers' causal explanations about emotions predicted children's emotion understanding. Fathers' causal explanations regarding desires predicted children's false belief performance.
Ontai & Thompson (2008)	48 – 60 months	76	Cross-sectional	False belief battery	Semi-structured conversation	General internal state language (no categories)	Mothers' conversational elaboration, not references to mental states, significantly predicted children's false belief performance.

Racine, Carpendale, & Turnball (2007)	36 – 60 months	78	Cross-sectional	False belief Emotion understanding	Wordless picture book	Belief-dependent emotion Non-belief-dependent emotion	Parents' belief-dependent talk about emotions predicted children's understanding of false belief.
Ruffman, Slade, & Crowe (2002)	T_1: 36 months T_2: 41 months T_3: 48 months	82	Longitudinal	False belief battery Emotion understanding Desire understanding Ambiguity task	Wordless picture book	Desire Emotion Modulations of assertion Think and know Other mental state	Mothers' use of ISL was correlated with children's theory of mind at all three time-points. When children's earlier theory of mind understanding was partialled out, mothers' ISL still predicted theory of mind performance, indicating a causal relationship.
Ruffman, Slade, Devitt, & Crowe (2006)	T_1: 36 months T_2: 48 months	55	Longitudinal	False belief battery Emotion understanding Desire understanding Conflict/cooperation task	Wordless picture book	Cognition Desire Emotion General mental states Modulations of assertions	All categories of internal state language were examined together. Mothers' use of mental state talk was a significant predictor of children's theory of mind, even when controlling for parenting style.
Slaughter, Peterson, & Mackintosh (2007)	38 – 57 months	30	Cross-sectional	False belief battery	Wordless picture book	Simple/ clarification of: Cognition Affect Perception	Mothers' use of cognition clarifications (not simple) predicted children's theory of mind performance.

Symons, Fossum, & Collins (2006)	T_1: 25 months T_2: 69 months	43	Longitudinal	Internal state language False belief battery	Laboratory free play	Cognition Desire Basic emotion	Mothers' appropriate use of desire language at T_1 predicted children's later theory of mind understanding at T_2.
Symons, Peterson, Slaughter, Roche, & Doyle (2005)	60 – 85 months	51	Cross-sectional	False belief battery	Story book reading	Cognition Emotion Desire	All categories of internal state language were examined together. Comments about the internal states of the characters in the story and discourse regarding story theme were related to children's false belief understanding.
Turnbull, Carpendale, & Racine (2008)	36 – 70 months	70	Cross-sectional	False belief battery	Wordless picture book	Cognition Emotion Desire	All categories of internal state language were examined together. When age was controlled, mothers' internal state language predicted false belief understanding. Mothers' internal state language did not remain a significant predictor when taking into account discussion about overall story elements.

While this pattern of findings indicates that mothers' references to cognitions are important for fostering children's false belief understanding, the majority of these investigations focused on the frequency of use of such terms. Beyond a simple tally of references to cognitions, research indicated that the more varied the references to cognitions, the better children's understanding of false belief (Adrian et al., 2005). In a closer inspection of cognitive terms, mothers' use of *know* and *remember*, but not *think*, predict children's false belief performance (Howard, Mayeux, & Naigles, 2008). In broad investigations of references to cognitions within sentences, clarifications of cognitive terms using explanatory, casual or contrastive statements have been identified as predictors of false belief understanding e.g. *"He remembers that he has not done the bedroom yet"* rather than *"he remembers"* (Slaughter, Peterson, & Mackintosh, 2007 p. 843). Broader still, within the context of the whole conversational exchange, the degree to which a mother's speech is semantically related to the child's previous conversational turn, known as *connectedness,* has been found to moderate the influence of mothers' cognitive references on children's false belief performance (Ensor & Hughes, 2008).

4.1.2 How might maternal internal state language facilitate children's understanding of belief?

The reason why caregivers' use of internal state language appears to facilitate children's theory of mind understanding is relatively unclear. It is proposed that within their conversations children are provided with opportunities to appreciate the perspectives of others, whilst shifting from concrete to abstract topics of conversation (Harris, 1999). Caregivers' propensity to comment on inner states may add to this "constant tutorial" (p.102) in children's understanding that conversation with others can move beyond current mutual activities and subjects of joint attention, to discussions of what is absent and unobservable, including the beliefs and knowledge of their conversational partner.

Along a similar vein, caregivers' mind-related discourse encourages children to attend to, reflect on and represent abstract concepts. By drawing attention to the thought process, caregiver speech scaffolds children to overcome the saliency of reality and understand the discrepancies between their own experience of reality and the reality experienced by others (Adrian et al., 2005). Given that one's beliefs and knowledge, more so than other mental states such as emotions and desires, can be subjective and are most likely to contradict someone else's perception of reality, this explanation best fits research showing that mothers' discourse about belief and knowledge is most related to children's passing of false belief tasks (Adrian et al., 2005; Ensor & Hughes, 2008; Ensor et al., 2014).

The linguistic account of theory of mind asserts that caregivers' use of internal state language exposes children to particular aspects of syntax, specifically propositions that invariably follow a mental state verb in a sentence, such as "She thought *the world was flat*" (de Villiers & Pyers, 2002, p. 1038). It has been argued that mastery of this feature of language, known as *sentential complements*, enable children to represent others' points of view. Understanding of the relation between the mental state verb, "she thought" and the complement, "the world was flat" enables children to evaluate perspectives of others in relation to their own reality. This view is consistent with Vygotsky's claim that language acquisition provides children with psychological tools (1978). In the absence of such tools, passing false belief tasks would be difficult (as they include such inner state verbs and propositions). Indeed, this position has been supported by Slaughter and colleagues' (2007) work which highlighted the importance of clarifications, as well as de Villiers and Pyers' work, (2002) where children's passing of false belief tasks were associated with their memory of sentential complements, with and without the use of inner state verbs.

Although the exact mechanism by which caregivers' references to inner states facilitates children's understanding of belief remains unclear, these current suggestions are

corroborated by research exploring children's outcomes when such conversations are diminished. Studies demonstrating differences in social understanding between deaf children within hearing families and native signers (for a review, see Peterson & Siegal, 2000) showed that profoundly deaf children from hearing families (who are therefore belatedly signing) consistently perform worse on false belief tasks than native signing children (Peterson & Siegal, 1999; Russell, Hosie, Gray, Scott, & Hunter, 1998). Hearing parents of deaf children, even if they learn to sign, have difficulties conversing about topics without the presence of a visual referent (Meadow, Greenberg, Erting, & Carmichael, 1981), resulting in less frequent and less rich conversation regarding abstract topics, such as non-present objects, events, memories, future events, and notably, inner states (Morford & Goldin-Meadow, 1997; Vaccari & Marschark, 1997). This research strengthens the claim that exposure to proficient conversational partners may be necessary for false belief understanding. Children's conversations with their caregivers regarding inner states may serve as a 'window' for children to gain insight into the minds of others.

4.1.3 The importance of mothers' internal state language beyond the preschool years

In this review thus far, there is clear evidence that mothers' references to internal states are positively associated with children's understanding of minds in the preschool years (Ruffman et al., 2002, 2006; Symons et al., 2005). However, few studies have explored this relationship beyond the fifth year of life (Ensor et al., 2014). A handful of studies indicate that mothers' overall frequency of references to internal states are associated with children's understanding of false belief beyond the preschool years (Symons et al., 2005). Others indicate that specific references to desire and causal explanations about emotions are positively associated with children's false belief understanding before their sixth birthday (Symons et al., 2006; LaBounty et al., 2008).

Evidence suggests that mothers' references to cognitive internal states fosters children's performance on *strange stories* tasks that measure children's advanced insights about the mind, such as understanding of instances concerning deception and misunderstanding (Adrian, Clemente, & Villanueva, 2007; Ensor et al., 2014). In a longitudinal study of children from two to ten years of age, mothers' references to cognitions during interactions with their children at age 2 and 6 years predicted children's understanding of false belief at 6 years (Ensor et al., 2014). Mothers' cognitive references to their two-year-olds predicted children's later performance at age 10 years on the strange stories task. This finding was corroborated by another study that found mothers' use of cognitive verbs predicted children's performance on the strange stories task at age 7 (Adrian et al., 2007).

Nonetheless, it may be the case that associations between mothers' references to internal states and children's mind-understanding in middle childhood are merely residual effects of earlier maternal input. Mothers' references to cognitions may be most critical during the third year of life in scaffolding children's theory of mind (McElwain, Booth-LaForce, & Wu, 2011). Maternal speech may foster children's understanding of minds until they reach a certain level of theory of mind mastery (Lagattuta et al., 2015). As children reach middle childhood and increasingly spend more time with peers and other adults, experience with the minds of interlocutors other than the mother may become increasingly important (Lagattuta et al., 2015). Before a more definitive conclusion can be made, more research is needed to examine whether concurrent associations can be identified between maternal references to internal states and children's understanding of higher-order false belief.

4.1.4 Mothers' use of internal state language: Considerations for research

There is substantial evidence indicating that maternal use of internal state language fosters children's theory of mind in the preschool years. To examine mothers' references to

inner states in the context of this thesis, however, there are certain methodological issues that must be considered.

4.1.4.1 Context of assessment. Mothers' use of internal state language may differ across different contexts of assessment. Although the majority of studies exploring maternal use of internal state language include observations of mother-child interactions, these associations were identified in a variety of different contexts. These include natural observations, joint activity tasks, free play or semi-structured observations (see Table 4.1).

Observational studies of mother-child interactions within the home have strength in their representation of children's typical conversational environments (Dunn, Brown, Slomkowski, et al., 1991). Although data from naturalistic studies may be assumed to represent children's everyday conversational environments, the rate of mother's spontaneous internal state language in such circumstances tends to be fairly low: within about 10% of utterances (Jenkins et al., 2003; Howard et al., 2008).

In order to promote an interaction that may be rich in internal state language, a second method has been adopted in other research: Parents are asked to describe wordless picture books to their children, which elicit more frequent internal state references than everyday conversation (Howe, Rinaldi, & Recchia, 2010; Sabbagh & Callanan, 1998). Internal state language has also been transcribed during free-play sessions (Symons et al., 2006), and semi-structured conversation tasks (Ontai & Thompson, 2008), yet rates of internal state language can be lower in these contexts compared to topic-sharing tasks such as wordless picture books (Hoff-Ginsberg, 1991).

4.1.4.2 Referent. It is also noteworthy that within these contexts of assessment there may be different referents of internal state language. In natural studies observing families in the home and during free play sessions, internal state language referring to family members' inner states has been reported (Dunn, Brown, & Beardsall, 1991; Dun, Brown, Slomkowski,

et al., 1991; Symons et al., 2002). However, there are notable differences in referents of internal state language examined in wordless-picture book tasks. Whilst some focused exclusively on mothers' references to the inner states of the characters in the books (Racine et al., 2007), others appear to include references to the inner states of mothers and children as well as characters (Adrian et al., 2005, Ruffman et al., 2002, 2006). The added referents in wordless picture books - the characters in the story - are an essential difference between these contexts of internal state language measurement. Maternal references to cognitive states of characters may be important in fostering children's understanding of minds in that children are encouraged to access a *double perspective* (Adrian et al., 2007, see also *landscape of actions* or *landscape of consciousness*, Bruner 1986) of the inner worlds of the characters in stories. It must, therefore, be noted that studies do not tend to differentiate between the mother's comments on her own inner states, those of the child or the characters in the book. This presents an issue that must be clarified in coding schemes of internal state language.

4.1.4.3 Coding schemes. Given that mothers' use of different types of internal state language shifts as children develop, and the relative importance of each category at different time-points of development (Ruffman et al., 2002), an inclusive coding scheme that captures all relevant categories of internal state language is required. As previously highlighted in this review and in Table 4.1, the majority of previous studies focused nearly exclusively on coding mothers' references to desires, emotions and cognitions. Although a coding scheme that mirrors these key categories of internal state language is required for comparison across studies of false belief, there is scope to expand these categories by considering other coding schemes used to examine mothers' internal state language with other dimensions of children's social understanding. Although a number of other coding schemes were considered for this investigation, including the widely used 'mind-mindedness' coding scheme (Meins, Fernyhough, Fradley, & Tuckey, 2001), this was not considered appropriate given interest in

internal state language terms mothers' use, and that a coding scheme appropriate for coding for mothers' speech to children of a variety of ages was required.

Within the Cardiff Child Development Study, a coding scheme was developed for parental use of child-directed internal state language at the early infancy assessment (mean age 6.6 months; Roberts et al., 2013). Like many of the studies of mothers' internal state language and children's false belief understanding (Dunn, Brown, & Beardsall, 1991; Dunn, Brown, Slomkowski, et al., 1991; Ruffman, et al., 2002, 2006), the coding scheme used by Roberts and colleagues (2013) was based on Bartsch and Wellman's (1995) belief-desire categorisation of theory of mind.

In their original coding scheme, Bartsch and Wellman refined codes based on data from the Child Language Data Exchange System (the CHILDES). Spontaneous utterances from 10 English-speaking children were collected longitudinally between the ages of 1 and 6, resulting in over 200,000 speech samples. From this database, Bartsch and Wellman refined codes for toddlers' references to *belief*, *knowledge* and *desire*, from their conceptualisation that belief and desire are fundamental to mind-understanding, and that this is underpinned by auxiliary constructs such as perception, physiological states, and emotional reactions; these lead to behaviour (see Figure 4.1).

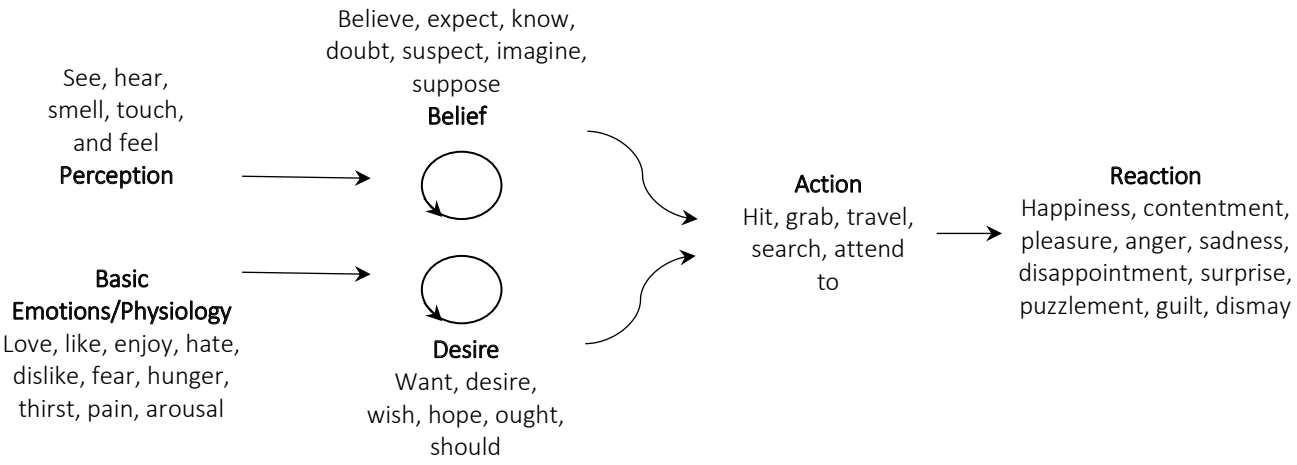

Figure 4.1 Bartsch and Wellman's (1995, p. 7) simplified scheme for depicting belief-desire psychological reasoning.

In Roberts and colleagues' adaptation of Bartsch and Wellman's (1995) scheme, the three auxiliary constructs, *basic emotions/physiology*, *perception* and *action* (renamed *intentional agency*) were incorporated into the scheme. Emotion and perception in particular, not only reflect these 'supporting' internal states proposed in Bartsch and Wellman's model, but also draw on the internal states coded in another classic scheme by Beeghly, Bretherton and Mervis (1986, see Table 4.2); a scheme originally used to code children's speech in a longitudinal study of 10, 13, 20, and 28 month-old-children from Boulder, Colorado, referred to as the Boulder Sample (Bretherton, McNew, & Beeghly-Smith 1981; Bretherton & Beeghly, 1982). This scheme has also informed categories coded in the false belief literature explored in this review (Adrian et al., 2005).

Table 4.2

Beeghly and colleagues' (1986) internal state coding scheme and examples for coding maternal speech.

Maternal internal state language category	Description	Verbatim example about child
Sensory perception	Sight, hearing, taste, smell, skin senses, including touch, pain, temperature	*"That feel soft?"* *"You heard voices."*
Physiology	Hunger, thirst, states of consciousness	*"You're a hungry guy."* *"You're not very alert today."*
Affect	Joy, surprise, love, kindness, distress, disgust, anger, fear	*"You having fun?"* *"Don't be angry."*
Moral judgement/obligation	Moral conformity or transgression, permission and obligation	*"You have to finish your snack."* *"Should your feet be on the table?"*
Volition/ability	Desire, need, ability to do something difficult	*"Is that too hard?"* *"You can do it."*
Cognition	Knowledge, memory, uncertainty, dreaming, reality versus pretending	*"Think hard!"* *"Do you know how to do it?"*

Despite Roberts and colleagues' (2013) expansion of categories, there appears to be some scope to expand this scheme into more categories. In particular, the *basic emotion/physiology* category includes a broad range of types of internal state language. From the examples, it can be seen that this category includes basic emotions such as *fear*, as well as physiological states, including *hunger*, *thirst*, *pain*, and *arousal* and finally preferences, such as *love*, *like*, *enjoy*, *hate*, and *dislike*. Separation of these categories may be an important next step in adapting this coding scheme for a broader age range.

Table 4.3

Roberts and colleagues' (2013) internal state language coding scheme and examples for coding parent's infant-directed speech, developed from Bartsch and Wellman (1995).

Maternal internal state language category	Examples	Cohen's K
Basic Emotions/Physiology Love, like, enjoy, hate, dislike, fear, hunger, thirst, pain, arousal.	*"Are you hungry?" "You like the pretty butterfly." "Are you not enjoying this game?" "Don't worry."*	.90
Perception See, hear, taste, smell, feel	*"Can you see the cow?" "Can you feel the fluffy lamb?"*	.88
Intentional Agency Attempt, try, acting to achieve a goal, acting with intent, purposeful acting on an object	*"What are you after?" "Are you trying to grab them?" "Can you open this one next?" "Were you hitting it?"*	.77
Desire Want, desire, wish, hope, ought, should	*"Do you want to have a go?" "Are you hoping it's something to eat?"*	.92
Belief Believe, know, suppose, expect, doubt, suspect	*"Do you think they're slugs?" "Do you know what that is?"*	1.00

The inclusion of intention was a novel addition to Roberts and colleagues' (2013) coding scheme. Bartsch and Wellman noted that in order to understand desire, it must be distinguished from intention; an expression of desire represents a current internal state, yet plans of intention must have a future quality. Essentially, "…planning to enact one's desires later clearly separates a notion of desire from *actions to obtain* the desire." (1995, p. 89, italics added). Yet, this future planning quality may represent an important internal state that had been neglected in coding schemes of internal state language thus far, although features briefly in some coding schemes under the category *volition* (Slaughter, Peterson, & Carpenter, 2008, 2009). Roberts and colleagues' coding scheme marked a first step in the development of coding schemes incorporating intention as a separate category. However the reliability statistic for occurrence of terms for intentional agency in transcripts, although in the acceptable range, was somewhat lower than the reliability statistics for the other categories

(see Table 4.3), suggesting there may be scope for further development and clarification of this code.

4.1.4.4 Identifying maternal correlates. The majority of studies presented in Table 4.1 include maternal characteristics as correlates of their use of internal state language. These include measures of mothers' talkativeness, typically measured by mean length of utterance or number of conversational turns (Adrian et al., 2005; Dunn, Brown, Slomkowski, et al., 1991; Ensor & Hughes, 2008) and a measure of maternal education (Dunn, Brown, Slomkowski, et al., 1991; Ruffman et al., 2002, 2006). Some studies have included socio-economic status as a correlate of mothers' internal state language (Howard et al., 2008; Symons et al., 2005, 2006).

The specific influence of each of these factors on mothers' production of internal state language remains unclear. Sociodemographic risk factors, including employment status, education, lone parenthood, crowding and type of family home are associated with children's performance on theory of mind tasks (Cole & Mitchell, 2000; Hughes, Deater-Deckard, & Cutting, 1999; Pears & Moses, 2003). Although in one study, maternal education was associated with mothers' use of internal state language (Adrian et al., 2005), this finding has not been consistent when other measures of sociodemographic risk are controlled (Dunn, Brown, Slomkowski, et al., 1991). It is possible that other sociodemographic risk factors may also influence mothers' references to internal states. Having two parents in the home, a higher income and more stability may result in less parent stress and more time to discuss internal states with children (Pears & Moses, 2003). Rarely have all these covariates been controlled within a single study of mothers' internal state language; therefore an investigation of these socio-demographic characteristics within the same model is warranted (de Rosnay & Hughes, 2006).

Socioeconomic hardship is associated with maternal behavioural problems (Grant et al., 2004), which in turn are associated with suboptimal parenting practices (Harold et al.,

2011). Mothers' histories of behavioural problems are associated with verbal and non-verbal dimensions of mother-child interaction, including fewer expressions of positive affect and less variable pitch contours related to the musical quality of infant directed speech (Hay et al., under review). It seems possible, therefore, that this stable personality trait (De Brito & Hodgins, 2009) may be associated with mothers' conversations about internal states with their children.

4.1.5 Aims of the study

It is well-established that mothers' references to internal states fosters children's understanding of minds in the preschool years. In this review, certain issues have arisen in terms of exploring mothers' use of internal state language in the next stage of this thesis. These include selection of an appropriate context and coding scheme to assess internal state language and identifying maternal characteristics that need to be controlled. These issues must be addressed before exploring mothers' internal state language in the next chapter of this thesis (Chapter 5).

4.1.5.1 To expand the CCDS internal state language coding scheme and assess its reliability. In the remainder of this chapter I will describe an expanded coding scheme for use at different time points in the longitudinal CCDS. The internal state language coding scheme used by the CCDS (Roberts et al., 2013) was selected as a starting point for this investigation. This coding scheme will be evaluated and expanded further into one that is appropriate for examination of adult language directed to children of various ages. In this thesis the expanded coding scheme will be applied to transcripts of video records of mother-child interactions when children were 6 months, 21 months and 6 to 7 years of age, using developmentally appropriate topic-sharing tasks to elicit mind-related language. This study will then examine the reliability of the expanded scheme.

4.1.5.2 To identify maternal characteristics associated with mothers' use of internal state language at the middle childhood assessment. Maternal use of internal state language is typically investigated whilst controlling for maternal talkativeness and education (Adrian et al., 2005; Dunn, Brown, Slomkowski et al., 1991; Ensor & Hughes, 2008; Ruffman et al., 2002, 2006), however, other potential correlates such as maternal behavioural problems must also be investigated. Before examining the relationship between maternal internal state language use and children's understanding of second-order false belief, maternal correlates that may also partially explain children's understanding of minds must also be identified.

4.1.5.3 To investigate the association between mothers' references to internal states and children's second-order false belief understanding in middle childhood. Few studies have explored family influences on children's understanding of second-order false belief in middle childhood (Hughes, 2016). The final aim of this chapter, therefore, was to apply the expanded coding scheme and examine the association between mothers' references to internal states in mother-firstborn interactions and firstborns' second-order false belief understanding. This was conducted whilst controlling for correlates of mothers' internal state language and of children's second-order false belief understanding (child age and verbal IQ, Chapter 3). In the present study it was expected that, in line with previous work (Adrian et al., 2007; Ensor et al., 2014), mothers' references to cognitive states at the middle childhood assessment would be positively associated with children's understanding of second-order false belief.

4.2 Method

The analyses presented in this chapter are based on Waves 1, 2, 4 and 6 of the Cardiff Child Development Study (Figure 4.2). A full description of the study design and procedure at each wave of assessment was presented in Chapter 2.

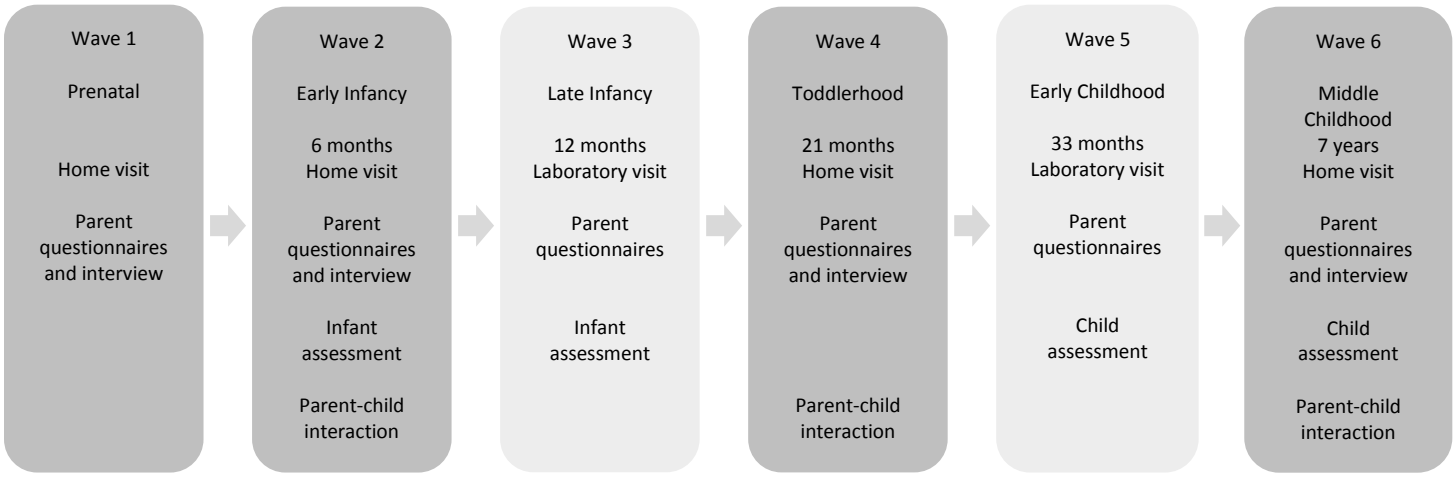

Figure 4.2 CCDS waves used in the present chapter.

4.2.1 Participants

This chapter focuses on families who took part in mother-child interaction tasks in the early infancy, toddlerhood, and middle childhood assessments. The progression of the sample from recruitment in pregnancy to data available for home assessments at each wave is presented in Appendix III. Figure 4.3 shows the progression of the sample from families seen in the home to available mother-child interaction data. The children's mean ages at these assessments were 6.63 (*SD* = .88, range 5.13 – 11.58) at early infancy, 20.63 in toddlerhood (*SD* 2.19, range 17.00 – 29.60) and 83.85 (*SD* 4.70, range 70.00 – 104.00) in middle childhood. Of the 321 families who were seen after childbirth, 276 (86.0%), 238 (74.1%) and 227 (70.7%) provided mother-child interaction data at the early infancy, toddlerhood and middle childhood assessments, respectively.

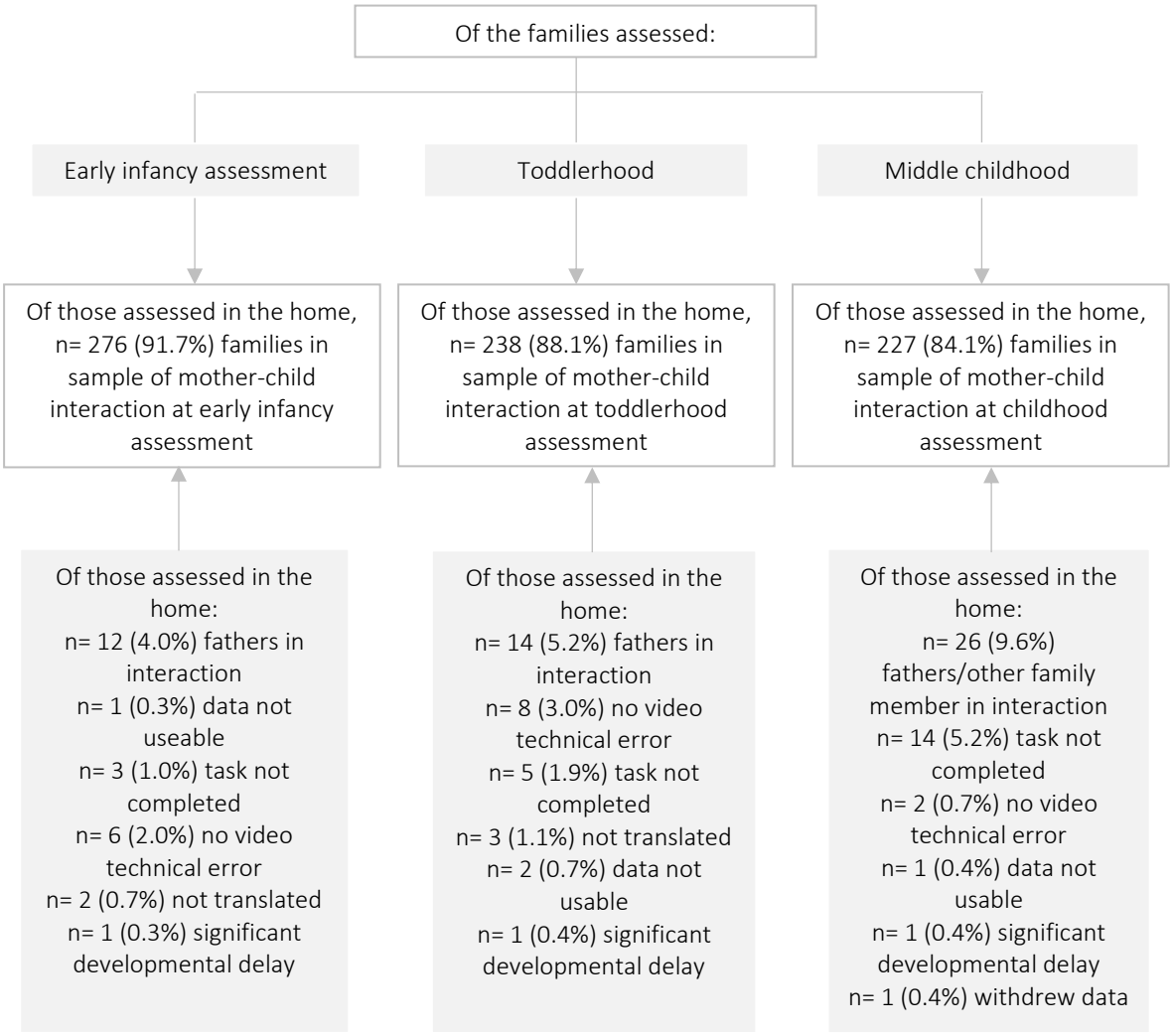

Figure 4.3. Derivation of the sample from families seen in the home to the participants assessed in this study (full attrition diagram in Appendix III).

4.2.2 Measures

4.2.2.1 Mother-child interaction. At early infancy, mothers and their firstborns were given a topic-sharing task using an activity board, a commercially available plastic toy with flaps that equates to a wordless picture book (Roberts et al., 2013). Pilot testing had shown that a toy rather than a book was more acceptable to parents. Similar wordless picture books have been used in previous research to elicit discourse between parents and their children (LaBounty et al., 2008; Ruffman, 2002). The activity board contained pictures of cartoon

animals from farm, safari, park, and under the sea themes on flaps that could be opened and closed (Figure 4.4). The activity board was presented to the mother and child as they were seated on the sofa or floor. Each mother was then asked to "Show (infant's name) this toy. Take him/her through the pictures," and was invited to speak in her preferred language. If mothers had questions or needed reassurance, they were told phrases such as "Show him/her the toy, as you would normally do." This mother-infant interaction was video recorded for 2 minutes.

Figure 4.4 Activity board used in early infancy mother-child topic sharing task

At the toddlerhood assessment, mothers and their firstborn toddlers were given a topic-sharing task using a teddy bear puzzle, a commercially available wooden puzzle of a bear, with six large removable pieces with handles (see Figure 4.5). When the pieces were correctly placed in the spaces, the puzzle would sing, "This is my tummy/ear/nose/foot/hand," and when complete the puzzle would sing the nursery rhyme 'Teddy Bear, Teddy Bear.' The puzzle was presented to the mother and child after a short 10-second restraint task where the child was held back from playing with the puzzle. The mother was then asked to "Show (infant's name) this toy as you normally would," in her choice of language. This interaction was video recorded for 2 minutes.

Figure 4.5 Bear puzzle used in toddlerhood mother-child topic sharing task.

In middle childhood, mother-firstborn dyads were observed as they played with an Etch-a-Sketch, a commercially available drawing game (see Figure 4.6). In this task the Etch-a-Sketch was presented to the mother and child, who were assigned one dial of the toy each to use; one which creates vertical lines and the other that creates horizontal lines. By using their dials at the same time, it is possible to produce diagonal lines. The mother and child were first told, "Now we'd like you to draw a picture with your mum. You can use that dial (researcher points to dial). Your mum can use that dial (researcher points to dial). You have to work together to draw a picture." After 1 minute of free play with the Etch-a-Sketch, the researcher said, "Now we'd like you to draw a picture of a house." The researcher gave the dyad 5 minutes to attempt to draw a house (Stevenson-Hinde & Shouldice, 1995), which was video-recorded. Interactions took place in the dyad's choice of language.

Figure 4.6 Etch-a-Sketch used in middle childhood mother-child topic sharing task.

The video recordings of the 2-minute activity board and teddy bear puzzle tasks, and the 5-minute Etch-a-Sketch house drawing task, were transcribed in 5 second segments (24 segments per participant for activity board and teddy bear puzzle; 60 segments per participant per Etch-a-Sketch). Whilst the majority of interactions took place in English, trained translators transcribed interactions that took place in Welsh, Spanish, French, Dutch and German. Examples of mother-child interaction transcripts are presented in Appendix IV.

4.2.2.1.1. Mothers' Internal State Language. Each 5-second segment of speech was coded for mothers' attributions made about the mind. The revised coding scheme was an expanded version of that used by Roberts and colleagues (2013). Internal state language was divided into seven categories: *Perception*, *physiology*, *preference*, *intention*, *desire*, *emotion* and *cognition*. The development of each category is detailed in the subsequent sections, and a summary of the overall coding scheme is presented in Table 4.4. All internal state terms coded from the transcripts are presented in Appendix V.

For each topic sharing task, all internal state codes for interactions that were shorter than the assigned time for the task were prorated up to 24 segments of speech (2 minutes) for the activity board (8.7%) and teddy bear puzzle tasks (25.0%). For the Etch-a-Sketch task, the majority of mother-child interactions were below 5 minutes in length; therefore, to limit

Table 4.4

The expanded CCDS internal state language coding scheme.

Internal state category	Internal state category description	Maternal verbatim examples		
		Early infancy	Toddlerhood	Middle Childhood
Perception	Comments made about perception of an object using one of five senses, such as "see," "hear," "feel," "taste," "smell."	*"Can you feel that?"* *"What can you see under the sea?"*	*"Can you hear teddy talking to you?"* *"What can you see?"*	*"What are you looking at?"* *"Do you see that?"*
Physiology	Comments made about physical states and sensations, including "sleepy," "pain," "hot/cold (as in temperature)," "sick," "comfy."	*"Are you getting tired?"* *"You're tired."*	*"Is that hurting you, is it?"*	- *(No instances of physiology occurred)*
Preference	Comments made about positive or negative judgements of an object, action or experience. Coding preference includes terms include "like," "hate," "love," "favourite," "enjoy," "interest."	*"You love your fishes."* *"They're your favourite kind, aren't they?"*	*"You like the orange bag don't you?"* *"You like the tummy."*	*"Will you like that?"*
Intention	Comments made about present intentional actions that are goal-directed and future intentions. Includes "try," "attempt," "on purpose," "mean to," "going to."	*"Oh, you're gonna open it."* *"Are you gonna try this one?"*	*"Are you gonna try put the nose back in?"* *"Are you going to make him again?"*	*"Are you going to spoil it?"* *"You trying to make a knocker?"*
Desire	Comments made about longing for an object, action or experience. Desire terms include "want," "wish," "hope," "fancy," "rather," "need (as in want)."	*"You wanna open that one?"* *"You'd rather eat it?"*	*"Do you want to do it?"* *"Do you fancy that one?"*	*"Oh, you want it right there, do you?"* *"Or do you wanna do some windows there?"*
Emotion	Comments made about feeling states, including basic emotions "happy," "sad," "surprised," "disgusted" and variations like "fed up," "bored," "glad," "excited."	*"You fed up there?"* *"You're getting bored with this aren't you?"*	*"Don't be upset."* *"Don't worry."*	*"You're fed up aren't you now."* *"Happy with that?"*
Cognition	Comments made about beliefs and knowledge. Also include general terms indicating other cognitive activity, such as "remember," "imagine," "pretend," "understand."	*"Do you remember Nelly the elephant?"* *"Do you think it's a safari?"*	*"Does it go that side, do you think?"* *"Can you work it out?"*	*"You've worked out how to do it."* *"Remember yours can only go up and down."*

prorating as much as possible, coding was limited to 3 minutes and shorter sessions (39.2%) were prorated up to 36 segments of speech. Prorated codes were computed by dividing all each code by the number of speech segments available, then multiplying by the number of speech segments of the full task length (24 for the 2 minute tasks, 36 for 3 the minute task). Each coding category was divided by number of minutes of task length to yield a rate-per-minute of each code.

4.2.2.1.1.1 Perception. There is a paucity of research in the role of perception in comparison to other internal states (Gopnik, Slaughter, & Meltzoff, 1994), particularly in studies of parent-child conversation. Perception featured in one of the original coding schemes of toddler internal state language (Bretherton & Beeghly, 1982), which also aligned with specifications made by others at the time (Gearhart & Hall, 1979). Bretherton and Beeghly's (1982) scheme included utterances regarding: sight, hearing, smell, taste, touch, pain, temperature, and was adapted for the study of mother's discourse (Beeghly et al., 1986).

More recent studies have developed a novel scheme to code for perception in mothers' conversations with their infants (Slaughter et al., 2008, 2009). In the scheme by Roberts and colleagues (2013), the mother's saying "look" alone was an exclusion criterion as it appeared to be a term used, not to comment on the child's internal state, but rather to capture and orient the child's attention. Slaughter and colleagues took this further to identify two types of perception categories: (a) imperatives, which included such terms used to manage the child's attention, or to request their involvement in mental activity (e.g., "Look at this!" "Touch those blocks") and (b) declaratives, which include mothers' comments on children's current mental states (e.g., "Are you looking at the doggie?" "How does that feel?"). Imperative perceptual terms were consistently used by mothers towards their infants at 9, 12 and 15 months of age, yet use of declarative terms declined when infants mastered

joint visual attention, highlighting the importance of separating these perceptual terms (Slaughter et al., 2008).

In the revised coding scheme, references to perception of objects, events or symbols (declaratives) using one of the five senses (see, hear, taste, feel and smell) were coded as references to internal states. Utterances commenting on the feeling of "hot," and "cold," (as in temperature) were also included. Utterances that involved commands or invitations to perceive, or to capture and engage attention (imperatives) were coded separately, but not included as references to internal states.

4.2.2.1.1.2 Physiology. Like perception, physiology has also not featured in the majority of recent coding schemes, despite being a category included in Bretherton and colleagues' schemes (1982, 1986). In this scheme, physiology was coded as utterances commenting on hunger, thirst, and states of consciousness, and it was identified that mothers' use of physiological terms increases as children reach the second year of life, along with use of cognitive and moral/obligation terms (Beeghly et al., 1986). In more recent studies, physiology has rarely featured in coding schemes as an internal state category. Instead 'physical states' have been coded separately from internal states in some schemes (Ruffman et al., 2002; Taumoepeau & Ruffman, 2006, 2008). These have included terms such as "cry," "smile," "laugh," "giggle," "hurt," "in pain," "sleepy," "tired," "hungry," and "thirsty" (Ruffman et al., 2002). Although Ruffman and colleagues (2002) did not find that mothers' talk about 'physical states' was associated with children's performance on theory of mind tasks, this may be because physical manifestations of internal states, such as "yawn," were grouped with internal states, such as "sleepy."

As little is understood about use of terms commenting on physical states, it was decided that the current coding scheme should expand upon the Roberts and colleagues' (2013) scheme by separating physiology from emotion, thus returning to the

recommendations of Bretherton and Beeghly (1982). This adaptation was further supported by research indicating that both mothers' and children's references to physiology may not follow the same pattern over development as emotion (Beeghly et al., 1986). As it can be difficult to separate perception from physiology, in this scheme, perception strictly refers to the five senses. Physiology however, refers to states of consciousness, such as "sleepy," "alert," "dopey, "hungry," and "thirsty." Utterances that comment on the external manifestations of these states, such as "giggle," "yawn," "sleeping," and "cry," were not coded as references to internal states.

4.2.2.1.1.3 Preference. Like physiology, preferences were also extracted from Roberts and colleagues' (2013) original scheme and coded separately from emotions. Despite some previous coding schemes including preferences with emotion categories (Jenkins et al., 2003), more recently preferences have been extracted as a separate category of interest (Recchia & Howe, 2008). Given that the frequency of children's use of emotion and preference-related terms differ across ages (Recchia & Howe, 2008), this provides good justification for their separation. In the present scheme, therefore, terms indicating the child's preferences such as "like," "love," "hate," "dislike" were coded. "Like" is coded only when denoting preferences, such as, "Do you like this game?" When "like" is used in idiomatic phrases, such as, "Shall we like, do it this way?" or for comparatives, "This game is like the one you have at Granny's house," these were not coded. Utterances indicating a positive or negative judgement on an object, activity or experience, such as, "Are you enjoying this game?" or, "You're more interested in chewing it, aren't you?" were coded as preferences.

4.2.2.1.1.4 Intention. The criteria for coding intentions were based on the definitions used by Roberts and colleagues (2013), where utterances commenting on children's attempts to achieve a goal, trying or purposeful action were coded. In the present scheme, this definition was clarified and made more conservative by drawing upon definitions of the *two*

faces of intention set forth by Bratman (1984). The first is *present-directed* intention, where present actions are seen to be intending to reach a current goal, e.g., "Are you trying to stroke the teddy?" The second face of intention is *future-directed intention*, involving not a present intentional act, but an intention to act later, e.g., "Are you going to stroke the teddy next?"

Therefore, within the expanded coding scheme, both present intentional actions and future intentions were coded. Intention terms included "try," "attempt," "plan," "on purpose," "mean to," "intend to," "going to." Comments made about children's mismatched actions and intentions were also coded, "You didn't mean to do that, did you?" "Did you do that by accident?" Furthermore, in line with Slaughter and colleagues' (2008) distinctions between imperatives and declaratives, utterances that simply provide commentary on what the child is currently doing, such as, "Are you putting that in there?" "What are you doing?" or inviting the child to attempt a goal, such as, "try this," and, "Can you find his nose?" were not coded.

4.2.2.1.1.5 Desire. Terms coded for desire were predominantly in line with Bartsch and Wellman's (1995) criteria, including utterances that commented on the child's longing to "…obtain an object, engage in an action, or experience a state of affairs" (p. 67). Desire terms included variations of "want," "wish," "hope," "love (to)," "like (to)," "fancy," "prefer," and, "rather." Phrases that also commenting on the child's desire such as, "You're after that, aren't you?" and, "You were dying to get to that a minute ago" were also coded. References to not wanting were also included. Instances where key terms were used in idiomatic phrases, such as, "wish upon a star" were not coded.

According to Bartsch and Wellman (1995) and Ruffman and colleagues (2002), statements of desire without an object, e.g., "Do you wanna?" and 'want-as-request' utterances, "I want a cookie" should be excluded. In the present coding scheme however, a more inclusive approach was adopted. Given that it is impossible to determine whether such comments are mind-related or not, excluding these terms based on making such assumptions

could be problematic (Brown et al., 1996). Therefore all instances of desire terms were included in this scheme.

Children's utterances of "need" can denote a desire; however in the case of adults, "need" refers "…prototypically to objects required or necessary for some function, or compulsory because of some rule or convention, not merely desired.*"* (Bartsch & Wellman, 1995, p. 93). Thus, in the present coding scheme, unless clearly used to denote a desire, "need", was coded separately amongst other similar terms such as, "supposed to," "ought to," and, "must." These were not included as internal states, but noted terms indicating obligation and adherence to rules, which may be of interest in their own right.

4.2.2.1.1.6 Emotion. The coding for emotion was in line with the original coding schemes: Bretherton and colleagues' (1982, 1986) coding for affect and Bartsch and Wellman's (1995) categorisation within their belief-desire reasoning model. In contrast to Roberts and colleagues' original scheme, physiology and preference were removed, so the emotion category now only included references to feeling states. Terms coded as emotion included variations of basic emotions: "happy," "sad," "angry," "surprised," "scared" and "disgust" and also included other feeling states, such as "bored," "embarrassed," "jealous," and "lonely." Phrases that indicate feeling states such as "fed up" or "make a fuss" were included. Instances were excluded when feeling terms were included in non-mind-related phrases such as "Happy birthday". Utterances were only coded as emotion if they were direct comments on the internal state; comments on behaviour that refer to expressions of emotional states such as "cry," "laugh," "smile," were not included in this scheme.

4.2.2.1.1.7 Cognition. Cognition represented a broad category of terms referring to beliefs and mental activity. These included "think" and "know" (Bartsch & Wellman, 1995), and also various modulations of assertion, e.g., "guess," "figure," "suppose," and other cognitive activity, such as "remember," "understand," "expect," "imagine," "forget," and

"pretend" (Bretherton et al., 1982; 1986). Any utterances including contrastives (e.g., "I thought that was a dog, but it is a bear.") were also noted and highlighted within this category. References to not knowing or believing were also included.

There has been some contention in previous research concerning the inclusion of conversational uses of cognitive verbs, such as, "You know what?" and, "I dunno," which have been excluded in some past research due to their ambiguity (Bartsch & Wellman, 1995; Shatz, Wellman, & Silber, 1983). However, such ambiguous phrases were included within the present coding scheme, based on the argument that it is impossible to determine if such conversational devices are mind-related or not, and excluding these terms based on this assumption could be problematic (Brown et al., 1996). Additionally, it has been demonstrated that there is no difference between such ambiguous terms and genuine terms in the strength of prediction to false belief understanding (Hughes & Dunn, 1998).

4.2.2.1.1.8 Other considerations. There are some additional considerations that must be noted. The first is that multiple categories of internal state language may be present within a single utterance, for example, "You *reckon* you *wanna* play with the bear?" would be coded as both cognition and desire. The second consideration is the referent of internal state language. In this scheme, mothers' references to her own and the child's inner states are reported separately. This is a notable change from the original scheme, which focused exclusively on mothers' references to the child's internal states. This change will expand the ways in which internal state language can be examined. Thirdly, the pronouns used in internal state utterances were also noted, as, particularly for adult speech, comments may be made about children's internal states directly to the child, "Are you happy?"; referring to first person plural with the child, "Are we happy?"; or they may be indirectly describing children's internal states, "He is happy." Finally, when coding both mother and child speech in the same interaction, unlike the recommendations set out by Shatz and colleagues (1983)

repetitions of internal state language are included in this scheme. This is due to the reasoning that excluding repeated terms could be too conservative and may underestimate use of internal state language.

4.2.2.1.1.9 Creating total scores. Instances of internal state language were counted to form frequency counts for each category, total frequency according to referent, (mother's own internal states or child's internal states), and overall total frequency of references to internal states. Mothers' internal state language was also coded for *variety* of terms within each category. For example, in four instances of references to cognition: "think", "thought", "know" and "remember", the frequency count for cognitive terms was 4, but the variety count was 3.

4.2.2.1.2 Mothers' talkativeness. Mothers' talkativeness during the early infancy, toddlerhood and middle childhood assessments was computed by dividing the number of 5-second segments containing speech by total number of 5-second segments in each task. Mothers were therefore given proportional talkativeness scores between 0 and 1. This measurement of talkativeness has been validated by *Audacity* voice analysis software in a subsample of cases $r(88) = .72$, $p < .001$ (Roberts et al., 2013). The mean score for maternal talkativeness was .87 ($SD = .18$) during the early infancy task, .76 ($SD = .18$) during the toddlerhood task, and .82 ($SD = .12$) during the middle childhood task.

4.2.2.1.3 Missing mother-child interaction data. Little's Missing Completely At Random (MCAR) test was used to establish if there were any patterns in missing data in the maternal talkativeness scores and use of internal state language. Little's MCAR test indicated random patterns of missing data for available maternal talkativeness $\chi^2(9) = 13.12$, $p = .16$ and internal state language scores $\chi^2(9) = 8.80$, $p = .46$ across the three waves of assessment. Therefore, where talkativeness and internal state language scores were missing, scores were imputed from the mother's most recent previous assessment where language data from a

mother-child interaction task was available. The scores were imputed using unstandardized predicted scores from SPSS regression analyses. The final sample size for mother-child interaction data was therefore 276 (86.0% of those seen after childbirth), where 13.8% were imputed scores for the toddlerhood assessment and 17.8% were imputed scores for the middle childhood assessment.

4.2.2.2 Maternal correlates of internal state language.

4.2.2.2.1 Maternal productive language. The Wechsler Test of Adult Reading (WTAR; Wechsler, 2001) was used to assess adults' ability to recognise and pronounce words with irregular phonological properties, and was developed for use as an estimate mothers' intellectual and memory abilities. Data were available for 197 (71.4%) of mothers with interaction data. Each mothers' score was calculated by age-normalising the data to produce a standardised score. The mean score for mothers' productive language was 98.04 (*SD* = 14.26) and ranged from 55 to 122.

4.2.2.2.2 Sociodemographic risk. See Chapter 2, Section 2.2.2.3, page 30.

4.2.2.2.3 Maternal behavioural problems. Maternal behavioural problems were assessed using seven DSM-IV items for conduct problems (disobedience, anger, stealing, dishonesty, truancy and vandalism) listed in the screening questionnaire for the International Personality Disorder Examination (IPDE; Loranger et al., 1994). Five symptoms of ADHD from the mother's prenatal self-report questionnaire called 'What I Was Like as a Child' were combined with the items for conduct problems to create a composite variable of mothers' history of behavioural problems. This composite variable was created by summing the scores for each set of symptoms, with missing items prorated. This had an internal consistency for mothers of $\alpha = .82$ (Hay et al., under review). Additional descriptive data are presented in Appendix VI.

4.2.2.3 Second-order false belief. In this task, children were told a second-order false belief story that was enacted with plastic Playmobil figures by the experimenter. Children had to answer all belief, justification and comprehension questions correctly to be classified as passing second-order false belief with full comprehension. Excellent reliability was established for passing this task (Kappa coefficient 1.00). Full details of this task are described in Chapter 3, page 59. Within the sample of children who had mother-child interaction data available, 227 (82.2%) completed the second-order false belief task.

4.2.2.4 Verbal IQ. Children's vocabulary knowledge was assessed using the British Picture Vocabulary Scale (BPVS; Dunn et al., 1982). Within the sample of children who had mother-child interaction data available, 229 (83.0%) completed the verbal IQ assessment. The mean score for verbal IQ was 99.74 (*SD* = 11.75), and the average age children in the sample were equivalent to was 84.20 months (*SD* = 14.52) and ranged from 57 to 150 months.

4.3 Results

4.3.1 Establishing reliability of the internal state language coding scheme. An independent observer coded maternal use of internal state language in 70 cases (25.4% of transcripts) from the early infancy assessment, 51 cases (21.4% of transcripts) from the toddlerhood assessment, and 68 cases (30.0% of transcripts) from the middle childhood assessment. Excellent inter-rater reliability was established at all waves of assessment. The inter-class correlations are presented in Table 4.5.

Table 4.5

Categories for coding internal state language; reliability analysis across three waves of assessment.

		Intra-class correlations for maternal internal state language Time of assessment		
		Early Infancy	Toddlerhood	Middle Childhood
References to child	Perception	.98	.97	1.00
	Physiology	1.00	1.00 [a]	1.00 [a]
	Preference	.98	.98	1.00
	Intention	.99	1.00	.98
	Desire	1.00	.99	.97
	Emotion	1.00 [a]	.94	1.00
	Cognition	.94	.98	.99
References to self	Perception	1.00 [a]	.88	.93
	Physiology	1.00 [a]	1.00 [a]	1.00 [a]
	Preference	1.00 [a]	1.00	.92
	Intention	1.00 [a]	1.00 [a]	.97
	Desire	1.00 [a]	1.00 [a]	.89
	Emotion	1.00 [a]	1.00 [a]	1.00 [a]
	Cognition	.98	.91	.99

Note. Reliability statistics represent Cohen's alphas. [a] Reliability analysis not calculable as zero variance in scores. Agreement is therefore 1.00.

4.3.2 Descriptive data for maternal use of internal state language

4.3.2.1 Overall frequency at three waves of assessment. The majority of mothers produced at least one reference to their children's or their own internal states (80.4%, 84.4% and 91.7% at the early infancy, toddlerhood and middle childhood interactions, respectively). The mean frequencies of internal state language across the three time-points are displayed in Figure 4.7. Mothers referred to the inner states of the child significantly more than to their own inner states, at the early infancy assessment $t(275) = 16.74$. $p < .001$, toddlerhood assessment $t(275) = 15.82$, $p < .001$, and the middle childhood assessment $t(275) = 12.37$, $p < .001$. A repeated-measures ANOVA indicated a significant difference in frequency of mothers' overall use of internal state language across the three time-points $F(2,550) = 9.08$, $p < .001$, where pairwise comparisons with Bonferroni correction indicated mothers' used

significantly less internal state language at the toddlerhood assessment than the early infancy and middle childhood assessments (*p*s < .01)

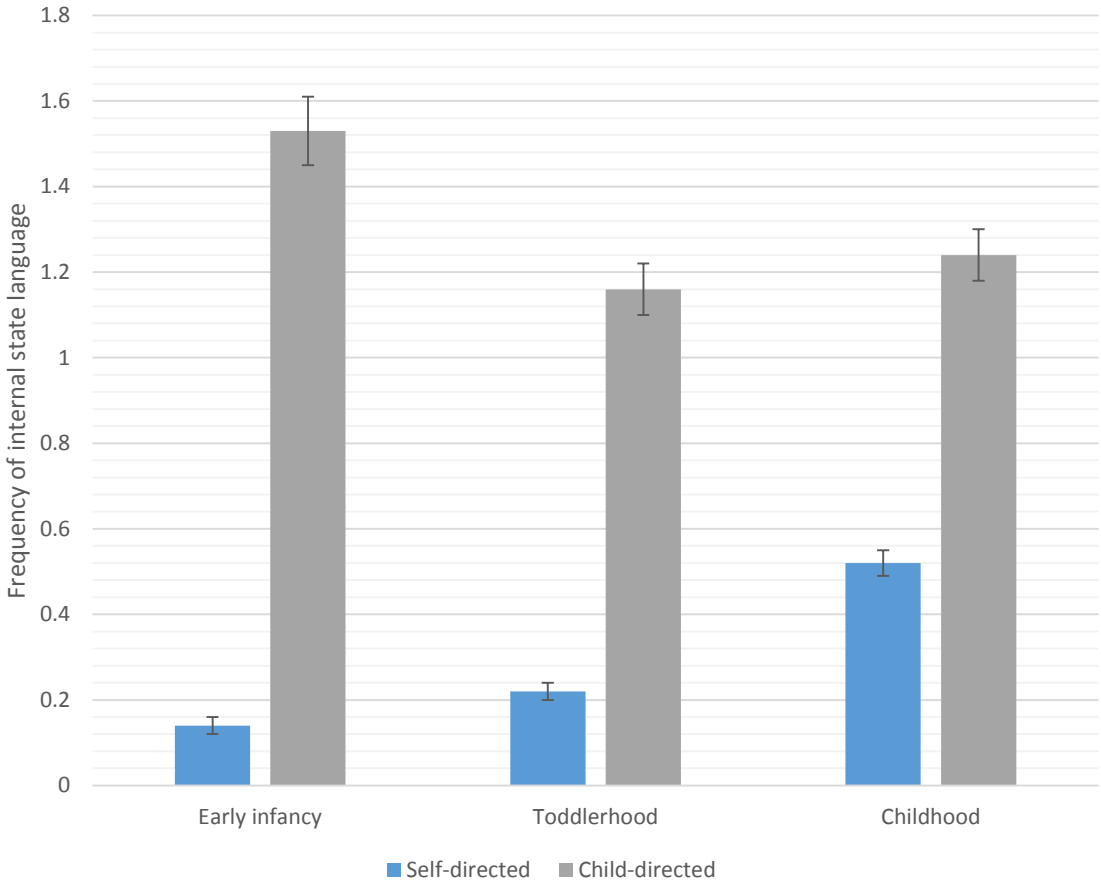

Figure 4.7. Frequency of maternal use of child-directed and self-directed internal state language across three waves of assessment. Means are based on rate per minute, error bars are ± SE of the mean.

4.3.1.2 Individual categories of internal state language. The range and mean rates for frequency of each category at the early infancy, toddlerhood and middle childhood assessments are presented in Table 4.6. Table 4.7 shows both frequency and variety of mothers' internal state language categories broken down by references to the child's inner states, and references to her own inner states. Perception was the most common occurring category during the early infancy interaction, desire at the early toddler interaction, and

cognition at the middle childhood interaction. This is further demonstrated by an illustration of the relative frequency of each internal state language category across the three time-points in Figure 4.8.

Table 4.6

Range, means and standard deviations for overall frequencies (rate per minute) of mothers' references to internal states at each wave of assessment.

Internal state language category	Early infancy		Toddlerhood		Middle Childhood	
	Range	Mean *(SD)*	Range	Mean *(SD)*	Range	Mean *(SD)*
Perception	.00 – 6.00	.61 *(.96)*	.00 – 2.12	.15 *.(32)*	.00 – 1.92	.10 *(.21)*
Physiology	.00 – 1.33	.03 *(.14)*	.00 – 1.00	.01 *(.07)*	.00 – .41	.01 *(.04)*
Preference	.00 – 2.00	.24 *(.39)*	.00 – 1.57	.09 *(.24)*	.00 – .43	.02 *(.07)*
Intention	.00 – 2.67	.16 *(.38)*	.00 – 2.40	.29 *(.42)*	.00 – 3.33	.49 *(.52)*
Desire	.00 – 3.00	.41 *(.55)*	.00 – 3.00	.38 *(.50)*	.00 – 2.67	.43 *(.44)*
Emotion	.00 – 1.00	.02 *(.13)*	.00 – 1.00	.03 *(.14)*	.00 - .92	.02 *(.08)*
Cognition	.00 – 3.00	.20 *(.40)*	.00 – 5.00	.43 *(.62)*	.00 – 6.95	.70 *(.76)*
Total internal state language about child	.00 – 6.50	1.53 *(1.41)*	.00 – 5.50	1.16 *(1.00)*	.00 – 6.33	1.24 *(.96)*
Total internal state language to self	.00 – 2.50	.14 *(.33)*	.00 – 2.57	.21 *(.34)*	.00 – 3.43	.52 *(.53)*
Total internal state language	.00 – 7.00	1.68 *(1.50)*	.00 – 6.50	1.38 *(1.12)*	.00 – 7.33	1.76 *(1.21)*

Note. $N = 276$.

Table 4.7

Means and standard deviations for frequency and variety of maternal internal state language categories (rate per minute) directed to child and about self at each wave of assessment.

Mothers' references to child's internal states	Wave of assessment						Mothers' references to own internal states	Wave of assessment					
	Early infancy assessment		Toddlerhood assessment		Middle Childhood assessment			Early infancy assessment		Toddlerhood assessment		Middle Childhood assessment	
	Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	Mean	SD
Perception							Perception						
Frequency	.60	.95	.13	.29	.03	.10	Frequency	.01	.07	.02	.10	.06	.16
Variety	.63	.77	.09	.20	.03	.10	Variety	.02	.15	.02	.09	.05	.11
Physiology							Physiology						
Frequency	.03	.14	.01	.07	.00	.00	Frequency	.00	.00	.00	.00	.00	.04
Variety	.05	.24	.01	.05	.00	.00	Variety	.00	.00	.00	.00	.00	.04
Preference							Preference						
Frequency	.24	.39	.08	.23	.00	.03	Frequency	.00	.05	.01	.05	.02	.07
Variety	.38	.60	.07	.19	.00	.03	Variety	.01	.08	.01	.05	.02	.07
Intention							Intention						
Frequency	.16	.38	.29	.42	.41	.45	Frequency	.00	.03	.01	.05	.06	.16
Variety	.21	.43	.20	.26	.23	.19	Variety	.00	.06	.01	.05	.05	.11
Desire							Desire						
Frequency	.40	.54	.37	.50	.40	.42	Frequency	.01	.05	.01	.05	.02	.07
Variety	.50	.52	.23	.25	.24	.21	Variety	.01	.10	.01	.05	.01	.06
Emotion							Emotion						
Frequency	.02	.13	.03	.14	.02	.08	Frequency	.00	.00	.00	.00	.00	.00
Variety	.03	.18	.03	.12	.02	.08	Variety	.00	.00	.00	.00	.00	.00
Cognition							Cognition						
Frequency	.08	.23	.25	.48	.35	.47	Frequency	.12	.29	.18	.30	.35	.43
Variety	.14	.37	.17	.28	.25	.28	Variety	.21	.46	.15	.23	.25	.25

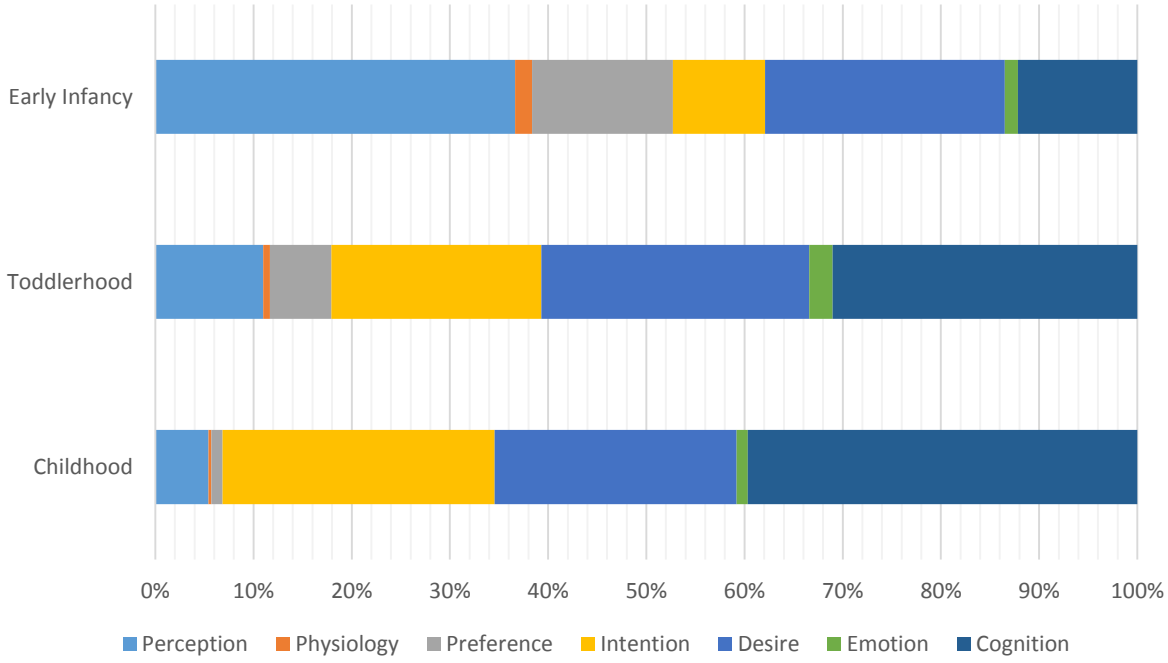

Figure 4.8 Relative frequencies of maternal child-directed internal state language categories across three waves of assessment.

4.3.3 Maternal correlates of language in mother-child interaction.

Table 4.8 summarises associations between measures of maternal language and all potential maternal covariates identified in section 4.1.4.4, page 94. As maternal talkativeness was measured within the same context of assessment as internal state language, these predictors of these aspects of maternal language were investigated separately.

Table 4.8

Intercorrelations among mothers' language during the mother-child interaction task and maternal risk factors.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Early infancy maternal talkativeness	-								
2. Early infancy maternal internal state language	.36** (276)	-							
3. Toddlerhood maternal talkativeness	.04 (276)	.16** (276)	-						
4. Toddlerhood internal state language	.14* (276)	.33** (276)	.36** (276)	-					
5. Middle childhood maternal talkativeness	.14* (276)	.18** (276)	.06 (276)	.12 (276)	-				
6. Middle childhood maternal internal state language	.03 (276)	.29** (276)	.16* (276)	.23** (276)	.39** (276)	-			
7. Maternal productive language	.06 (197)	.11 (197)	.08 (197)	.15* (197)	.04 (197)	.14* (197)	-		
8. Maternal adversity score	-.23** (276)	-.32** (276)	-.06 (276)	-.15* (276)	-.13* (276)	-.18** (276)	-.61** (197)	-	
9. Maternal behavioural problems	-.14* (276)	-.18** (276)	-.07 (298)	-.09 (276)	-.13* (276)	-.19** (276)	-.46** (197)	.46** (276)	-
Mean	.87	1.68	.76	1.38	.82	1.76	98.04	-.11	5.43
(SD)	*(.18)*	*(1.50)*	*(.18)*	*(1.12)*	*(.12)*	*(1.21)*	*(14.26)*	*(.95)*	*(4.04)*

Note. *$p < .05$, ** $p < .01$, number of participants is shown in brackets below the correlation.

Sociodemographic adversity and maternal history of behavioural problems were found to be negatively associated with mothers' talkativeness scores at the early infancy and middle childhood assessments. Therefore these correlates were entered into a logistic regression analysis to establish their contribution towards maternal talkativeness at each wave of assessment. When entered into the same model, only sociodemographic adversity predicted maternal talkativeness at the early infancy assessment (β = -.04, $p < .10$, see Table 4.9).

Table 4.9

Prediction of mothers' talkativeness and use of internal state language at three waves of assessment from maternal risk factors.

Maternal talkativeness								
Early infancy (model 1)			Toddlerhood (model 2)			Middle Childhood (model 3)		
Predictor	ΔR^2	*β*	Predictor	ΔR^2	*β*	Predictor	ΔR^2	*β*
	.05***			.01			.02*	
Maternal adversity score		-.04**	Maternal adversity score		-.01	Maternal adversity score		-.01
Maternal behavioural problems		-.00	Maternal behavioural problems		.00	Maternal behavioural problems		.00
Maternal internal state language								
Early infancy (model 4)			Toddlerhood (model 5)			Middle Childhood (model 6)		
Predictor	ΔR^2	*β*	Predictor	ΔR^2	*β*	Predictor	ΔR^2	*β*
	.10***			.02*			.06**	
Maternal adversity score		-.47***	Maternal adversity score		-.14*	Maternal productive language		.00
Maternal behavioural problems		-.02	Maternal behavioural problems		-.01	Maternal adversity score		-.13
						Maternal behavioural problems		-.07*

Note. The coefficients presented are those obtained in the final models: Model 1: $F(2, 273) = 7.72$, $p < .001$, $R^2 = .07$, Model 2: $F(2, 273) = .47$, $p = .47$, Model 3: $F(2, 273) = 3.25$, $p < .05$, Model 4: $F(2, 273) = 15.89$, $p < .001$, Model 5: $F(2, 273) = 3.16$, $p < .05$, Model 6: $F(3, 193) = 3.97$, $p < .01$.

$^{t}p < .10$, $*p < .05$, $**p < .01$, $***p < .001$.

Sociodemographic adversity and mothers' history of behaviour problems were also negatively associated with maternal internal state language at all time-points. Maternal productive language was also positively associated with references to internal states at the middle childhood assessment. In logistic regression analyses, these correlates were entered into the model. Only sociodemographic risk predicted mothers' use of internal state language at the early infancy (β = -.47) and toddlerhood (β = -.14) assessments (ps < .05). Mothers' history of behavioural problems significantly and negatively predicted maternal references to inner states at the middle childhood assessment (β = -.07, p <.05, see Table 4.9).

4.3.4 Is maternal language related to children's second-order false belief understanding in middle childhood?

Seventy children (30.8%) passed the second-order false belief task with full comprehension in the sample used in this investigation. No features of mothers' language at the early infancy and toddlerhood assessments were associated with children's passing of second-order false belief. Similarly, mothers' talkativeness at the middle childhood assessment was unrelated to children's passing of second-order false belief questions. Therefore, all subsequent analysis focused on maternal use of internal state language at the middle childhood assessment. Table 4.10 summarises associations between mothers' use of internal state language and children's understanding of second-order false belief questions. Mothers' frequency and variety of cognitive terms, both in referring to the cognitive states of the child and of herself, were positively associated with firstborns' passing of the second-order false belief questions.

Table 4.10

Correlations between maternal internal state language terms (frequency and variety) at the middle childhood assessment and firstborn second-order false belief understanding with full comprehension.

Mothers' references to child's internal states			Mothers' references to own internal states		
Internal state term		Second-order false belief understanding	Internal state term		Second-order false belief understanding
Perception	Frequency	.03	Perception	Frequency	-.07
	Variety	.03		Variety	-.07
Physiology	Frequency	. [a]	Physiology	Frequency	.05
	Variety	. [a]		Variety	.05
Preference	Frequency	-.06	Preference	Frequency	.02
	Variety	-.06		Variety	.02
Intention	Frequency	-.03	Intention	Frequency	.04
	Variety	-.04		Variety	.03
Desire	Frequency	.03	Desire	Frequency	.12[t]
	Variety	-.02		Variety	.11[t]
Emotion	Frequency	.07	Emotion	Frequency	. [a]
	Variety	.07		Variety	. [a]
Cognition	Frequency	.14*	Cognition	Frequency	.17**
	Variety	.15*		Variety	.15*
Total	Frequency	.08	Total	Frequency	.15*
	Variety	.07		Variety	.13*

Note. $N = 227$. [a] No occurrence of internal state language term, [t]$p < .10$, *$p < .05$, **$p < .01$.

Logistic regression analyses were used to investigate the association between maternal references to cognition and children's passing of second-order false belief questions further. The four models presented in Table 4.11 assessed the prediction of firstborns' passing of second-order false belief questions from mothers' references to her own and to her child's cognitive states in terms of variety and frequency. In each model, known covariates of passing second-order false belief (Chapter 3) firstborn age and verbal IQ, were entered. Maternal behavioural problems was entered at the second step as an identified covariate of maternal internal state language. Mothers' cognitive references were entered at the final step of each model.

Mothers' references to the child's cognitive states was explored in models 1 and 2. In model 1, the frequency of mothers' references to the child's cognitive states represented a significant final step in explaining children's second-order false belief understanding with full comprehension χ^2 (1) = 5.34, p < .05, Wald statistic = 4.94, p <.05, *OR* = 1.97, 95% CI(1.09 – 3.57), and the overall model was significant χ^2 (4) = 22.48, p < .001, Nagelkerke R^2 =.13. Mothers' variety of references to the child's cognitive states also predicted a significant advantage on firstborns' second-order false belief, representing a significant final step in model 2 χ^2 (1) = 5.75, p < .05, Wald statistic = 5.62, p <.05, *OR* = 3.24, 95% CI(1.23 – 8.55), final model χ^2 (4) = 22.89, p < .001, Nagelkerke R^2 = .14 (Table 4.11).

In models 3 and 4, mothers' references to her own cognitive states were investigated as predictors of firstborns' second-order false belief understanding. Mothers' frequency of references to her own cognitive states significantly predicted children's passing of second-order false belief, with a significant final step χ^2 (1) = 7.47, p < .01, Wald statistic = 7.12, p <.01, *OR* = 2.42, 95% CI(1.26-4.62), final model χ^2 (4) = 24.61, p < .001, Nagelkerke R^2 =.15. Mothers' variety of references to her own cognitive states also predicted children's second-order false belief understanding, with a significant final step χ^2 (1) = 4.66, p < .05, Wald statistic= 4.52, p <.05, *OR* = 3.40, 95% CI(1.10 – 10.49), final model χ^2 (4) = 21.78, p < .001, Nagelkerke R^2 = .13 (Table 4.11).

Table 4.11

Prediction of children's passing of second-order false belief with full comprehension from mothers' references to cognitive states.

Mothers' references to child's cognitive states

Model 1							Model 2						
Predictor	R^2	*B*	*SE*	Wald χ^2	*eв*	95% CI for OR	Predictor	R^2	*B*	*SE*	Wald χ^2	*eв*	95% CI for OR
Step 1	.10***						Step 1	.10***					
Constant		-15.13	3.81	15.80	.00		Constant		-15.10	3.79	15.87	.00	
Firstborn age		.12**	.04	9.68	1.13	1.05 – 1.21	Firstborn age		.12**	.04	9.59	1.12	1.04 – 1.21
Verbal IQ		.04**	.02	8.87	1.05	1.02 – 1.08	Verbal IQ		.04**	.02	8.88	1.05	1.02 – 1.08
Step 2	.10***						Step 2	.10***					
Mothers' behavioural problems		-.03	.04	.97	.49	.90 – 1.05	Mothers' behavioural problems		-.03	.04	.45	.97	.90 – 1.05
Step 3	.13***						Step 3	.14***					
Frequency of cognitive references		.68*	.31	4.94	1.97	1.08 – 3.57	Variety of cognitive references		1.18*	.50	5.62	3.24	1.23 – 8.55

Mothers' references to own cognitive states

Model 3							Model 4						
Predictor	R^2	*B*	*SE*	Wald χ^2	*eв*	95% CI for OR	Predictor	R^2	*B*	*SE*	Wald χ^2	*eв*	95% CI for OR
Step 1	.10***						Step 1	.10***					
Constant		-15.40	3.86	15.94	.00		Constant		-14.36	3.75	14.70	.00	
Firstborn age		.12**	.04	9.66	1.13	1.05 – 1.21	Firstborn age		.11**	.04	8.78	1.12	1.04 – 1.20
Verbal IQ		.05**	.02	9.32	1.05	1.02 – 1.08	Verbal IQ		.04**	.02	8.03	1.04	1.01 – 1.07
Step 2	.10***						Step 2	.10***					
Mothers' behavioural problems		-.03	.04	.41	.97	.90 – 1.06	Mothers' behavioural problems		-.03	.04	.50	.97	.90 – 1.05
Step 3	.15***						Step 3	.13***					
Frequency of cognitive references		.88 **	.33	7.12	2.42	1.26 – 4.62	Variety of cognitive references		1.22	.58	4.52	3.40	1.10 – 10.49

Note. $N = 224$. The coefficients presented are those obtained in the final models. R^2 represents Nagelkerke statistic. *$p < .05$, **$p < .01$, ***$p < .001$.

4.4 Discussion

The primary aim of this chapter was to expand the internal state language coding scheme previously used in the Cardiff Child Development Study (Roberts et al., 2013). Following the development of this scheme I conducted an initial exploration of mothers' use of child-directed internal state language during early infancy, toddlerhood and middle childhood. Secondly, I identified maternal correlates of internal state language use. Thirdly and finally, I investigated the hypothesis that mothers' references to cognitive states during a topic-sharing task in middle childhood would predict firstborns' second-order false belief understanding at the same time-point of assessment.

4.4.1 Expanding the internal state language coding scheme used by the Cardiff Child Development Study

In a previous study, the original internal state language coding scheme was used to explore mothers' child-directed speech in the early infancy assessment (Roberts et al., 2013); this was based on Bartsch and Wellman's (1995) categorisation of theory of mind and consisted of five categories: *basic emotions/physiology, perception, intentional agency, desire* and *belief*. This coding scheme expanded on the majority of previous schemes used in moderately sized, longitudinal studies that were limited to desire, emotion and belief (Ensor & Hughes, 2008; LaBounty et al., 2008). However, there were three main issues that needed to be addressed: (1) there was scope to expand the internal state language categories beyond the five already identified (2) the coding scheme lacked detailed descriptions and examples that would enable the coding scheme to be applied to adult language towards children of different ages; and (3) despite acceptable inter-rater reliability, the novel category *intentional agency* required further development.

The adapted coding scheme for internal state language consisted of seven categories: *perception, physiology, preference, intention, desire, emotion* and *cognition*. The two new

categories, physiology and preference, were added for several reasons. In the original internal state language coding scheme, these terms were included within the basic emotion/physiology category. However, studies have suggested that, over time, the pattern of mothers' use physiology and preference-related terms differs from terms commenting on children's emotions (e.g., Beeghly et al., 1986; Recchia & Howe, 2008), providing strong justification for the separation of these categories.

All original and new categories in the present coding scheme were described in detail in section 4.2.2.1.1, page 101, in the form of a manual to support the basic descriptions in Table 4.4. Each code was refined and clarified, based on recommendations from original and recent coding schemes reviewed in the introduction. Particular focus was given to the category intention, which was developed using Bratman's (1984) definitions of the two faces of intention. With this adapted coding scheme and supporting manual, there was a clear improvement in the inter-rater reliability for all codes in the new scheme at the early infancy assessment. Excellent inter-rater reliability was also established for maternal speech at the toddlerhood and middle childhood assessments, indicating the effectiveness of this expanded scheme.

4.4.2 Maternal correlates of internal state language.

Previous studies of mothers' references to internal states have controlled for maternal talkativeness and sociodemographic risk, predominantly maternal education (Howard et al., 2008; Symons et al., 2005, 2006; Ruffman et al., 2002, 2006). However, these covariates, in addition to other potential correlates such as mothers' behavioural problems have, thus far, rarely been investigated in relation to mothers' internal state language within a single study. This study corroborates previous work suggesting that sociodemographic risk is negatively associated with maternal talkativeness and use of internal state language (Cole & Mitchell, 2000; Hughes et al., 1999; Pears & Moses, 2003).

Maternal history of behaviour problems was also found to be negatively associated with maternal use of internal state language. This finding can be brought together and extend previous work investigating parenting practices that are linked with parental behavioural problems. Mothers with a history of behavioural problems have been found to exhibit more negative parenting behaviours, such as more hostility in interactions and more harsh, coercive or inconsistent disciplinary practices (Kim-Cohen, Caspi, Rutter, Polo Tomás, & Moffitt, 2006; Jaffee, Belsky, Harrington, Caspi, & Moffitt, 2006). This study extends these findings by highlighting the impact maternal antisocial histories may have on nuances in mother-child interactions, namely, discussions about internal states that foster children's understanding of minds.

4.4.3 Mothers' internal state language predicts children's understanding of second-order false belief

Concurrent associations were found between mothers' references to internal states and children's understanding of second-order false belief with full comprehension. Children who heard more frequent and more varied maternal references to cognitive states in the topic-sharing task at the middle childhood assessment were found to have a two-fold increase in the likelihood of passing the second-order false belief questions. This corroborates previous findings showing positive associations between mothers' references to cognitive terms in picture book reading tasks and performance on strange stories tasks at ages 7 and 10 (Adrian et al., 2007; Ensor et al., 2014). The frequency and variety of mothers' references to the child's and her own internal states predicted children's second-order false belief understanding; this finding was slightly more pronounced for mothers' frequency of references to her own cognitions. This provides support for both views that mothers' references to cognitive states fosters children's understanding of minds by drawing attention to the child's thoughts (Adrian et al., 2005), and by exposing children to the perspectives of

others (Harris, 1999). Mothers who frequently discuss not only the child's, but their own internal states, may make contrasting internal states more salient to their child. Although this finding stands in contrast to earlier work showing weaker associations between 7-year-olds' higher-order theory of mind and mothers' references to her own and the child's inner states (Adrian et al., 2007), it is possible this difference is due to the nature of different tasks used across studies. The use of the Etch-a-Sketch as the topic sharing task in this study does not lend itself to coding references to characters discussed in picture book reading tasks, but focuses instead on mother-child discussions regarding their exploration of the toy.

4.4.4 Limitations of the study

It is also important to note potential issues with the context in which internal state language was examined in this study. The equivalence of the topic sharing tasks used at each assessment could be brought into question, as it cannot necessarily be assumed that the activity board, teddy bear puzzle and Etch-a-Sketch tasks are analogous. Given that one of the aims of this study was to examine mothers' use of internal state language during mother-child interactions within a broad time interval, it was essential to select tasks that were developmentally appropriate. Given that there were no notable differences between the number of mothers using internal state language during each task, this presents promising evidence that these tasks can be used for the purpose of this investigation.

Additionally, this study has only explored internal state language within very concentrated time-periods. Although internal state language has been commonly explored in the context of shorter mother-child interaction tasks (Sabbagh & Callanan, 1998), exploring internal state language in natural observations of families within the home may give a more accurate reflection of children's daily exposure to internal state language. Examining internal state language in this way presents a number of challenges. Perhaps most importantly, the time-consuming nature of this method inevitably results in a trade-off with sample size. It is

possible however, that this study has provided a balance between the issues of time and context. In the present sample, the families were examined in the home, and the topic-sharing tasks involved very limited instruction and consisted of toys typically found in the home. This balance is further evidenced when comparing the patterns of mother and child conversation reported by Howe and colleagues (2010); the patterns of internal state language in the present tasks appear to more closely reflect patterns found in natural interactions than structured tasks.

4.4.5 Chapter summary and next directions in the thesis

The expanded internal state language coding scheme previously used by the Cardiff Child Development Study was presented in this chapter. The expanded coding scheme was shown to be successful in coding maternal speech to children at different ages. The patterns of internal state language for mothers were described; mothers' use of internal state language closely resembled patterns from previous research. This coding scheme can now be used in future studies. The first finding using this scheme, however, is that mothers' references to internal states continues to foster children's understanding of minds beyond the preschool years. By conducting an in-depth analysis of maternal child-directed discourse in a topic-sharing task, it has been possible to examine aspects of internal state language that are most important in children's understanding of minds beyond the preschool years. These included: category; frequency; variety; and referent. Future steps in this thesis include examining the significance of mothers' internal state language in line with the arrival of a sibling. Chapter 5 will address this issue.

CHAPTER 5

"Shall we think, what a, what a house looks like? So we're gonna do a square."

Explaining Why Younger Siblings Foster Firstborns' Understanding of Second-Order False Belief in Middle Childhood: An Investigation of Mother-Firstborn Conversations about Internal States

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5.1 Introduction

This thesis has drawn attention to two predictors of children's understanding of minds. The first is the presence of a younger sibling living in the home (Chapter 3) and the second is maternal use of internal state language (Chapter 4). What has not yet been established, however, is the relationship between these two predictors and their relative contribution to firstborns' understanding of minds. In the present chapter, the relationship between sibling presence in the home and maternal internal state language will be explored, to discover the contribution of both of these variables on firstborns' second-order false belief understanding. By using the expanded internal state language coding scheme described in Chapter 4, this chapter will examine the relationships between sibling presence, maternal internal state language and firstborns' understanding of second-order false belief.

5.1.1 Could mothers' internal state language mediate the link between sibling presence and firstborns' understanding of minds?

Siblings may directly foster firstborns' theory of mind through a) talk about causality and internal states (Dunn, Brown, Slomskowski, et al., 1991); b) management of conflict (Howe, 1991); c) joint play (Youngblade & Dunn, 1995); d) shared jokes (Dunn, 1994); and e) reasoning about moral issues (Dunn & Munn, 1987). Additionally, siblings may foster children's understanding of false belief indirectly, by triggering changes in parent-firstborn interactions (Carpendale & Lewis, 2006). It has been suggested that "…having siblings may simply be a 'marker for a change' in the nature of the parent-child interaction experienced by children" (Carpendale & Lewis, 2006, p. 136-137). Indeed, the arrival of a sibling is associated with decreases in attachment security (Teti, Sakin, Kucera, Corns, & Eiden, 1996), maternal attention, affection, play, responsiveness and verbalisations (Baydar et al., 1997; Dunn & Kendrick, 1980, 1982; Field & Reite, 1984; Kendrick & Dunn, 1982), in addition to considerable increases in mother-firstborn negative confrontation (Dunn & Kendrick, 1980) and references to internal states (Dunn & Kendrick, 1982a).

In their seminal work, Judy Dunn and Carol Kendrick described changes in the quality of mothers' conversations with their firstborns before and after the birth of a sibling (1982a). In their naturalistic observations within the home, the frequency of mothers' references to the inner states of others increased threefold following the birth of a sibling; this increase reflected mothers' discussions of the younger sibling's feelings, desires and intentions with firstborn child. Yet changes in conversation are also apparent within mother-child conversations in the absence of a sibling. Conversations that follow the birth of a sibling centre on the firstborns' role within the family, as a brother or sister and as an older child. Take the following excerpt of a transcript between a mother and her firstborn daughter (Dunn & Kendrick, 1982a, p. 67):

C:	(Looking at baby's clothes) I want one of those.
M:	Well, you know there aren't any babygros for you. What are you doing with those?
C:	I'm a baby. I'm a baby. Another one for me. I want.
M:	There isn't another one for you.
C:	I want one. I'm a baby.
M:	Now look. We've been through this about five times. There are no babygros in the world that would fit you 'cause you're a big girl.

These common topics of conversation between mother and firstborn highlight the developmental, physical and attributional differences between the firstborn and their sibling, to both the child and the mother. It seems likely therefore, that the arrival of a sibling highlights the developmental difference between the two children, leading to a major shift in the mothers' perception of the firstborn child to an independent, thinking being. This may lead to more differentiation in mothers' type internal state language used toward the firstborn and to the younger sibling, resulting in a higher level of stimulation in language input from the mother to her firstborn. Indeed, despite their propensity to use internal state language being consistent over time (Meins, Fernyhough, Arnott, Turner, & Leekam, 2011), mothers tend to adjust the type of internal state references in conversations with their first- and second-born children (Jenkins et al, 2003). At present, this possibility is speculative due to the lack of research examining changes in mothers' speech in mother-firstborn interactions upon sibling arrival. However, it is considered likely that the presence of a sibling may positively foster firstborns' understanding of minds indirectly by triggering a stimulating effect on theory of mind by the mother (Hughes, 2011).

5.1.2 Aims of the study

Few studies have explored family influences on children's understanding of second-order false belief in middle childhood (Hughes, 2016). In this thesis thus far, this has been addressed by examining the influence of siblings (Chapter 3) and of mothers' language

(Chapter 5) on firstborns' understanding second-order false belief. The overarching aim of this chapter was to bring these two strands of work together, in order to understand processes by which younger siblings may foster firstborns' understanding of minds.

5.1.2.1 Does mothers' use of internal state language change upon arrival of a second child? The first aim of this study was to examine whether mothers' use of internal state language alters upon the arrival of a sibling, either in frequency of use or in a shift to a higher-level type of internal state language, such as references to cognitive states. Mothers' internal state language will be explored before the arrival of any siblings in early infancy, and after the siblings arrived in middle childhood.

5.1.2.2 To what extent does maternal internal state language mediate the link between sibling presence and firstborns' second-order false belief understanding? The second aim of this study was to test the extent to which mothers' references to internal states mediates the positive association between younger siblings and firstborns' second-order false belief understanding with full comprehension (Chapter 3). On account of the literature describing processes by which children directly influence their siblings' theory of mind (Dunn, Brown, Slomkowski, et al., 1991; Dunn, 1994; Dunn & Munn, 1987; Howe, 1991), it is not expected that mothers' internal state language will fully explain the sibling effect on second-order false belief understanding. Rather, it is hypothesised that a change in mothers' internal state language is one of many that foster children's developing theories of mind upon the arrival of a sibling.

5.2 Method

The analyses presented in this chapter are based on Waves 1, 2 and 6 of the Cardiff Child Development Study (Figure 5.1). A full description of the younger sibling study sample and study design and procedure at each wave of assessment is presented in Chapter 2.

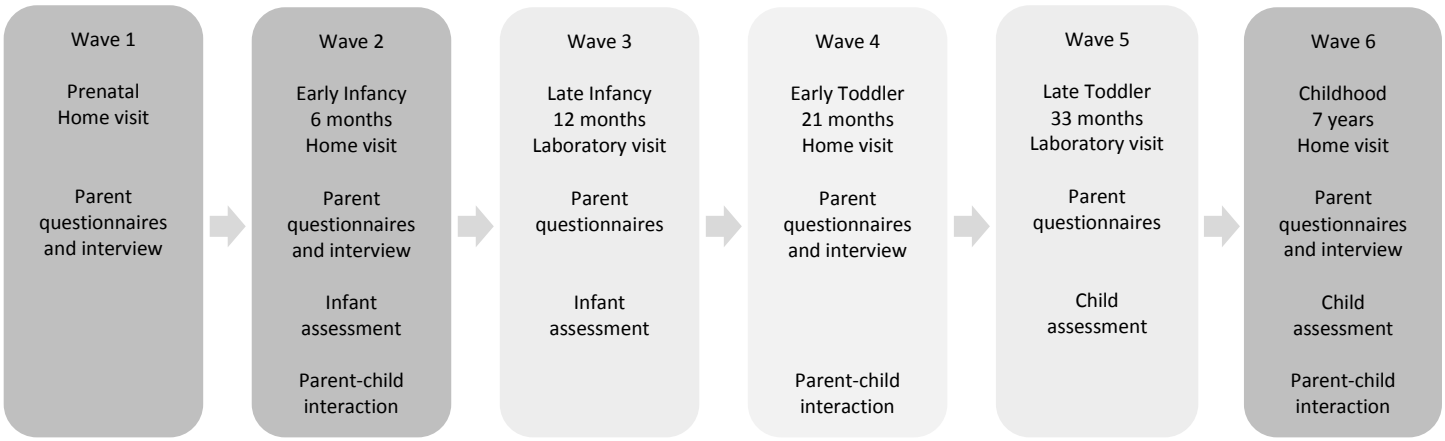

Figure 5.1 CCDS waves used in the present chapter.

5.2.1 Participants

Of the 269 children in the younger sibling study sample, 266 (98.9%) were assessed in early infancy and 255 (94.8%) were observed in the home. At the middle childhood assessment, 244 (90.7%) were assessed and 229 (85.1%) were directly observed in the home. The progression of the younger sibling study sample to the 229 children assessed in the home at the middle childhood assessment is described in Chapter 3, section 3.2.1, page 57 (Figure 3.2). Similarly, the progression of the sample from those seen in the home at the early infancy and middle childhood assessments to the families who provided mother-child interaction data is described in Chapter 4, section 4.2.1, page 98 (Figure 4.3). Of the 229 children assessed in the home at the middle childhood assessment, mother-child interaction data were available for 209 (91.3%) families.

Of the 209 families that were investigated in the present chapter, 52 (24.9%) did not have a sibling, and 157 (75.1%) had at least one sibling living in the home. As sibling presence and birth intervals were the only sibling variables associated with passing second-order false belief in Chapter 3, these were the only constellation variables explored in this investigation.

5.2.2 Measures

5.2.2.1 Mother-child interaction. Mothers and their firstborn children were observed during topic-sharing interaction tasks prior to the birth of a sibling and after the birth of a sibling. This involved a 2-minute observation with an activity board toy at the early infancy assessment and a 5-minute observation with an Etch-a-Sketch toy at the middle childhood assessment (Figure 5.2). Full task details are described from page 98 in Chapter 4.

Figure 5.2 Activity board (left) was administered at 6 months (before sibling arrival), Etch-a-Sketch (right) was administered at 7 years (after sibling arrival).

Two minutes of the activity board and 3 minutes from the Etch-a-Sketch drawing task were transcribed from videos, and when necessary, translated, in 5 second segments (Appendix IV). Of the 229 children in the sibling sample that were assessed in the home 209

(91.3%) had mother-child interaction data available from the early infancy assessment, and 184 (86.5%) from the middle childhood assessment.

5.2.2.1.1. Maternal talkativeness. Mothers' talkativeness during the early infancy and middle childhood assessments was computed by dividing the number of 5-second segments containing speech by total number of 5-second segments in each task. Mothers were therefore given proportional talkativeness scores between 0 and 1. This measurement of talkativeness has been validated by *Audacity* software in a subsample of cases $r(88) = .72$, $p < .001$ (Roberts et al., 2013). The mean score for maternal talkativeness was .87 ($SD = .18$) during the early infancy task and .82 ($SD = .12$) during the middle childhood task.

5.2.2.1.2. Maternal references to internal states. Each 5-second segment of speech was coded for mothers' attributions made about the mind. The revised coding scheme was an expanded version of that used by Roberts and colleagues (2013) (page 102 of Chapter 4). Internal state language was divided into seven categories: *Perception*, *physiology*, *preference*, *intention*, *desire*, *emotion* and *cognition*, and included references to firstborns' and mothers' own internal states. An independent observer coded maternal use of internal state language in 70 cases (25.4%) from the early infancy assessment and 68 cases (30.0%) from the middle childhood assessment, establishing excellent inter-rater reliability (median $\alpha = .98$ for both assessments). References to internal states were examined by referent, frequency and variety (see Chapter 4 for full details of coding scheme and Appendix V for complete lists of internal state language terms that were coded).

5.2.2.1.3. Missing mother-child interaction data. For both tasks, all talkativeness and internal state codes for interactions that were shorter than the assigned time for the task were prorated up to 24 segments of speech (2 minutes) for the activity board task (6.7%) and up to 36 segments of speech for the Etch-a-Sketch task (36.4%). Each coding category was divided by number of minutes of task length to yield a rate-per-minute of each code. The scores were

imputed using unstandardized predicted scores from SPSS regression analyses. The final sample size for mother-child interaction data within the sibling sample was therefore 209 (91.3% of the sample used in this study), where 12.0% were imputed scores for the middle childhood assessment.

5.2.2.2 Second-order false belief task. Children were told a second-order false belief story that was enacted with plastic Playmobil figures by the experimenter. Children had to answer all belief, justification and comprehension questions correctly to be classified as passing second-order false belief with full comprehension. Excellent reliability was established for passing this task (Kappa coefficient 1.00). Full details of this task are described on page 59 of Chapter 3. Of the 209 children in the sibling sample with mother-child interaction data available, 204 (97.6%) completed the second-order false belief task.

5.2.2.3 Study correlates

5.2.2.3.1 Maternal behavioural problems. Maternal behavioural problems were included in the analysis as a covariate of mothers' references to internal states. Maternal behavioural problems were assessed using seven DSM-IV items for conduct problems and five symptoms of ADHD. These items were combined to create a composite variable of mothers' history of behavioural problems (see page 110 of Chapter 4).

5.2.2.3.2 Child verbal IQ. Firstborns' verbal IQ was included in the analysis as a covariate of their passing of second-order false belief (Chapter 3). Firstborns verbal IQ was assessed at middle childhood using the British Picture Vocabulary Scale (BPVS; Dunn, Dunn, Whetton, & Pintillie, 1982). The mean standardised score for the 209 children in the sibling sample with available mother-child interaction data was 100.39 (*SD* = 11.60, range 69 to 130), and the average age children in the sample were equivalent to was 84.84 months (*SD* = 14.52) and ranged from 57 to 150 months.

5.3 Results

5.3.1 Preliminary descriptive data

Of the 209 children in the sibling sample who had mother-child interaction data available, 64 (30.6%) passed the second-order false belief task. In terms of mothers' references to internal states, the majority of mothers produced at least one reference to their child's or their own internal state (83.3% and 90.4% at the early infancy and middle childhood interactions, respectively). There was no difference in mothers' overall frequency of internal state language between the assessments. Mothers referred to the inner states of the child significantly more than to their own inner states at both assessments (*p*s <.001).

5.3.2 Is maternal language related to presence of a sibling in the home?

No differences were found when comparing mothers' language according to the birth interval groups specified in Chapter 3 (no sibling, early arrival sibling and average to late arrival sibling). Therefore all analyses focus on comparing the sibling present in the home versus no sibling present groups.

5.3.2.1 Maternal language at the middle childhood assessment. No differences were detected between mothers' talkativeness at the middle childhood assessment according to whether there was a sibling in the home, therefore all subsequent analyses are focused on maternal internal state language. Means and standard deviations of mothers' use of internal state language according to sibling groups at the middle childhood assessment are presented in Table 5.1. At the middle childhood assessment, the only difference detected was that mothers' referred to the firstborns' cognitive states significantly more, both in terms of frequency $t(215.15) = 2.61$, $p < .01$ and variety $t(163.50) = 2.23$, $p < .05$ if the firstborn had a sibling (Figure 5.3).

To establish whether mothers who went on to have more children by the middle childhood assessment had a prior tendency to refer to internal states more than those who did

not, subsequent analyses compared mothers' language at the early infancy assessment according to the sibling presence groups, prior to any sibling arrival.

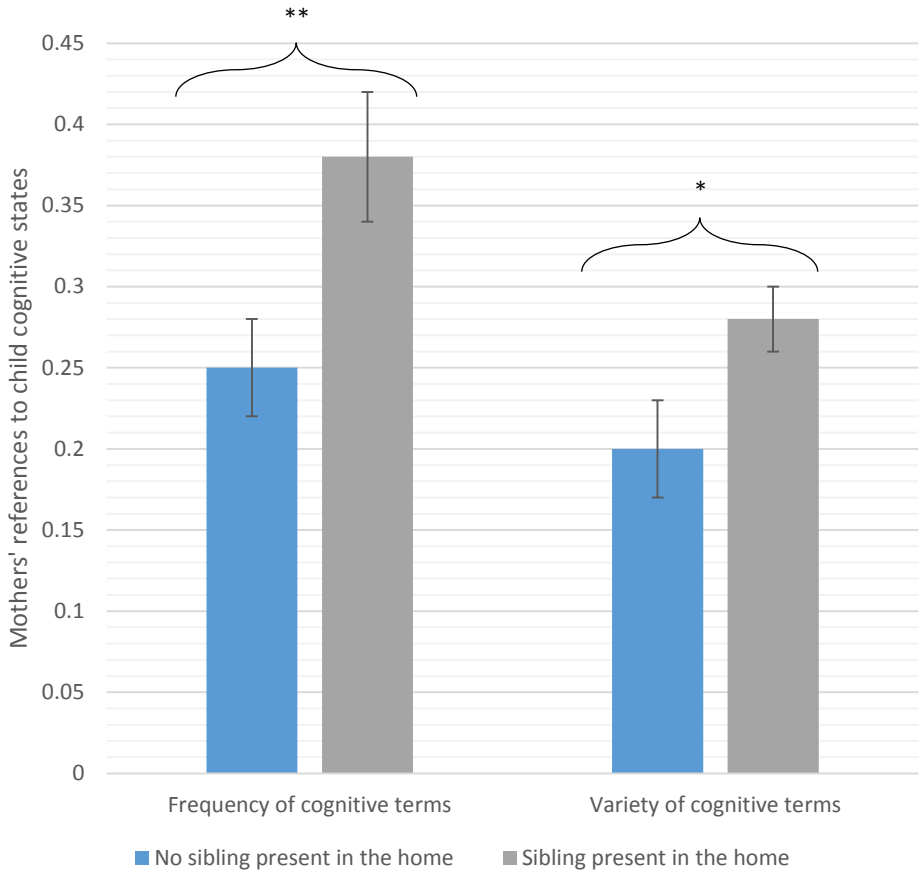

Figure 5.3 Frequency and variety of mothers' references to the firstborn child's cognitive states according to sibling presence groups, error bars are ± standard error of the mean, **p* <.05, ***p* <.01.

Table 5.1

Means and standard deviations for maternal use of internal state language (rate per minute) at the middle childhood assessment according to sibling presence groups.

Mothers' references to child's internal states	Sibling presence groups				Mothers' references to own internal states	Sibling presence groups			
	No younger sibling present in the home		Younger sibling present in the home			No younger sibling present in the home		Younger sibling Present in the home	
	Mean	SD	Mean	SD		Mean	SD	Mean	SD
Perception					Perception				
Frequency	.06	.15	.02	.08	Frequency	.08	.22	.05	.14
Variety	.06	.15	.02	.08	Variety	.06	.12	.05	.12
Physiology					Physiology				
Frequency	.00	.00	.00	.00	Frequency	.00	.00	.01	.05
Variety	.00	.00	.00	.00	Variety	.00	.00	.01	.05
Preference					Preference				
Frequency	.01	.04	.00	.00	Frequency	.02	.06	.02	.07
Variety	.01	.04	.00	.00	Variety	.02	.06	.02	.07
Intention					Intention				
Frequency	.47	.39	.39	.51	Frequency	.08	.18	.05	.17
Variety	.28	.20	.22	.20	Variety	.07	.13	.04	.10
Desire					Desire				
Frequency	.41	.43	.42	.48	Frequency	.01	.05	.02	.09
Variety	.26	.18	.23	.22	Variety	.01	.05	.02	.08
Emotion					Emotion				
Frequency	.02	.07	.01	.05	Frequency	.00	.00	.00	.00
Variety	.02	.07	.01	.05	Variety	.00	.00	.00	.00
Cognition					Cognition				
Frequency	.23	.28	.38	.54	Frequency	.30	.29	.36	.48
Variety	.19	.22	.28	.32	Variety	.26	.25	.25	.27

Note. $N = 209$

5.3.2.2 Maternal language at the early infancy assessment. No differences were detected between mothers' talkativeness at the early infancy assessment according sibling presence groups. Means and standard deviations of mothers' use of internal state language according to sibling groups at the early infancy assessment are presented in Table 5.2. There were no significant differences in mothers' use of category, frequency or variety of internal state language between sibling groups (prior to sibling arrival) at the early infancy assessment.

5.3.3 To what extent do maternal references to child cognitive states mediate the association between sibling presence in the home in middle childhood and firstborns' understanding of second-order false belief with full comprehension?

According to the Baron and Kenny (1986) causal steps approach, four conditions must be met in order to establish a partially mediating effect: (a) the dependent variable (second-order false belief understanding) must be predicted by the independent variable (sibling presence), (b) the mediating variable (maternal references to child cognitive states) must be predicted by the independent variable, (c) the dependent variable must be predicted by the mediating variable, and (d) the effect of the independent variable on the dependent variable must be attenuated when the mediating variable is controlled. Following these steps, in the subsequent sections mediations are tested further using the bootstrap procedure using the PROCESS custom dialogue box for SPSS (Hayes, 2013; available from www.afhayes.com/spsssas-and-mplus-macros-and-code.html).

Table 5.2

Means and standard deviations for maternal use of internal state language (rate per minute) at the early infancy assessment according to sibling presence groups.

Mothers' references to child's internal states	Sibling presence groups				Mothers' references to own internal states	Sibling presence groups			
	No younger sibling present		Younger sibling present			No younger sibling present		Younger sibling present	
	Mean	SD	Mean	SD		Mean	SD	Mean	SD
Perception					Perception				
Frequency	.52	.90	.74	1.05	Frequency	.01	.07	.01	.06
Variety	.29	.40	.37	.39	Variety	.01	.07	.01	.06
Physiology					Physiology				
Frequency	.03	.12	.03	.13	Frequency	.00	.00	.00	.00
Variety	.03	.12	.03	.13	Variety	.00	.00	.00	.00
Preference					Preference				
Frequency	.22	.39	.26	.40	Frequency	.00	.00	.01	.06
Variety	.18	.30	.20	.31	Variety	.00	.00	.01	.06
Intention					Intention				
Frequency	.16	.39	.16	.37	Frequency	.00	.00	.00	.04
Variety	.10	.22	.12	.24	Variety	.00	.00	.00	.04
Desire					Desire				
Frequency	.41	.58	.44	.57	Frequency	.00	.00	.01	.06
Variety	.23	.25	.28	.27	Variety	.00	.00	.01	.06
Emotion					Emotion				
Frequency	.00	.00	.02	.11	Frequency	.00	.00	.00	.00
Variety	.00	.00	.01	.08	Variety	.00	.00	.00	.00
Cognition					Cognition				
Frequency	.11	.27	.10	.26	Frequency	.14	.30	.11	.29
Variety	.10	.25	.08	.19	Variety	.13	.26	.10	.23

Note. $N = 209$

5.3.3.1 Mothers' frequency of references to child's cognitive states. With covariates of second-order false belief and maternal internal state language controlled (child age, verbal IQ and maternal behavioural problems), regression analyses indicated that (a) sibling presence significantly predicted second-order false belief understanding with full comprehension $\beta = .89$, (b) sibling presence significantly predicted frequency of maternal references to child cognition $\beta = .18$ (c) frequency of maternal references to child cognition significantly predicted second-order false belief understanding $\beta = .64$ (all ps $<.05$), and (d) the effect of sibling presence on second-order false belief understanding was attenuated when frequency of maternal references to child cognition was controlled $\beta = .87$, $p < .05$. This mediation model was then tested further using the bootstrap procedure using the PROCESS custom dialogue box for SPSS (Hayes, 2013; available from www.afhayes.com/spsssas-and-mplus-macros-and-code.html). Within this model, covariates of second-order false belief, firstborn age and verbal IQ were controlled. Tests for mediation using bootstrap estimation of indirect effects with 5000 replications did not confirm the mediation model (95% confidence interval [CI] = [-.02, .29]) (see Table 5.3).

Table 5.3

Prediction of maternal frequency (model 1) and variety (model 2) of references to child cognitive states and presence of a sibling on firstborns' second-order false belief understanding with full comprehension.

Model 1					Model 2				
Variable	R^2	*B*	*SE*	95% CI for OR	Variable	R^2	*B*	*SE*	95% CI for OR
	.14***					.14***			
Constant		-11.88	4.02		Constant		-11.91	4.02	
Firstborn age		.08*	.04	.00 - .16	Firstborn age		.08*	.04	.00 - .16
Verbal IQ		.04**	.02	.01 - 07	Verbal IQ		.04**	.02	.01 - .07
Maternal behavioural problems		-.06	.05	-.16 - .03	Maternal behavioural problems		-.06	.05	-.15 - .03
Presence of younger sibling		.87*	.42	.04 - 1.69	Presence of younger sibling		.87*	.42	.04 – 1.69
Maternal frequency of references to child's cognitive states		.54ŧ	.33	-.09 – 1.19	Maternal variety of references to child's cognitive states		.90ŧ	.52	-.11 – 1.92
Direct effect of sibling presence		.87	.42	.04 – 1.69	Direct effect of sibling presence		.87*	.42	.04 – 1.69
Indirect effect of frequency of maternal references to child's cognitive states		.10	.08	-.01 - .29	Indirect effect of variety of maternal references to child's cognitive states		.10*	.08	.00 - .30

N = 201. Coefficients are based on the final models. ŧ*p* <.10, **p* < .05, ***p* < .01, ****p* <.001. Significance of indirect effect is determined if confidence interval does not cross zero.

5.3.3.2 Mothers' variety of references to child's cognitive states. With covariates of second-order false belief and maternal internal state language controlled, (child age, verbal IQ and maternal behavioural problems), regression analyses indicated that (a) sibling presence significantly predicted second-order false belief understanding $\beta = .89$, (b) sibling presence significantly predicted variety of maternal references to child cognition $\beta = .11$, (c) variety of maternal references to child cognition significantly predicted second-order false belief understanding $\beta = 1.05$ (all ps $<.05$), and (d) the effect of sibling presence on second-order false belief understanding was attenuated when variety of maternal references to child cognition was controlled $\beta = .87$, $p < .05$. Tests for mediation using bootstrap estimation of indirect effects with 5000 replications using PROCESS confirmed the mediation model (95% confidence interval [CI] = [.00, .30]) (Table 5.3). When taken together, these results indicate a partial mediation model.

5.4 Discussion

The present study examined links among presence of a sibling, mothers' references to internal states and firstborns' understanding of second-order false belief with full comprehension in middle childhood. I built upon the earlier findings that both presence of a sibling (Chapter 3) and mothers' concurrent references to cognitive states (Chapter 4) fosters children's understanding of minds at 7 years of age by testing two hypotheses. The first of these was that mothers' references to internal states would differ according to whether there was a sibling present in the home. Secondly, it was hypothesised that mothers' references to inner states would mediate the relationship between sibling presence and children's understanding of second-order false belief.

5.4.1 Mothers' internal state language differs according to sibling groups

Mothers' use of internal state language differed at the middle childhood assessment according to sibling groups. Mothers with two or more children referred to their firstborn's

cognitive states more frequently and used more varied terms than those with an only child. This difference was not present at the early infancy assessment, which suggests that mothers who go on to subsequent childbearing do not necessarily have more of a propensity for internal state language use, but this may be a change that is the result of the arrival of a sibling. Although these findings do not allow us to clarify the ways in which the presence of a sibling may change maternal use of internal state language, this finding represents an important step in understanding how family interactions may change upon the arrival of a sibling. Previous work has explored changes in maternal speech within mother-child-sibling triadic interactions (Dunn & Kendrick, 1982a). This study expands these findings by demonstrating changes in the conversational climate of mother-child dyadic interactions in the absence of a sibling.

5.4.2 Aspects of mothers' internal state language partially mediates the association between presence of a sibling and children's understanding of second-order false belief with full comprehension

Building on these findings, the contribution of both sibling presence and maternal references to cognitive terms towards children's understanding of second-order false beliefs was explored in a mediation analysis. When taken together, it was found that mothers' variety of references to the firstborns' cognitive states had at least a partially mediating effect on the relationship between sibling presence and firstborn understanding of second-order false belief. This indicates that the arrival of a sibling may trigger changes in mothers' conversations of internal states with their firstborn; namely, that mothers discuss more diverse cognitive states with their firstborn following the birth of a sibling.

The relationship among these three variables have, together, received little attention in the literature on children's developing theories of mind. While it is possible that the arrival of a sibling triggers the mother to come to know and treat their firstborn child increasingly as

one with a mind, it is important to note that the associations between these variables are likely to be reciprocal in nature. Children's early theory of mind ability predicts later maternal cognitive references; a pattern known as *partner effects* (Ensor et al., 2014). When also taking into account cognitive advances associated with sibling arrival (McAlister & Peterson, 2007; Zajonc & Markus, 1975), it seems likely that the child has a key role in triggering discussions of more complex internal states in their interactions with their mothers.

5.4.3 Limitations of the study

Examining family influences on children's understanding of minds longitudinally presents a number of challenges. One issue that must be acknowledged in this study is the need to impute maternal talkativeness and internal state language data. Given that the Cardiff Child Development Study is primarily a longitudinal development rather than mother-child interaction, there were instances where interactions took place with caregivers other than the mother. Although data were imputed only from earlier time-points where data was available and this was kept to a minimum, it is recommended that the findings must be interpreted with some caution. That being said, it is now current and recommended practice to address missing data with imputation, as missing data reduces sample size and therefore statistical power, and can also bias parameter estimates (Newman, 2003; Roth, 1994).

5.4.4 Summary

This study has demonstrated the importance of examining different family influences on children's mind-understanding in middle childhood. Yet in doing so, I have also highlighted that further research must continue to explore the relationship between family influences and theory of mind by considering how changes in family structure affect the dynamics of children's close relationships.

CHAPTER 6

"Do you think that's the teddy's tummy? What do you think?"

Early Arriving Younger Siblings: Antecedents and Consequences for Mother-Child Interaction

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6.1 Introduction

In Chapter 3, I examined the relationship between sibling constellation factors and children's understanding of second-order false belief. Although younger sibling presence was found to foster firstborns' understanding of minds, it was established that this advantage was only the case for children who did not experience early entry into siblinghood. Firstborn children who experienced an *early arrival sibling* performed similarly to only children on the second-order false belief questions. In this chapter, I will investigate families within the *early arrival sibling* group. First, I will review maternal antecedents that predict early subsequent childbearing and explore relevant predictors of early sibling arrival within the families in Cardiff Child Development Study. Second, I will explore the consequences of early sibling arrival on mother-firstborn interactions. Given that aspects of mother-child conversation explain, in part, the influence of siblings on second-order false belief (Chapter 5), I will investigate whether features of mother-firstborn interaction known to foster children's mind-

understanding alter for the children who experienced the birth of their early arrival younger sibling by toddlerhood.

6.1.1 Early arriving siblings

Short birth intervals between first- and second-born children are of interest within several literatures beyond that of developmental psychology, given that short intervals are associated with higher rates of maternal, perinatal, infant and child (first- and second-born) adverse outcomes (Conde-Agudelo, Rosas-Bermudez, Kafury-Geota, 2007; Conde-Agudelo, Rosas-Bermudez, Castaño, & Horton, 2012). Much of this work is investigated under the banners of *short interpregnancy interval* or *rapid repeat pregnancy*, which in many studies is defined as an interval of ≤ 24 months between the delivery of a live birth and subsequent conception also resulting in a live birth (for example Crittenden, Boris, Rice, Taylor, & Olds, 2009). Given this criterion, the families who experienced an early arriving sibling within the CCDS sample fit well within the category as a rapid repeat pregnancy group as classified within the literature.

6.1.2 Antecedents of early sibling arrival

A well-studied predictor of mothers who have a short interpregnancy interval is maternal age. Early research indicated a strong association between maternal age at first birth and further childbearing, where younger mothers had an increased pace of further childbearing and lifetime fertility (Bumpass, Rindfuss, & Janosik, 1978; Trussell & Menken, 1978). However, recent studies have indicated that this association has weakened considerably, with more young mothers delaying subsequent childbearing and ending further reproduction (Morgan & Rindfuss, 1999). One exception, however, is the group of adolescent mothers, who have been identified as a particular risk group for rapid subsequent childbearing, with 42% becoming pregnant again within the first 24 months of their first birth (Raneri & Wiemann, 2007). Poverty, failure to adopt effective methods of contraception,

partner violence, alcohol or drug use, future childbearing intentions, a lack of return to education, and low cognitive ability are some of the many factors that significantly predict short birth intervals in adolescents (Coard, Nitz, & Felice, 2000; Crittenden et al., 2009; Crosby et al., 2002; Jacoby, Gorenflo, Black, Wunderlich, & Eyler, 1999; Raneri & Wiemann, 2007).

Another age group that have been identified as more likely to have short intervals between their first and second children are primiparous women over 30 (Gemmill & Duberstein Lindberg, 2013; Kaharuza, Sabroe, & Basso, 2001). According to a recent Office for National Statistics survey (2012), postponement of childbearing to a later age is becoming more common, with the standardised mean age for commencing childbearing now being 29.7 years: the highest age since 1938 where the ages of first birth data became available. This is likely to reflect changes in women's economic position in terms of increases in educational and occupational opportunities, leading to the postponement of childbearing (Dion, 1995), and an increase in the rate of transition to the second birth (Hoem & Hoem, 1989; Kreyenfeld, 2002). Highly educated women are increasingly more likely to postpone childbirth to a time where they have a substantial income to afford childcare to prevent interruption to their careers (Rindfuss, Morgan, & Offutt, 1996). This may result in a *time-squeeze effect*, where the delay in childbearing may result in a more rapid transition from first to second children in light of the biological limits of fertility (Kreyenfeld, 2002).

The increase in women's economic independence is also presumed to be linked to changes in women's tendency to marry, which in turn is related to childbearing and reproductive choices. It has been predicted that 94% of highly educated women will marry in their lifetime (Goldstein & Kenney, 2001), but they are more likely to delay marriage to a later age (Heath, 2009) and opt for longer cohabitation prior to marriage (Isen & Stevenson, 2010). In the UK, married or civil partnered couples have been reported to have the highest

average number of dependent children within the household, at 1.79 children per family, compared to 1.62 for cohabiting couples and 1.59 for lone parent families (Office for National Statistics, 2013b). Given that cohabitation is often viewed as a precursor to marriage and childbearing, cohabitors are less likely to expect to bear children within a two-year time window than married couples (Rindfuss & van den Heuvel, 1990). Although studies examining the association between relationship status and short interpregnancy intervals are sparse, relationship circumstances may be an important factor in the timing of progressing to multiple children. While it is possible that women's increasing tendency to delay marriage to a later age may result in a time-squeeze effect, cohabiting couples are more likely to have pregnancies that are unplanned and mistimed (Reed, 2006), and therefore may also be likely to experience short interpregnancy intervals.

It is well established that mental health issues such as anxiety and depression are associated with an increased risk of pregnancy during the teen years (Gest, Mahoney, & Cairns, 1999; Quinlivan, Tan, Steele, & Black, 2004; Woodward, Fergusson, & Horwood, 2001). However, links between mental health issues and subsequent childbearing have been rarely studied in adolescents and severely neglected amongst all age groups. Some studies have attempted to harness longitudinal data to investigate associations between these variables, but have failed to detect associations between depressive symptoms and subsequent pregnancies in studies of adults (Bennett, Culhane, McCollum, & Elo, 2006) and of adolescents (Raneri & Wiemann, 2007). Yet one study has detected a possible independent contribution of depressive symptoms towards subsequent pregnancies in African American adolescent mothers (Barnet, Liu, & DeVoe, 2008). It is plausible that maternal depression following the birth of the firstborn child may have an impact on the timing and nature of family transition to the second child, given that depression has been associated with impaired reproductive decision making (Cooper, Shapiro, & Powers, 1998), reduction in use of birth

control (Lehrer, Shrier, Gortmaker, & Buka, 2006) and an increased number of subsequent pregnancies (Barnet, Liu, & DeVoe, 2008).

Factors that increase the risk for risky sexual behaviours throughout adolescence and young adulthood also includes women's history of conduct problems. Conduct disorder in childhood is one of the most significant risk factors for young motherhood (Woodward & Fergusson, 1999; Zoccolillo & Rogers, 1991). Adolescent girls with conduct disorder have been identified to be as much as four times more likely than matched controls to have become pregnant by 21 years of age (Bardone, Moffitt, Caspi, Dickson, & Silva, 1996). Despite this finding, very little or no examination of the association between individuals with behaviour problems and subsequent childbearing has been conducted. It would seem intuitive to examine behavioural problems as potential determinants of family size, given that conduct disorder is associated with a tendency to affiliate with deviant peers (Bachanas et al., 2002), receive less parent-teen sexual guidance (Wilson & Donenberg, 2004) and experience high levels of family conflict (Ary, Duncan, Duncan, & Hops, 1999), which are all associated with higher levels of risky sexual behaviour. Furthermore, conduct disorder is characterised by impulsivity (or, *behavioural undercontrol* or *disinhibition*) which has been linked to risky sexual behaviour (Donohew et al, 2000; Lejuez, Bornavolova, Daughter, & Curtin, 2005; Ramrakha, Caspi, Dickson, Moffitt, & Paul, 2000).

6.1.3 Consequences of early sibling arrival

Mothers who have a short birth interval between children may experience a number of perinatal health issues. Rapid subsequent childbearing also puts both first- and second-born children at risk (see Conde-Agudelo et al., 2007, 2012). These physical health problems are summarised by Conde-Agudelo and colleagues (2012) (see Figure 6.1). Coupled with existing sociodemographic and psychological problems that predict to the timing of the second birth, mothers in this particular risk group can experience mental health problems

following the birth of their second child, such as postpartum low mood (Gürel & Gürel, 2000).

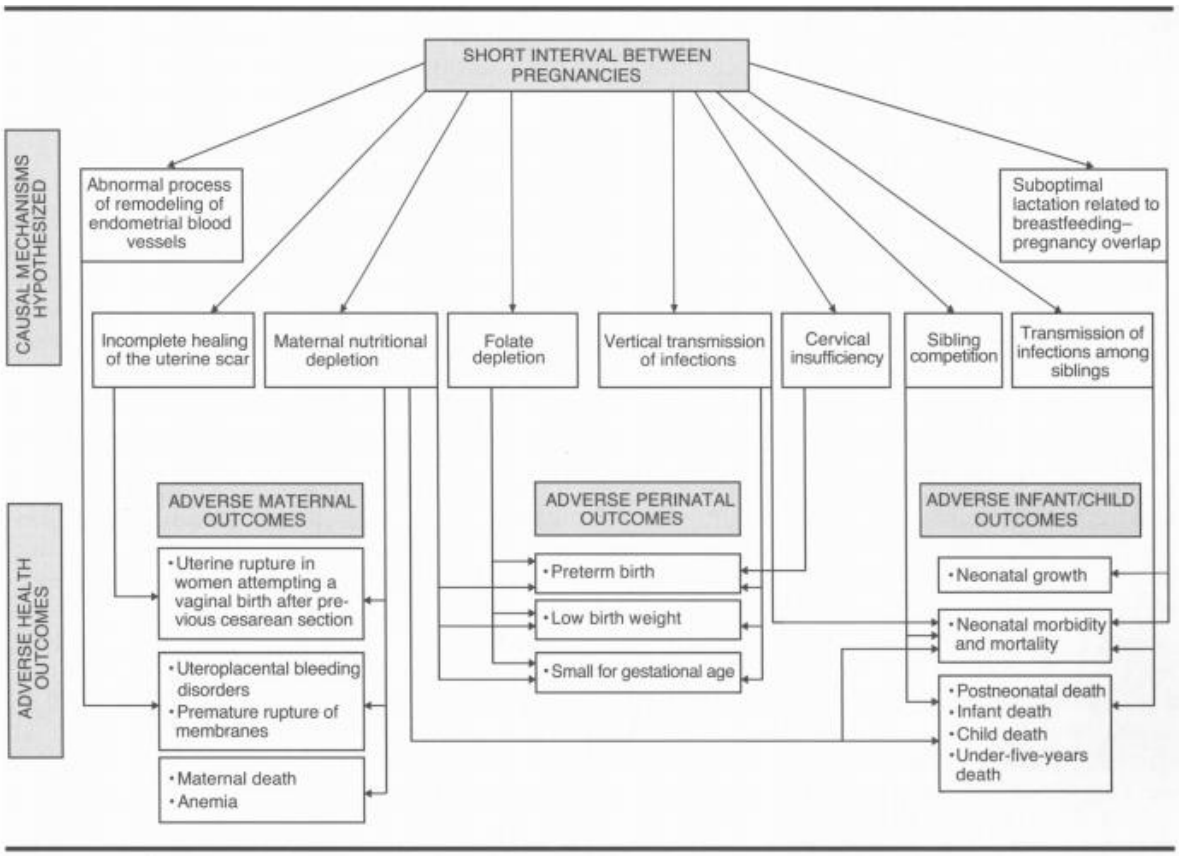

Figure 6.1 Hypothetical causal mechanisms proposed by Conde-Agudelo and colleagues (2012) for the association between short inter-pregnancy, -birth, or -recuperative intervals and increased risk of adverse maternal, perinatal, infant and child health outcomes.

Taking into account existing sociodemographic and psychological issues, in addition to the physical health problems associated with interpregnancy intervals, the time-period following the second birth for this particular at-risk group is stressful. Maternal low mood postpartum may result from physical distress from frequent deliveries, from separation from the firstborn child during hospital stays, increases in work-load and responsibilities, and decreases in opportunities for maternal private activities associated with caring for multiple very young children (Gürel & Gürel, 2000; Hannah, Adam, Lee, Glover, & Sandler, 1992;

Thorpe et al., 2003). Given that 40% - 55% of short interpregnancy interval births are unintended (Gemmill & Duberstein Lindberg, 2014; Kaharuza et al., 2001), stress resulting from worries concerning finances and lack of preparation may also contribute to maternal mental health problems following a rapid subsequent birth.

Adverse outcomes resulting from rapid subsequent childbearing are likely to impact on the mother-firstborn relationship. However, the effect of short birth intervals on the mother-child relationship has been rarely studied. Short birth intervals between siblings are associated with a more pronounced decline in positive mother-firstborn interactions and increase in maternal controlling parenting styles (Baydar et al., 1999). This reduction of positive interaction was mediated by family economic wellbeing, indicating that reduction in mother-child positive interactions is likely to be in attributable in part, to economic hardship. In addition to this study that specifically investigated the impact of short birth intervals, we can also look to early sibling research for insights into the consequences of early sibling arrival on mother-child interactions. Judy Dunn's early work examined the changes in mother-child interactions following the birth of a sibling, where the median age of the older child at the time of sibling birth was 25 months (Dunn & Kendrick, 1980). In their sample, birth of a sibling was associated with decreases in maternal attention and initiation of conversation, in addition to more confrontation.

6.1.4 Aims of the Study

6.1.4.1 Antecedents of early sibling arrival. The first aim of this study is to profile mothers who had short intervals between their first- and second-born children in the Cardiff Child Development Study. Previous studies exploring antecedents of early sibling arrival have focused on analysing individual risk factors in isolation, which may exclude other important features that contribute to short intervals between first- and second-born children. Therefore, I will explore the extent to which a) maternal age at first birth, b) other

sociodemographic risk factors and c) maternal psychological factors contribute to the arrival and timing of a second born child. The selection of sociodemographic and psychological domains was guided by previous research implicating the importance of age, education, income, relationship status, postnatal depression and childhood conduct disorder in sexual behaviour and family planning (Bardone et al., 1996; Barnet et al., 2008; Raneri & Wiemann, 2007; Rindfuss & van den Heuvel, 1990).

6.1.4.2 Consequences of early sibling arrival for mother-firstborn interactions.

Early sibling arrival is associated with much adversity, and this appears to negatively affect the mother-firstborn relationship (Baydar et al., 1999). However, it is yet to be established whether short birth intervals affect features of the mother-child relationship most relevant to firstborns' theory of mind development. In the present chapter, I will examine differences in mother-child interactions at the toddlerhood assessment (mean age 21 months). This will involve an investigation of a subsection of the early arrival sibling group where infant siblings were already present in the home. In this chapter I will describe how the birth of an early arrival sibling impacts features of mothers' speech that are significant in firstborns' later understanding of minds. By harnessing the longitudinal data from the CCDS, I will explore whether any differences were apparent prior to early sibling arrival in early infancy mother-child interactions and whether differences persist into middle childhood.

6.2 Method

The analyses presented in this chapter are based on Waves 1, 2, 4 and 6 of the Cardiff Child Development Study (Figure 6.2). A full description of the younger sibling study sample and study design and procedure at each wave of assessment is presented in Chapter 2.

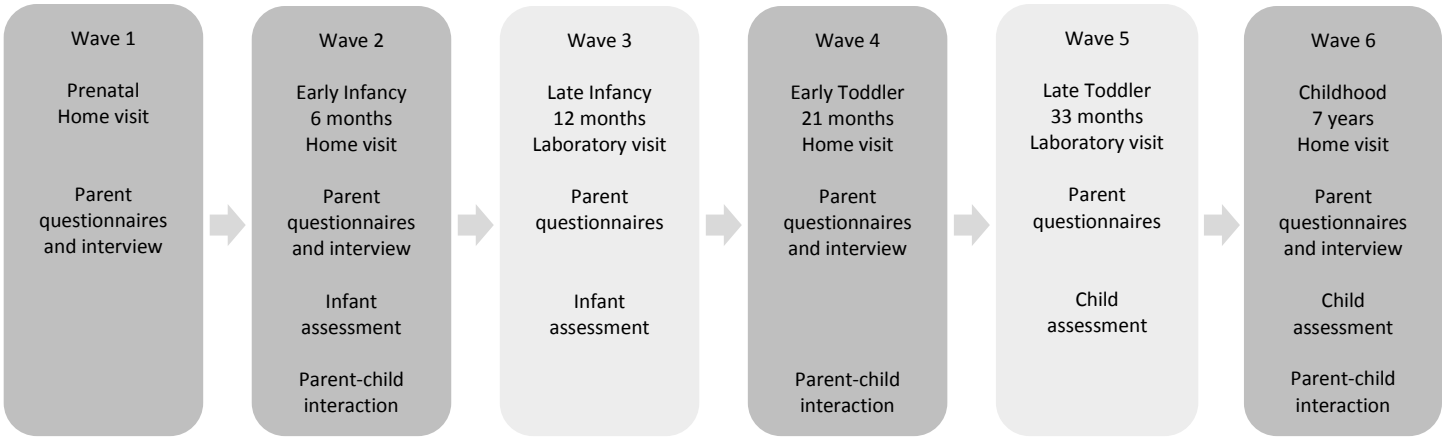

Figure 6.2 CCDS waves used in the present chapter.

6.2.1. Participants

This investigation focused on the 269 families included in the CCDS sibling sample. The progression of the full CCDS sample to the 269 families included in the sibling sample is described in Chapter 2, page 28. In the sibling sample, 196 (72.9%) children had at least one younger sibling living in the home by the middle childhood assessment, and the mean age of the closest in age younger sibling was 35.25 months (*SD* = 16.23) (see Chapter 2 for full details). A quartile split within the whole sibling sample yielded identical criteria (≤ 24 months) as Chapter 3 for the *early arrival sibling* group. Fifty families (25.6%) were categorized as having an early arrival sibling.

6.2.2 Measures

6.2.2.1 Sociodemographic adversity. For the purpose of this investigation, mothers' demographic characteristics were investigated individually in addition to the family's

exposure to socio-economic adversity variable described in Chapter 2 (section 2.2.2.3, page 30). These included:

6.2.2.1.1 Maternal age at first birth. Mothers' age at the time of the birth of the firstborn child was investigated both as a continuous variable and was also investigated by separating mothers into groups. Given that both teen mothers and older mothers are considered more likely to have a short interval between the birth of the first- and second-born child, and this is unlikely to be a linear relationship, thus three groups were made; (a) 41 (15.3%) were adolescent mothers (≤ 19 years), (b) 105 (39.0%) become mothers in their 20s (20-29 years) and (c) 123 (45.7%) become mothers over 30 (≥ 30 years).

6.2.2.1.2 Maternal education. A dichotomous variable indicated whether the mother had achieved the minimum level of qualifications required for the completion of secondary education in the United Kingdom (5 General Certificate of Secondary Education examinations grade A*- C or equivalent; 1 = yes, 0 = no).

6.2.2.1.3 Social class. Mothers were dichotomized as working class (0) or middle/upper class (1) by the highest ranked employment the mother ever had using the Standard Occupational Classification 2000 (SOC2000; Elias et al., 1999).

6.2.2.1.4 Relationship status. Two variables were used; the first being marital status (1 = married, 0 = unmarried), and the second being whether mothers were in a stable partnership with the firstborns' father (1 = stable partnership, 0 = no stable partnership).

6.2.2.2 Maternal history of conduct problems. Mothers' history of conduct problems were assessed using self-reported items from a prenatal (Wave 1) questionnaire entitled, 'What I Was Like as a Child'. This questionnaire included a set of items measuring DSM-IV symptoms of conduct disorder, including measures of anger, fighting, disobedience, truancy, stealing, dishonesty, and vandalism rated on a scale from 0 (absent) to 2 (definitely

present). The conduct symptom items showed an acceptable level of internal consistency α = .74 (Hay et al., 2011). Additional descriptive data are available in Appendix VI.

6.2.2.3 Mothers' postnatal depression. Mothers were interviewed by formally trained research assistants during the early infancy visit (Wave 2) using the Schedules for Clinical Assessment in Neuropsychiatry (SCAN; Wing et al., 1990). SCAN interviews were coded according to DSM-IV diagnostic criteria, and final decisions regarding clinical diagnosis were made in case conferences with at least one adult psychiatrist. Diagnoses of postnatal depression were made with good agreement $\kappa = .80$, $p < .001$ (Perra et al., 2015). Dichotomous variables of mothers' depressive episodes after the first pregnancy were computed.

6.2.2.4 Mother-child interaction. Mothers and their firstborn children were observed during topic-sharing interaction tasks at three time-points. This involved a 2-minute observation with an activity board toy at early infancy (6 months), a 2-minute observation with a wooden teddy bear puzzle at toddlerhood (21 months); and a 5-minute observation with an Etch-a-Sketch toy at middle childhood (7 years) (see Figure 6.3). These observations were transcribed into 5-second segments of speech (see Appendix IV). Of the 269 children in the younger sibling study sample, 242 (90.0%) had mother-child interaction data available at the early infancy assessment, 205 (76.2%) at the toddlerhood assessment and 198 (73.6%) at the middle childhood assessment. Full details of the mother-child interaction tasks at each wave of assessment are described in Chapter 4, from page 98.

Figure 6.3 Topic-sharing tasks used in mother-child interaction tasks (left to right: Early infancy activity board, toddlerhood teddy bear puzzle and middle childhood Etch-a-Sketch).

6.2.2.4.1 Mothers' talkativeness. Talkativeness was computed by dividing number of 5-second segments of speech by total number of 5-second segments in each task, yielding proportional scores of mothers' talkativeness ranging from 0 to 1 (see Chapter 4, page 110 for full details).

6.2.2.4.2 Mothers' references to internal states. Each 5-second segment of speech was coded for mothers' attributions made about the mind. The revised coding scheme was an expanded version of that used by Roberts and colleagues (2013) (see Table 4.4 in Chapter 4, page 102). Internal state language was divided into seven categories: *Perception*, *physiology*, *preference*, *intention*, *desire*, *emotion* and *cognition*, and included references to firstborns' and mothers' own internal states. Inter-rater reliability for this scheme was excellent (median $\alpha = 1.00$ across all tasks). References to internal states were examined by referent, frequency and variety (see Chapter 4 for full details of coding scheme and Appendix V for complete lists of internal state language terms that were coded).

6.2.3 Data analysis

For each topic sharing task, all talkativeness and internal state codes for interactions that were shorter than the assigned time for the task were prorated up to 24 segments of speech (2 minutes) for the activity board (0.07%) and the teddy bear puzzle (24.9%) tasks.

For the Etch-a-Sketch task, the majority of mother-child interactions were under 5 minutes in length; therefore, to limit prorating as much as possible, coding was limited to 3 minutes and shorter sessions (37.4%) were prorated up to 36 segments of speech. Each coding category was divided by number of minutes of task length to yield a rate-per-minute of each code. The purpose of this mother-child interaction study was to investigate mothers' use of internal state language within the small subsample of the early arrival sibling group.

6.3 Results

6.3.1 Sociodemographic and psychological antecedents of early sibling arrival

Associations between all variables of interest are presented in Table 6.1. Sibling presence, number and timing were all highly correlated with the early arrival sibling variable. Therefore, sociodemographic and psychological predictors of all sibling arrival variables were explored to establish that predictors of early sibling arrival were not simply predictors of sibling arrival in general.

6.3.1.1 Maternal age at first birth and sibling arrival. As a continuous variable, maternal age was negatively associated with number of siblings in the home; mothers who were younger at the time of their first birth had more subsequent childbirths. As research suggests that the relationship between maternal age at first birth and pace of childbearing is non-linear, three groups were investigated: (a) adolescent mothers (≤ 19 years, mean age 18.44, *SD* = .86); (b) 20s mothers (20-29 years, mean age 25.85, *SD* = 2.89); and (c) over 30s mothers (≥ 30 years, mean age 33.93, *SD* = 2.72). The only difference detected was between groups in the number of subsequent childbirths $F(2,268) = 5.16$, $p < .01$ where over 30s mothers had significantly fewer subsequent childbirths than the 20s mothers ($p < .01$), see Table 6.2.

Table 6.1

Intercorrelations among all variables of interest.

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Sibling variables	1. Presence of a younger sibling in the home	-											
	2. Number of younger siblings in the home	.79** (269)	-										
	3. Timing of younger sibling arrival	.[a] (195)	-.31** (195)	-									
	4. Early arrival younger sibling	.16** (268)	.39** (268)	-.59** (195)	-								
Sociodemographic variables	5. Mothers' age at first birth	-.07 (269)	-.14* (269)	-.11 (195)	-.04 (268)	-							
	6. Mothers' education	.05 (269)	.01 (269)	-.03 (195)	-.03 (268)	.50** (269)	-						
	7. Mother's social class	.04 (269)	-.05 (269)	.23** (195)	-.03* (268)	-.56** (269)	.15** (269)	-					
	8. Mothers' marital status	.12* (269)	-.10 (269)	.09 (195)	.01 (268)	-.53** (269)	.32** (269)	.14** (269)	-				
	9. Mothers' stable relationship	.14* (269)	.06 (269)	.03 (195)	.00 (268)	.37** (269)	.29** (269)	.07** (269)	.24** (269)	-			
	10. Sociodemographic adversity	-.14* (269)	-.05 (269)	.12 (195)	-.03 (268)	-.73** (269)	-.74** (269)	.69** (269)	.66** (269)	-.65** (269)	-		
	11. Mothers' retrospective conduct problems	.01 (269)	.03 (269)	.07 (195)	.09 (268)	-.46** (269)	-.46** (269)	.33** (269)	.32** (269)	-.27** (269)	.53** (269)	-	
	12. Mothers' depressive disorder first six months postpartum	.01 (237)	.01 (237)	.05 (177)	-.01 (236)	-.15 (.02)	-.06 (237)	-01 (237)	-.05 (237)	.[a]	.18** (237)	.21** (237)	-
	Mean	.73	.91	35.25	.19	28.41	4.25	1.46	1.95	.90	-.06	2.06	.09
	SD	*.45*	*.70*	*16.23*	*.39*	*6.21*	*1.61*	*.50*	*1.73*	*.30*	*1.02*	*2.23*	*.29*
	(*N*)	(269)	(269)	(195)	(268)	(269)	(269)	(269)	(269)	(269)	(269)	(269)	(237)

Note. Associations between dichotomous variables were tested by Kappa coefficients. Sample sizes are presented in brackets below coefficients.

*p <.05. **p <.001, [a]correlation not computed as one variable is constant.

Table 6.2

Sibling status by the childhood assessment (presence, number, timing and early arrival) according to maternal age at first birth groups.

	Adolescent mothers (≤ 19 years) *n* = 41	20s mothers (20-29 years) *n* = 105	Over 30s mothers (≥ 30 years) *n* = 123
Younger sibling present in the home (%)	68%	80%	68.3%
Number of younger siblings in the home (mean, *SD*)	.95 *(.86)*	1.06 *(.72)*	.76 *(.60)*
Timing of younger sibling arrival (mean, *SD*)	38.04 *(20.61)*	35.14 *(16.62)*	34.46 *(14.26)*
Younger sibling present in the home an early arrival sibling (%)	20%	21.9%	15.4%

6.3.1.2 Other sociodemographic risk factors and sibling arrival. Associations between sibling status and sociodemographic variables indicated that couples who were married in pregnancy (Wave 1) were more likely to have a second child. Social class was associated with the timing of the second child, where middle/upper class mothers had larger birth intervals between their first- and second-born children, while lower class mothers were associated with having an early arriving second child. Given the high intercorrelations between measures of family environment, these variables may contribute towards the timing and arrival of second children as part of an overall sociodemographic risk factor; therefore subsequent models explored associations using the sociodemographic adversity score.

6.3.1.3 Psychological predictors of sibling arrival. Descriptive statistics for mothers' postnatal depressive disorder and retrospective conduct symptoms are presented in Table 6.1. Of the 237 (88.1%) women in the sibling sample that were assessed with the SCAN interview, 22 (9.3%) met the DSM-IV criteria for postnatal depression. Though the prevalence of mothers' postnatal depressive disorder was lower than rates reported in the full

sample (11.1%, Perra et al., 2015) this was not significantly different and remained in line with estimated prevalence rates of 10-13% (O'Hara & Swain, 1996). Mothers who experienced postnatal depression also experienced higher rates of adversity (Mean .15, *SD* = .97) compared to those who did not (Mean -.34, *SD* = .74), $t(23.57) = 2.28$, $p < .04$. They also reported higher rates of retrospective symptoms of conduct disorder (Mean 3.23, *SD* = 2.45) than the mothers who did not meet diagnosis for postnatal depression (Mean 1.70, *SD* = 1.99), $t(235) = 3.34$, $p < .001$.

Intercorrelations between all variables did not suggest associations between maternal psychological factors of interest and sibling status variables. However, in view of the shared variance between maternal postnatal depressive disorder, conduct problems and sociodemographic adversity in addition to prior evidence for associations with early sibling arrival, a logistic regression analysis was conducted to assess the combined contribution of the predictors. Examination of the correlation matrix (Table 6.1) and of collinearity statistics established no issues with collinearity amongst predictor variables (VIF < 10, Tolerance > .20) (Menard, 1995; Myers, 1990). When sociodemographic adversity was entered at the first step and mothers' postnatal depressive disorder at the second step, mothers' retrospective conduct symptoms were revealed to be a significant third step in the model $\chi^2(3) = 4.07$, $p < .05$, Nagelkerke $R^2 = .03$. Mothers who reported more symptoms of conduct disorder in their youth were more likely to have a short birth interval between their first- and second-born child, resulting in an early arrival younger sibling, Wald statistic = 3.86, $p < .05$, *OR* = 1.19, 95% CI(1.00-1.41) (see Table 6.3).

Table 6.3

Logistic regression of socioeconomic adversity, mothers' postnatal depressive disorder and mothers' retrospective conduct problems as predictors of early sibling arrival.

Variable	Value	R^2	*B*	*SE*	Wald χ^2	*eβ*	95% CI for OR
Step 1		.00					
Socioeconomic adversity			-.36	.27	1.85	.90	.41 – 1.17
Step 2		.00					
Mothers' postnatal depressive disorder	No (Reference)		-	-	-	-	-
	Yes		-.15	.60	.06	.86	.27 – 2.79
Step 3		.03*					
Mothers' retrospective conduct symptoms			.17*	.09	3.86	1.19	1.00 – 1.41

Note. The table presents coefficients obtained at the final step of the model. $N = 236$, †$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

6.3.2 Consequences of early sibling arrival for mother-child interaction

Of the 50 families in the early arrival sibling sample, 43 of these were seen at the toddlerhood assessment. For the purpose of examining mother-child interaction following the birth of the younger sibling at this time-point, mothers who had not yet given birth to the early arrival sibling were excluded from the early arrival sibling group, yielding a sample of 24 mother-child dyads who had an *early arrival sibling present at toddlerhood assessment*. Twenty-two of these had mother-child interaction data available. The mean age of the early arrival younger siblings in this group was 3.60 months *(SD* = 3.63) at the time of the toddler assessment.

6.3.2.1 Mother talkativeness. No differences were detected in mothers' talkativeness at the early infancy interaction and the middle childhood interaction between the sibling groups. However, mothers who had an early arrival sibling born by the time of the toddlerhood interaction spoke to their firstborn significantly less (Mean .62, *SD* = .27) than mothers who did not (Mean .77, *SD* = .20) $t(23.79) = -2.64$, $p < .05$ (see Figure 6.4).

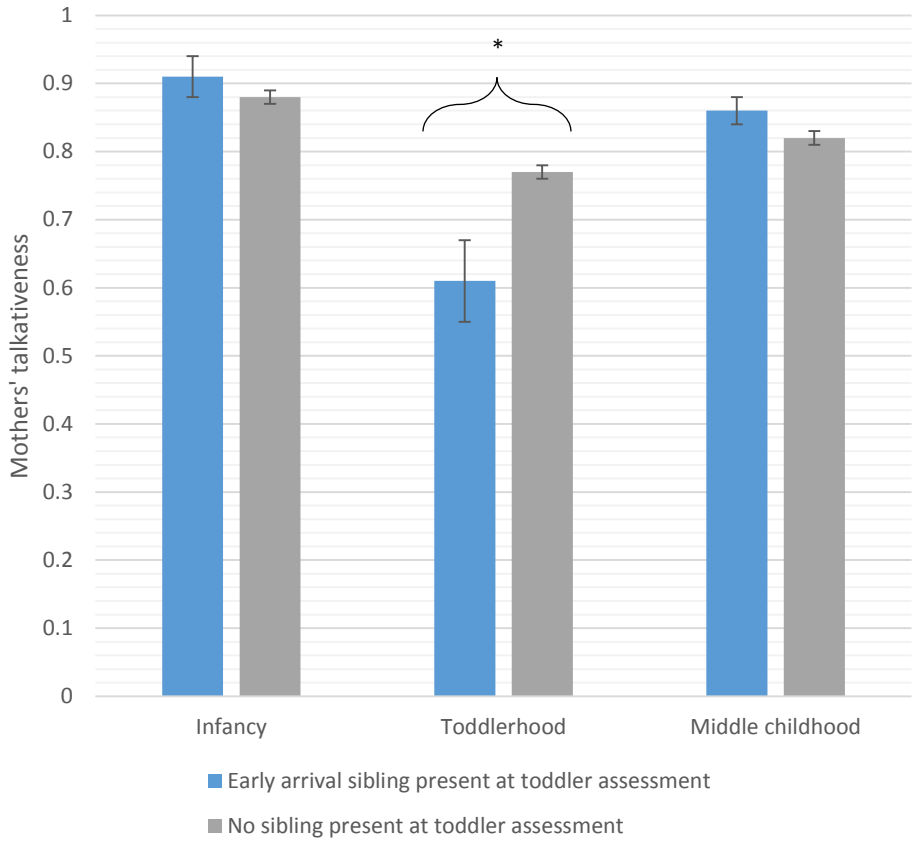

Figure 6.4 Mothers' talkativeness scores at the infancy, toddlerhood and middle childhood assessments according to whether a sibling was present at the toddlerhood assessment, error bars are ± standard error of the mean, *p <.05.

6.3.2.2 Mother references to internal states. No differences were detected between the early sibling arrival group and the no sibling group at the infancy and middle childhood assessment in mothers' frequency and variety of internal state language. However, mothers' who had a second child present by the toddlerhood assessment referred to internal states fewer times than those without $t(34.92) = -2.75$, $p < .01$. When frequency of references to internal states was separated according to referent, it was revealed that mothers referred to the child's internal states less at the toddlerhood assessment if an early arrival sibling was present $t(30.89) = -2.22$, $p < .05$ (Figure 6.5).

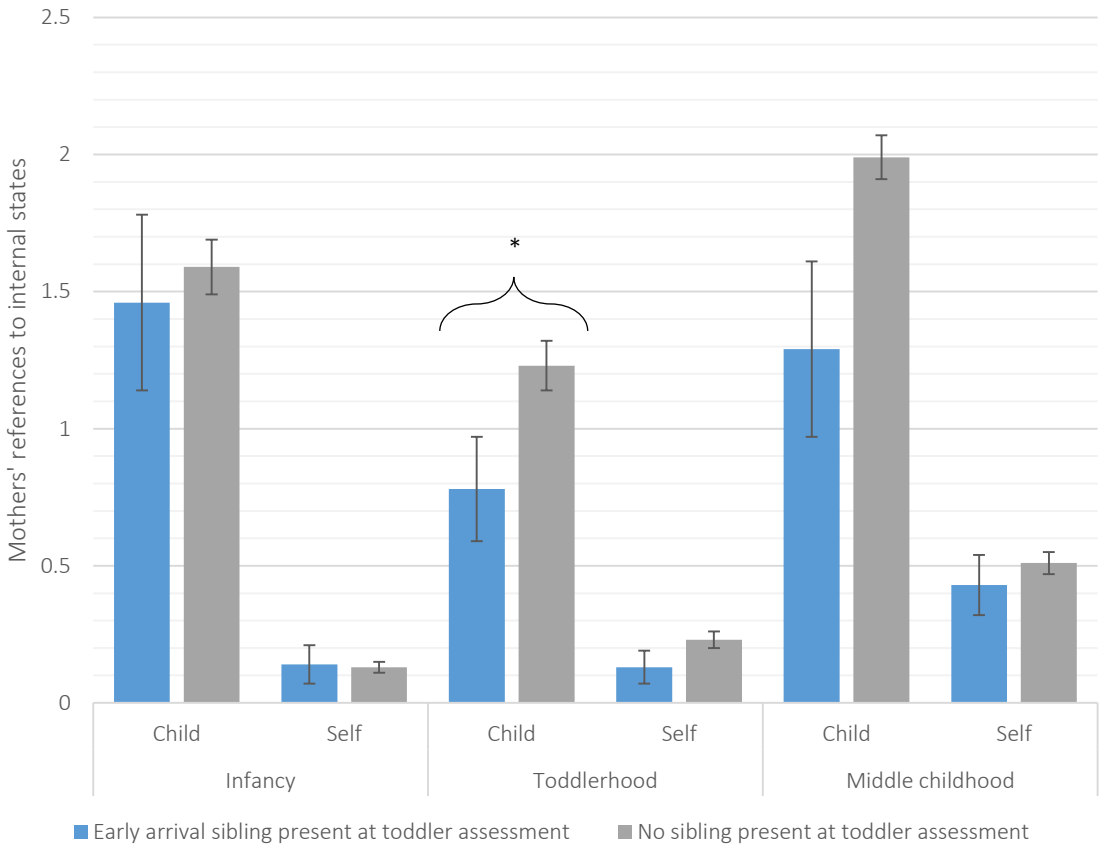

Figure 6.5 Mothers' references to the child's and her own internal states (rate per minute) at the infancy, toddlerhood and middle childhood assessments according to whether a sibling was present at the toddlerhood assessment, error bars are ± standard error of the mean, *p <.05.

Table 6.4 shows the breakdown of internal state language categories used by mothers at the early infancy assessment, according to whether there was an early arrival sibling present. The only difference in internal state language between the early arrival sibling group and no sibling present group at the toddler interaction was mothers' references to child cognitive states. Where an early arrival sibling was present at the toddlerhood assessment, mothers referred to the firstborns' cognitive states significantly fewer times $t(45.01) = -2.29$, $p < .05$ (see also Figure 6.6).

Table 6.4

Means and standard deviations for maternal use of internal state language (rate per minute) at the toddlerhood assessment according to early arrival sibling presence group (n = 22) and the no sibling group (n = 178).

Mothers' references to child's internal states	Sibling presence groups				Mothers' references to own internal states	Sibling presence groups			
	Early arrival sibling present		No sibling present			Early arrival sibling present		No sibling present	
	Mean	SD	Mean	SD		Mean	SD	Mean	SD
Perception					Perception				
Frequency	.06	.21	.15	.35	Frequency	.02	.11	.02	.12
Variety	.06	.21	.10	.22	Variety	.02	.11	.02	.10
Physiology					Physiology				
Frequency	.05	.21	.00	.04	Frequency	.00	.00	.00	.00
Variety	.02	.11	.00	.04	Variety	.00	.00	.00	.00
Preference					Preference				
Frequency	.03	.13	.08	.26	Frequency	.03	.13	.00	.04
Variety	.03	.13	.07	.20	Variety	.03	.13	.00	.04
Intention					Intention				
Frequency	.30	.46	.31	.49	Frequency	.00	.00	.01	.07
Variety	.19	.25	.21	.30	Variety	.00	.00	.01	.07
Desire				.	Desire				
Frequency	.19	.38	.39	.57	Frequency	.00	.00	.01	.06
Variety	.15	.30	.23	.28	Variety	.00	.00	.01	.06
Emotion					Emotion				
Frequency	.04	.20	.03	.16	Frequency	.00	.00	.00	.00
Variety	.04	.20	.03	.14	Variety	.00	.00	.00	.00
Cognition					Cognition				
Frequency	.11	.29	.28	.58	Frequency	.07	.25	.19	.35
Variety	.08	.23	.19	.33	Variety	.07	.25	.15	.26

Note. Early arrival sibling present at toddlerhood assessment $n = 22$, no sibling present at toddlerhood assessment $n = 178$.

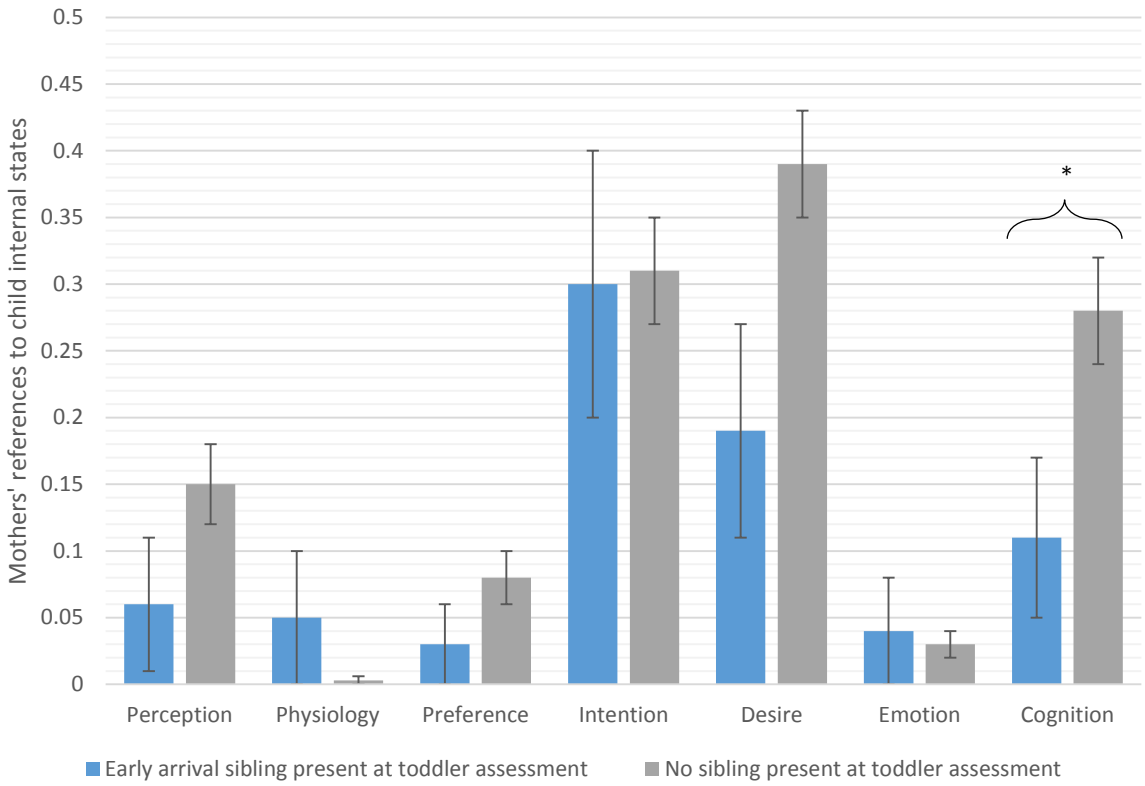

Figure 6.6 Mothers' references to the firstborns' internal state categories (rate per minute) at the toddlerhood interaction according to whether a sibling was present, error bars are ± standard error of the mean, *p <.05.

6.4 Discussion

In Chapter 3 of this thesis, early arrival siblings did not foster firstborns' understanding of second-order false belief. Therefore, the aim of the present chapter was to examine characteristics of this group that may begin to explain why early arrival siblings did not provide a similar advantage to later arriving siblings. In the present chapter, this was done by exploring maternal antecedents of early subsequent childbearing and by examining changes that occur within early mother-firstborn interactions after an early arrival sibling is born.

6.4.1 Antecedents of early sibling arrival

Mothers' retrospective symptoms of conduct disorder predicted rapid subsequent childbearing following the birth of their first child. This finding builds on previous research suggesting that conduct disorder predicts reproductive behaviour in young mothers; in the present sample, mothers' history of conduct symptoms predicted rapid multiple births regardless of age. This finding is notable given that the majority of work exploring maternal predictors of short birth intervals has heavily focused on adolescent mothers (Barnet et al., 2008; Raneri & Wiemann, 2007). Given the homotypic continuity of conduct problems and ongoing related issues in adulthood, including substance abuse, engagement in crime, early home leaving, multiple and violent cohabitation partnerships (Bardone et al., 1996), it is essential to recognise that the risk of rapid childbearing is not one that is limited to adolescent mothers.

The finding that mothers' postnatal depression was not associated with rapid subsequent childbearing corroborates previous work that also showed no link between depressive symptoms and unintended pregnancy within 1 year after a birth, when educational status and contraceptive use were controlled (Bennett et al., 2006). Although sexual behaviour may reduce during episodes of depression, this stands in contrast to studies linking depressive symptoms with risky sexual behaviour (Ramrakha et al., 2000). The present study does not provide a definitive conclusion: there was a relatively small cell size of the depressed group and no measure of sexual behaviour following childbirth. Therefore further exploration of associations between depressive disorder and rapid childbearing should use more measures within a high risk or clinical sample.

Socioeconomic adversity did not predict early subsequent childbearing in the present sample, which stands in contrast to previous work showing low educational status doubles the risk of unintended repeat pregnancy within 1 year after a birth (Bennett et al., 2006). This

discrepancy may be due to a variety of reasons: One, is that the present investigation took place within a representative community sample rather than a high-risk sample. Another reason for this discrepancy may be that, given the high association between economic hardship and mothers' conduct problems, the inclusion of conduct problems in the model in the present study may have explained variance that has not previously been captured in previous studies.

6.4.2 Consequences of early sibling arrival for early mother-child interactions

The consequences of short birth intervals between children for the mother-firstborn relationship has been severely neglected in developmental literature thus far. In this study, mothers spoke differently to their firstborn child following the rapid arrival of a second child. Mothers in this group talked less to their firstborn generally, and referred to their firstborns' cognitive states significantly less if they had a second child at the time of the toddlerhood mother-child interaction task. These differences, however, were not apparent at the baseline (infancy) mother-child interaction task, nor at the middle childhood mother-child interaction task when firstborns were 7 years of age. This suggests that mothers of early arrival siblings did not have an overall propensity to speak differently to their firstborn children, but rather their capacity to engage in conversations with their firstborn shortly after early sibling arrival may alter as a result of caring for multiple children under 2 years of age.

Nevertheless, it is possible that mothers' reduction in conversation and references to internal states in the early arrival sibling group in early mother-firstborn interactions may be exacerbated by factors other than the stress of caring for multiple children. This group scored significantly higher on symptoms of conduct disorder, which may additionally hinder their ability to engage in conversations with their firstborn child. Mothers with conduct disorder show a lack of emotional and verbal responsiveness to their young children in addition to less provision of appropriate play materials. These suboptimal parenting behaviours are linked to

children's later developmental delays (Serbin, Peters, McAffer, & Schwartzman, 1991). Given that short birth intervals are associated with postpartum low mood (Gürel & Gürel, 2000), it may be that the mothers' of early arrival siblings were more likely to be depressed at the time of the assessment. This may explain the reduction in references to internal states, given that maternal depression is associated with differences in mothers' frequency of references to inner states, and ability to comment appropriately on the minds of their infants (Pawlby et al., 2010). Although not possible within the confines of the present investigation, these possibilities must be further studied within larger studies of early mother-child interaction following the early arrival of a second child.

6.4.3 Limitations

This study has limitations. The antecedents explored in this study predicted towards families experiencing the birth of an early arrival younger sibling, and did not include rapid subsequent pregnancies that resulted in terminations or losses. Therefore, this study undoubtedly underestimated the number of rapid repeat pregnancies that occurred within this sample. Future work must examine the antecedents of rapid repeat pregnancy in community samples by examining information on miscarriages and terminations, in addition to reports of sexual behaviour following the birth of the firstborn child. However, the measure of rapid birth of a second child in this study may have been more precise, given that a number of unintended pregnancies that end in termination are typically underreported (over 40% in the National Survey of Family Growth; NSFG) in surveys of the general population (Fu, Darroch, Haas, & Ranjit, 1999).

Secondly, it must be acknowledged that the cell size of families that had an early arrival sibling present at the toddler mother-child interaction was small. Given that the CCDS is a prospective longitudinal study of child development, and not one of family planning outcomes, this investigation was only possible by taking advantage of the data available. That

being said, the longitudinal nature of the study provided a unique opportunity to compare the mother-firstborn conversational climate upon arrival of an early sibling to the climate prior to sibling arrival when the firstborn was 6 months old and later in development when they reached 7 years of age. While the results in this exploratory study must be taken as preliminary, this study has highlighted the need for more research into the effect that early sibling arrival has on mother-child interactions.

6.4.4 Summary

In this chapter, it was first identified that mothers' retrospective symptoms of conduct disorder predict the timing of family formation, in that mothers with conduct symptoms were more likely to have a short birth interval between her first- and second-born children. Secondly, mother-firstborn interactions that followed the birth of an early arrival sibling were found to differ from mother-child interactions where no sibling was present. Mothers of two young children by the time that the firstborn was a toddler were less talkative and referred to their firstborns' cognitive states less. Interestingly, short birth intervals affect features of mother-firstborn conversations that are considered most relevant for promoting children's developing understanding of minds. This, as pointed out in Chapter 3, may have long term consequences for child development. Although findings related to the mother-firstborn interactions at the toddlerhood assessment must be taken as somewhat preliminary, this chapter has highlighted the importance of examining how short birth intervals between children affect mother-child interactions.

CHAPTER 7

General Discussion

7.1 Introduction

The overarching aim of this thesis was to examine the influence of children's close relationships on their understanding of minds in middle childhood. Past research has focused on investigating the link between children's close relationships and their developing theories of mind in the preschool years, neglecting that children's theory of mind continues to develop beyond the 5th year of life. Studies of family influence on children's mind-understanding have also focused on children's individual relationships with family members, rather than considering the connections between them. Therefore, in this thesis I examined the influence of younger siblings on children's higher-order understanding of minds in middle childhood. I explored how siblings influence mind-understanding by investigating how the arrival of a sibling changes the dynamic of the mother-firstborn relationship. This investigation took place within a prospective longitudinal study of firstborn children and their families who were followed from pregnancy to 7 years postpartum. In this chapter, I will synthesise the key empirical findings of this thesis. To support this, a summary of these empirical findings

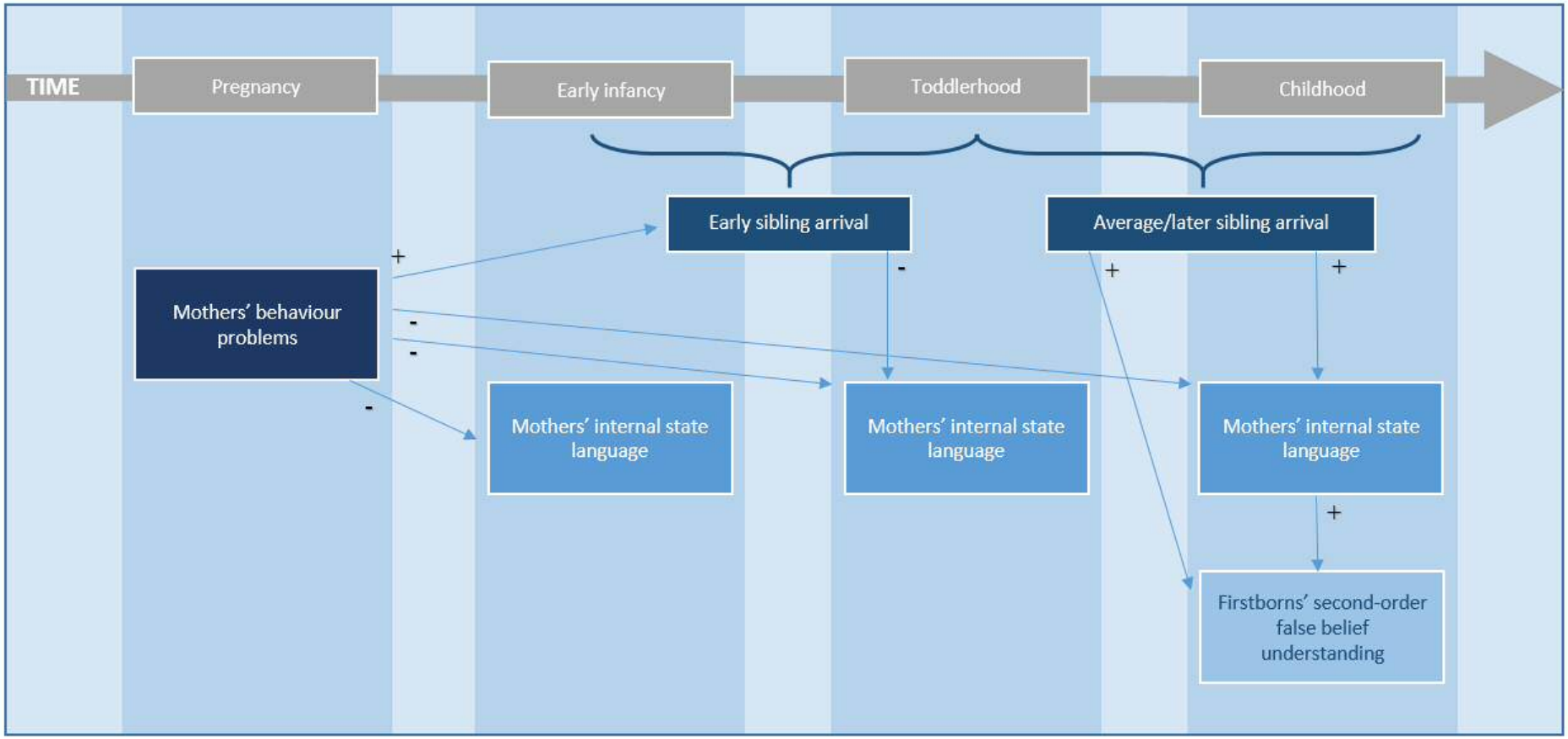

Figure 7.1 Summary of associations between the variables of interest in the thesis. Plus symbols indicate positive associations, minus symbols indicate negative associations.

is presented in Figure 7.1. Following this, the limitations and implications for theory and future research will be discussed.

7.2 Summary of Findings

7.2.1 Average to late, but not early, arriving younger siblings foster second-order false belief understanding

In Chapter 1, I reviewed the literature regarding the influence of siblings on children's understanding of minds. In doing so, I highlighted that the link between having siblings and children's performance on measures of theory of mind is dependent on sibling constellation factors (Buhrmester, 1992), such as birth-order, age-spacing and gender composition. Of these constellation factors, previous findings were mostly mixed regarding the influence of younger siblings on children's understanding of minds (e.g., Peterson, 2000, Farhadian et al., 2010, Ruffman et al., 1998; Wright & Mahford, 2012). This is possibly due to the focus on children's mind-understanding in the preschool years, the use of small samples and lack of control regarding known correlates of theory of mind (Chapter 3).

Therefore in Chapter 3, I set out to investigate the influence of younger siblings on firstborns' higher-order understanding of minds at age 7. I examined various sibling constellation factors, including sibling presence, birth interval and gender composition on an established measure of higher-order theory of mind: the second-order false belief task. I found that when other child correlates of second-order false belief were controlled, presence of a sibling resulted in a two-fold advantage on firstborns' passing of the second-order false belief task with full comprehension. However, this was only true for children who experienced the birth of sibling after their second birthday.

7.2.2 Explaining the influence of younger siblings on second-order false belief understanding

In Chapter 1 of this thesis, I described the ways in which siblings may foster understanding of minds in childhood. One way siblings may foster children's theory of mind is by triggering changes within the mother-firstborn relationship, namely, in mothers' propensity to refer to their firstborn as one with a mind in her use of internal state language. Through the use of this prospective longitudinal design, with mother-child interaction data available before and after the arrival of siblings, this study presented an opportunity to test this hypothesis.

Therefore, in Chapter 4, I reviewed the literature regarding the relationship between mothers' references to internal states and children's theory of mind understanding. Though the positive association between mothers' internal state language and children's understanding false belief in the preschool years was well-evidenced, few studies had explored this relationship at age 7. Additionally, little was known about maternal correlates of mothers' propensity to discuss internal states with her child. As such, I expanded the internal state language coding scheme previously used on the Cardiff Child Development Study (Roberts et al., 2013), to one more appropriate for coding mother's speech to her child across different ages. I applied this to mothers' speech during interactions with their firstborn child during infancy, toddlerhood and in middle childhood.

I established excellent reliability using the expanded internal state language coding scheme, and the patterns of internal state language categories reflected those reported in previous studies. I discovered that mothers with a history of behavioural problems used less internal state language. When controlling for mothers' behavioural problems, mothers' frequency and variety of references to the child's, and her own, cognitive states at the middle

childhood interaction predicted an advantage on firstborns' performance on the second-order false belief task.

In Chapter 5, I brought the two findings from Chapter 3 and Chapter 4 together, by testing the hypothesis that siblings foster firstborns' understanding of minds in middle childhood by triggering changes to the mothers' references to internal states. First, I examined whether mothers' references to internal states changed upon arrival of a sibling. I compared mothers' references to internal states prior to sibling arrival in early infancy, to mothers' references in middle childhood according to whether children had a sibling at middle childhood or whether they were only children. There was no difference in mothers' use of internal state language between sibling presence groups at the early infancy interaction. However, at the mother-child interaction in middle childhood, mothers who had a second child referred to their firstborns' cognitive states more frequently and in a more varied way than those who did not.

Having established positive associations between sibling presence, mothers' references to firstborn cognitive states and firstborns' second-order false belief understanding, I tested the extent to which mothers' cognitive references mediated the link between sibling presence and firstborns' understanding of minds. I found that the relationship between presence of a sibling and firstborns' understanding of second-order false belief was explained in part, by mothers' variety of references to cognitive states.

7.2.3 Timing matters: An investigation of antecedents and consequences of early arrival siblings

In Chapter 3, I found that the younger sibling effect on firstborns' understanding of second-order false belief was only the case for children who did not experience an early arriving younger sibling. Therefore, in Chapter 6 I focused on exploring factors that may begin to reveal why this was the case. I reviewed and examined maternal antecedents of early

sibling arrival, finding that mothers' symptoms of conduct disorder predicted having a short birth interval between the first and second child.

I also investigated the consequences of having an early arrival sibling on early mother-firstborn interactions. Mothers who had a second child by the time of the toddlerhood assessment (21 months) spoke less within mother-firstborn interactions, and referred to cognitive states less than mothers who did not have a second child at the same time-point. Given that there was no difference in mothers' speech between the no sibling, early arrival sibling and average/later arrival sibling groups at the early infancy or middle childhood assessments (Chapter 5 and Chapter 6), this suggests that early arriving siblings only affect mothers' speech shortly after their arrival. This finding, together with the lack of sibling effect for early arriving siblings reported in Chapter 3, could suggest that the negative impact early arrival siblings have on mothers' speech in early interactions may have long term consequences for firstborns' understanding of minds.

7.2.4 Overall summary of findings

This thesis highlights processes by which younger siblings may or may not foster firstborns' understanding of minds in middle childhood. The findings presented in this thesis suggest that the arrival of a sibling triggers a change in the conversational climate of mother-child dyadic interaction. The collective findings presented in this thesis serve as a reminder of the complexities of studying the relationship between siblings and children's understanding of minds. The influence of younger siblings does not occur in isolation of other relationships. Rather, the sibling effect on theory of mind must be understood by examining how the birth of the second child affects children's other close relationships. The effect the arrival of the sibling has on these relationships may well differ according to maternal antecedents of childbearing and sibling constellation factors.

Investigating the influence of siblings within the context of the Cardiff Child Development Study provided several advantages in conducting this complex investigation. The study sample was large and diverse enough to examine various sibling constellation factors, such as birth interval and gender composition, and the relation to firstborns' understanding of minds. Additionally, this representative sample included firstborns who had experienced the birth of a sibling in addition to those who did not. This enabled the investigation to move beyond smaller sibling studies that were unable to separate normative development from changes related to sibling arrival. The use of a prospective longitudinal study from pregnancy to 7 years postpartum gave a unique opportunity to examine the changes in mother-child interaction before the birth of the second child, and at several time-points after. This enabled the investigation of how the dynamics of the mother-child relationship change as family formation changes over time.

7.3 Limitations

The studies presented in this thesis have limitations. The first limitation that must be acknowledged is the single second-order false belief task that was used as the main dependent variable in this thesis. This task was part of a large battery of social, emotional and cognitive assessments that were administered at the middle childhood home visit. As such, the number of assessments possible within the time-constraints of home visits inevitably resulted in a trade-off with the number of trials possible in each assessment. That being said, I used stringent criteria for passing second-order false belief; all analyses in this thesis focused on children's passing of second-order false belief with full comprehension. Additionally, the second-order false belief story used in present thesis closely resembled the simplified story used by Coull and colleagues (2006), as did the second-order, justification and comprehension questions used to assess task performance (see Tables 7.1 and 7.2, and also Appendix I). In their study, the story was acted out using Lego models of locations and dolls

to represent the characters in the story, which closely resembles the Playmobil set used in the CCDS.

In addition to the task closely resembling previous work as much as possible, it is also notable that test-retest reliability of other simple second-order tasks, such as that used by Sullivan, Zaitchik and Tager-Flusberg (1994) have been reported as acceptable (.72, Hughes, Adlam, Happé, Jackson, Taylor, & Caspi, 2000). In light of this, the use of a single task to assess children's understanding of minds has been defended. Indeed, Hughes and colleagues (2000) stated that "Many studies seek to establish whether or not a child has a theory of mind on the basis of his or her responses to a handful of questions on a single task. Our results suggest that this procedure will yield moderately reliable data that are acceptable for research purposes." (p. 488).

Table 7.1

Coull and colleagues' (2006) second-order false belief story format.

It is Paul's birthday. Paul and Sally are in his play room. He is showing Sally his favourite new present—a robot. Paul puts the robot back in the box with the lid on and then has to go outside. While Paul is away, Sally decides to play a trick on Paul and move the robot from its box and hide it away in the cupboard. While Sally is hiding the robot in the cupboard, Paul passes by the window and sees Sally hiding the robot in the cupboard. But Sally doesn't see Paul watching her hide the robot in the cupboard. She doesn't see him! Paul then returns to the toy room.		
Story questions and example answers		
Second-order false-belief question	Where does Sally think Paul will look for the robot?	Box.
Justification question	Why does Sally think Paul will look for the robot in the _____?	Because she doesn't know that Paul knows the robot is in the cupboard.
Probe question 1	Does Paul know that the robot is in the cupboard?	Yes
Probe question 2	Does Sally know that Paul saw her hide the robot?	No.
Probe question 3	Where will Paul look for the robot?	In the cupboard.

Table 7.2

Second-order false belief story format used in the Cardiff Child Development Study.

It is almost bedtime. Nick has had his special teddy for a very long time. He likes to have it nearby when he goes to sleep. Nick puts the teddy under the duvet on the bed. Mum doll comes in and asks Nick to come brush his teeth. Alex sees Nick leave and runs to get the teddy to hide it in the cupboard. But Nick comes back, stands in the doorway and sees Alex hide the teddy in the cupboard. She goes away again. Alex goes back to playing. Nick comes back in. "I want my teddy," he says.		
	Story questions and example answers	
Second-order false-belief question	Where does Alex think Nick will look for the teddy?	Bed.
Justification question	Why does Alex think Nick will look for the teddy in the _____?	Because she doesn't know that Nick knows the teddy is in the cupboard.
Comprehension question 1	Does Nick know that the teddy is in the cupboard?	Yes
Comprehension question 2	Does Alex know that Nick saw her hide the teddy?	No.
Comprehension question 3	Where will Nick look for the teddy?	In the cupboard.

Nevertheless, more research must be conducted to corroborate the findings reported in this thesis. Given that an aggregate of children's performance on multiple false-belief tasks would yield a more reliable index of children's understanding of minds (Hughes et al., 2000), it is recommended that future studies attempt to replicate these findings using a battery of false belief tasks. The inclusion of simpler second-order stories in such a battery that include second-order ignorance questions or memory aids, for example (Coull et al., 2006), would prevent underestimating children's ability to engage in second-order reasoning (see Hogrefe, Wimmer, & Perner, 1986).

Research may also move beyond false belief tasks in the future. Although the use of the second-order false belief task resulted in comparability with other work within the literature concerning higher-order theory of mind, this task represents just one domain of social understanding. More could be understood about the sources of individual difference in

children's theory of mind in middle childhood by assessing other dimensions of children's mind-understanding (Astington, 2001). These could include the *strange stories task* (Happé, 1994), the *triangles task* (Castelli, Happé, Frith & Frith, 2000) or the *silent film task* (Devine & Hughes, 2013).

Another limitation that must be acknowledged is the issue of missing mother-child interaction data at different assessment points. In this thesis, I focused on how mother-child interactions change following the arrival of a sibling. Due to the focus on this relationship, instances where children were seen interacting with another caregiver in the home were not included in this investigation. However, where appropriate, I imputed missing data from earlier time-points where mother-child interaction data were available. This has its limitations, in that it assumes a linear relationship in features of mother's language over different time-points, however this is recommended practice in longitudinal research (Newman, 2003). All analyses were conducted with and without imputed data prior to what was reported in this thesis: no different results were found in the analyses of the raw data.

7.4 Future Directions

The benefit of studying sibling influences within this longitudinal study enabled the examination of antecedents and consequences of sibling arrival and how these may be related to children's understanding of minds. The approach I have taken in this thesis reflects Baydar and colleagues' (1997) model of the effects of the birth of a sibling shown in Figure 7.2. Highlighted in this figure are pathways that have been explored in this thesis. Path A represents the association between sibling presence and firstborns' understanding of minds (Chapter 3) and path B represents the relationship between mothers' internal state language and firstborns mind-understanding (Chapter 4). Path C was investigated in both Chapters 5 and 6, in the study of how sibling presence and early arrival affects mother-child interactions.

Finally, pathway D represents the investigation in Chapter 6, where the maternal antecedents of short birth intervals were identified.

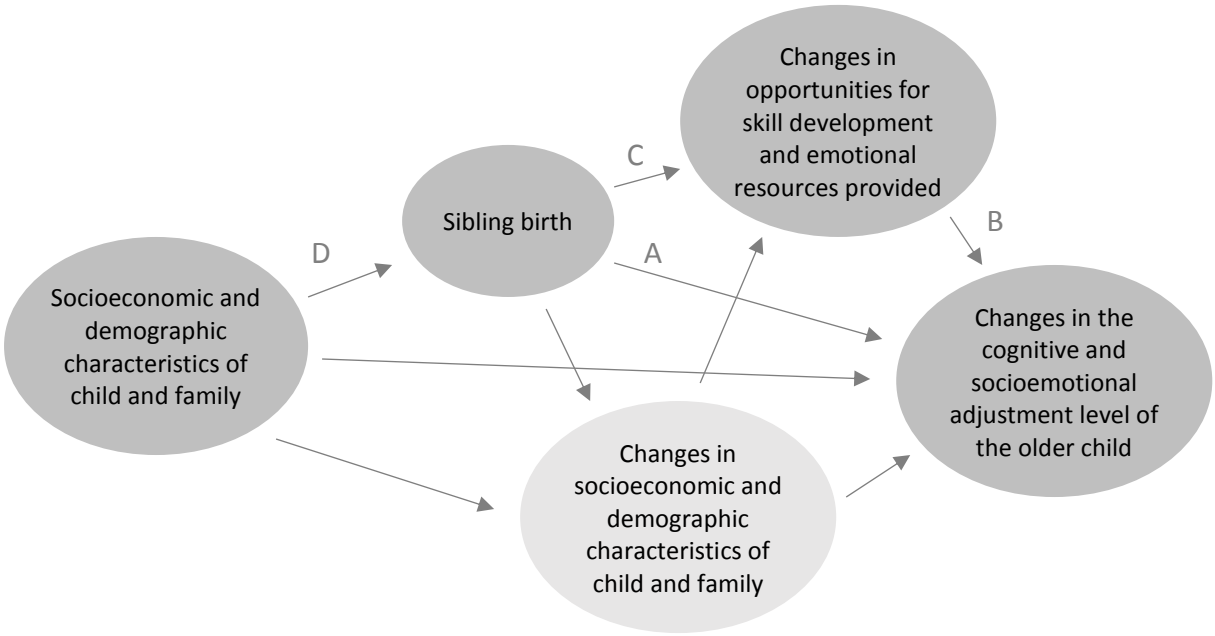

Figure 7.2 Baydar and colleagues' (1997) model of the effects of the birth of a sibling. Shaded are the factors that were investigated in this thesis.

Placing the findings within the context of Baydar and colleagues' (1997) model highlights how future work should build on the findings presented in this thesis, by examining the changes in socioeconomic and demographic characteristics of the firstborn and family upon sibling arrival. Sibling arrival is associated with decreases in mothers' time at work, where in contrast, mothers without a second child increase their work hours. The decrease in maternal earnings and increase in resources needed to care for multiple children results in more socioeconomic hardship. Additionally, firstborns who experience the arrival of a sibling spend less time in day care than those who do not, presumably because mothers are available in the home following the arrival of the new baby (Baydar et al., 1997). These factors may explain some of the changes in mother-child interaction reported in this thesis.

Though it was not feasible to investigate these outcomes within this thesis, it is recommended that future research takes these socioeconomic and demographic characteristics into account.

The relationships explored in this thesis should also be investigated further in studies that include a preschool-age assessment. In Chapter 4 of this thesis, I reported that mothers' references to internal states during the early infancy and toddlerhood mother-child interactions were not related to children's later understanding of minds. However, this stands in contrast to other research suggesting that mothers' references to cognitive states earlier in development may help children to better understand and engage with the minds of others (Adrian et al., 2007). Therefore, it is possible that the relationship between maternal internal state language and children's second-order false belief understanding in this study may represent residual effects of mother-child interactions from earlier years. Although no relationship with maternal references to internal states was found at the early infancy and toddlerhood interactions, this seems appropriate given that complex internal state references most relevant for false belief understanding would not be in the range of the infants' Zone of Proximal Development. Further longitudinal research is required to examine the influence of maternal speech from the preschool years to middle childhood on children's understanding of second-order false beliefs. Ideally, this would also give the opportunity to track the effect of younger siblings earlier in development using standard first-order false belief tasks.

The findings presented in this thesis have contributed to our understanding of the processes by which younger siblings influence firstborns' theory of mind. Future work must now continue to explore the other processes by which younger siblings influence firstborns' understanding of minds, by examining other relationships within the family system. This should include further work examining the influence of fathers' speech (LaBounty et al., 2008) and the dynamics of sibling interactions associated with children's social understanding (Dunn, 1994). One avenue that has received little attention thus far, is how

siblings foster children's understanding of minds through shared humour (Hoicka & Akhtar, 2012). Future research must continue to investigate the processes by which siblings influence theory of mind in the same spirit of this thesis; not by examining children's relationships in isolation, but by considering how relationships change and how one relationship may influence others (Dunn, 1993).

7.5 Implications of the Findings

The findings presented in this thesis speak to the importance of children's social worlds in the development of theory of mind. All prominent individualistic theories of theory of mind development accommodate the influence of social interaction in some way. In modular accounts of theory of mind (Leslie, 1994), social interaction is thought to trigger maturation of hardwired theory of mind mechanisms. In the theory-theory approach to the development of theory of mind (Wellman, 1990), it is thought that children's social and mental knowledge is acquired through theory formation and revision. 'Theory theorists' suggest that during development there are fundamental theory shifts in children's mind-understanding, in which children's social experiences play an important role. Finally, simulation theory (Harris, 1991) emphasises the use of imagination and pretence to simulate what another might be thinking, based on what mental states the individual has experienced themselves already. In this view, children's social interactions that foster their imaginative capacity for pretence fosters theory of mind development (Hughes & Leekam, 2004). Carpendale and Lewis's (2004) social constructivist account is a recent alternative to existing theories, which have been criticised for underemphasising the importance of children's external, social worlds and focusing too heavily on individual development. In this view, children's understanding of minds is thought to be the essential foundation in which children's understanding of minds develops. Although the extent to which theory of mind develops within the context of social interactions is still up for debate, this thesis

demonstrates the ongoing importance of children's close family relationships in children's continuing developing understanding of minds beyond the preschool years.

Carpendale and Lewis's view (2004) called for more research concerning *how* social experience influences children's developing understanding of minds (Bartsch & Estes, 2004). The present thesis has provided some insights by highlighting that the effect of siblings on firstborns' second-order false belief understanding can be explained in part, by changes in mothers' references to cognitive states. This work highlights that future study concerning sibling influence on theory of mind must move beyond merely examining the relationship between the quantity of siblings and children's understanding of mind. Rather, entry into siblinghood must be regarded as a proxy for changes in children's social experiences within the family. In this thesis, I have demonstrated that these changes are not limited to children's interactions with their siblings, but that siblings trigger changes throughout the family system. Future research must continue in this vein to examine changes in children's conversational environment beyond the mother-child dyad.

One recurring finding in this thesis was the importance of mothers' behavioural problems, which was associated with mothers' propensity to refer to internal states at all mother-child interaction tasks (Chapter 4) and was also associated with early sibling arrival (Chapter 6). These findings highlight the importance of controlling for mothers' behavioural problems in future research, both as a predictor of mother-child conversational environments and as a predictor of timing of sibling arrival. These findings also have implications for clinical practice. Mothers' symptoms of conduct disorder, but not age, predicted a short birth interval between the first- and second- child. Given the host of issues associated with rapid subsequent childbearing (Conde-Agudelo et al., 2007, 2012) and the consequences maternal behavioural problems have for the provision of an optimal caregiving environment (Kim-Cohen et al., 2006), this thesis has identified a risk group that warrants further research and

clinical intervention. Programmes such as The Family Nurse Partnership (Robling et al., 2016) which offer intensive home visiting from a specialist nurse for first-time adolescent mothers could also be of benefit for mothers with behavioural problems. Such programmes are effective in reducing closely-spaced pregnancies, and may be an avenue where mothers can receive support and encouragement to talk to their babies in ways that promote the development of theory of mind.

7.6 Final Conclusions

Studying the connections between children's close relationships can reveal a great deal about the social influences on children's developing understanding of minds. In this thesis, I have identified that younger siblings provide firstborns with an advantage on measure of higher-order theory of mind. This advantage can be explained in part, by an increase in mothers' references to cognitive states upon arrival of a second child. However, I have highlighted that this process whereby siblings foster firstborns' mind-understanding is only the case for children who do not experience an early arriving younger sibling. Firstborns with a closely spaced younger sibling performed similarly to children who did not have a younger sibling. By investigating early mother-child interactions of dyads who experienced early sibling arrival, it was revealed that mothers spoke less in general, and referred to cognitive states less often following rapid sibling birth. This thesis has highlighted how changes in family structure affect the dynamics of children's close relationships, and has made a new contribution to our understanding of how these close relationships foster children's developing understanding of minds.

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APPENDIX I

Second-order false belief supplementary material

Table 1.

Second-order false belief coding and frequencies of appropriate and inappropriate justifications.

			Frequency of response (n)
Appropriate justifications			95
Code 1	Embedding of mental state: Child explicitly embeds a mental state within another character's mental state.	"Because she thinks Nick has no idea that she's put the teddy in the cupboard."	3
Code 2	Nesting of crucial information within another's belief: Information regarding what character has found out is contained in a mental state.	"Because she hid it under the duvet, and then, and she thinks Kate didn't see her. Eee! She won't find out about this!"	27
Code 3	Location: Original location of the object is mentioned.	"'Cause he, that's where he hided it."	65
Inappropriate justifications			44
Code 1	First-order reasoning: Child mentions irrelevant knowledge of one of the characters.	"Because he… he… didn't see like him… and he thought no one had taken it out of his bed so he would think it's in his bed."	6
Code 2	Zero-order reasoning: Unnecessary focus on the location of the teddy.	"Because normally his teddy is there."	3
Code 3	Irrelevant information.	"Because she was out with mum."	7
Code 4	Nonsensical information.	"Because that's the, that's the spot to find things."	28

Note. These verbatim examples followed the justification question that followed the second-order false belief story: Why does Alex think Nick will look for the teddy in the _____?

Table 2.

Contingency table of frequency of correct responses to comprehension questions according to appropriate or inappropriate justification.

	Frequency of correct responses to comprehension questions		
Justification	Comprehension question 3	Comprehension question 4	Comprehension question 5
Appropriate *(n= 95)*	23 (54.8%)	36 (85.7%)	78 (83.0%)
Inappropriate *(n= 44)*	71 (78.0%)	87 (91.6%)	30 (69.8%)

Note. Appropriate/inappropriate responses are described on p. 215. Comprehension questions refer to questions 3, 4 and 5 (see Table 3.4, p 61).

Table 3.

Contingency table of frequency of correct responses to comprehension questions according to appropriate justification codes.

	Frequency of correct responses to comprehension questions		
Appropriate Justification	Comprehension question 3	Comprehension question 4	Comprehension question 5
Code 1	3 (100.0%)	3 (100.0%)	3 (100.0%)
Code 2	27 (100.0%)	27 (100.0%)	25 (96.2%)
Code 3	41 (67.2%)	57 (87.7%)	50 (76.9%)

Note. Appropriate/inappropriate responses are described on p. 215. Comprehension questions refer to questions 3, 4 and 5 (see Table 3.4, p 61).

Table 4.

Contingency table of frequency of correct responses to comprehension questions according to inappropriate justification codes.

	Frequency of correct responses to comprehension questions		
Inappropriate Justification	Comprehension question 3	Comprehension question 4	Comprehension question 5
Code 1	3 (50.0%)	5 (83.3%)	4 (66.7%)
Code 2	3 (100.0%)	3 (100.0%)	3 (100.0%)
Code 3	5 (83.3%)	6 (100.0%)	4 (57.1%)
Code 4	12 (44.4%)	22 (81.5%)	19 (70.4%)

Note. Appropriate/inappropriate responses are described on p. 215. Comprehension questions refer to questions 3, 4 and 5 (see Table 3.4, p 61).

APPENDIX II

Excerpts of executive function tasks from the Cardiff Child Development Study

Amsterdam Neuropsychological Tasks Manual

Cardiff Child Development Study

Amsterdam Neuropsychological Tasks

Manual

Leo M. J. de Sonneville

Dale F. Hay

Stephanie van Goozen

Universiteit Leiden

CARDIFF UNIVERSITY

PRIFYSGOL CAERDYDD

The Cardiff Child Development Study ANT Manual

This manual has been compiled by Amy Paine and Salim Hashmi for the Cardiff Child Development Study (CCDS) team. This manual includes a compilation of instructions and descriptions from Dr de Sonneville's ANT manuals, as well as advice and figures created by the CCDS team. This manual should be used in conjunction with official ANT manuals. This manual is specific to the tasks created for the purpose of the CCDS data collection, and the details of SPSS files are specifically those created with CCDS data. The advice for analysis of this data has been compiled from our examination of recommendations in the literature.[5]

Table of Contents

[5] Appendix II only includes the sections of the manual relevant to the executive function tasks that were used in this thesis. These sections are highlighted in grey in the contents table.

Response Organisation Objects (ROO)

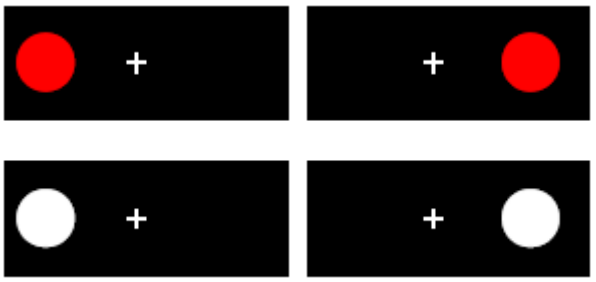
Overview of ROO

In the ROO game, which consists of three parts, children were instructed to place an index finger of each hand on the corresponding sides of the mouse. For each part, children were given instructions by the experimenter, with examples. They were given a practice run of every part before starting the test trials. There were three tasks:

1) Fixed Compatible 1: In this part children were presented with a fixation cross on a black screen. They were asked to respond to red balls that would appear at random on either side of the fixation cross, by clicking on the corresponding side of the mouse. If the red ball appeared on the left of the cross, they click the left side, if it appeared to the right side, they click the right side.

2) Fixed Incompatible 2: In this part children were presented with the same fixation cross on the screen. They were asked to respond to white balls that would appear randomly on either side of the fixation cross, by clicking the opposite side of the mouse. If a white ball appeared to the left of the fixation cross, they click the right side, if it appeared to the right of the cross, they click the left side.

3) Random Mix Compatible and incompatible 3: In this part children were presented with the fixation cross. They were presented either the red or the white balls, and were asked to respond appropriately to the balls by clicking the side of the mouse they were trained in during the previous two parts.



Variables labels in SPSS

Data for responses to the left side and the right side were merged to give overall scores for each part, based on the recommendation that they are never analysed separately. The following variables were provided in the SPSS file. In order to clarify the variable labels in the SPSS file, we have included definitions of the labels for our understanding. Table 2 simply lists the variables within the SPSS file.

Table 1. *Definitions of labels used to describe variables in the ROO SPSS file*

Variable Label	**Definition**
W6 CT ROO Mean RT	Mean reaction time to stimuli in milliseconds
W6 CT ROO Z-Score RT	Reaction time adjusted into z score as a function of child age
W6 CT ROO Z-Score N errors	Number of errors adjusted into z score as a function of child age
W6 CT ROO Percentage Error	Percent of errors
W6 CT ROO Median	Median reaction time to stimuli in milliseconds
W6 CT ROO SD RT	Standard deviation of reaction time to stimuli in milliseconds
W6 CT ROO Mean RT Error	Mean reaction time to erroneous responses in milliseconds

Note. To prevent repetition (there are many more variables than this in the final file – see Table 2), we have defined the main element of the label, but this will apply for every part of the ROO. The psychological constructs are not defined here as this is clarified in the next section.

Table 2. *Variable names and labels in the ROO SPSS file*

Variable Name	**Variable Label**
Tc1_ol	W6 CT ROO Mean RT Compatible 1
Zc1_ol	W6 CT ROO Z-Score RT Compatible 1
Zec1_ol	W6 CT ROO Z-Score N errors Compatible 1
Ti2_ol	W6 CT ROO Mean RT Incompatible 2
Zi2_ol	W6 CT ROO Z-Score RT Incompatible 2
Zei2_ol	W6 CT ROO Z-Score N errors Incompatible 2
Tc3_ol	W6 CT ROO Mean RT Compatible 3
Zc3_ol	W6 CT ROO Z-Score RT Compatible 3
Ti3_ol	W6 CT ROO Z-Score N errors Compatible 3
Zi3_ol	W6 CT ROO Mean RT Incompatible 3
Zec3_ol	W6 CT ROO Z-Score RT Incompatible 3
Zei3_ol	W6 CT ROO Z-Score N errors Incompatible 3
Pec1_ol	W6 CT ROO Percentage Error Compatible 1
Pei2_ol	W6 CT ROO Percentage Error Incompatible 2
Pec3_ol	W6 CT ROO Percentage Error Compatible 3
Pei3_ol	W6 CT ROO Percentage Error Incompatible 3
Pe3_ol	W6 CT ROO Percentage Error Overall 3
Mc1_ol	W6 CT ROO Median RT Compatible 1
Mi2_ol	W6 CT ROO Median RT Incompatible 2
Mc3_ol	W6 CT ROO Median RT Compatible 3

Mi3_ol	W6 CT ROO Median RT Incompatible 3
Sc1_ol	W6 CT ROO SD RT Compatible 1
Si2_ol	W6 CT ROO SD RT Incompatible 2
Sc3_ol	W6 CT ROO SD RT Compatible 3
Si3_ol	W6 CT ROO SD RT Incompatible 3
Tec1_ol	W6 CT ROO Mean RT Error Compatible 1
Tei2_ol	W6 CT ROO Mean RT Error Incompatible 2
Tec3_ol	W6 CT ROO Mean RT Error Compatible 3
Tei3_ol	W6 CT ROO Mean RT Error Incompatible 3
ResponseInhibitionRT	W6 CT ROO Response Inhibition Reaction Times (Mean Latency)
ResponseInhibitionSD	W6 CT ROO Response Inhibition Standard Deviation (Fluctuation in Speed)
ResponseInhibitionPercentError	W6 CT ROO Response Inhibition Percentage of Errors (Accuracy)
CogFlexRT	W6 CT ROO Cognitive Flexibility Reaction Times (Mean Latency)
CogFlexSD	W6 CT ROO Cognitive Flexibility Standard Deviation (Fluctuation in Speed)
CogFlexPercentError	W6 CT ROO Cognitive Flexibility Percentage of Errors (Accuracy)

Details of Specific Cases

Age. Note that child ages in the SPSS file are based on the date of birth provided by the experimenter **during the child testing** and the date of testing, therefore they would be adjusted to session 1 or session 2. However, as these DOBs have been entered in the sessions, there may be errors in the ages. When LdS, SH, RF created the z-scores, these z-scores were created based on these ages. Although obvious errors were corrected, there is no guarantee that these ages are all completely correct (so be aware of this if using z-scores). If an accurate age variable is needed, these have been computed separately (by AP).

Depending on the type of hypotheses/analyses, sometimes z-scores are preferred, and sometimes the raw scores. In many cases raw scores are more sensitive, in particular, when focusing on task manipulation effects (that represent a psychological construct such as inhibition or memory load) (de Sonneville, personal communication, 2015). Added note from Leo regarding this: "It simply has to do with the formula for the z-score and the commonly known fact that more difficult responses (with a larger RT) are accompanied by larger SDs. So, as the SD value is the denominator, the z-scores of more difficult responses tend to be 'attenuated'. So, it may happen that there is a perfect interaction effect shown in raw scores (group x task condition) while the z-

score of the two task conditions are practically equal." (de Sonneville, personal communication, 2016).

Corrected cases. Although it is worth double checking the ages in these files, when data was handled by Leo, Rhiannon and Salim in Summer 2015, any obvious cases where age was clearly incorrect (e.g., 2013 instead of 2003, or if the incorrect ID was clearly selected during testing) the correct DOB was provided and this was corrected for Leo's z scores. All of these corrected scores are within a document located: S:\Research\DHPVG\ANT tasks\ANT data archive\ANT data July 2015\ANT corrections 20.7.15.

1217. There was a mix up with this ID and another ID, which is why this ID does not currently have a z –score (contact Leo if z-scores are needed for this case).

Case Exclusions. Within the W6 ANT data audit, there is a full list of cases that were available and reasons for their absence (i.e., technical error/child refusal etc). This can be found in this location: S:\Research\DHPVG\ANT tasks\W6 ANT data audit. Amongst the reasons for why cases are missing, there is a 'case excluded' label. Cases were excluded when Leo highlighted the data as anomalous, and child testing notes suggested this was due to factors in the testing environment (for example, child not concentrating/particularly noisy environment/child walks away).

Computing Psychological Constructs

"The ROO task measures inhibition of prepotent responses and attentional flexibility (set shifting)." (de Sonneville, p. 2 of ANT manual). S:\Research\DHPVG\ANT tasks\ANT setup documents\ANTtaskdescriptions.

Response Inhibition. Creation of the response inhibition variable is based on previous research. Creation of the inhibition score is fundamentally based upon differences in performance between part 2 fixed incompatible and part fixed compatible. These variables have been created in the ROO SPSS file according to these instructions, and are based on Barneveld, de Sonneville, van Rijn, van Engeland, & Swaab, 2013, Oerlemans et al., 2014 and Van der Meer, 2014, who computed these scores using a near-identical task to the ROO (and was recommended for use by Leo). The following methods have been used to compute response inhibition scores:

Response Inhibition: Reaction times. Mean latency has been assessed by calculating the difference between children's mean reaction speed times between incompatible (part 2) and compatible (part 1):

Ti2_ol - Tc1_ol = ResponseInhibitionRT

This will (almost always) yield a positive number. When this positive value is larger, the impact of the task manipulation is larger, consequently, the task effect is larger and the child's response inhibition is poorer. The smaller the number, the better the inhibition as the task effect in this child is smaller. In this manual (and in ANT tasks generally, when relevant) subtract the result of the easy condition from the more difficult condition. Essentially following this calculation, **the smaller the number, the better the child's response inhibition.**

Response Inhibition: Standard deviation. Fluctuation in speed has been assessed by calculating the difference between children's standard deviations between incompatible (part 2) and compatible (part 1):

Si2_ol - Sc1_ol = ResponseInhibitionSD

Response Inhibition: Percentage of errors: Accuracy has been assessed by calculating the difference between children's percentage of errors between incompatible (part 2) and compatible (part 1):

Pei2_ol - Pec1_ol = ResponseInhibitionPercentError

Cognitive Flexibility. Creation of the cognitive flexibility scores is fundamentally based upon differences in performance between the **only the compatible** stimuli from part 3 random mixed compatible and incompatible and part 1 fixed compatible. These variables have been created in the ROO SPSS file according to these instructions, and are based on Barneveld, de Sonneville, van Rijn, van Engeland, & Swaab, 2013, who computed these scores using a near-identical task to the ROO (and was recommended for use by Leo). The following methods have been used to compute cognitive flexibility scores:

Cognitive Flexibility: Reaction times: Mean latency has been assessed by calculating the difference between children's mean reaction speed times between compatible from random mixed compatible and incompatible (part 3) and fixed compatible (part 1).

Tc3_ol - Tc1_ol = CogFlexRT

Cognitive Flexibility: Standard deviation: Fluctuation in speed has been assessed by calculating the difference between children's standard deviations between compatible from random mixed compatible and incompatible (part 3) and fixed compatible (part 1).

Sc3_ol - Sc1_ol = CogFlexSD

Cognitive Flexibility: Percentage of errors: Accuracy has been assessed by calculating the difference between children's percentage of errors between compatible from random mixed compatible and incompatible (part 3) and fixed compatible (part 1).

Pec3_ol - Pec1_ol = CogFlexPercentError

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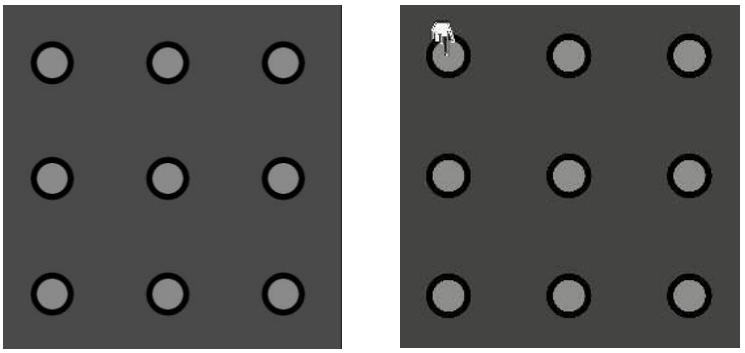
Van der Meer, J.M., Lappenschaar, M.G., Hartman, C.A., Greven, C.U., Buitelaar, J.K. & Rommelse, N.N. (2014, Epub). Homogeneous combinations of ASD-ADHD traits and their cognitive and behavioral correlates in a population-based sample. *Journal of Attention Disorders*.

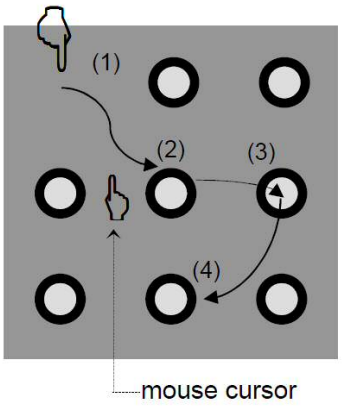
Visuospatial Sequencing (VSS)

Overview of Visuospatial Sequencing

In VSS, the child was presented with a grey square with 9 circles placed in a 3x3 matrix. After a beep signal, a hand would appear and signal a pattern, i.e. by clicking on a specific number of circles (targets) resulting in a specific temporal-spatial pattern. This pattern would start with few circles, and progress to longer and more complicated patterns (3 targets, increasing to 7).



After the display of the pattern, the child would gain control of the mouse, and was asked to recreate the pattern they had been shown; the same circles, in the same order that was presented.



Variables labels in SPSS

Leo provided the following variables in the SPSS file. In order to clarify the variable labels in the SPSS file, we have included definitions of the labels for our understanding. Table 2 simply lists the variables within the SPSS file.

Table 1. *Definitions of labels used to describe variables in the VSS SPSS file*

Variable Label	**Definition**
W6 CT VSS Number of Correct Trials	Number of trials fully correct, i.e. perfect replication of the temporal-spatial target sequence
W6 CT VSS Number of Identified Targets	Number of correctly identified targets
W6 CT VSS Number of Identified Targets in Correct Order	Number of correctly identified targets in the correct temporal order
W6 CT VSS Number of False Alarms	Number of targets selected that were not presented in the pattern
W6 CT VSS Number of Misses	Number of targets missed from presented pattern
W6 CT VSS Mean Pointing Interval	Time between clicks (in ms) (time it takes to move from one target to another). NB: not really relevant (see Tint_vs)
W6 CT VSS Z-Score of Number of Correct Trials	Number of trials fully correct adjusted into z score as a function of child age
W6 CT VSS Z-Score of Number of Identified Targets	Number of correctly identified targets adjusted into z score as a function of child age
W6 CT VSS Z-Score of Number of Identified Targets in Correct Order	Number of correctly identified targets in the correct sequence adjusted into z score as a function of child age
W6 CT VSS Z-Score of Number of False Alarms	Number of targets selected that were not presented in the pattern adjusted into z score as a function of child age
W6 CT VSS Z-Score of Number of Misses	Number of targets missed from presented pattern adjusted into z score as a function of child age
W6 CT VSS Cognitive Control	The difference between number of correctly identified targets and number of correctly identified targets in the correct sequence

Table 2. *Variable names and labels in the VSS SPSS file*

Variable Name	Variable Label
Nct_vs	W6 CT VSS Number of Correct Trials
Nit_vs	W6 CT VSS Number of Identified Targets
Nitco_vs	W6 CT VSS Number of Identified Targets in Correct Order
Nf_vs	W6 CT VSS Number of False Alarms
Nm_vs	W6 CT VSS Number of Misses
Tint_vs	W6 CT VSS Mean Pointing Interval
Zct_vs	W6 CT VSS Z-Score of Number of Correct Trials
Zit_vs	W6 CT VSS Z-Score of Number of Identified Targets
Zitco_vs	W6 CT VSS Z-Score of Number of Identified Targets in Correct Order
Zf_vs	W6 CT VSS Z-Score of Number of False Alarms
Zm_vs	W6 CT VSS Z-Score of Number of Misses
CogControl	W6 CT VSS Cognitive Control

Details of Specific Cases

Age. Note that child ages in the SPSS file are based on the date of birth provided by the experimenter **during the child testing** and the date of testing, therefore they would be adjusted to session 1 or session 2. However, as these DOBs have been entered in the sessions, there may be errors in the ages. When LdS, SH, RF created the z-scores, these z-scores were created based on these ages. Although obvious errors were corrected, there is no guarantee that these ages are all completely correct (so be aware of this if using z-scores). If you need an accurate age variable these have been computed separately (by AP).

Depending on the type of hypotheses/analyses, sometimes z-scores are preferred, and sometimes the raw scores. In many cases raw scores are more sensitive, in particular, when focussing on task manipulation effects (that represent a psychological construct such as inhibition or memory load) (de Sonneville, personal communication, 2015). Added note from Leo regarding this: "It simply has to do with the formula for the z-score and the commonly known fact that more difficult responses (with a larger RT) are accompanied by larger SDs. So, as the SD value is the denominator, the z-scores of more difficult responses tend to be 'attenuated'. So, it may happen that there is a perfect interaction effect shown in raw scores (group x task condition) while the z- score of the two task conditions are practically equal." (de Sonneville, personal communication, 2016).

Corrected cases. Although it is worth double checking the ages in these files, when data was handled by Leo, Rhiannon and Salim in Summer 2015, any obvious cases where age was clearly incorrect (e.g., 2013 instead of 2003, or if the incorrect ID was clearly selected during testing) the correct DOB was provided and this was corrected for Leo's z scores. All of these corrected scores are within a document located: S:\Research\DHPVG\ANT tasks\ANT data archive\ANT data July 2015\ANT corrections 20.7.15.

Case Exclusions. Within the W6 ANT data audit, there is a full list of cases that were available and reasons for their absence (i.e., technical error/child refusal etc). This can be found in this location: S:\Research\DHPVG\ANT tasks\W6 ANT data audit. Amongst the reasons for why cases are missing, there is a 'case excluded' label. Cases were excluded when Leo highlighted the data as anomalous, and child testing notes suggested this was due to factors in the testing environment (for example, child not concentrating/particularly noisy environment/child walks away).

Computing Psychological Constructs

VSS measures "memory for visuospatial temporal patterns." (de Sonneville, p. 2 of ANT manual). S:\Research\DHPVG\ANT tasks\ANT setup documents\ANTtaskdescriptions. Creation of the variables is based on previous research:

Visuospatial working memory. Can be measured using the number of correctly identified locations in the right order (Nitco_vs - W6 CT VSS Number of Identified Targets in Correct Order) (Bloemsma et al., 2013). Also used in Schuitema et al., 2015. Nitco_vs is labelled as VisuospatialWM in the Psychological Constructs SPSS file.

Cognitive control. Can be measured as the difference "…between number of locations identified correctly (visuospatial WM) and number of (correctly identified) locations in the right order (visuospatial WM + visuotemporal WM)" (Huijbregts et al., p. 741).

Nit_vs - Nitco_vs = CogControl

References

Bloemsma, J. M., Boer, F., Arnold, R., Banaschewski, T., Faraone, S. V., Buitelaar, J. K., Sergeant, J. A., Rommelse, N., & Oosterlaan, J. (2013). Comorbid anxiety and neurocognitive dysfunctions in children with ADHD. *European Child & Adolescent Psychiatry*, *22*(4), 225-234.

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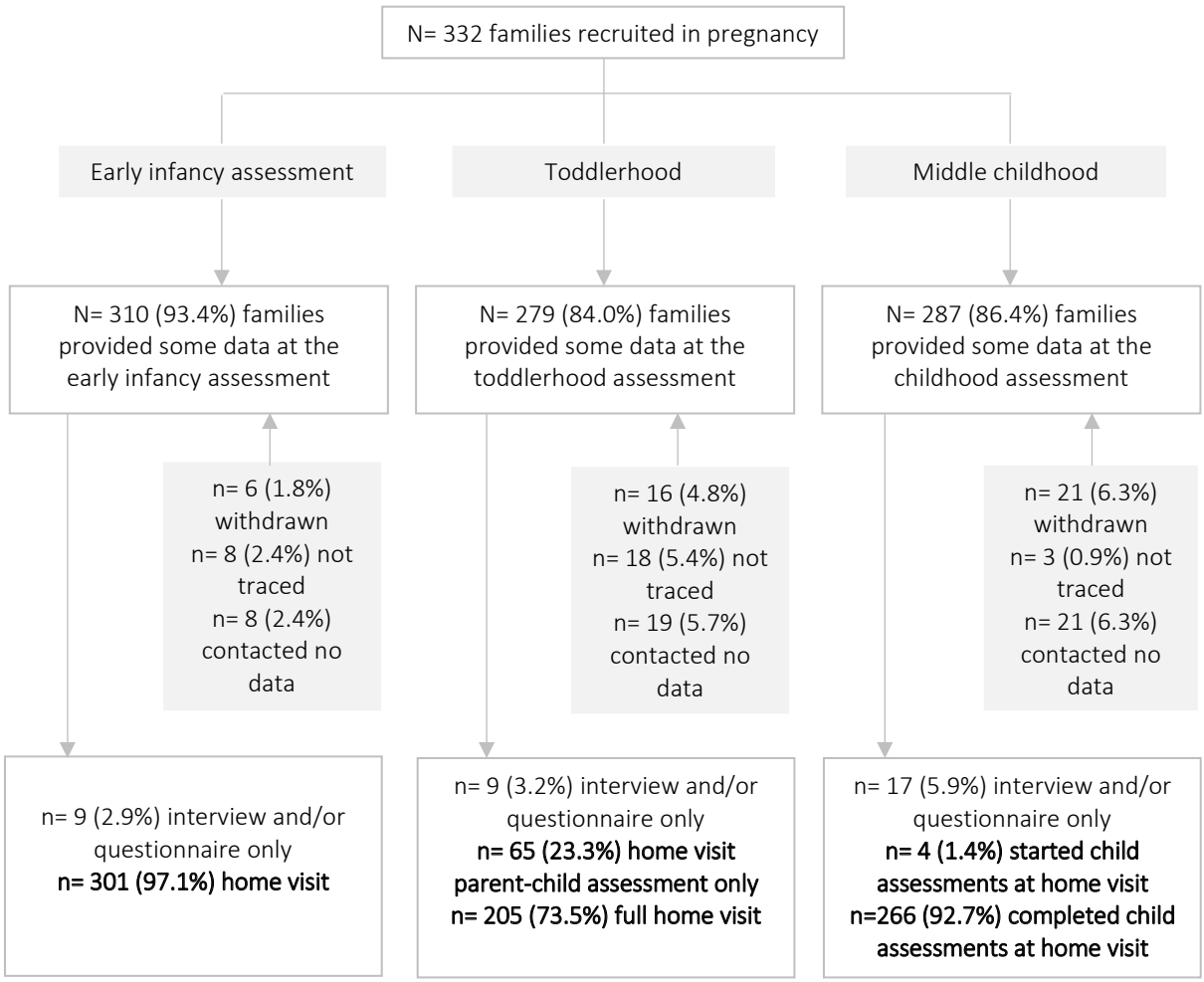
Huijbregts, S., Swaab, H., & de Sonneville, L. (2010). Cognitive and motor control in neurofibromatosis type I: influence of maturation and hyperactivity-inattention. *Developmental neuropsychology*, *35*(6), 737-751.

Schuitema, I., de Sonneville, L., Kaspers, G., van der Pal, H., Uyttebroeck, A., van den Bos, C., & Veerman, A. (2015). Executive dysfunction 25 years after treatment with cranial radiotherapy for paediatric lymphoid malignancies. *Journal of the International Neuropsychological Society, 21*, (1- 13).

APPENDIX III

Sample attrition from recruitment to early infancy, toddlerhood and middle childhood assessments



APPENDIX IV

Example transcripts of mother-child interactions

Example 1. Early infancy transcript with activity board

Minutes	Seconds	Maternal speech and action	Internal state language coding
00	00 - 05	Let's have a look. What's this? [Gasps] What's that?	MC Perception imperative(pl)
00	05 - 10	Look, there's the farmyard. You lift up that page.	MC Perception imperative(pl)
00	10 - 15	Oh, ooh. Look at that. Look at that, there's a cow there.	MC Perception imperative(pl)
00	15 - 20	Do you want to lift the pages yourself? There's the jungle.	MC Desire
00	20 - 25	Yes. Let's lift up the page.	
00	25 - 30	[Gasps] Look at that!	MC Perception imperative(pl)
00	30 - 35	Are we going to have a look? There's the garden.	MC Intention(pl) + MC Perception imperative(pl)
00	35 - 40	Do you wanna lift? [Gasps] Look! It's a little bird!	MC Desire + MC Perception imperative(pl)
00	40 - 45	Yeah. And there's the underwater *inaudible* fish.	
00	45 - 50	And a dolphin [gasps] let's lift up that one.	
00	50 - 55	[Gasps] Yes. Look at that. Look at the dolphins!	MC Perception imperative(pl)
00	55 - 60	Look! At all of them…	MC Perception imperative(pl)
01	00 - 05	Shall we see what else is under there?	MC Perception imperative(pl)
01	05 - 10	We've had a look at the cow haven't we? [Gasps] look at that!	MC Perception imperative(pl)
01	10 - 15	It's a hen. See all the chickens. Do you see the chickens?	MC Perception imperative(pl) + MC Perception declarative
01	15 - 20	Yeah. Clever boy. *inaudible* Do you see?	MC Perception declarative
01	20 - 25	I'll show you this little one if you want.	MC Desire
01	25 - 30	Look at that!	MC Perception imperative(pl)
01	30 - 35	Look at that!	MC Perception imperative(pl)
01	35 - 40	You like the chicken at the moment don't you? Yeah.	MC Preference
01	40 - 45	Right let's lift up the little bird. [Gasps] Look at that! Look at the butterfly!	MC Perception imperative(pl)
01	45 - 50	What do you want to do? Carry on a bit? [Mother giggles].	MC Desire
01	50 - 55	Do you want to open this page? See what's underneath the dolphins? [Gasps]	MC Desire + MC Perception imperative(pl)
01	55 - 60	Look at that! Look at the fish!	MC Perception imperative(pl)

Note. Maternal speech is presented in normal font, maternal internal state language is presented in blue font. Child speech is presented italicised and bold. Action is presented in brackets.

Example 2. Toddlerhood transcript with teddy bear puzzle

Minutes	Seconds	Maternal speech and action	Internal state language coding
00	00 - 05	[Mother holds child when puzzle is out of reach]	Restraint task: Internal state language not coded
00	05 - 10	[Puzzle is given to the child]	
00	10 - 15	Ok, do you want to touch it?	MC Desire + MC Perception imperative
00	15 - 20	Ohh.	
00	20 - 25	Look. Remember, you can just slightly move things. There.	MC Perception imperative + MC Cognition
00	25 - 30	[Gasps] That's his foot. Just like Holly's foot.	
00	30 - 35	-	
00	35 - 40	Do you want mummy to do it? You just do it exactly the way Kathryn did it, just move it a little bit.	MC Desire
00	40 - 45	This is his other foot, like Kathryn's other foot.	
00	45 - 50	Well done.	
00	50 - 55	Yeah. This is tummy. This is his tummy like Kathryn's tummy.	
00	55 - 60	Kathryn's tummy, bear's tummy.	
01	00 - 05	Mummy just move it ever so slightly.	
01	05 - 10	Take pressure off it.	
01	10 - 15	Try again. Ohh. Do you want me to show you?	MC Desire
01	15 - 20	There. What else have we got?"	
01	20 - 25	Ears, like Kathryn's ears, and you got…	
01	25 - 30	a nose and mouth like Kathryn's nose and mouth.	
01	30 - 35	and you got a hand like Kathryn's hand.	
01	35 - 40	Kathryn try it with me then.	
01	40 - 45	Kathryn do it with mummy. No? Okay, let me show you then.	
01	45 - 50	There.	
01	50 - 55	Ahh thank you! Are you going to put it back in? Turn it around!	MC Intention
01	55 - 60	Turn it around.	
02	00 - 05	Thank you.	
02	05 - 10	What's that, what have you seen, nosy parker?	MC Perception declarative

Note. Maternal speech is presented in normal font, maternal internal state language is presented in blue font. Child speech is presented italicised and bold. Action is presented in brackets. Child's name has been changed.

Example 3. Middle childhood transcript with Etch-a-Sketch

Minutes	Seconds	Mother speech and action	Internal state language coding
00	00 - 05	Ok you're in charge of that one [Mother points to child's dial). I'm in charge of this one. Here we go. So what is it you want to draw? Any picture?	Free play prior to start of cooperation task: Not coded
00	05 - 10	Right what shall we draw? ***A uhh…***	
00	10 - 15	***Keep going further.*** What is it going to be?	
00	15 - 20	Because I need to help you by doing this side. ***Uhh it is a…***	
00	20 - 25	Well shall we do a house? If you start, look. ***Yeah a house.***	
00	25 - 30	Look if I go this way. A house is easier because it's like a square.	MC Perception imperative
00	30 - 35	So you need to go up now. [Mother points where on screen]. I think you're in charge of that bit yeah. See?	MC Obligation + MS Cognition + MC Perception imperative
00	35 - 40	It might be. If we do it like a block of flats now we got a…	
00	40 - 45	Shall I go that way? **Yeah.** Because we didn't have room to do the triangle.	
00	45 - 50	***And I'll go round.*** Oh, ooh ooh Shall we do it like a… could be like a roof?	
00	50 - 55	How are we going to do windows? I don't know how you do the	MC Intention + MS cognition
00	55 - 60	***Ok so now what shall we do with the windows?*** I don't know if we can get a gap.	MS Cognition
01	00 - 05	Shall I just go back and kind of come down. Oooh hang on. Stop.	
01	05 - 10	Go across. Up.	
01	10 - 15	Stop.	
01	15 - 20	Ok, if I go across that way and you come down.	
01	20 - 25	Stop. Ooh.	
01	25 - 30	Up. Stop.	
01	30 - 35	If you go down a bit [Mother points]. Then we can make a window.	
01	35 - 40	There we go. Shall we go… ***No bit across by here [Child points to screen].***	
01	40 - 45	You have to go down then.	MC Obligation
01	45 - 50	Right. Shall we try and do a door?	
01	50 - 55	You go down.	
01	55 - 60	****Child inaudible* Door. Up. [Child reaches over and twists mother's dial].*** Oi that's my one! [Mother knocks child's hand]. ***HA HA HA!***	
02	00 - 05	Down. Are we doing a door? ***Yeah.***	
02	05 - 10	Go that way then. [Mother points direction]. Oh no you can't! [Mother laughs].	
02	10 - 15	You go back up then.	

02	15 - 20	A little higher. Go back up. Up. ***Go across. Across!*** I know, but it's a very short door.	MS Cognition
02	20 - 25	If we go up to there. Stop.	
02	25 - 30	Then go down. Right shall we try and do a circle for a thing?	
02	30 - 35	I don't even know how to do a circle. ****Child inaudible* for a circle.*** Like a door handle?	MS Cognition
02	35 - 40	**How do you do a circle?** I don't know. I'm guessing if you go up?	MS Cognition
02	40 - 45	And if I go that way. Then if you turn and I turn at the same time.	
02	45 - 50	Yay keep going the same way. [Mother and child laugh].	
02	50 - 55	Maybe that can be the pattern on the door. ***I'm gonna do it.***	
02	55 - 60	-	
03	00 - 05	***A little pattern on the door then.*** Or maybe it could be like, ooh, we could have like hedges.	
03	05 - 10	***Yeah.*** Oh, hang on.	
03	10 - 15	Go down a bit. That's going all the way up that can be like a tree.	
03	15 - 20	***What shall I do I can't turn it?*** Hang on you're going over the house now.	
03	20 - 25	***What are you doing?*** I'm trying to bring it down.	MS Intention
03	25 - 30	Can you get it down?	Over 3 minutes: Not coded
03	30 - 35	I think this picture's getting a bit messy.	
03	35 - 40	***Can I use both knobs?*** [Child takes Etch-a-Sketch from mother]. No we're not, that's part of the thing. She said we've got to do one each and work together as a team.	
03	40 - 45	***Can we swap then? Swap jobs.***	
03	45 - 50	Hang on we've got to do this for the minute. ***Ahh can we do *child inaudible*.***	
03	50 - 55	Let's just bring it down. Then we can see… how about we do some curtains or something?	
03	55 - 60	***Ok how do we do those then?*** Ok. I don't know.	
04	00 - 05	Here we go. Ok. All the way down. Brilliant.	
04	05 - 10	Hang on. ***Go.***	
04	10 - 15	It's not the best curtain is it? ***[Child laughs] No.***	
04	15 - 20	***This game is like *child inaudible*.*** Ok where are we now?	
04	20 - 25	You've lost interest haven't you? **Do you have… [Child laughs]. Can we just start again?**	
04	25 - 30	Shall we show the picture of our block of flats? [Experimenter takes Etch-a-Sketch and shows camera].	
04	30 - 35	[Child runs up and takes it off Experimenter and holds it in front of the camera].	

Note. Maternal speech is presented in normal font, maternal internal state language is presented in blue font. Child speech is presented italicised and bold. Action is presented in brackets.

APPENDIX V

All internal state language terms used within each category at each wave of assessment

Internal state language used at early infancy assessment

Perception	Physiology	Preference	Intention	Desire	Emotion	Cognition	
See	Tired	Like/not like	Going to	Want/ wanna	Agitated	Think	Realise
Look	Sick	Love	Gonna	Would you like to?	Worry	Know/don't	See (as in
Watch	Hungry	Favourite	Trying	Rather	Fed up	know/dunno	'find out')
Feel		Impressed	Attempt	Fancy	Bored	Bet	Expect
Touch		Interested		Hope	Worry	Recognise	Believe
Taste/tasty		Fun (as in 'having')			What is the matter?	Got it	Wonder
		Fascinated			Grouchy	Remember	Find out
		Don't care (lack of preference)				Forget	Sure
		Fond of					
		Had enough					

Internal state language used at toddlerhood assessment

Perception	Physiology	Preference	Intention	Desire	Emotion	Cognition	
See	Hurt	Interested	Going to	Want/wanna	Upset	Realised	Remember
Hear	Fart	Like/not like	Gonna	Would you like to?	Worry	Think/thought	Sure
Look		Bugging (you)	Trying	Fancy	Excited	Know	Idea
Listen		Love	Meant to	Hope	What is the matter?	Wonder	Confused
Watch		Not bothered		Rather	Bored	Work out	Bet
Touch		Keen on		Dying to	Happy	Forgot	Check
				Need (as in want)		Believe	Understand
						Expect	

Internal state language used at middle childhood assessment

Perception	Physiology	Preference	Intention	Desire	Emotion	Cognition	
See	Tired	Like/not like	Going to	Want/wanna	Happy	Think/thought	Pretend
Look	Cold	Love	Gonna	Would you like to?	Angry	Know	Remember
Listen	Hurt	Prefer	Trying	Hope	Worry	See (as in	Guess
		Interested	Have a go	Need (as in want)		'find out')	Work out
						Reckon	Suppose
						Mean	Sure
						Forget	Idea
						Get it	Decide
						Understand	Wonder
						Figure out	Dream

APPENDIX VI

Supplementary descriptive data for measures of mothers' history of behavioural problems

Table 1.

Mean, range and standard deviation of mothers' history of behavioural problems (conduct + ADHD problems).

	Minimum	*Maximum*	*Range*	*Mean*	*SD*
Mothers' history of behavioural problems	0	20	20	5.43	4.04

Note. N=276. This variable was used in Chapters 4 and 5, see p. 110 and p. 135.

Table 2.

Mean, range and standard deviation of mothers' history of conduct problems.

	Minimum	*Maximum*	*Range*	*Mean*	*SD*
Mothers' history of conduct problems	0	12	12	2.06	2.23

Note. N=269. This variable was used in Chapter 6, see p. 155.