Re-examining pathways to social understanding in children with typical development and autism

Coull, Greig Joseph

Re-examining pathways to social understanding in children with typical development and autism

Greig Joseph Coull

Submitted for the degree of Ph.D.

University of Durham

Department of Psychology

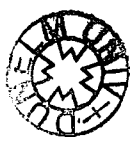
2007

Declaration

I declare that all of the material presented herein is original work, of which no part has been reproduced from elsewhere and which is solely the work of the author of this thesis.

Copyright

The copyright of this thesis belongs to the author, Greig Coull.



Abstract

Broadening of the original concept of theory of mind has been necessary to more accurately reflect the social complexity involved in arriving at an understanding of others' minds. However, such expansion has primarily focused on developmental mechanisms, whereas the issue of *what* social understanding actually encompasses has been relatively neglected. In an effort to dispel the resulting ambiguity which surrounds this latter aspect, this thesis pursued clarification of the potential constituents to children's social understanding in typical development and autism. Part 1 of the thesis required methodological enterprise as a prelude to the more theoretically driven focus outlined in Part 2 in order to first verify the subsequent use of valid and comprehensive measures of social cognition.

Part 2 delved into the issue of: "What are the constituents of children's social understanding?" adopting the theoretical framework offered by Tager-Flusberg and Joseph (2005) to guide our exploration of the constituents – social cognition, social perception, social attention, and language – and the possible continuity of paths between them. Contrary to expectation, no link was found between social-perceptual and social-cognitive abilities in 4- to 6-year-olds. However, a subsequent study of a much larger group of typically developing 4- to 5-year-olds was sufficiently broad to enable structural equation modelling of relationships between these constructs and constructs of social attention and language. These analyses revealed well-differentiated constituents of social understanding and directed us to a new model of social understanding in which language abilities were integral to the relationship between social perception and social cognition. Also, this new model suggested that the continuity between these three constructs was quite distinct from a lower-level construct encompassing joint attention and orienting abilities. The final experimental

chapter then examined these findings in the context of autism – findings indicated that children with autism performed significantly less well than language-matched typical children within the domain of social attention but performed comparatively well within the social-perceptual construct. However, unlike typical children, neither this lack of a significant social-perceptual impairment nor language matching was sufficient to lead to social-cognitive success for children with autism. This substantiates the view that children with autism may only arrive at social-cognitive understanding by certain aspects of language, such as syntactic comprehension. The thesis findings underline the importance for social understanding research - in an ever-expanding field - to embrace apparent important distinctions between inherently different constituents of social understanding. Implications for future research and theoretical considerations are discussed.

Contents

- Acknowledgements viii
- List of Figures x
- Preface xi

Introduction – Social understanding and theory of mind: What do we need to re-examine?

- **Chapter 1 – A widened lens on theory of mind: The broader notion of social understanding 2**

1.1: Early concepts and theories of theory of mind 4
1.2: Theoretical changes in the study of theory of mind: The influence of social experience and language 9
1.3: Broader views of the theory of mind concept 14
1.4: Summary and outline of forthcoming chapters 21

Part 1 – Developing a new methodology to assess social cognition

- **Chapter 2 – A new method of assessing children's second-order false belief understanding 26**

2.1: Factors of task design influencing first-order false belief understanding 27
2.2: Factors of task design influencing second-order false belief understanding 29
2.3: Simplifying the task demands of second-order false belief stories 35

- **Chapter 3 – A new composite measure of first-order and second-order social cognition 48**

3.1: Effectiveness of the new composite theory of mind task 54
3.2: Summary of findings for the composite theory of mind task 57

Part 2 – Investigating the constituents and continuity of children's social understanding

- **Chapter 4 – Componential models of social understanding 66**

4.1: Why investigate the relationship between components of social understanding? 66
4.2: Examining a componential model of theory of mind 69
4.3: Developing the methodology to examine constituents of social understanding 75

- **Chapter 5 – Using the componential model to explore the relationship between social cognition and social perception 78**

5.1: How are the social-perceptual and social-cognitive components of social understanding related? 85
5.2: Is social-perceptual ability related to a pass/fail measure of social-cognitive ability? 89

▪ **Chapter 6 – Exploring the componential model more broadly: What does a model of social understanding actually constitute for typically developing children? 96**

6.1: Measures of social cognition 96
6.2: Reviewing the construct of social perception 98
6.3: Discussing the new construct of social attention 102
6.4: Language links to social understanding 106
6.5: Summary of hypotheses 111
6.6: Results part 1: Descriptive statistics and normality testing 129
6.7: Results part 2: Correlation and factor analyses of the interrelationships within and between the four constructs 138
6.8: Results part 3: Structural equation modelling and regression analysis 144

Chapter 7 – Is there a different path to social understanding for children with autism? 160

7.1: Social cognition in autism 167
7.2: Social perception in autism 169
7.3: Social attention in autism 171
7.4: Language in autism 175
7.5: Summary and hypotheses 179
7.6: Results part 1: General performance of children with autism across social understanding and language tasks 186
7.7: Results part 2: Autism symptomatology and relationships between construct aggregate scores for social understanding and language 197
7.8: Results part 3: Comparing children with autism to a language matched group of typically developing children on constructs of social understanding 204
7.9: Results summary 210

Part 3 – Re-examining pathways to children's social understanding

▪ **Chapter 8 – General discussion and conclusions 223**

8.1: Summary of Part 1: Methodological chapters 224
8.2: Summary of Part 2: Theoretically-oriented chapters 227
8.3: Social understanding rather than theory of mind 233
8.4: Constituents and continuity of social understanding in typical and atypical development 235
8.5: Limitations 242
8.6: Future directions 243
8.7: Conclusions 246

- **References** 247
- **Appendices** 270

Acknowledgements

This thesis has arrived in its final form via the direct and indirect support of many different people whom I would like to thank. Acting as my primary supervisor, I have been more than fortunate to be expertly guided through my PhD experience by Sue Leekam. It has been a great pleasure to have Sue alongside me, constantly providing guidance, support and encouragement and ultimately inspiring me to aim for research to be proud of. Thanks for everything Sue! My thanks also go to Mike Burt for stepping into the breach as my second supervisor – your input, support and expertise have proved invaluable along the way. My gratitude also extends to Gerda Arts and Steven Muncer for priceless statistical assistance – both were an oasis of help amidst the statistical desert! Many thanks to Bob Metcalfe for help in devising the task-based sound program and for his electronic equipment ingenuity. Many thanks also go out to the Economic and Social Research Council for having faith in my research and supporting me financially – a sound investment I believe..!

Of course, none of this research would have been possible without the enthusiastic involvement of various schools including: Hayshead Primary School in Arbroath; along with numerous Durham schools: Belmont Infant School, Bowburn Junior School, Cheveley Park Primary School, Langley Moor Primary School, Neville's Cross Primary School and St. Hild's C of E School. Many thanks also to all the co-operation of various National Autistic Society schools – The Robert Ogden School in Thurnscoe, Thornhill Park School in Sunderland, and Ash Trees School in Billingham. I am also really grateful to the hundreds of parents who allowed their children to be involved in this research. However, it is the children themselves who deserve the greatest thanks – for their continual efforts, enthusiasm and playfulness which together made my experience all the more rewarding.

While I am here, there's a huge thank you to all my friends who have kept me sane and kept me sociable over the last 3 years! None more so than Sarah and Emma with whom I've been fortunate enough to go through the whole experience with – sharing the office and sharing laughs and thoughts about our progress helped make the last 3 years a whole lot more reassuring and enjoyable! Thanks as well to all my family who have taken an interest and been supportive in different ways. Most notably to Plook for being a great big brother to look up to and for offering to read this thesis while wearing your English teacher hat (but wisely wriggling out of it!). And I can't thank Mum and Dad enough for always encouraging and supporting me in whatever I've done; none more so than during the PhD – together you have always inspired me to want to learn more and achieve more. Last but most definitely not least, I give my final, special thanks to Kirsten – you have been everything to me during the last 3 years and the best support I could have wished for – thanks for everything Mykoist, not least your unwavering patience! Your wonderful and wise ways have kept me smiling and ensured that this man has finished his PhD a contented man.

List of Figures

Page

71, **Figure 4.1**: Schematic representation of the Tager-Flusberg and Sullivan (2000) componential model of theory of mind

73, **Figure 4.2**: Tager-Flusberg and Joseph (2005) schematic model of the acquisition of a representational theory of mind

79, **Figure 5.1**: Parts (shaded in grey) of the Tager-Flusberg and Joseph (2005) model being tested in this chapter

125, **Figure 6.1**: Diagram depicting set-up of equipment for social attention tasks

132, **Figure 6.2**: Percentage of children correctly justifying responses to both stories

135, **Figure 6.3**: Percentage of correct head or eye turns within 6 or 3 seconds to social and non-social stimuli

142, **Figure 6.4**: Factor scree plot of all 10 social understanding and language variables

148, **Figure 6.5**: Structural equation model of Tager-Flusberg and Joseph (2005) model

150, **Figure 6.6**: Updated structural model based on Tager-Flusberg and Joseph (2005)

154, **Figure 6.7**: Best fitting model of children's social understanding and language

189, **Figure 7.1**: Percentage of correct head or eye turns to social and non-social stimuli by children with autism

190, **Figure 7.2**: Percentage of correct head or eye turns to social and non-social stimuli within 6 seconds

Preface

"...there has been little work in formulating a model of theory of mind, or more broadly, social knowledge. What are its basic concepts, rules and representations?...The absence of such a model has led to the broadening of the concept of theory of mind with little regard to potentially important theoretical distinctions that have implications for underlying mechanisms within this broad domain." (Tager-Flusberg & Sullivan, 2000 (p. 60)).

Though stated 7 years ago, Tager-Flusberg and Sullivan's comment resonates today by virtue of it being both true and untrue. It is true in the sense that the concept of theory of mind has broadened to include social understanding - mirrored by the development of a number of theories addressing the nature of this social understanding (e.g., Carpendale & Lewis, 2004, 2006; Tager-Flusberg & Joseph, 2005). Yet it is untrue in the sense that there is still little empirical work that has tried to bridge across from children's low-level intentionality to their representational theory of mind. The aim of this thesis is to provide such a link in order to further our understanding of the constituents of children's social understanding. I attempt to bridge this gap in the field of children's theory of mind using Tager-Flusberg and colleagues untested model of theory of mind as a vehicle for the theoretical endeavour. Accordingly, to achieve this, the thesis is divided into two parts. Part 1 describes the development of new methodology that re-examines the distinction between first-order and second-order levels of social-cognitive theory of mind. Part 2 incorporates this newly-developed methodology alongside other aspects of social understanding and language into a comprehensive series of studies investigating pathways to social understanding in typically developing children and children with autism.

INTRODUCTION –

SOCIAL UNDERSTANDING AND THEORY OF MIND:

WHAT DO WE NEED TO RE-EXAMINE?

Chapter 1

A widened lens on theory of mind:

The broader notion of social understanding

From its inception, the concept of theory of mind has established itself at the heart of a body of literature focusing on children's social cognitive development. The ability to be aware that other individuals may hold thoughts different from your own and to be able to use that knowledge to predict how others may behave is fundamentally a human capacity. All major institutions in life such as education require such a social foundation, otherwise communication would break down and social interaction would be ineffective.

Since research on theory of mind began, its domain of influence has broadened beyond all recognition. While the focus throughout the 1980's until the mid-1990's centred upon cognitive abilities and understanding of a child's ability to attribute mental states such as belief and desire, research since has led the field to shift from a purely cognitive standpoint to a more encompassing focus - one which incorporates an awareness of the importance of social interaction and early experience in theory of mind development. Reflecting this expansion, the area has seen the terminology vary from *theory of mind* and *mentalising* to increasingly more comprehensive terms such as *social intelligence* and *social understanding*. Such broadening has undoubtedly, and importantly, added a depth to the area which is more in tune with the complexity and social basis of understanding other people's minds. However, in furthering the field, two key issues have become intertwined, which if focused on more independently should advance the field yet further. The first of these receiving most focus is the issue of how theory of mind (whether narrowly or broadly defined) develops. The second, more theoretical endeavour, receiving less attention, asks

'What is theory of mind?' This thesis will be primarily tackling the latter issue in a bid to determine what is at the core of a broader notion of theory of mind in children and how paths link different constituents of this capacity together.

Traditionally, interpretation of theory of mind has focused narrowly on the understanding of representational mental states such as belief. More recently, with some theories incorporating a more social dimension and a wealth of evidence reflecting this, the term theory of mind increasingly loses favour to the more encompassing phrase social understanding. This breadth of meaning is translated into a diverse research endeavour which not only examines children's social cognition, but which also includes investigation of earlier manifestations of social understanding in the domains of attention, perception, emotion and language. Thus, in its more broadly defined sense, theory of mind or social understanding has become an umbrella term for a wide range of abilities and this diversity contrasts with the narrow approach to theory of mind still taken by traditionalists within the field. Given that the terms underlying the different positions are often used interchangeably and given the intertwining of this issue with the aforementioned issue of how theory of mind actually develops, there is a degree of ambiguity about how the broader view of social understanding relates to the traditional view of social cognition. Examination of the link between the narrow and broad definitions of theory of mind, as planned here, should shed light on the distinction between different domains subsumed within the broader account and provide illumination on the continuity in ability from these domains to representational understanding. In setting the context for our investigation to these ends, we begin by considering the historical origins to this research area before focusing on the impetus for its recent broadening expansion and then

discussing the issues of definition and continuity currently surrounding theory of mind or social understanding.

1.1 Early concepts or theories of theory of mind

The origin of theory of mind research can be traced back to a primate study by Premack and Woodruff (1978) in which they asked if chimpanzees had a theory of mind. While finding that chimpanzees could understand the art of deception led Premack and Woodruff to claim that chimpanzees did have a theory of mind, various philosophers such as Dennett (1978) argued that further task specification was needed to give conclusive proof of an ability to understand the minds of others. Suggestions followed that tasks used with children or chimpanzees would need to demonstrate an understanding that beliefs can be false and an ability to predict how people would behave on the basis of their false belief. Wimmer and Perner (1983) introduced a simple paradigm which could demonstrate unequivocally whether children could understand that mental states can be independent of reality. Their story used in this paradigm is based on a character, Maxi, who has a mistaken belief regarding the location of his chocolate – he thinks it is in a blue cupboard when in reality it is in a green cupboard. When children are asked where Maxi will look for his chocolate they respond correctly if they can reason that Maxi will act on the basis of his false belief rather than the child wrongly attributing what they already know to be the case in reality. With such a simple yet effective design, this type of task became the classic test within the tradition of theory of mind research. Researchers then had a tool with which to assess the point in development at which children became able to conceive of the representational nature of mental states. Consequently, the trend throughout the 1980's and a large part of the 1990's was to use this paradigm to provide evidence for acquisition of a theory of mind. Indeed, numerous studies demonstrated that the

ability to understand that thoughts may be independent of reality was generally evident by age 4 in typically developing children (Astington & Gopnik, 1991; Hogrefe, Wimmer & Perner, 1985; Perner, Leekam & Wimmer, 1987; Sodian, 1991; Wimmer & Perner, 1983) though several other studies have demonstrated such understanding in children at 2 and 3 years of age (Chandler & Hala, 1994; Sullivan & Winner, 1993; Wellman, 1991).

While the benefit of the false belief paradigm was undoubted, it also served as a framework for a more complex paradigm to assess higher-order theory of mind abilities (e.g., "he thinks that she thinks..."). Perner and Wimmer (1985) devised a second-order false belief task which tapped a child's ability to attribute mental states not to physical states (first-order understanding) but to other people's mental states. The ability to understand the recursive nature of mental states was found to emerge in children by age 6 (Perner & Wimmer, 1985), although studies which simplified the demands of the paradigm found this ability appeared in children at 4 or 5 years of age (e.g., Coull, Leekam, & Bennett, 2006; Leekam, 1991; Sullivan, Zaitchik & Tager-Flusberg, 1994; Winner & Leekam, 1991) Generally, acquiring such understanding was taken to signal a fully fledged theory of mind. Thus, within the context of this research perspective, a time-scale was outlined of the ages at which these important theory of mind abilities emerged. In parallel, several theorists attempted to explain how children acquired a theory of mind.

While making a valuable methodological contribution within theory of mind research, Perner also proposed a conceptualisation of theory of mind development. Perner (1991), along with Wellman (1990), provided two of the main theoretical offerings within theory of mind research which became known as *theory theories*. These theorists shared the view that the child's development of theory of mind could

be thought of in terms of theory formation. While their accounts are also similar in that they regard theory of mind development as a process which is internal, cognitively driven and individual to the child, they differ in their depiction of the type of theory which the child acquires. From Wellman's (1990) perspective, the child's theory allows the child to distinguish between physical objects and mental entities. Furthermore, given the abstract nature of mental entities, he asserts that a theory is necessary in order to allow the child to reason about these when attempting to understand others' minds. For Wellman, two particular mental entities – desire and belief – shape the child's theory formation – with understanding of desire appearing around age 2. By age 4 the child's theorising allows their concept of desire to be distinguished from the intrinsically more complex concept of belief. Thus, transitional stages within children's theory of mind development are identified as the points at which the child's knowledge develops within their belief framework such that their understanding becomes incompatible with their current theory. In contrast, Perner focuses more on the idea of representation within the child's theory of mind – the idea that mental representations are simply that – representations. According to Perner, following a period up to 4 years of age when the child has understood the basis of representation, there is then a crucial conceptual change within the child's theory, known as metarepresentation, at which point the child understands that representations do not necessarily reflect reality. Thus, it is at this point that children understand that people's representations, such as belief, can be false. Perner suggests that within a couple of years of acquiring this conceptual knowledge, children can then recursively apply the notion of metarepresentation to relate mental states to other mental states. By this stage, children are able to understand that people can hold false beliefs about other people's beliefs; so by viewing the child as a theoretician in this

way, Perner explains the child's journey to arrive at complex social cognition in terms of a purely cognitive vehicle. Thus, both theorists regard the critical point in theory of mind development as the conceptual change which leads to the emergence of understanding that people's thoughts can be independent of reality. In summary, absent of any mention of children's social experiences or environment, the theory theories regard the child's theory of mind as a cognitive framework which becomes more refined as the child matures. And it is the development of the particular cognitive mechanism – whether representation or the desire-belief distinction – which provides children with increasingly complex insights into understanding others' minds.

With regard also to atypical development, theory of mind research became of great interest, particularly within the field of autism. Central to a diagnosis of autism is the presence of a triad of impairments, one of which is social interaction. Baron-Cohen, Leslie and Frith (1985) were the first to investigate the presence of a theory of mind in children with autism. In their false belief study which compared children with autism to typical children and developmentally delayed children, they found that although children with autism were matched to clinical controls in terms of mental age, only the children with autism were impaired in their ability to attribute mental states. Many studies since have demonstrated that autistic children are significantly worse than matched controls on a wide range of theory of mind tasks (e.g., Baron-Cohen, 1989; Baron-Cohen, 2000a, b; Baron-Cohen, Tager-Flusberg & Cohen, 1993). Such findings led Baron-Cohen to suggest that autism could be defined by a specific theory of mind deficit such that the social impairments which are characteristic of autism could be explained by a "circumscribed cognitive failure". Thus, Baron-Cohen regarded theory of mind as a cognitive construct and proposed a model (1994) of

understanding others' minds in which typically a fully specified module exists in the brain for theory of mind. With regard to atypical development, Baron-Cohen (1995) explained the social and communicative functioning deficits which feature in autism to be as a result of an impaired theory of mind module. Therefore, in harmony with the minimal role for the social environment in theory of mind development considered by the theory-theorists, Baron-Cohen tendered the social environment no more than a possible triggering influence upon the development of understanding others minds.

Similarly, given the emphasis at the time upon cognitive explanations to theory of mind development and the need to understand whether people with autism have a unique impairment, Leslie (1987) accounted for the social deficits in autism by proposing that theory of mind was a modular entity whereby a decoupling mechanism within the cognitive structure of the brain was impaired. Leslie suggested that children with autism have problems with false belief tasks because they cannot decouple true and false representations of the world and because they are also impaired in their ability to form propositional attitudes – i.e. an attitude such as *thinking* or *believing* is applied to a proposition which describes an external state of affairs such as: she thinks that "the doll is in the garden". However, following Leslie's claim, a later study (Leekam & Perner, 1991) - which focused on false photographs rather than false beliefs - showed that children with autism could detach their perception of reality (in this case a photograph) from reality itself. This finding conveyed that autistic children do not have a decoupling deficit but that they have impairment in their ability to form propositional attitudes necessary for representational understanding. In summary, both Baron-Cohen and Leslie propose impaired cognitive mechanisms as the underlying cause of theory of mind deficits which can explain the social problems which children with autism encounter. However, as will be discussed, such cognitive, modular

accounts of theory of mind are insufficient in explaining the full range of social deficits which feature in autism and are too narrow in scope to explain social understanding in typical children.

While Baron-Cohen and Leslie's early work subscribed to the view that theory of mind development in autism is delayed by difficulty with representational understanding, studies since have shown that children with autism have difficulty with joint attention prior to their problems with representational theory of mind skills, (e.g., Mundy & Sigman, 1989; Mundy, Sigman & Kasari, 1990). These studies were important for two reasons. Firstly, they indicated that studying the process of development itself from as early an age as possible is fundamental to understanding the nature of developmental disorders such as autism (see Karmiloff-Smith, 1998). Secondly, they elucidated possible precursors to social cognition/theory of mind both in typical and atypical development. The consideration of such precursors is fundamental to a broader interpretation of social understanding. Therefore the cognitive accounts offered by Baron-Cohen and Leslie which focus on relatively late emergence of ability within the domain of children's social cognition inevitably offer an over-simplification of theory of mind development, particularly with regard to autism. Shortcomings such as these can also be recognised in the theory theories outlined earlier which adopt a position of cognitive maturation and neglect to include a social or true developmental dimension in consideration of children's theory of mind.

1.2 Theoretical changes in the study of theory of mind: The influence of social experience and language

While the aforesaid theories drew criticism from several quarters, most notably from Russell (1996), the theory of mind tradition itself became increasingly

questioned by researchers who were aware that it was highly improbable that a complex construct such as theory of mind could develop independently of any social or experiential factors. As a result, several alternative accounts of theory of mind development emerged that suggested various mechanisms of change which incorporated the child's social context. For instance, Butterworth (1991) and Hobson (1993b) acknowledged a social dimension to children's theory of mind by proposing that inner states are perceived directly through interpersonal engagement with others. In addition, Harris (1991) proposed that children acquire a theory of mind through social interaction whereby introspection and imaginative role-play allow the child to access their own mental states which can then be generalised to other minds. Distinct from Perner's account (1991), the important step in the child's theory of mind development according to Harris (1991) is not realisation of the representational capacity of the mind, it is grasping the concept that mental states can relate to situations which are distinct from reality. So Harris' simulation account incorporates more of a social influence on children's theory of mind than the theories summarised above. However, Harris' theory does not explicitly acknowledge the importance of social experiences for theory of mind. Furthermore, as Russell (1996) indicates, there are issues with how children may introspect from their inner feelings to other people when the subjective meaning of these mental state terms are likely to be grounded in shared interaction with other people rather than children's own private experiences. Regardless, these accounts did offer opposition to the theory-theories and in the process they began to point towards the child's wider social context.

Preceded by the work of Dunn in the 1980's which essentially first grasped the importance of looking at children's experiences within social interaction in order to understand children's social cognition, dissatisfaction with the theory-theories and

modular theories of social cognition grew throughout the 1990's. Increasingly, evidence suggested that theory of mind abilities were intertwined with everyday experiences and early social and language development. Dunn continued to champion the impact of a child's social experiences within the family. She proposed that children developed an understanding of mind through child-adult interactions such as conflict and cooperation. For example, experiences such as cooperating with older siblings and observing mother-sibling dyadic conflicts were found to be predictive of false belief understanding (Dunn, Brown, Slomkowski, Tesla & Youngblade, 1991). Further studies (Jenkins & Astington, 1996; Perner, Ruffman & Leekam, 1994) found that the presence of siblings had a facilitative effect upon first-order belief understanding. Similar studies have shown that specifically older siblings can facilitate children's acquisition of mental state understanding, (e.g., Lewis, Freeman, Hagestadt, & Douglas, 1994; Ruffman, Perner, Naito, Parkin, & Clements, 1998). Further research has demonstrated associations between theory of mind and various aspects of children's social experiences. For instance, theory of mind abilities have been linked to social factors such as quality of attachment with caregivers (Fonagy, Redfern, & Charman, 1997), parenting style (Hughes, Deater-Deckard, & Cutting, 1999) and parental mind-mindedness (Meins et al., 2002).

As well as an apparent role for social experiences in children's social understanding, many studies have demonstrated a link between social understanding and language abilities. For example, Astington and Jenkins (1999) and Ruffman, Slade, Rowlandson, Rumsey and Garnham (2003) have conducted longitudinal studies and found that language performance predicted children's false belief understanding. Also, in an attempt to address the bidirectionality which has been evidenced in ToM developments and other social and language developments, there

have been an increasing number of intervention studies. For example, Hale and Tager-Flusberg (2003) and Lohmann and Tomasello (2003) have both used training studies to try and tease apart the influence of language from theory of mind development to determine the contribution of one to the other and found that children's syntactic abilities facilitated social-cognitive skills but not vice-versa. Strong relations between social understanding and language have also been found in autism – children with higher verbal mental ages have been found to have less impaired theory of mind understanding (Happé, 1995; Leekam & Perner, 1991; Prior et al., 1998). This is supported by studies conducted with individuals toward the more able end of the autism spectrum, who by way of their more typical language abilities, are able to perform relatively well on theory of mind tasks (Bowler, 1992; Ozonoff, Pennington, & Rogers, 1991). Furthermore, research conducted with deaf children provided further evidence of the close interweaving of language, social experience and theory of mind. Language had been found to allow more normal development of theory of mind abilities in deaf children born to deaf rather than hearing parents (Peterson & Siegal, 2000; Woolfe, Want & Siegal, 2002). Thus, by virtue of being native users of the same method of communication (i.e. sign language), deaf parents have greater opportunity for interaction and conversation with their deaf children than late-signing parents. Such findings from both typical and atypical development highlight the importance of considering children's social context and early language experiences when researching theory of mind. The above studies convey that the research spotlight is now focused very much on the dynamic interplay between interactions within the social environment and the development of language and social understanding.

As illustrated by the wealth of evidence above, theory of mind is linked to a multitude of different social experiences and aspects of language. However, up until

this point I have been talking about the evidence that links to theory of mind as defined in its traditional sense – i.e. in terms of cognitive performance on a false-belief task. Thus, these studies describe the relationship of children's theory of mind with social experience and language in the context of the narrow interpretation of children's theory of mind. However, in acknowledging the importance of social experience for children's theory of mind abilities, researchers within the field have been increasingly eager to incorporate a social dimension into their theories. Indeed, acknowledging the social dimension and importance of early emerging abilities, Carpendale and Lewis (2004) defined children's theory of mind development more broadly by using the phrase social understanding. Carpendale and Lewis (2004, 2006), Garfield, Peterson, and Perry (2001), and Klin, Jones, Schultz, and Volkmar (2003) suggested mechanisms for how children's social understanding may be linked with their experiences within their social interactions at an early age prior to the emergence of false belief understanding. They recognised that cognitive accounts of theory of mind and studies which focus purely on the presence or absence of representational theory of mind (i.e. performance on false belief tasks) were unlikely to fully reflect an ability as complex and multifaceted as a child's understanding of others' minds. Indeed, Chandler (1988) criticised the theory of mind tradition for collapsing children's social cognitive development to the transition point at which a child was able to pass false belief tasks.

From the perspective of children with autism, Hobson (1993a) identified that their difficulties with language and social interaction are liable to stem from problems with early aspects of theory of mind in infancy. Furthermore, as pointed out by Klin et al. (2003), there is a need for psychological theory to propose a model of its developmental psycho(patho)logy with a focus on early emerging skills and processes

which may have downstream effects. In the recent accounts of social understanding noted above, emphasis is placed upon social actions and interactions occurring in the first few years of development. Therefore, by preceding the point of conceptual change in theory of mind development highlighted by the theory-theorists and by considering the possibility of earlier forms of social understanding and interaction, these accounts embrace both a developmental and social dimension. Such views are congruent with the probabilistic nature of epigenesis as outlined by Gottlieb (1998) and are consistent within dynamic systems frameworks which discuss bidirectional transactions between the organism and the environment. As such, advocates of these recent accounts of social understanding view a child's theory of mind in much broader terms than theory of mind traditionalists.

1.3 Broader views of the theory of mind concept

In reflection of a broader focus upon theory of mind development, Tager-Flusberg (2001) proposed a model which describes theory of mind in terms of a broader, componential framework (see also Tager-Flusberg & Sullivan, 2000). Two components are outlined in this model – a social-perceptual (SP) component and a social-cognitive component (SC). The SC component refers to an explicit theory of mind incorporating those abilities which reflect an acquisition of the understanding of mind as a representational system. Therefore, this component encompasses the inferential understanding of mind which has been at the core of cognitive explanations of theory of mind. However, unlike these accounts, the componential view – via the SP component – entertains an implicit level of theory of mind which precedes the cognitive level developmentally. The distinction between the two components is that the SP component refers to the lower level capacity to make online judgements of a person's inner states or emotions based on perceptual information (such as the face or

voice), while the SC component refers to the ability to make cognitive inferences about the content of such mental states. The SP component refers to early perceptual skills which extend from infancy onwards such as gaze following, joint attention and face processing and encompass the type of theory of mind skills which researchers such as Bloom (2000) describe as facilitating word learning. Thus, by examining early emerging perceptual skills in the context of theory of mind development there is an opportunity to explore the pathway from early social experiences to more complex social-cognitive processing necessary for effective social interaction.

Via the breadth of the componential view of theory of mind, this model could begin to counter some of the criticism of the original theory of mind hypothesis of autism (Baron-Cohen et al., 1985). As outlined by Mundy and colleagues, children with autism have problems with joint attention prior to their problems with representational theory of mind skills. Thus by incorporating a developmental perspective, the componential model can more readily address such findings. However, while Tager-Flusberg describes possible components underlying theory of mind development, she does not really outline how early social experiences and interactions may lead to the emergence of social-perceptual skills, or how these skills may develop into social-cognitive skills. Furthermore, even in her updated model (Tager-Flusberg & Joseph, 2005) which includes early abilities such as *attention to social information* there is considerable ambiguity about what constituents of children's social understanding are distinguished by the model – for instance, the social-perceptual component appears to encompass joint attention abilities and abilities which appear to be inherently more complex such as inferring a person's mental state or emotion from their facial expression. In order to comprehensively address the issue of what theory of mind is and what it consists of, exploration of

Tager-Flusberg's models will provide insight into the interrelationships between different aspects of theory of mind such as social attention, social perception and social cognition and should provide a suitable vehicle to enhance our understanding of the constituents and continuity of children's social understanding.

Recent accounts offered by Carpendale and Lewis (2004, 2006) and Klin et al. (2003) provide more specificity of the mechanisms and abilities involved in social understanding in typical development and autism respectively. In what is likely to prove a seminal paper on social understanding, Carpendale and Lewis outlined a constructivist and emergent account which places social interaction at the heart of children's social understanding. Within this framework, they argued that all previous accounts of children's theory of mind - whether theory theories, maturation theories or enculturation theories – could not be validated in light of the wealth of new evidence implicating a role for social interaction in the development of social understanding. To address this void, Carpendale and Lewis' account focuses on a mechanism known as the *epistemic triangle* (Chapman, 1991) which incorporates a child's experience of the world along with the communicative interaction with others regarding their experiences and beliefs. In contrast to the enculturalist tradition (as endorsed by Dunn) they proposed that the child does not *passively* adopt social knowledge but rather *actively* constructs it through the process of triadic interaction. Their mechanism draws upon Piagetian and Vygotskian concepts whereby the former emphasised the relations between people and the objects which they experience in the world while the latter was concerned with the role of social interactions in the development of higher mental functions. Through mutual integration of these concepts, Carpendale and Lewis describe an epistemic triangle in which operative and communicative interaction combine through regularity of experiences with others to

construct a gradual understanding of mind in the child. They assume a view of belief that contrasts with those in the theory of mind tradition – namely that beliefs cannot be independent of activity and yet cause activity; rather, beliefs are created through action. Via their broad framework they are able to account for much of the recent evidence implicating a role for social interactions in the development of social understanding.

From their emergent, constructivist account of social understanding, Carpendale and Lewis offer a developmental framework which allows the social and cognitive underpinnings of social understanding to be considered simultaneously. Furthermore, by focusing on triadic interaction, Carpendale and Lewis can extend beyond the cognitive accounts to provide a developmental explanation of social understanding that extends from infancy onwards without reference to supposed innate capacities. As a result of placing social interaction at the foundation of social understanding, Carpendale and Lewis identify several key issues which they think should direct where this field of research ought to advance further. Given the protracted view of the theory of mind developmental process, they suggest that research should use task-based procedures to determine what factors may facilitate construction of social understanding at points earlier than the child is able to reason with false beliefs. They also indicate that there needs to be a detailed exploration of what it actually means for a child to understand beliefs. Given the significance of this mental state within later theory of mind development, it would appear to be important to delve further into the nature of this understanding in an effort to avoid the over-simplification of the conceptual change typically identified at 4 years of age. Finally, Carpendale and Lewis underline the need to look beyond 4 years of age and to document further developments connected with more complex social understanding

(e.g., higher-order beliefs). Synthesis of these key areas reveals that there is a pressing need to understand the mechanisms underlying social understanding more clearly in terms of the progression from infancy through to late childhood. While the work of Carpendale and Lewis (2004, 2006), alongside, say, the mind-mindedness work of Meins and colleagues and the communicative language research conducted by Dunn and colleagues provide examples of research which highlight crucial potential causal mechanisms within children's social understanding, this thesis is concerned with mapping out what constitutes children's social understanding and determining how possible distinct domains of social understanding relate to each other. It is argued that in order to effectively understand the developmental progression from early precursors (such as social attention and social perception) through to later emerging aspects of theory of mind/social understanding (such as social cognition) it is first necessary to clarify what these supposed constructs of ability are; are they all aspects of social understanding? Does the development of these abilities on the path to social cognition suggest homotypic continuity? Alternatively, does their disparity indicate heterotypic continuity and thus that certain abilities may not actually constitute social understanding? Therefore, as expressed toward the beginning of this chapter, there is a need to tackle the (thus far relatively neglected) issue of establishing what theory of mind/social understanding actually is. The plan to study the paths between each of these aspects of social understanding via structural equation modelling should provide clarification of boundaries or crossover between the constructs of social cognition, social perception and social attention and delineate possible paths between these aspects of children's social understanding and language.

While Carpendale and Lewis (2004) provide a detailed account of social understanding development in typically developing children, they admit that their

focus on processes involved in (early) social understanding in atypical development such as autism is rather limited. For instance, in describing early development of social understanding from dyadic skills to triadic orienting abilities, Carpendale and Lewis do not really outline how this process may proceed in atypical development. Yet, they acknowledge the merit in exploring claims like that of Hobson (1993a) which suggest autism is linked to problems with early affective engagement in such interactions. Also of merit is focusing on whether certain compensatory mechanisms such as language come into play in the development of social understanding in children with autism (e.g., as argued by Tager-Flusberg & Joseph, 2005). Furthermore, as Cicchetti (1984, p. 1) states: "...we can learn more about the normal function of an organism by studying its pathology, and likewise more about its pathology by studying its normal condition." Therefore, investigation of the above issues and of what constitutes social understanding in children with autism within the current thesis will not only provide further understanding of the close links between problems with social understanding and the social deficits experienced by children with autism. It will also provide a complementary insight into paths to social understanding in typically developing children. Thus, focus on the processes and potential compensatory strategies by which children with autism may arrive at social-cognitive understanding should provide rich detail in highlighting the mechanism behind the breakdown of normative processes.

In a similar vein to the comment by Carpendale and Lewis (2006) on the need to focus on early emerging aspects of social understanding in autism, Charman (2003) asserted the importance in understanding the mechanisms by which joint attention behaviours are related to later outcomes and understanding why the development of joint attention skills is impaired in autism. As Volkmar, Lord, Bailey, Schultz and

Klin (2004) point out, it is crucial to study the interrelationships among early emerging interaction skills because it is unlikely that any of the early emerging processes will follow independent developmental courses. Recent years have seen a proliferation of studies investigating such behaviours and early emerging social attention abilities in children with autism. In a study by Leekam, Lopez and Moore (2000) it was suggested that impairments in dyadic social engagement may be present in autism and may relate to the triadic social engagement impairments most noticeably in joint attention behaviours. Furthermore, joint attention skills have been intimated as the main precursor of subsequent ToM disabilities in autism (Charman et al., 2001). Recent research suggests that the cognitive impairments that underlie these abnormalities may be at a more basic, low-level perceptual processing level (Milne et al., 2002) or at the level of processing and understanding emotions (Baron-Cohen et al., 2000; Klin, Jones, Schultz, Volkmar, & Cohen, 2002). In a more recent study (Leekam & Ramsden, 2006) it was reported that while triadic interaction difficulties are critically important to subsequent development, dyadic interaction difficulties alone provided a powerful indicator of later language and social cognitive skills. The preceding evidence indicates that broad investigation of social understanding in children with autism is likely to provide valuable insight into the continuity and discontinuity of the links between early emerging aspects of social understanding and later more complex levels of social understanding. This endeavour in addition to the planned concurrent investigation of such abilities in typically developing children should assist in defining the constituents of social understanding and illuminating the continuity from low-level social understanding abilities such as social attention through to more complex understanding within the traditional domain of social cognition. While the benefit of a developmental perspective to examining social

understanding is undoubted and a longitudinal investigation would be a fruitful approach to delineating children's social understanding abilities, this option was beyond the scope of the current investigation.

1.4 Summary and outline of forthcoming chapters

The aim of this chapter was to provide a theoretical context for the empirical work of this thesis. As discussed, historical developments in the field have led to a growing dissatisfaction within the field regarding cognitive accounts of children's theory of mind. This is clear from the wealth of studies which have identified the intertwining of children's developing social-cognitive abilities with early social experiences and language. New, broader accounts of theory of mind/social understanding have been developed which necessarily consider interactions and the development of early abilities before the emergence of traditional social-cognitive abilities. However, the broadening of the field has led to the concept of theory of mind or social understanding becoming ambiguous. While the new focus on how social understanding develops has been important, it is not clear what develops into what. So, it is not clear whether the various developing skills that are all proposed to be social understanding or theory of mind are actually consistent with each other in any specific way. This means that in order to look at its development we really need to look at what social understanding is and what it consists of. This has implications for understanding of the constituents of children's social understanding and of the continuity in ability from low-level social understanding through to more complex aspects such as social cognition. In order for research to effectively address the issue of how social understanding develops it would appear to be invaluable to first clarify what the constituents of children's social understanding actually are.

Therefore, the overarching aim of the thesis was to investigate the constituents of children's social understanding from social attention through to social cognition. To achieve this, Part 1 of the thesis consists of two methodological chapters and Part 2 consists of four theoretically-driven chapters. Within Part 1, chapter 2 investigates potential task artefacts of social-cognitive tasks which may cloud measurement sensitivity. Incorporating these findings regarding task design, chapter 3 then describes the development and testing of a composite social-cognitive methodology. Having established a valid and comprehensive method of assessing children's social cognition within Part 1, Part 2 of the thesis then incorporates this methodology within the broader investigation of the relationships between different aspects of social understanding. Chapter 4 sets the context for part 2 through discussion of componential models of theory of mind/social understanding and identifies the recent Tager-Flusberg and Joseph (2005) model as the chosen vehicle for testing hypotheses regarding the constituents of children's social understanding. Using part of Tager-Flusberg and Joseph's model as a framework, chapter 5 then examines the relationship between children's social-perceptual and social-cognitive abilities. Building on this, chapter 6 reviews key literature consistent with the broader view of children's social understanding across social cognition, social perception, social attention and language before investigating these four areas using various analyses including structural equation modelling. Thereafter, chapter 7 complements the endeavour of chapter 6 by examining relationships across tasks and between constituents of social understanding in a group of children with autism in order to determine whether the same relationships hold for this atypical group of children. Part 3 of the thesis then summarises the key findings from each of the preceding chapters and discusses significant emergent issues and directions for future research.

PART 1 –

DEVELOPING A NEW METHODOLOGY TO ASSESS SOCIAL COGNITION

Outline of Part 1

As outlined in chapter 1, the overarching aim of this thesis is to clarify what the constituents of social understanding actually are. Before such theoretical enterprise in Part 2 of the thesis, it is important to first ensure that the methods employed for this endeavour tap into the supposed understanding required by the child. While the majority of tasks within the domains of social perception, social attention and language to be used throughout Part 2 were believed to appropriately tap into their relevant areas, the methodological examination of Part 1 was devoted solely to the domain of social cognition for the following reasons. As was apparent from chapter 1, social cognition is integral to theory of mind research; providing the link to the bulk of this research which has gone before and whether regarded in a traditional sense or not, abilities within this domain provide the greatest indication of ability to interact effectively with others as a social being. In addition, given that the overall aim of the thesis was focused around the clarification of ambiguous concepts, it was essential to first investigate conceptual concerns held by the author regarding certain social-cognitive methodology. Accordingly, with some concern that a second-order false belief task designed by Sullivan et al. (1994) does not sensitively measure what they purport the task to measure, chapter 2 provides experimental manipulation of such methodology to underline the importance of social-cognitive task sensitivity. In arriving at a more specific second-order false belief measure (free from the concerns of the task used by Sullivan et al.) chapter 3 then explores the possibility of extending this measure to arrive at a composite false belief story which can simultaneously measure first-order and second-order mental states. It was hoped that such a composite task would provide a unique opportunity to discover children's respective first-order and second-order social-cognitive abilities, whilst avoiding task confounds

that are likely to arise by testing children on separate tasks on separate occasions. Furthermore, with such a task having been developed and tested in chapter 3, it was planned that this comprehensive measure could then be used throughout the empirical investigation within part 2 as a valid indicator of children's social-cognitive abilities.

Chapter 2

A new method of assessing children's second-order false belief understanding

Introduction

There are a multitude of methods available to researchers within the field of theory of mind (ToM) and social understanding and the general ambiguity which envelops definitions of ToM or social understanding is matched by a lack of clarity in some areas of ToM task design. Therefore it is necessary to have clearly defined theory of mind tasks which genuinely measure the actual ability being hypothesised by the researcher. In addition, as this thesis focuses on cross-sectional research with children aged 4 to 6 years it was necessary to use a series of tasks which were appropriate for that particular age group. Since some tasks have previously been used with infants and others have been used with 7- to 8-year-olds, it was necessary to build new tasks across the spectrum of social understanding that were age appropriate to the children tested throughout this thesis. As part of this methodological endeavour, the first goal of the thesis was to develop a new composite theory of mind method that could be used to measure first-order and second-order mental states (e.g., *belief* and *ignorance*) in parallel in the same child. Once developed, this task is to be used in two studies described in Part 2 that will examine the relationships between performance on this task and measures of social perception, social attention and language.

In parallel with the main aim of building a new composite theory of mind task there were two subsidiary aims relevant to the present study. Both aims centre upon how task design can influence children's false belief understanding. Specifically, the first aim was to investigate how second-order false belief stories can be simplified by

reducing the information processing and language demands of such stories. The second aim was to investigate the conceptual distinction between different kinds of mental states which may lead to simplification of the conceptual demands of false belief understanding. It is important to address these two aims in order to test the claim of Sullivan et al. (1994) that children understand second-order theory of mind by the age of 4. While their second-order false belief task is well used within the theory of mind literature, we have two reservations regarding their methodology which are considered worthy of investigation. Compared to previous stories (e.g., Perner & Wimmer, 1985), Sullivan et al. designed second-order belief stories with reduced processing demands and found evidence of these abilities in 4-year-olds. However, we believe that the information processing demands of Sullivan et al.'s stories could have been reduced further. Secondly, the supposed simplicity of their second-order false belief stories is potentially confounded by the inclusion of a second-order ignorance question prior to the second-order false belief question, thus combining representational (i.e. beliefs) and non-representational (i.e. ignorance) understanding within one story. Therefore, while it would have been straightforward for us to address our overall aim by simply adopting the Sullivan et al. story format as the basis for the design of our composite theory of mind task, it was necessary to first investigate these two issues of task design.

2.1 Factors of task design influencing first-order false belief understanding

Researchers in social cognition traditionally examine children's understanding of first-order mental states (e.g., "he thinks that . . .") rather than children's understanding of second-order ToM (e.g., "he thinks that she thinks"). Within the first-order literature, the evidence points to two avenues through which children's performance may be influenced on false-belief tasks – via either reducing

the information processing demands of false-belief tasks or varying the conceptual demands of false-belief test questions. These two possibilities are explored below.

There are various ways in which first-order tasks can be simplified in terms of information processing demands, leading to enhanced performance by preschool children. Indeed, Wellman, Cross and Watson's (2001) meta-analysis of theory of mind studies revealed several factors of task design which led to improved false belief performance such as: children's active participation within the scenes of the story, whereby participation perhaps made an otherwise abstract task seem quite concrete; thus reducing the processing requirements of the task. Another way in which false belief performance improved was demonstrated in a study where the motive for the main protagonist within the story is made explicit through a deceptive context (e.g., Chandler, Fritz, & Hala, 1989); this serves to ease the child's information processing of the story because the act of deception allows the child to focus on the key mental states. A number of studies have reduced information-processing demands in false-belief tasks by varying the wording of test questions. For instance, Lewis and Osborne (1990) found that young children's false belief performance was greatly improved in a condition where a temporal reference was given to the object in question – therefore, this facilitated the child's interpretation of the (ambiguous) false belief question and helped to reduce the degree of processing required. Similarly, Siegal and Varley (2002) suggest that false-belief performance can be enhanced when test questions are presented in a manner that explicitly signals the purpose/relevance of tasks. For example, by using a test question that explicitly asks where the protagonist thinks the other person will look *first* for the object; this allows the child to avoid inferring that the question refers to the first location to be

searched. These various examples serve to illustrate how simplifying information processing demands can facilitate children's first-order false belief performance.

While there has been little research investigating how simplifying the specific cognitive demands of mental state attribution can facilitate false belief performance, Fabricius and Imbens-Bailey (2000) do suggest a way in which false-belief tasks may be inadvertently simplified. They argue that a feature of the false-belief test may actually undermine the specificity/validity of the test. The basis of their argument is that in false-belief tasks, when the child is asked where they think the character (X) will now look for the object, the correct answer can be reached by the child simply realising that X does not know about the object being in the new location. So, on the basis of attributing the concept of ignorance rather than false-belief the child may choose the old location when asked to choose between the two locations. Fabricius and Imbens-Bailey's research suggests that understanding of ignorance might assist the child in making a correct false-belief judgement and since the former developmentally precedes the latter, then inclusion of ignorance within a false belief story may reduce the conceptual demands such that the child is not actually attributing the concept of belief but ignorance. However, this explanation might not apply to all types of false-belief task. Perner and Horn's (2003) findings show that when the unexpected contents version of this task is given, in which the child is not asked about imminent action (where will the protagonist look) but what a protagonist thinks, children have more difficulty in attributing false belief. Therefore, this conceptual distinction between ignorance and false belief is relatively unclear. We now turn to evidence from second-order tasks to examine how factors of task design may influence children's second-order false belief understanding.

2.2 Factors of task design influencing second-order false belief understanding

Second-order mental state attribution was traditionally tested using Perner and Wimmer's (1985) paradigm. In this paradigm, two characters - Mary and John - are independently informed of the location of a critical object, X, such that they both have a true first-order belief as to the object location but John has a false second-order belief about Mary's belief. Children are asked where they think John thinks Mary will look for X. Results suggested that the ability to correctly reason about second-order beliefs is not present until 7 years of age. Hogrefe et al. (1986) provided further evidence of emergence of this ability at 7 years of age. Additional findings showed that 5-year-olds could attribute second-order ignorance, supporting evidence from first-order studies that ignorance is a simpler mental state for children to understand. As for first-order beliefs, the same arguments about simplifying false belief tasks in terms of either lowering the processing requirements or varying the conceptual demands should be equally applicable to second-order beliefs.

Since Perner and Wimmer's (1985) study, subsequent studies have shown that by simplifying information processing demands, second-order understanding emerges earlier than documented in the studies of Perner and Wimmer (Leekam & Prior, 1994; Perner & Howes, 1992; Winner & Leekam, 1991). However, as for first-order understanding, a distinction needs to be made between tasks using second-order representational and nonrepresentational understanding (Leekam, 1990), since some second-order mental states are simpler than others (i.e. second-order ignorance is a simpler concept for children to understand than second-order beliefs). Therefore, I will investigate how task design influences second-order understanding in 2 ways: via simplification of information processing demands and via simplifying the conceptual demands of false belief understanding.

Sullivan et al. (1994) investigated how second-order false belief stories can be simplified by reducing the information processing demands of such stories. With more scope in second-order rather than first-order belief tasks for longer and more complex stories, Sullivan et al. had simplified the information-processing demands of their second-order false-belief stories by shortening story length, providing feedback to four probe questions and involving fewer characters, locations, and episodes. They found that by simplifying the stories created by Perner and Wimmer (1985) as well as their own, children as young as 4 years of age were able to exhibit second-order reasoning of false beliefs and 90 per cent of children aged 5 and a half years were able to do so. Therefore, they argued that the processing requirements of Perner and Wimmer's paradigm were sufficiently demanding to underestimate by several years the age at which children are able to engage in second-order reasoning.

Although Sullivan et al. (1994) found that children could attribute second-order beliefs up to two years earlier than Perner and Wimmer's (1985) results had indicated, it was possible that Sullivan et al. had not simplified their task sufficiently. The second-order belief stories of both Perner and Wimmer, and Sullivan et al. necessitated that children pay attention to at least three different dialogues. Coull (unpublished) argued that these stories were unnecessarily complex for the following reasons. Firstly, there is no need to include any dialogue in second-order belief stories. Secondly, to minimize information-processing demands, stories should require only two characters rather than the usual three or more characters featured in the stories of Perner and Wimmer, and Sullivan et al. Furthermore, to answer the second-order false-belief question correctly, Coull argued that it was necessary only to have directed attention towards the epistemic states of two characters rather than three. Finally, stories need have only two scenes, rather than the usual three or more

scenes; thus requiring the child to concentrate on less narrative detail. Therefore, given that the aim of Sullivan et al. was to simplify Perner and Wimmer's task by reducing task complexity, Coull aimed to further reduce the information-processing demands of second-order belief stories to discover if further improvements could be made. Therefore, as a pilot study to the development of new social-cognitive stories in the current study, Coull presented 5- to 7-year-olds with stories which had only two characters, contained no spoken dialogues, were shorter in length and had fewer scenes, and compared them to their performance on Perner and Wimmer's original story. Results from this showed that significantly more children were able to attribute second-order beliefs when given the new simplified stories compared to Perner and Wimmer's story. While these findings provided further evidence that simplifying the information processing demands of a second-order false belief test improved children's task performance, a surprising finding was that only 42 per cent of 5- to 6-year-olds could pass these simplified second-order stories. In contrast, Sullivan et al. found that 90 per cent of children at this age could attribute second-order beliefs. What could explain this discrepancy?

To attempt to explain this contrast between the results of Sullivan et al. and Coull (unpublished), we turn to logic presented by Leekam (1991). Leekam discussed the importance for theory of mind tasks to distinguish between different types of higher-order mental states. Given conclusive evidence that children understand the concepts of desires and intentions before they understand beliefs within first-order understanding it is highly probable that the same logic applies to second-order understanding. Indeed, Leekam described a study in which children's performance was significantly better giving correct responses to questions of second-order intention compared with second-order belief. This is congruent with Perner's

argument that 5-year-olds difficulty with second-order false beliefs lies in the complexity of representational understanding rather than recursion per se. Therefore, while the basis of Leekam's logic was the conceptual distinction between second-order intentions and second-order belief, the same principle applies to the distinction between second-order ignorance and second-order belief.

The above principle would appear to have particular relevance for explaining the contrast in findings between Sullivan et al. (1994) and Coull (unpublished). While Sullivan et al. found that they could improve upon Perner and Wimmer's (1985) results there was a crucial difference between their paradigms. Perner and Wimmer (and Coull) did not incorporate a second-order ignorance question into their task, whereas Sullivan et al. did. As second-order ignorance understanding is known to precede second-order belief understanding by about two years (Hogrefe et al., 1986), combining these two mental states within one task may have influenced the child's conceptual understanding. It is suggested here that this juxtaposition may lead the child through to answer a question on second-order false-belief understanding simply on the basis of attributing a character's ignorance of another's belief. This is illustrated in the story designed by Sullivan et al. Their story is based on a mother's ignorance of her son's belief, where he, Peter, wants a puppy for his birthday, is told by his mother that he is receiving a toy, where in fact his mother had bought him a puppy as a surprise. Peter later finds the puppy, unbeknownst to his mother. The crucial stages of second-order ignorance and second-order belief proceed as follows:

(i) Grandma: 'Does Peter know what you really got him for his birthday?'

(ii) *Second-order ignorance question: 'What does Mum say to Grandma?'*

(Answer: NO)

(iii) Grandma to Mum: 'What does Peter think you got him for his birthday?'

(iv) *Second-order false-belief question: 'What does Mum say to Grandma?'*

(Answer: TOY)

We argue that it is plausible that the child can answer (iv) by merely following on from answer 'No' to (ii) to correctly answer 'toy' rather than 'puppy'. On this basis, the child can correctly answer 'toy' by acknowledging that the mother is ignorant of reality, rather than making an inference from the analysis of two conflicting propositions that define both the reality of the situation and the situation as falsely believed by the mother (i.e. holds a false belief of reality). If this is the case, and given that children's understanding of ignorance precedes belief in second-order reasoning (Hogrefe et al., 1986), it may be argued that the juxtaposition of a second-order ignorance question with a second-order belief question serves to facilitate a child's ability to attribute second-order beliefs.

If the above rationale is correct then the validity of Sullivan et al.'s claims would be called into question. Specifically, the age at which they claimed children understand second-order false beliefs may not be an accurate reflection of their representational abilities. Furthermore, studies which have adopted Sullivan et al.'s paradigm may need to revise their findings to distinguish between representational and non-representational understanding. Similarly, future researchers planning to adopt this paradigm should be aware that there is an important distinction between understanding of ignorance and belief, and crucially that the Sullivan et al. paradigm does not make this distinction.

Further support for the conceptual distinction argument outlined above is provided in a study conducted by Karmiloff-Smith, Klima, Bellugi, Grant, and Baron-Cohen (1995). Their study examined theory of mind, among other variables, in individuals with Williams Syndrome. Children were tested on the Perner and

Wimmer (1985) paradigm and on the second-order story designed by Sullivan et al. (1994). It was found that 31 per cent of individuals succeeded on the former story whereas 88 per cent succeeded on the latter. Karmiloff-Smith et al. explained this inconsistency by suggesting that second-order belief attribution was *couched* in the latter story via the simpler propositional mental state *know* rather than *believe*. The above argument is given further support via Fabricius and Imbens-Bailey's (2000) earlier suggestion that children may answer false belief questions correctly on the basis of their understanding of ignorance rather than belief. Therefore, it is important to explore how a questioning sequence incorporating ignorance immediately prior to belief may lead to improved false-belief performance. This is particularly important since the inclusion of the non-representational state of ignorance may inflate our perception of children's representational abilities and lead to an overestimation of the age at which second-order representational understanding emerges.

Our discussion thus far has revealed two ways in which task demands may be simplified in first-order and second-order belief understanding. These stories can be simplified by reducing the information processing demands and simplified via the specific cognitive demands of mental states (distinguishing between the demands of ignorance and false belief). In order to address concerns regarding Sullivan et al.'s second-order false belief methodology, both of these routes to story simplification were investigated in the study below.

2.3 Simplifying the task demands of second-order false belief stories[1]

Introduction

The main aim of part 1 of this thesis was to build a new composite theory of mind task that can be used to measure first-order and second-order social cognition.

[1] This study which was carried out as part of the PhD is now published as Coull, Leekam, and Bennett (2006) in Social Development, 15, 260-275.

However, as the preceding discussion has demonstrated, we first needed to investigate whether conceptual constraints on second-order belief attribution might be eased by asking children a question about second-order ignorance immediately before a question about second-order belief. Therefore, in this study, the question format (ignorance question first vs. no ignorance question) was manipulated in a standard task identical to that given by Sullivan et al. (1994). It was predicted that children who received second-order false-belief stories that included a second-order ignorance question would show significantly better second-order belief understanding than children who did not receive an ignorance question within the sequence. It was also predicted that the simplified stories with reduced processing demands developed within the pilot study would produce better performance, particularly when a second-order ignorance question was included.

Method

Participants

Fifty children from two primary schools participated in this experiment. The majority of children were either 4 or 5 years of age ($N = 41$), with several 6-year-olds (N = 9). Ages ranged from 4 years 0 months to 6 years 5 months, with a mean age of all the children tested of 5 years and 6 months (s.d. = 8 months). There were a roughly equal number of boys (23) and girls (27) who participated. Twenty-five children were given the 'False belief only' question-format and 25 were given the 'Ignorance and false belief ' question-format. The mean age of the children in these groups was 5 years and 5 months, and 5 years and 6 months.

Design and Procedure

A mixed design was used with question-format (ignorance +

false belief (IG + FB), false belief only (FB)) as a between-subjects variable and information load/story type (standard, new) as a within-subjects variable. The dependent variable (maximum score of 4) was the number of correctly justified false-belief responses. Appendix 2.1 lists the scoring criteria and gives examples of correct and incorrect justifications. The story order was counterbalanced within and across groups.

To examine the reliability of performance on each story type, children were tested on two story trials instead of one trial for each version of the second-order belief task. Thus, the 25 children in each question-format group were presented with two 'standard' stories taken from Sullivan et al. (1994) and two more simplified stories based on those previously used by Coull (unpublished). The format of standard and new stories was essentially the same; however, the new stories were shorter in length, omitted any dialogue between characters, and had fewer scenes and characters.

The story themes for the standard story type included Sullivan et al.'s (1994) puppy story and their chocolate bar story, which was slightly differently themed (cake story), but importantly, retained the same structure as before. The themes for the new story type included a story about a robot which one child hides from another and another story about a child who moved a bar of chocolate to stop it melting on the beach and was observed by the second child. An example of each story type is shown below in Table 2.1. The two other stories used in this study are presented in Appendix 2.1.

Table 2.1

Example of new Coull, Leekam, and Bennett story used in explicit comparison with Sullivan, Zaitchik, and Tager-Flusberg story

Story used by Sullivan et al. (1994)

Tonight it is Peter's birthday and Mum is surprising him with a puppy. She has hidden the puppy in the basement. Peter says, 'Mum, I really hope you get me a puppy for my birthday.' Remember, Mum wants to surprise Peter with a puppy. So, instead of telling Peter she got him a puppy, Mum says, 'Sorry Peter, I did not get you a puppy for your birthday. I got you a really great toy instead.'
Probe question 1: 'Did Mum really get Peter a toy for his birthday'? *No.*
Probe question 2: 'Did Mum tell Peter she got him a toy for his birthday'? *Yes.*
Probe question 3: 'Why did Mum tell Peter that she got him a toy for his birthday'? *To surprise Peter.*
Now, Peter says to Mum, 'I'm going outside to play.' On his way outside, Peter goes down to the basement to fetch his football. In the basement, Peter finds the birthday puppy! Peter says to himself, 'Wow, Mum didn't get me a toy, she really got me a puppy for my birthday.' Mum does *not* see Peter go down to the basement and find the birthday puppy.
Nonlinguistic control question: 'Does Peter know that his Mum got him a puppy for his birthday'? *Yes.*
Now, the telephone rings, ding-a-ling! Peter's grandmother calls to find out what time the birthday party is. Grandma asks Mum on the phone, 'Does Peter know what you really got him for his birthday'?
[1]Second-order ignorance question: 'What does Mum say to Grandma'? *No.*
Memory aid: Now remember, Mum does not know that Peter saw what she got him for his birthday.
Then, Grandma says to Mum, 'What does Peter think you got him for his birthday'?
[1] [2]Second-order false-belief question: 'What does Mum say to Grandma'? *Toy.*
Justification question: 'Why does Mum say that'? *Because she doesn't know that Peter saw the puppy.*

Story used by Coull et al. (2006)

It is Paul's birthday. Paul and Sally are in his toy-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.
Probe question 1: 'Did Paul leave the room'? *Yes.*
Probe question 2: 'Did Sally leave the robot in the box'? *No.*
Probe question 3: 'Why did Sally move the robot to the cupboard'? *To play a trick.*
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.
Nonlinguistic control question: 'Does Paul know that Sally hid the robot in the cupboard'? *Yes.*
[1]Second-order ignorance question: 'Does Sally know that Paul knows where the robot is'? *No.*
Memory aid: Now remember, Sally doesn't know that Paul saw her hide the robot.
[1] [2]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.*

[1] Children in the IG+FB condition received both questions.
[2]Children in the FB only condition received only the false-belief question.
For all 4 stories, children in the FB only condition received exactly the same stories as the IG+FB group with the exception of the second-order ignorance question.

In order to enable children to visualize the stories, the experimenter used various dolls to act out each story. All of the characters featured in the stories were represented by three-dimensional figures while modelling clay and Lego were used to construct the various locations and furnishings described in the stories.

The experimenter saw all the children individually inside a quiet area of their school. Before beginning each story, the experimenter introduced the child to the various characters, props, and furnishings that were to be used. After explaining the procedure to the child, the experimenter then orally presented the stories to the child verbatim as outlined in Table 2.1 in parallel with the enactment of each story.

In order to compare the procedure used by Sullivan et al. (1994), all of the stories contained a series of probe and control questions. Following Sullivan et al., each story contained three probe questions after the first episode to ensure that the children understood the central theme of the story. Furthermore, both standard and new stories included a non-linguistic control question that assessed the children's understanding of first-order knowledge. For all probe and control questions, feedback was provided and corrections were done if necessary. In a similar way to Sullivan et al., all 'yes' and 'no' responses to these questions were balanced in order to avoid creating a bias for responses.

Once the children had been asked the various probe and control questions, they were required to answer the crucial test questions. One group of children were asked a second-order ignorance question followed by a memory aid and a second-order false-belief question whereas the other group of children received the same

presentation with the exception of the second-order ignorance question. Both ignorance and false-belief questions were asked as open-ended questions; however, if the children did not provide an answer then a forced-choice format was adopted. For example: "Does Sally know that Paul knows where the robot is?" or "Does Sally not know that Paul knows where the robot is?" In these cases, the forced-choice response was counterbalanced across children. Finally, all the children were asked to justify their response to the second-order false-belief question. No feedback or correction was provided for either of the test questions or the justification responses. Test question responses were scored as correct or incorrect. Responses to justification questions were scored according to the criteria used by Perner and Wimmer (1985).

Results

All results are based on correctly justified false-belief responses. One point was awarded to a child for each trial if they gave a correct response and justification to the second-order false-belief question. There were no practice effects for either group. Initial analyses of normality revealed that the dataset was not normally distributed because of a negatively skewed distribution within the group of children who were also asked an ignorance question (IG + FB); therefore, nonparametric statistics were used to analyse the dataset.

First, we examined the effect of question type. As predicted, children who received the second-order ignorance question before the second-order belief question (IG + FB) performed better on the second-order false-belief question than children who received only the second-order belief question (FB). The mean score for children in the IG + FB group was 2.04 (s.d. = 1.27) whereas the mean score for children in the FB-only group was 1.28 (s.d. = 1.17); Mann-Whitney, U = 204, z = −2.17, p = .03. Within each of these groups, no significant differences were found

that arose from simplifying the information load (i.e., performance on the new vs. original stories). Children in the IG + FB group had similar scores whether they were given either Sullivan et al.'s standard stories or the new stories (mean 'standard' = 1.00; s.d. = .71; mean 'new' = 1.04; s.d. = .79). The same applied to children in the FB group (mean 'standard' = .68; s.d. = .69; mean 'new' = .68; s.d. = .75). Therefore, contrary to expectation, the more simplified format in the new stories did not enhance performance.

Given that there was no difference between performance on new and standard stories, responses were combined from both story types in subsequent analyses. Table 2.2 shows the number of children passing one, two, three, or all four trials of false-belief test questions. Taking a strict criterion of three out of four trials correct, it may be seen that irrespective of story type, 36 per cent (nine children) in the IG + FB group consistently attributed second-order false beliefs, whereas only 12 per cent (three children) in the FB group consistently attributed second-order false beliefs ($\chi^2 = 3.95, p < .05$).

Table 2.2

Number and percentage of children passing 0 to 4 trials of second-order false belief

		0, 1 or 2 trials		3 trials		4 trials	
Group	n	n	%	n	%	n	%
IG + FB	25	16	*64*	5	*20*	4	*16*
FB	25	22	*88*	1	*4*	2	*8*

The above results show that irrespective of age and story type, children within the group who received a second-order ignorance question in addition to a second-order false-belief question were significantly better in their second-order false-belief performance than children who did not receive a second-order ignorance question. This supports the hypothesis that second-order false-belief tests incorporating a second-order ignorance question have a facilitative influence upon second-order false belief performance.

It was clear from above that 36% of 4- to 6-year-olds who had been given stories similar in nature to those received by the children in Sullivan et al.' study, were able to attribute second-order beliefs. This is discrepant from the 90% of children able to do so in their study. However, this latter figure refers to 90% (n = 20/22) of children within the age range of 5 years and 5 months to 6 years and 5 months who were able to correctly justify at least 1/2 (i.e. 50%) trials of the false belief question. Examination of the same level of performance by children within the same age range on 50% of trials in the current study revealed that 67% (n = 12/18) of children were able to achieve this. Thus, the findings from the two studies are closer than the initial comparison between the two studies would suggest.

Discussion

As outlined in the introduction, the main aim of Part 1 of the thesis was to develop a simplified and composite methodology with which to assess social cognition. Given reservations about the second-order methodology used by Sullivan et al. (1994), this study focused on developing a simplified measure of second-order belief understanding. To achieve this we addressed two particular aims: investigating the effect on children's second-order belief understanding of simplifying the

information processing demands of second-order belief stories; and investigating the effect on children's second-order understanding of simplifying the specific cognitive demands of mental state attribution (ignorance vs. false belief).

In terms of the first aim, results showed that additional attempts to lessen the processing demands of the second-order story did not make any difference beyond the simplification already made by Sullivan et al. (1994). This suggested that the new story format introduced here provided a suitable and concise platform with which to assess children's second-order false-belief understanding. However, although the story methods in each study led to similar performances, it is true that children's performance generally within Sullivan et al.'s study was more convincing than children's performance here, as demonstrated by 90% success by 5-year-olds in their study vs. 67% in the current study. This discrepancy may be due to one of two possible reasons. Firstly, unlike the current study, Sullivan et al. provided feedback or correction after each probe and control question had been answered by the child which may have enabled the child to recognise crucial features of the story more readily. Secondly, Sullivan et al. utilised two experimenters in their procedure, one of whom was able to enact much of the story, while the other presented the story, but both of whom acted out the scenes of the story. This 'double act' may have enabled the child to distinguish characters and actions more easily than children in the current study given the lone experimenter. Given these suggestions, as well as the small sample size of both studies, it is perhaps not surprising that children's performance levels differed.

In addressing the second aim, investigation of the conceptual distinction between ignorance and belief revealed that 4- to 5-year-olds are significantly more likely to correctly answer second-order false-belief questions when these are

preceded by a second-order ignorance question than when they are not. The findings indicate that inclusion of the concept of ignorance was crucial to facilitating children's second-order belief performance. Almost 40 per cent of 4- to 5-year-olds could consistently provide the correct answer to second-order false-belief questions, having been asked about second-order ignorance immediately beforehand. In contrast, just over 10 per cent of 4- and 5-year-olds could consistently provide the correct answer to second-order false belief in the absence of second-order ignorance. These findings convey the extent to which children's second-order belief performance can be enhanced by couching it within second-order ignorance understanding. It is therefore possible that the opportunity to reflect on second-order ignorance might help to scaffold a fragile understanding of second-order false beliefs.

What might be the mechanism for the facilitation of false belief understanding by inclusion of ignorance? It may be argued that the use of complex syntactic structures might help children to answer the belief question. Giving the child a question with a double embedded structure "Does Sally know that Paul knows where the robot is?" may prime the child to answer a subsequent question of a similar structure "Where does Sally think that Paul will look?" This view would be supported by recent linguistic accounts of ToM development, which propose that understanding of syntactic complexity plays a major role in children's false belief understanding (e.g., de Villiers, 2000).

To examine the possible role of syntactic priming, a post hoc experiment was carried out with 15 children (mean age 5 years and 6 months) drawn from the same schools as in the main experiment. These children did not take part in the main experiment. All were subjected to the IG + FB condition only. The procedure was

carried out in exactly the same way as in the main experiment with one small change. Prior to the second-order ignorance question, these 15 participants were also asked a linguistic control question "Does Sally know that Paul saw her hide the robot in the cupboard?" This question taps a higher level of linguistic complexity than the original non-linguistic control question ("Does Paul know that Sally hid the robot?"), yet it does not refer to higher-order mental states directly. The results showed no further facilitative effect of the linguistic control question on second-order belief attribution when compared with the children who were given the second-order ignorance question but not the linguistic control question. Given the earlier findings, this implies that there is something special about reflecting on second-order ignorance that may allow it to facilitate second-order belief. The wording of the linguistic control questions focuses on knowledge of action, whereas the wording of the ignorance questions (despite varying between standard and new stories) focuses on knowledge of knowledge. Thus, it would appear that it is the conceptual understanding of ignorance that is fundamental to providing a short cut to second-order belief understanding.

There are several different ways that this may be explained. One is that directing a child's attention to someone's knowledge immediately prior to their belief is a sufficient and *necessary* factor in simplifying second-order belief understanding. Knowledge is inherently more concrete and less open to interpretation than belief, so by presenting such a sequence of questions in false-belief tasks, focus on knowledge may be enough to prime children's fragile understanding of false beliefs. It is possible then that conceptual understanding is more crucial in earlier ToM development at the ages of 4 to 5 - as demonstrated here - whereas more general information-processing resources come into play later in development.

However, it also the case that juxtaposing a second-order false belief question with a second-order ignorance question does not necessarily imply that the latter *scaffolds* a fragile understanding of second-order false beliefs. Rather, given the important distinction between ignorance as a non-representational concept and belief as a representational concept, it is probable that children who focus on second-order ignorance in false-belief tasks achieve second-order belief success by virtue of their non-representational rather than representational understanding. Such a scenario has implications both for the findings of Sullivan et al.'s (1994) study and consequent studies which have employed their methodology. Based on their finding that 40% of 4-year-olds could correctly answer second-order belief questions, Sullivan et al. had claimed that preschoolers could attribute second-order beliefs. However, if the above scenario is true whereby children achieve success through non-representational reasoning, then Sullivan et al.'s claims are misleading and overestimate children's genuine second-order belief reasoning ability. Furthermore, studies which have employed Sullivan et al.'s procedure prefacing a second-order belief questions with a second-order ignorance question, are liable to have similarly inflated findings. Rather than Sullivan et al.'s finding that 90% of children aged 5 and a half could attribute second-order beliefs, finding that 12% of 5 and a half year-olds correctly attributed second-order beliefs in our non-ignorance condition in the present study is likely to provide a more accurate reflection of young children's second-order belief abilities.

In summary, this study has achieved each of its two subsidiary aims. We have learned of the facilitative effect which children's understanding of second-order ignorance has on their second-order false belief performance; and we have used our newly developed second-order belief story to help confirm our reservations that the second-order belief methodology used by Sullivan et al. (1994) was perhaps not

simplified in the manner they had claimed. Study 1 has provided a successful test of a new second-order false belief methodology; meeting the overall aim of the chapter. Now, acknowledging that second-order ignorance and second-order belief need to be kept separate within social cognitive stories, we can take our new methodology forward to Chapter 3 to develop it further into a composite first-order and second-order methodology.

Chapter 3

A new composite measure of first-order and second-order social cognition

Introduction

. Chapter 3 discusses the steps to further develop the new second-order false belief methodology with the aim to arrive at a composite social-cognitive measure which can simultaneously measure first-order and second-order mental states. This was thought to be beneficial as such a comprehensive, consistent measure is likely to avoid the task confounds that are likely to arise from testing children on separate measures on separate occasions. Therefore, given the apparent simplicity and conciseness of the new second-order false belief story developed in Chapter 2, the next step in developing the method was to design a task that combined first-order and second-order belief understanding. This chapter reports a study that tests children's ability on a new combined task.

Traditionally, first-order and second-order mental state understanding have been tested in two separate tasks. The aim of developing a composite false-belief methodology was to provide a test of both first-order and second-order belief understanding into one story. In designing a false belief story narrative which examines understanding of first and second-order beliefs in parallel, it was anticipated that such a composite task would provide greater insight into consistency of ability when analysing social cognitive performance within the two respective levels of understanding than would be obtained when these levels are tested separately. In addition, a more practical benefit of using such methodology would be the potential easing of a (social understanding) test battery load both for children and

experimenters. Therefore, the primary aim of the present study was to test the function of a new composite false-belief methodology.

The logic behind the composite methodology was similar to that of the new second-order belief stories developed in the previous chapter. Indeed, the story content itself was identical; however, given the influence of second-order ignorance upon second-order belief understanding as described in the previous chapter, the composite stories omitted ignorance questions. Furthermore, to enable the design of a composite first-order and second-order story, Table 3.1 (within the method section) illustrates how the first-order question and justification question were incorporated into the format of the story. Three alternatively themed versions of this composite first-order and second-order belief story are presented in Appendix 3.1.

If performance levels on the new composite false belief methodology are found to correspond to those from studies that have examined first and second-order false belief understanding separately, then this will provide validation for our composite false belief measure. As mentioned previously, numerous studies have conveyed that in typical development first and second-order false belief understanding is present by 3- to 4 years of age and 5- to 7 years of age respectively. Therefore, in order to obtain a range of performance across both levels in the current study we examined theory of mind performance in typically developing 4- to 6-year-olds. Given the simplified nature of the false belief methodology used here, if the method is valid, then it would be expected that a significant majority of the 4- to 6-year-olds tested here would pass the first-order false belief questions. Furthermore, since 12% of 4- to 5-year-olds could consistently apply correct reasoning to second-order belief questions as described in Chapter 2, it was expected that a slightly higher proportion of children would pass the second-order false belief question here for the

following two reasons: children here were slightly older than those in chapter 2 (age range: 4 years and 9 months to 6 years and 9 months compared to 4 years and 0 months to 6 years and 5 months) and the inclusion here of a first-order false belief question prior to second-order false belief may help to scaffold the child's fragile second-order understanding.

To summarise: the main aim of the study was to test the effectiveness of a new composite false belief methodology which has the potential to gauge first-order and second-order mental state understanding in conjunction. This methodology is expected to provide measures of first-order and second-order levels of understanding which are comparable to findings obtained by testing these separately.

Method

Participants

Nineteen typically developing children comprising 9 boys and 10 girls were selected from a junior school in County Durham, (age range from 4 years and 10 months to 6 years and 9 months, mean = 5 years and 9 months, s.d. = 8 months). This age range was chosen to reflect the findings of Coull et al. (2006), Leekam (1991) and Sullivan et al. (1994) showing that some 4- to 6-year-olds can attribute second-order beliefs and enabled a distinction to be made between those who could and could not perform well on second-order mental state tests. None of the children participating here took part in the previous experiment.

Materials

Social-Cognitive Task

In total, 4 composite false belief stories were created with different themes but which were structurally similar to each other (see Appendix 3.1). All 4 stories were presented to all children. Stories were read aloud, but to encourage children's

engagement with these stories the various scenes were acted out with the aid of models. Structures were made out of modelling clay and Lego to represent the various locations, whilst puppets and toy people were used to represent the various characters.

Table 3.1 below provides one of the four story versions to summarise the standard sequence of scenes and questions used to test children's composite understanding of first and second-order beliefs. Through a sequence of scenes concerning two characters, first and second-order reasoning skills were examined in the following way. Firstly, Character A, moves a critical object from one location (left there by Character B) and moved it to a different location unbeknownst to Character B. Then at this point 'frozen in time' the first-order question was posed: "Where does Character B think the object is?" immediately followed by a justification question. Next came the critical scene to enable incorporation of second-order understanding: as if the story was 'playing from pause', the next scene is structured – "While A was moving the object into the new location, B saw A moving the object but A does not realise that B saw them move the object in the new location." Therefore A has a false belief about B's belief of where the object is now located. Consequently, the second-order question was posed: "Where does A think B will look for the object?" immediately followed by a justification question. Also, because the correct response to both the first and second-order questions was the same (old location), a control question was asked at the end of the story which asked where B would now look for the object – correct response: new location. Therefore, this allowed us to determine whether participants were achieving correct responses through valid reasoning or whether they were simply providing the same response for each question.

Table 3.1

Prototypical version of composite false belief story assessing first and second-order understanding

"Paul and Sally and the robot" Scenario
Scene 1: It's Paul's birthday. Paul and Sally are in his toy-room. He is showing Sally his favourite new present – a robot. *Scene 2:* Paul puts the robot back in the box with the lid on and then has to go outside. *Scene 3:* 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. First-order false belief question: Where does Paul think the robot is? Justification question: Why does Paul think the robot is in the _____?* *Scene 4:* While Sally was 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! *Scene 5:* Paul then returns to the toy-room. Second-order false belief question: Where does Sally think Paul will look for the robot? Justification question: Why does Sally think Paul will look for the robot in the _____?** Control question: Where will Paul look for the robot? *Criteria for appropriate/inappropriate first-order justifications are given below. ** Criteria for appropriate/inappropriate second-order justifications are given below. NB. The shaded areas highlight the parts of the story which were presented to children in chapter 2.

In relation to first-order reasoning, justification responses were regarded as appropriate under the following criteria:

1. First-order reasoning: e.g., "Paul does not know the robot is hidden in the cupboard."
2. Nesting of crucial information within character's belief: e.g., "Paul does not know that Sally hid the robot."

3. Original location of critical object: e.g., "Paul put it in the box before he left."

Justification responses for first-order reasoning were regarded as inappropriate under the following criteria:

1. Zero-order reasoning: e.g., "That is where the robot is."
2. Irrelevant information: e.g., "Paul watches from the window."
3. Nonsensical information: e.g., "Paul was really excited."

The appropriateness of the responses to the second-order justification questions was assessed by the same criteria as used by Perner and Wimmer (1985). That is, a response was deemed to be correct within one of the following three criteria:

1. Embedding of mental states: e.g., "Sally does not know that Paul knows where the robot is."
2. Nesting of crucial information within character's belief: e.g., "Sally thinks that Paul did not watch her hide the robot."
3. Original location of critical object: e.g., "Paul had left the robot in the box."

Justification responses for second-order reasoning were regarded as inappropriate under the same criteria as outlined for inappropriate first-order justifications, but given the higher level associated with second-order understanding, first-order reasoning was also inappropriate for second-order justifications, e.g., "Paul knows it is hidden in the cupboard." On the basis of the criteria outlined above, all of the justification responses were analysed by an independent coder who was unaware of the rationale of the study. While a few responses were ambiguous, generally justifications were clearly defined in terms of the criteria, and from the entire sample, substantial inter-rater reliability was achieved: Cohen's kappa = 0.74.

Procedure

Once ethical approval was obtained, consent letters were sent to the parents from one infant school. From those parents who had consented, 19 children were randomly selected from two year groups, who were then seen individually.

All children received all 4 false belief trials in a counterbalanced order. Each composite false belief story was preceded by an introduction of the characters and then the child was asked to listen carefully to the short story, as several questions relating to the story were to be asked at various intervals. Each story was then read aloud and acted out with the various models. No prompts were given after questions were asked, although on a handful of occasions a question was repeated upon request by the child. There was no time limit in place. Responses were written down verbatim by the researcher. At no point in the story was the child told whether their answer was correct or not, although encouraging feedback was provided.

Results

In order to test whether the composite false belief task produced equivalent findings to previous false belief studies that had examined these levels separately, analysis was carried out by examining: i.) the percentage of children who appropriately justified their responses to test questions and ii.) the consistency in performance across first and second-order understanding.

3.1 Effectiveness of the new composite theory of mind task

Preliminary analyses showed that there was no effect of the story type (4 variations – robot, flag, chocolate bar, and doll) upon performance within terms of either first-order or second-order theory of mind. Furthermore, there were no effects of the order of presentation of the stories. Therefore all resultant analyses were based on performance from each of the 4 false belief stories.

Replicating the analysis used within chapter 2 to assess children's social-cognitive (only second-order belief understanding), Table 3.2 provides a summary of the number of correctly justified responses to first-order and second-order belief questions. Correct justifications to test questions are categorised here whilst acknowledging that a correct response was provided to the false belief question. There was only one instance where a child provided the wrong response to the (second-order) test question but then followed this with an appropriate justification – otherwise all correct justifications summarised below were in agreement with a correct test question response. As would be expected for first-order belief understanding, Table 3.2 below indicates that a significant proportion of 4- to 6-year-olds could reliably provide correct justifications – 84% of 4- to 6-year-olds could support their correct false belief response with an appropriate justification in at least 3 out of 4 trials. Indeed, all of the children could provide correct justifications to the first-order test question on at least 50% of occasions. For second-order questions answered correctly, a majority (69%) of 4- to 6-year-olds could provide an appropriate justification on at least 2 out of 4 trials. Of this group, 32% of 4- to 6-year-olds could reliably provide correct justifications to correct test questions responses on at least 3 out of 4 trials. This is higher than the 12% of children achieving this level of understanding in chapter 2 and was expected since the children here were slightly older and due to the possible facilitative effect of also asking children about first-order beliefs beforehand.

Table 3.2

Number of 4- to 6-year-olds providing correctly justified response to false belief question

First-order questions

	All 4 trials	3 trials	2 trials	1 trial	0 trials
N	n	n	n	n	n
19	9	7	3	0	0

Second-order questions

	All 4 trials	3 trials	2 trials	1 trial	0 trials
N	n	n	n	n	n
19	2	4	7	1	5

In order to examine the consistency of each child's responses to first and second-order questions, their pattern of performance – displayed in Table 3.3 – was analysed using a McNemar test. The number of children who passed the first-order question and failed the second-order question in at least 75% of trials was different from the number of children showing the reverse pattern of performance but this difference did not quite reach significance, χ^2 (1) = 6.11, p = 0.06. This reveals that the majority of children were liable to either consistently answer both questions correctly or incorrectly. This difference was expected since children would be unlikely to exhibit second-order belief understanding before displaying first-order belief understanding.

Table 3.3

Within-subject comparison of first and second-order belief performance in at least 3 out of 4 trials

	$1^{st}/2^{nd}$: + +	$1^{st}/2^{nd}$: + -	$1^{st}/2^{nd}$: - +	$1^{st}/2^{nd}$: - -
N	n	n	n	n
19	5	5	0	9

3.2 Summary of findings for composite theory of mind task

Together the above findings suggest that the composite false belief methodology developed here produced first-order and second-order belief performance in 4- to 6-year-old children which was comparable to previous studies which examine these levels of understanding separately. Also, the McNemar test confirms that children's first-order belief understanding is a necessary but not sufficient ability to enable children to consistently understand second-order beliefs.

Discussion

To recap, the main aim of the current study was: to test the effectiveness of a new composite social-cognitive methodology upon typically developing 4- to 6-year-olds. It was hypothesised that the composite false belief task which combines tests of first and second-order mental state understanding would yield levels of performance that would be comparable to previous false belief studies which examine these levels in separate tests.

Findings from the current study were similar to those obtained from conventional first and second-order false belief studies. As Wellman et al. (2001) note within their meta-analysis of theory of mind studies, the vast majority of 4- to 5-year-olds can consistently apply correct first-order belief reasoning – this is

congruent with the first-order findings for the present study. In using a composite false belief task which examined first and second-order understanding in parallel, the results indicated firstly that a large majority of 4- to 6-year-olds could reliably answer first-order questions correctly and an overwhelming proportion of this group could consistently provide correct justifications to these questions. This finding concurs with evidence from previous first-order false belief studies which indicates that first-order mental state understanding is generally evident by 4 years of age, (e.g., Gopnik & Astington, 1988; Hogrefe et al., 1986; Wimmer & Perner, 1983).

With respect to second-order mental state understanding, it was found that roughly a quarter of the 4- to 6-year-olds could reliably answer second-order questions whilst also correctly answering the corresponding control questions. This indicates that children were not randomly guessing the location of where the object was believed to be. This is supported by the finding that over two thirds of 4- to 6-year-olds in the present study could typically provide appropriate second-order justifications, whilst a third of these could *consistently* apply correct second-order reasoning. This suggests that the ability to attribute second-order mental states is emergent by the age of four, and is effectively in place by 6 years of age. Via simpler stories than used in early second-order false belief studies (e.g., Hogrefe et al., 1986; Perner & Wimmer, 1985) this finding is congruent with more recent studies adopting narratives with reduced processing demands (e.g., Sullivan et al., 1994) and corroborates the level of second-order understanding described in the previous chapter. Although, a slightly higher proportion of children could successfully attribute second-order beliefs in the present study, this may be due to the fact that the children here were of a slightly higher age. However the mean age of the children passing second-order tasks here was only 4 months greater than the mean age of the

children who consistently attributed second-order beliefs in chapter 2, although such a narrow age gap can have disproportionately large effects at a time in the child's development when this type of understanding is quickly evolving. Indeed, Bennett and Matthews (2000) found that 50% of 6-year-olds were able to attribute second-order beliefs, and Broomfield, Robinson, and Robinson (2002) found an equivalent level of ability in similarly-aged children. Taken together, these findings suggest that the younger age of children in the present study led to a slightly lower task performance, but which was comparative to other studies, particularly given the inclusion here of a strict criterion of correctly justified responses only. It is also possible that children here performed more successfully on second-order belief questions than children described in chapter 2 because the first-order phase of the story included in the present study had drawn their attention to the nature and effect of mistaken beliefs, albeit at a more simplistic level. Thus, the comparability of the present findings to findings from studies which have tested first-order and second-order mental states separately, suggest that the composite false belief task provides a valid gauge of first and second-order belief understanding.

As has been illustrated thus far, children performed relatively well on second-order aspects of the composite theory of mind task and very well on first-order aspects of the task. In terms of their consistency across first and second-order belief understanding, our findings revealed that the majority of children were liable to either pass both first and second-order questions or fail both first and second-order questions. This indicates that once a child has acquired the ability to attribute first-order mental states, they usually also have the ability to attribute second-order mental states. This consistency was not immediately apparent for 4- to 6-year-olds since a quarter of children were able to apply first-order reasoning but unable to apply the

more complex second-order mental state understanding. Nonetheless, just as many children were as likely to pass both first and second-order questions as pass only first-order questions. Although it cannot be concluded from this that children can reason about second-order mental states just as easily as first-order mental states, there is an indication that the lag between children's ability to pass first and second-order tasks is not as prolonged as 2 or 3 years as would have been surmised from the findings of Perner and Wimmer (1985) and Wimmer and Perner (1983). Such a claim was made by Sullivan et al. (1994) and if a larger sample of children had been tested in the present study, firmer conclusions could have been drawn regarding the duration and influence (task artefacts vs. conceptual change) of the lag between the ability to pass first-order and second-order tasks. It is unlikely that the conclusions drawn from a study which investigates this lag in ability via separate false belief tasks would be as convincing as a study which examines this lag in parallel. Thus such a methodology which examines first and second-order in parallel within the same test may provide a unique opportunity to discover individuals' respective first and second-order social-cognitive abilities, whilst avoiding task confounds which are likely to arise from testing individuals on separate theory of mind tasks in separate instances.

The discussion has illustrated that the new false belief methodology which was introduced in the current study as the first composite test of both first-order and second-order understanding, produces levels of performance which are comparable to findings from previous studies in typical development. In summary, the new composite false belief methodology appears to represent an effective combined social-cognitive task which can serve several purposes. It provides an opportunity to examine both first and second-order mental state attribution concurrently within the

same task and thus provide valuable insight into individual consistency across these levels of understanding. Secondly, it also offers a measurement of composite social-cognitive ability which consequently provides a comprehensive assessment of social-cognitive capacity. Furthermore, researchers and child participants alike may benefit from a reduced task load in which both levels of social cognition can be assessed within one story, rather than the standard practice of assessing first-order and second-order social cognition independently.

In Part 1, a composite social-cognitive methodology has been developed and tested. This methodological focus was necessary given the previously outlined concern that a well-used representational theory of mind task (i.e. the stories of Sullivan et al., 1994) may not actually tap into children's false belief understanding. While it would have been straightforward to simply implement Sullivan et al.'s task within the broader investigations of Part 2 (as will be the procedure with tasks in the other constructs of social attention, social perception and language), there was not immediate acceptance of tasks of social cognition for the following two reasons. Firstly, even within the context of a broad investigation across social understanding, the domain of social cognition is integral to theory of mind research and provides the strongest link with past research; as such it is particularly important that the tasks tapping into this domain are carefully selected and that they measure what they purport to measure. Secondly, given that the overall aim of the thesis was to illuminate the constituents of children's social understanding, it was imperative to first investigate conceptual concerns regarding Sullivan et al.'s second-order belief task. The findings from chapter 2 confirmed these concerns and justified the design of alternative methodology. Building on the findings from chapter 2 and the simplified story format therein described by Coull (unpublished), the present chapter

has described the development and testing of a composite (first-order and second-order) false belief methodology. This endeavour has provided a broad measure of children's social-cognitive understanding which together with tasks within the domains of social attention, social perception and language can now be used in Part 2 to investigate the main question of the thesis, namely: what are the constituents of children's social understanding?

PART 2 –

INVESTIGATING THE CONSTITUENTS AND CONTINUITY OF CHILDREN'S SOCIAL UNDERSTANDING

Outline of Part 2

Given the apparent suitability of the composite false belief methodology developed and tested within Part 1, the next stage was to use this – alongside other measures - to investigate the wider view of theory of mind/social understanding that has been proposed in recent years by examining the relationship between children's abilities within the domains of social cognition, social perception, social attention and language. Part 2 contains 4 chapters. In chapter 4, the goal of Part 2 is first outlined and the broad rationale for the methodology is discussed. Chapters 5 and 6 are guided by an attempt to examine the constituents of typical children's social understanding in the context of Tager-Flusberg and Joseph's (2005) model of social understanding (or theory of mind as they term it). In Chapter 5, a basic proposal drawn from the Tager-Flusberg and Joseph model and other models (e.g., Baron-Cohen, 1994; Tager-Flusberg & Sullivan, 2000) is investigated; namely that children's social cognitive abilities are positively associated to their social-perceptual abilities. Chapter 6 then broadens the investigation to incorporate a focus upon two additional constructs: social attention and language; with an extensive review of the literature before describing the comprehensive analysis of testing 4- to 5-year-olds in the areas of social cognition, social perception, social attention and language using Structural Equation Modelling to arrive at a final model for the constituents of social understanding. To complement all the research into typically developing children's social understanding within preceding chapters, chapter 7 then applies the findings from these chapters to a sample of children with autism. In particular, to test whether the relations between different constituents of social understanding observed in the typically-developing 4- to 5-year-olds apply to children with autism, comparison was

made between a group of children with autism who were matched on verbal ability to a subset of the large group of typical children who had been tested within chapter 6

Chapter 4

Componential models of social understanding

4.1 Why investigate the relationship between components of social understanding?

Chapter 1 discussed the impetus within the field of theory of mind in moving from a narrow cognitive stance to a broader, more social perspective upon children's understanding of others minds. Undoubtedly, this shift in focus is more in tune with the social basis and complexity involved in such understanding. However, as argued within chapter 1, emphasis has focused on how and when different aspects of children's understanding develop with less attention upon what it is that underlies children's social understanding. Furthermore, unfortunately the advantage of a broader approach brings with it a lack of definition – increasingly, inherently different abilities are confused by the same terminology or studies refer to a whole range of disparate aspects of social understanding under an umbrella term such as theory of mind/social intelligence. Resultantly, there is a degree of ambiguity regarding the theoretical distinction between constituents of children's social understanding and there is uncertainty upon the continuity from early aspects of social understanding to later aspects such as social cognition. Elucidation of both of these issues will importantly provide insight into the manifestation of a range of social understanding abilities – and this is important for one primary reason. In order to fully understand the developmental process up to the point by which children can effectively engage in social interaction with others, it is necessary not only to outline which abilities appear when. First, it is necessary to clarify just *what* these abilities actually are.

Theoretical offerings have been given in the attempt to model specific abilities subsumed by children's theory of mind/social understanding. Baron-Cohen's

(1994, 2004) model distinguished between various modules of a child's theory of mind, suggesting that early abilities within social attention were associated with children's traditional theory of mind abilities. Similarly, Tager-Flusberg and Sullivan (2000) proposed a componential model of theory of mind in which social-perceptual abilities were associated with children's social-cognitive abilities. While their original model is developed from traditional componential or modular conceptions of theory of mind (e.g., Baron-Cohen, 1994), Tager-Flusberg's more recent model (Tager-Flusberg & Joseph, 2005) extends the original framework of the model further and so provides a valuable opportunity to examine children's theory of mind/social understanding abilities in broader terms. The focus on earlier emerging abilities taken by each of these accounts is essential for a broader investigation. In addition, there is a clear need in research within this area to provide empirical evidence of the relationships proposed within these models.

While it is acknowledged that such componential models are not entirely harmonious with a growing trend in research for delineating the developmental process for social understanding, these models do span across development and offer an opportunity to test the distinction between abilities which perhaps deserve to be regarded as fundamentally distinct capacities. In addition, the componential model has not been tested directly and it would appear to be theoretically short-sighted to render such models redundant before at least testing the claims which define them. Therefore, this will be addressed here by empirically testing the componential model of theory of mind to primarily test the claims of Tager-Flusberg, but also by definition, those of Baron-Cohen. This will serve as a suitable vehicle with which to address our overarching aim of the thesis: to provide elucidation of the constituents

of children's social understanding and illumination of the continuity in the pathway from early to late social understanding.

While the benefit of a developmental perspective to examining social understanding is undoubted and a longitudinal investigation would be a fruitful approach to delineating children's social understanding abilities, this option was beyond the scope of the current investigation. For instance, since children's early abilities within social understanding appear in infancy and their social-cognitive skills generally appear between the ages of 3 to 6 years of age, for a longitudinal investigation to be completely insightful across this range this would require a duration of at least 3 years over at least two time points. Therefore, the relationships within componential models of theory of mind were tested concurrently in typically developing 4- to 5-year-olds, while acknowledging that analysis of children's social understanding in Part 1 of the thesis, although examined concurrently, still revealed interesting conceptual differences. Furthermore, as advocated by Carpenter, Akhtar, and Tomasello (1998) and Carpenter, Pennington and Rogers (2002), taking a snapshot of children's development can be useful in inferring likely developmental patterns. Given that Tager-Flusberg (2001) suggested that it is probable that the social-perceptual component of theory of mind develops throughout childhood and since there is ample evidence of continual development of social-cognitive abilities, there is apparent merit in taking a snapshot of these abilities at one developmental point. Also, concurrent examination of abilities within and between these latent constructs (particularly using structural equation modelling as will be conducted within chapter 6) will provide an interesting insight into similarities and differences across a broad range of children's social understanding.

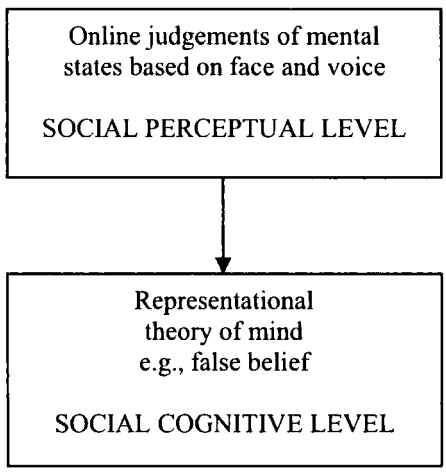
4.2 Examining a componential model of theory of mind

As indicated above, several componential models of theory of mind have been proposed. Baron-Cohen (1994) preceded the componential models of Tager-Flusberg (2001, 2005) with his modular mindreading model of children's theory of mind. In this account he proposed 4 modules which could explain how children acquired theory of mind: the intentionality detector and eye direction detector modules typically function between 0-9 months. These modules help to build dyadic representations such as "Sally wants the robot" which then form the foundation for skills within the next module: the shared attention mechanism (SAM). The SAM combines the dyadic representation of both earlier modules to create triadic representations such as "Paul sees that Sally wants the robot". Baron-Cohen proposed that this ability typically appears between 9- to 14-months-old and allows joint attention behaviours such as gaze following to occur, which then appear to be necessary but not sufficient for development within the final module: the Theory of Mind Mechanism (ToMM) which develops between 2- to 4 years of age. Baron-Cohen asserted that once this module is in place children can begin to represent the full range of mental states (e.g., knowledge and belief) allowing children to understanding for example, that beliefs can be false.

Tager-Flusberg (2001) argued that Baron-Cohen's account of children's theory of mind did not take a strong developmental perspective. In acknowledging this, Tager-Flusberg (2001) (see also, Tager-Flusberg & Sullivan, 2000) embraced the suggested broader view of theory of mind development by introducing a componential model of theory of mind. In their account, Tager-Flusberg and Sullivan outline two components – the social-perceptual (SP) component and the social-cognitive (SC) component. The SC component refers to an explicit theory of mind

which entails those abilities which reflect an acquisition of the understanding of the mind as a representational system, e.g., knowledge of simple mental states (appearing around 3 years of age) and knowledge of complex mental states - appearing around 4 years of age for first-order beliefs and around 5 to 7 years of age for second-order beliefs. Tager-Flusberg and Sullivan suggest that the SP component is an implicit level of theory of mind which may precede the explicit social-cognitive component developmentally but is likely to continue to develop across childhood. This framework is illustrated in Figure 4.1. The crucial distinction between the two components is that the SC component refers to the capacity to make cognitive inferences about the content of people's mental states (e.g., false belief understanding) while the SP component refers to the lower level ability to make an on-line immediate judgement of a person's mental state based on perceptual information (e.g., judging how they may feel from the expression in their face or voice). Tager-Flusberg (2001) does not provide an exhaustive list of what SP includes but refers to the above ability as well as the ability to distinguish between people and objects. The most commonly mentioned social-perceptual ability that Tager-Flusberg refers to is the ability to detect facial expressions (e.g., "Reading the Mind in the Eyes" task designed by Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997). However, the SP component also refers to lower-level abilities including perception and response to social stimuli appearing from 6 months of age upwards, such as gaze-following, joint attention and social referencing (i.e. the type of abilities referred to by Baron-Cohen within the SAM module of his 1994 model).

Figure 4.1. *Schematic representation of the Tager-Flusberg and Sullivan (2000) componential model of theory of mind*



By outlining a component of theory of mind which can encompass earlier perceptual abilities, Tager-Flusberg and Sullivan's model offers an opportunity to explore the development from early emerging capacities in infancy through to advanced mindreading abilities in adolescence such as attributing mental states to people through on-line judgement of the emotions or thoughts expressed in their eyes (Baron-Cohen et al., 1997). Furthermore, in terms of autism, this expanded model can more readily account for the findings which led to criticism of the original theory of mind hypothesis of autism offered by Baron-Cohen et al. (1985). As mentioned in chapter 1, this theory stated that the social and communicative impairments which characterise autism could be explained solely by a representational theory of mind deficit. However, studies have shown that children have problems with joint attention prior to their problems with representational theory of mind skills, (e.g., Mundy & Sigman, 1989; Mundy et al., 1990). Also, the origins of social dysfunction in autism can be traced back to impairments which form the foundation of the social-perceptual domain such as social-orienting deficits (Osterling & Dawson, 1994).

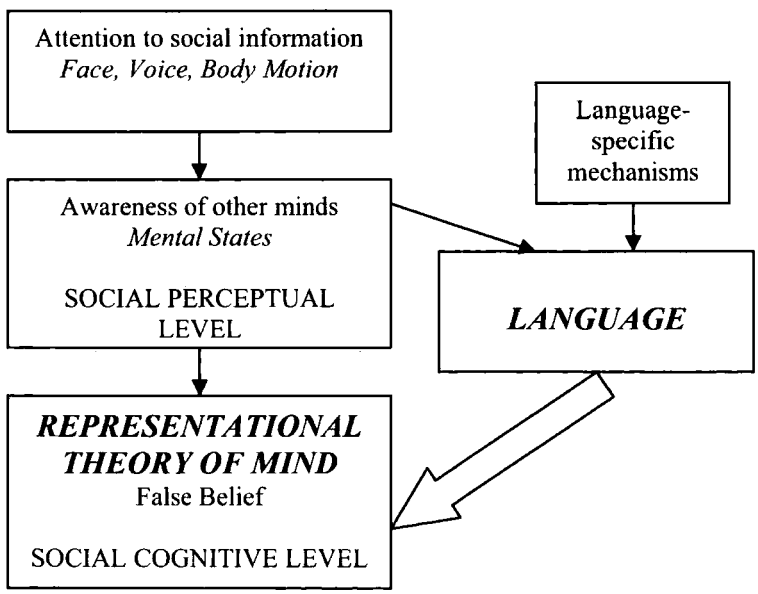
While it is true that Tager-Flusberg and Sullivan's (2000) model did broaden the theory of mind lens to arrive at a model detailing separate areas of children's social understanding, Tager-Flusberg and Sullivan do not really delve into what early social experiences can lead to the emergence of social-perceptual skills or exactly what social-perceptual abilities may develop into social-cognitive skills. With regard to typical development, Tager-Flusberg and Sullivan explain in their article that social-perceptual skills are likely to provide the foundation to social cognition – i.e. children are unlikely to be able to develop social cognitive skills without first acquiring certain social-perceptual abilities. This has also been argued by several theorists (e.g., Hobson, 1993b) however there has been no direct test of the relationship between these components. Also, as Tager-Flusberg and Sullivan noted in their article:

"...there has been little work in formulating a model of theory of mind, or more broadly, social knowledge. What are its basic concepts, rules and representations?...The absence of such a model has led to the broadening of the concept of theory of mind with little regard to potentially important theoretical distinctions that have implications for underlying mechanisms within this broad domain." (p. 60).

In the intervening years, there has been a wealth of empirical research (see chapter 6 for a review of recent literature) which has been conducted in this broader vein, with a disproportionate amount of research attempting to identify what constitutes children's social understanding and identify underlying mechanisms serving social cognition. Indeed, it would appear that Tager-Flusberg's model remains untested in typical development.

Perhaps reflecting on her point described above, Tager-Flusberg elaborated on her original account and proposed a more comprehensive model of children's theory of mind (Tager-Flusberg & Joseph, 2005, p. 310), pictured below in Figure 4.2. As this model illustrates, Tager-Flusberg and Joseph detail not only social perception and social cognition, but also incorporate language and lower-level perceptual abilities in the form of attention to social information (termed from here on as *social attention*). Thus, by virtue of its delineation of abilities across development from social attention through social perception to social cognition, such a model of theory of mind provides a more extended, encompassing framework for the investigation of children's social understanding. The explicit importance assigned to early social information within Tager-Flusberg and Joseph's model mirrors themes within current explanations of social understanding (e.g., Carpendale & Lewis, 2004, 2006).

Figure 4.2. *Tager-Flusberg and Joseph (2005) schematic model of the acquisition of a representational theory of mind*



From above, it can also be seen that language plays a much more significant role within this model than compared to Tager-Flusberg's original (2000) model. Within the original model, Tager-Flusberg speculated that language was not linked to social perception in any way, and that language may only be important for social cognition - particularly for children with autism (e.g., Tager-Flusberg, 1997). Therefore, the linking of language to both social cognition and social perception as illustrated above is a considerable addition to the original model. However, their inclusion of a language construct is congruent with the burgeoning focus within empirical research upon elucidating the links between language and different aspects of social understanding, particularly false belief understanding within the domain of social cognition (e.g., Astington & Baird, 2005; de Rosnay & Hughes, 2006; de Villiers & de Villiers, 2000; Slade & Ruffman, 2005). Therefore, the wealth of recent research which has identified links between different aspects of social understanding and language appears to be reflected by the encompassing nature of Tager-Flusberg and Joseph's model.

Within their model, Tager-Flusberg and Joseph (2005) propose for typically developing children that social-perceptual ability directly leads to both language ability and to social cognition. In addition, they propose that as language - particularly syntax ability – develops, this then influences children's social cognition (representational understanding). While Tager-Flusberg and Joseph outline these probable links and while there has been a plethora of empirical studies in this area exploring the language-social cognition links, it is true that the rest of the model remains virtually untested (Leekam, 2005). Certainly, the nature of the links between each aspect of social understanding – social attention, social perception and social cognition – is ambiguous. Indeed, while Tager-Flusberg and Sullivan acknowledged

the following point within their article (2000): "we do not yet have clear evidence from either the developmental or the cognitive science literature on how these components might be interrelated" (p. 80), there has been little attempt since to explore these interrelationships to better understand what constitutes children's social understanding. Indeed, it appears that no study thus far has simultaneously investigated across these three domains of social understanding.

In summary, this section has described several componential models which have been proposed to account for children's developing theory of mind or social understanding. Given that neither the model of Tager-Flusberg and Sullivan (2000) or Tager-Flusberg and Joseph's (2005) model have been directly tested, and given the utility in using such models as a guide to investigating broader definitions of children's social understanding, the next couple of chapters will use the Tager-Flusberg and Joseph model as a guide to examining the constituents of social understanding.

4.3 Developing the methodology to examine the constituents of social understanding

By defining a model of children's social understanding in terms of components to broadly represent children's capacities, these components are likely to encompass a range of ability within them. For instance, Tager-Flusberg (2001) asserted that each component would have a distinct underlying mechanism for processing different aspects of social information. Therefore, given the broad range and complexity of social information which children are required to process, it is inevitable that these components of social understanding denote a myriad of abilities – i.e. a broad component such as social perception cannot be measured definitively. As such, it is necessary to accept that these components are not directly observable and as such social perception, social cognition and social attention should be

regarded as latent constructs. While Tager-Flusberg *may* regard these 3 domains as latent constructs, they are *explicitly* regarded as such here by way of their make-up and for purposes of later factor analyses and structural equation modelling.

While the components of social understanding represent latent constructs, which by definition relate to terminology that are inherently subjective, such constructs nonetheless provide an approximation of the different aspects of children's social understanding. Distinguishing between social attention, social perception, and social cognition helps to classify a range of their social understanding which can be individually assessed via tasks – for instance, social cognition has traditionally been examined via performance on false belief tasks. By this rationale, each of the three constructs can be tested empirically and in order to provide a comprehensive profile of children's ability within each component, chapter 6 builds on the findings of chapter 5 by examining children's abilities across at least 2 measures within each construct. Such empirical testing of models is important in order for the field to progress conceptually, and in order to assess the constituents of social understanding and the relations between them, structural equation modelling (SEM) offers a sensible and effective method of analysis. SEM is the only analysis that allows complete and simultaneous tests of all relationships within a model. Therefore, as will be shown in chapter 6, SEM can provide valuable insight into the relationships between constructs via modelling the framework which best fits the dataset. As well as statistically testing the direction and strength of links between constructs and thus indicating possible heterotypic or homotypic continuity in social understanding abilities, SEM offers the additional benefit of detailing how tasks load within constructs. Given that relatively newly-defined constructs such as social attention and social perception were under investigation, this feature of SEM allowed the issue of

definition to be addressed in terms of how the various constructs are best defined and assisted in the overarching aim to distinguish between the constituents of children's social understanding. However, prior to reviewing the key literature and describing methodology and results for each of the four domains within chapter 6, chapter 5 focuses on the constructs underpinning the componential models of Tager-Flusberg and her colleagues: social cognition and social perception.

Chapter 5

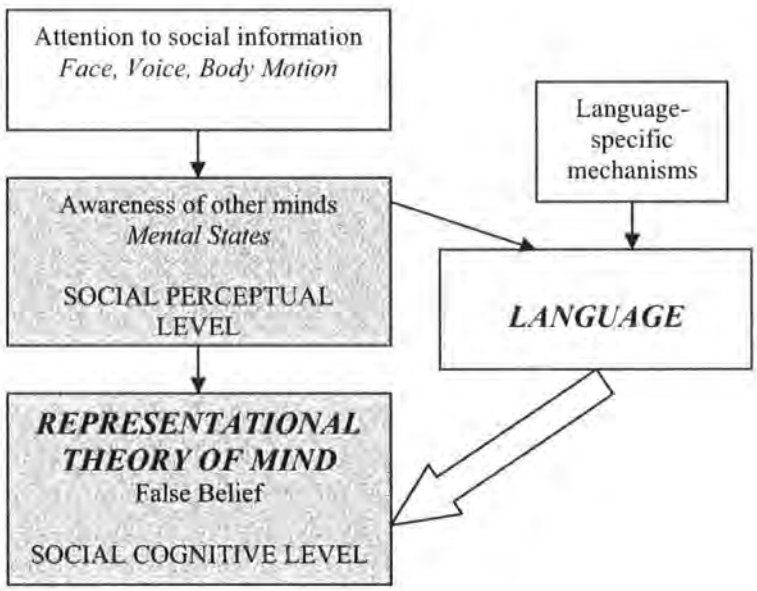
Using the componential model to explore the relationship between social cognition and social perception

As outlined in the previous chapter, to explore the untested model of social understanding as proposed by Tager-Flusberg and Joseph (2005), focus was first reserved exclusively on the relationship between social perception and social cognition as this forms the backbone of their componential account. Therefore, the aim of the present study was to examine the concurrent association between social perception and social cognition. Specifically, is there a significant positive correlation between 4- to 6-year-olds performance within the social-perceptual and social-cognitive components of theory of mind?

In order to investigate the relationship between social-perceptual processing and social-cognitive processing (these parts of Tager-Flusberg's model are highlighted below in Figure 5.1), the present study looked at children's performance across two different tasks. Tager-Flusberg and Sullivan (2000) had examined social-perceptual processing by way of an emotion-matching task but they obtained unexpected results using this task which contrasted with previous findings (Tager-Flusberg, Boshart & Baron-Cohen, 1998). It was suggested by Tager-Flusberg and Sullivan that one reason for this discrepancy could be that a more sensitive measure of social-perceptual processing is provided by the "Reading the mind in the eyes" task – *Eyes Task* - designed by Baron-Cohen et al. (1997). This version of the Eyes Task is an adult measure of theory of mind capacity which taps into social-processing skills since it requires individuals to assign a complex mental state to a person based solely on an on-line judgement of the expression in the person's eyes – therefore it involves attribution of the relevant mental state but not inference of the

content of that mental state (the latter resembling social-cognitive processing). To deal with several psychometric flaws, this task was subsequently revised (Baron-Cohen, Wheelwright, Hill, Raste & Plumb, 2001) and a child version has been introduced.

Figure 5.1. *Parts (shaded in grey) of the Tager-Flusberg and Joseph (2005) model being tested in this chapter*



In the present study, a child version of the Eyes Task (Baron-Cohen, Wheelwright, Spong, Scahill & Lawson, 2001) was implemented. This differs from the adult version only in the sense that the mental state terms which the child has to select from are more simplistic in meaning than the mental state terms used in the adult version. Therefore, this task was used in the present study primarily since it was suggested to be a more sensitive measure than for example, an emotion matching task, of non-linguistic theory of mind abilities such as social-perceptual processing (Tager-Flusberg & Sullivan, 2000). Baron-Cohen, Wheelwright, Spong, et al. (2001) found that a small proportion (8%) of 6- to 8-year-olds could not score above chance

on this task. Therefore, although the age range of the children within this study was 4 to 6 years of age, it was hypothesised that a slightly larger proportion of children would not score above chance. In addition a fairly normal distribution of scores was expected within this age range.

Whilst the Eyes Task was used in the present study to examine performance within the SP domain, ability within the SC component was explored via performance on the newly developed composite false-belief methodology (as outlined in chapter 3). In addition to examining the direct association between social perception and social cognition, IQ was measured to control for possible effects on social-cognitive or social-perceptual abilities. Numerous studies have demonstrated that verbal IQ is related to theory of mind ability (e.g., Cole & Mitchell, 2000) and given the degree of language involved in the social-perceptual task it was quite possible that verbal IQ may be involved in the interrelationship between social perception and social cognition. Also, Gagliardi et al. (2003) found that mental age scores were positively correlated to performance on a social-perceptual type task. Therefore, it seemed prudent to have a measure of IQ. Due to age, children's second-order false belief performance may be expected to vary within our study since our age-group spans a range from 4 years to 6 years of age – mirroring the main transition phase for children's second-order belief understanding. Therefore, we would expect that older children and children with higher verbal abilities would perform better within the two components of theory of mind.

Having established the suitability of a new composite social-cognitive measure within chapter 3, the aim of the present chapter was to look at the concurrent relationship between social-perceptual processing and social-cognitive processing. This venture should provide valuable insight into how children's social-perceptual

abilities are linked to social cognition generally, but also to both first-order and second-order mental state understanding. Given the structure of Tager-Flusberg's models (Tager-Flusberg & Sullivan, 2000; Tager-Flusberg & Joseph, 2005), a significant positive relationship was expected to exist between typically developing children's social-perceptual and social-cognitive abilities.

Method

Participants

The 19 children who completed all 4 social-cognitive stories as described in chapter 3 are the same children who completed the social-perceptual task and IQ test in the present study. Their data are included here in order to examine the association between performance on the social-cognitive and social-perceptual task. In addition a new scoring system was piloted in this study. To recap, children's ages ranged from 4 years and 10 months to 6 years and 9 months (mean: 5 years and 9 months, s.d.: 8 months).

Design

This study had a within-subjects design. Children received 28 Eyes Task trials and 4 false-belief trials in a counterbalanced order in which the trials for each task were presented in two blocks to reduce possible effects of fatigue. Half of the children were given 14 eye trials followed by 2 false-belief stories, with this pattern repeated twice, while the remaining children received the trials in the opposite order.

Materials

Social-Cognitive Task

Data from the composite social-cognitive task (chapter 3) was used again for a new analysis in order to investigate the association between children's social-cognitive and social-perceptual abilities. However, for the purpose of this and

subsequent chapters using statistical methods, a new scoring system was introduced to assess children's composite false belief understanding. Although this scoring system was different to the one described in previous chapters, it was necessary in order to allow the variability of social cognition scores to be more comparable to the range of social-perceptual scores. This new scoring system was also implemented to obtain a wider-ranging scale of social cognition for each child for the purposes of correlational analyses in following chapters. One of the four composite false belief stories appears again below in Table 5.1 with the new scoring system shown.

For a summary of the procedure and list of appropriate/inappropriate justifications for the composite false belief task refer back to the method section in chapter 3 (pp. 52-53). As can be seen below in Table 5.1 the new scoring system awarded one point within each story for correct responses to the first and second-order test questions. While the answer to these is essentially a choice of two options – the old or new location – answers to the justification questions are intrinsically more complex, i.e. a detailed sentence containing several key terms worded in the correct order. To reflect this in terms of scoring, correct justifications to first-order questions were awarded 2 points, while correct justification to more complex second-order questions were awarded 4 points. Thus, with a maximum of 8 points for each story, an average score (range: 0-8) of false belief understanding was created. When an incorrect response to the control question was combined with incorrect justifications, the child's score for that particular story was marked as zero. Furthermore, to distinguish between children who answered all 5 story questions correctly from children who provide an incorrect response only to the control question, the children within this latter scenario had one point deducted (i.e. they

would have a story score of 7, rather than 8 as obtained by children correctly answering all 5 questions).

Table 5.1

Example of story used to assess children's social-cognitive performance

"Paul, Sally and the robot" Story
Scene 1: It's Paul's birthday. Paul and Sally are in his toy-room. He is showing Sally his favourite new present – a robot. *Scene 2:* Paul puts the robot back in the box with the lid on and then has to go outside. *Scene 3:* 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. First-order false-belief question: Where does Paul think the robot is? *(1 point)* Justification question: Why does Paul think the robot is in the _____? *(2 points)* *Scene 4:* While Sally was 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! *Scene 5:* Paul then returns to the toy-room. Second-order false-belief question: Where does Sally think Paul will look for the robot? *(1 point)* Justification question: Why does Sally think Paul will look for the robot in the _____? *(4 points)* Control question: Where will Paul look for the robot? *Bracketed scores indicate the scoring system used to provide a continuous measure of SC ability (average story score ranging from 0-8).*

Social-Perceptual Task

The Eyes task required children to make a judgement about a person's mental state solely by perceiving the eye region from a picture of a face. The child version of the Reading the Mind in the Eyes task (Baron-Cohen, Wheelwright, Spong et al., 2001) requires the child to choose from four mental state terms to describe the perceived mental state. This version consists of 28 pictures of human faces which display only the person's eye region. Children are required to pick one of 4 words

placed around the picture which they think best describes what the person in the picture is thinking or feeling. Only one of the 4 words is correct and if the child did not understand any of the words then the experimenter explained the word by providing an example sentence containing the word. Across the sequence of pictures, various combinations of 4 mental state terms are used from an overall pool of 42 mental state terms. In addition the position of the correct word is randomised. All of the pictures of equal size (11.5cm x 4.5cm) were presented in black and white on A4 paper. Once all trials had been completed each child had an individual score out of a total of 28. The Eyes task stimuli were downloaded with permission from the source: the Autism Research Centre via its website (www.autismresearchcentre.com/tests).

IQ Test

The Wechsler Abbreviated Scale of Intelligence (WASI) was used to collate information on the full scale IQ, verbal IQ and performance IQ for each of the participants. The WASI consists of 4 sub-tests – Vocabulary, Similarities, Block Design and Matrix Reasoning and provides a reliable, brief measure of intelligence. The first two sub-tests which measure crystallised abilities constitute the verbal scale and result in the verbal IQ. The latter two sub-tests compose the performance scale and measure visuomotor/coordination skills and nonverbal fluid abilities. For a study discussing the application of short forms of IQ tests such as the WASI see Minshew, Turner, and Goldstein (2005) who discuss verbal IQ, performance IQ as well as full scale IQ. Due to child absence, only 18 of the 19 children could be tested on all 4 sub-tests.

Procedure

The social-cognitive and social-perceptual tasks were completed within one test session lasting about 25 minutes, while the WASI testing occurred in a different

session, lasting approximately 25 minutes. The social-cognitive tasks were conducted as described in the previous chapter. The experimenter followed the procedure for the social-perceptual Eyes task as informed by the instructions accompanying the test. Children were told that they had to choose one of four words around a picture which best described what the person in that picture was thinking or feeling. After responding, the experimenter gave encouraging feedback without indicating whether the child's response was correct or not. No time limit was in place and children were provided with mental state definitions where necessary.

During the second testing session, all 4 subtests of the WASI were administered in the following order: Vocabulary, Block Design, Similarities, and Matrix Reasoning. Again, children were not told whether their responses were correct or not; the experimenter simply gave encouraging feedback throughout the test.

Results

5.1 How are the social-perceptual and social-cognitive components of social understanding related?

The main aim here was to investigate the componential model of theory of mind by examining the interrelationship between social perception and social cognition. The continuous measure of children's social-cognitive ability as outlined in the method section (pp. 82-83) - since describing children's composite social-cognitive performance - is termed here as composite social cognition (CompSC). Correlation analysis was conducted while controlling for age and IQ before proceeding with multiple regression analysis. The conclusions drawn from these analyses were then investigated further via logistic regression analyses with overall social-cognitive performance measured in terms of a pass/fail criterion.

Assessment of normality via both Kolmogorov-Smirnov and Shapiro-Wilk statistics revealed that all variables were normally distributed (all $p > 0.05$); therefore, we proceeded with Pearson's zero-order and partial correlations. Table 5.2 displays the zero-order correlations for the following variables: Eyes task, CompSC, first-order belief understanding and second-order belief understanding. It can be seen that the social-perceptual Eyes task was not significantly related to the continuous composite social-cognitive measure. When examining the levels of the composite task separately, social-perceptual ability was not significantly related to either first-order false belief understanding or second-order belief understanding. In addition, age was not significantly related to either social-perceptual or social-cognitive ability. However, correlations were analysed between age and the original measure of social-cognitive ability as used in chapters 2 and 3 (i.e. the number of correctly justified false belief responses) to ensure that this non-correlation was not as a result of using the new scoring system. Similarly to the findings obtained within those chapters, age was not related to the old scoring system for composite false belief understanding. Furthermore, none of the IQ scales (full scale IQ, verbal IQ, nonverbal IQ) were significantly related to social perception or any measure of social cognition. As Table 5.2 shows, one of the few significant correlations obtained was for the relationship between first-order and second-order belief understanding, $r = 0.58$, $p = 0.01$; this corroborates the earlier analysis within chapter 3 suggesting a link between these levels of understanding.

Table 5.2

Zero-order correlations of social-perceptual and social-cognitive variables

Variable	Eyes task	CompSC	1st-order FB	***2nd-order FB***
Eyes task	1			
CompSC	0.23	1		
1st-order FB	0.10	0.82**	1	
2nd-order FB	0.26	0.94**	0.58**	1

**: significant at 0.01 level

Given that age and each IQ scale were not significantly related to either social perception or social cognition, the partial correlations when controlling for the former two variables were not greatly different to the pattern of zero-order correlations. When controlling for age, there was no significant correlation between Eyes task and CompSC: $r = 0.25$, $p > 0.3$, or indeed, between Eyes task and either first-order FB or second-order FB, both $p > 0.2$. Also, when controlling for age, there were no significant correlations between the Eyes task and the full scale of the WASI, $r = 0.15$, $p > 0.5$; or the Eyes task and the VIQ, $r = -.03$, $p > 0.9$. However, there was a marginally significant correlation between the Eyes task and nonverbal IQ: $r = 0.41$, $p = 0.10$. Partial correlations while controlling for age also indicated that there were no significant correlations between any of the social-cognitive measures and any of the WASI scales. When controlling for each of the IQ scales, partial correlations indicated that there were no significant correlations between the Eyes task and any social-cognitive measures.

Multiple regression analysis was then used to investigate the dataset further. For this endeavour we used the CompSC measure to define each child's overall

social cognitive ability. Firstly, a regression analysis was conducted to investigate the relative contribution of the Eyes task, IQ performance and age to predict children's overall social cognitive ability. Assumptions of the regression such as normality of residuals, no multicollinearity, homoscedasticity and independence of errors were all met. As suggested by the correlation analysis, neither Eyes task nor age, nor any of the IQ scales were significant predictors of social cognitive ability. Examining regressions involving each IQ scale separately, the model which accounted for most of the variance in social cognition included nonverbal IQ, rather than full scale IQ or verbal IQ. However even then the total variance was only 12.6%, with the first step including Eyes task accounting for only 6.9% of the variability in social cognitive ability. When nonverbal IQ was included into the model at the next step, it accounted for only a further 5.7% of the variance. The F-change value for both steps revealed that the addition of either variable did not make a difference to prediction of social cognitive ability: Step 1: $F(1,16) = 1.19$, $p = 0.29$; Step 2: $F(2,15) = 1.08$, $p = 0.36$. Thus the final model was not significantly better at predicting false belief understanding than using the CompSC mean as an estimate.

As outlined in the introduction, Tager-Flusberg and Sullivan (2000) suggest that development of social-perceptual ability is likely to continue throughout childhood. Acknowledging this and that social cognitive ability (and/or age/IQ) may influence social perceptual ability we conducted multiple regression analyses similar to above, but with Eyes task performance rather than CompSC as the dependent variable. We obtained similar findings with the exception that nonverbal IQ was found to be a significant predictor of social-perceptual ability at the 10% level ($F = 3.01$, $p = 0.10$). Aside from this, there were no significant predictors of children's social-perceptual ability. In summary, irrespective of age or IQ, no relationship was

found (in either direction) between children's social-perceptual and social-cognitive abilities.

5.2 Is social-perceptual ability related to a pass/fail measure of social-cognitive ability?

While the previous section described analysis conducted in the context of a continuous overall social-cognitive measure, we now turn to analysis using a dichotomous measure of social cognition. Logistic regression analysis was used to investigate whether social-perceptual ability (or age/IQ) predicted children's ability to pass or fail social-cognition. Specifically, the overall social-cognitive variable (CompSC) was dichotomised to provide an indication of the extent to which the variables account for the ability of the individual to either pass or fail composite false belief stories. Thus the overall social-cognitive measure CompSC that was analysed within the previous section was dichotomised here by applying a passing criterion of 50%. This level of achievement was applied by Wellman, Cross and Watson (2001) in their meta-analysis to determine the age at which children were liable to succeed on 50% of first-order trials. Therefore, this level was adopted here to enable confidence that those children classed as passers were displaying appropriate social-cognitive responses by virtue of genuine understanding rather than guessing. Thus, children who had average social-cognitive (CompSC) scores greater than or equal to 4 were classed as passers. Indeed, this relatively strict pass-level resulted in 53% of children being classed as failers despite nonetheless having answered some first and second-order questions correctly. The effect of this was to create a passing group who could consistently apply the necessary first-order and/or second-order justifications, whilst also offering the correct response to the control question. Thus, if similar findings to the multiple regression analysis were obtained here this would

substantiate the conclusions drawn from the preceding analysis. Further, this would instil confidence in our conclusions regarding how social-perceptual processing may be related to success or failure on tasks which tap social-cognition.

In opting for the 50% criterion level, 47% of the TD group were classed as passers for their combined first and second-order ToM scores. Summary statistics can be seen in Table 5.3. It can be seen from Table 5.3 that the mean age of those children who can *reliably* pass a composite first-order and second-order false belief task was 5 years and 7 months. Furthermore, the children passing the composite social-cognitive task exhibited better performance on the social-perceptual Eyes task than children failing the SC task, however this difference was not significant: $F(1, 17) = 2.10$, $p = 0.17$. Unsurprisingly however, the SC passers displayed significantly better first-order and second-order belief understanding than the SC failers, both $p < 0.01$. Therefore, as expected this suggests that those children who are more likely to pass combined first and second-order false belief tests such as this, show greater ability over both levels of false belief understanding. The general better performance of passers than failers across the variables generally was explored in more depth via logistic regression.

Table 5.3

Means and standard deviations for passers and failers of composite social-cognitive task

Variable	*Passers (n = 9)*		*Failers (n = 10)*	
	M	*SD*	M	*SD*
Age (months)	67	*5.77*	71	*8.67*
Eyes task (max. 28)	13.22	*4.35*	11.00	*2.06*
First-order beliefs (max. 12)	9.78	*2.91*	5.60	*3.17*
Second-order beliefs (max. 20)	13.78	*4.30*	3.60	*3.13*
Full scale IQ	109.33	*12.60*	103.89[1]	*12.34*
Verbal IQ	106.33	*11.78*	105.22[1]	*17.43*
Nonverbal IQ	110.44	*12.63*	101.00[1]	*5.98*

[1]Based on 9 children

Stepwise logistic regression analyses were conducted to attempt to give some indication of the extent to which the various factors – age, Eyes task and IQ – may explain children's ability to pass or fail composite false-belief stories (i.e. the dichotomised measure of CompSC). For each of the analyses the plot of unstandardized residuals revealed no obvious pattern, thus suggesting that the data were normal. Logistic regressions analyses revealed that including age and Eyes Task within the first block of the model did not predict social-cognitive success any better than when the constant was included: $\chi^2(2) = 4.64$, n.s.. Wald statistics for both variables revealed that they were non-significant predictors: 1.76, n.s.; and 2.73, n.s respectively. The second block containing the three IQ scales did not predict social-cognitive success any better: $\chi^2(3) = 6.46$, n.s. Similarly to the two variables in the

first block, the Wald statistics revealed that all 3 IQ scales were not significant predictors of social-cognitive ability - full scale IQ: 1.73, n.s.; verbal IQ: 0.03, n.s.; although nonverbal IQ approached significance as a predictor of children's social-cognitive performance: 2.97, $p < 0.09$. This analysis corroborated the findings obtained in the multiple regression analysis, suggesting that as well as choosing an appropriate pass/fail criterion, that children's social-perceptual abilities and social-cognitive abilities were not related.

Discussion

Investigation of Tager-Flusberg and Sullivan's (2000) componential model of theory of mind revealed that for typically developing 4- to 6-year-olds, social-perceptual processing was not related to social-cognitive abilities. The absence of a relationship between social-perception and social cognition was contrary to the hypothesis. It had been expected that those children who were scoring more highly within the social-perceptual domain would also be scoring more highly within the social-cognitive domain (particularly second-order belief understanding). Such a relationship was anticipated in line with the arguments made by Baron-Cohen (1994), Tager-Flusberg and Sullivan, and Tager-Flusberg and Joseph (2005) that the social-cognitive component of theory of mind builds on social-perceptual knowledge. However, it would appear that those children who are more able within the social-perceptual domain do not necessarily possess more highly developed social-cognitive skills than children who are less able within the social-perceptual domain. This idea was reinforced by the finding obtained when a 50% pass/fail criterion was adopted for composite social-cognitive performance (i.e. combined first and second-order abilities). Although, social-cognitive passers scored more highly on the social-perceptual Eyes task than social-cognitive failers, this difference was not significant.

This was especially interesting given that children performed relatively well within both domains – 79% of children scored above chance on the Eyes Task and 47% of the children were classed as passers of the social-cognitive task, indicating for both components that there was a relatively broad range of abilities. Given the argument that social-perceptual abilities precede social-cognitive abilities developmentally and given that it has been plausibly suggested that abilities within the latter domain would build upon earlier abilities (e.g., Tager-Flusberg & Joseph), what could explain the absence of a relationship between the social-perceptual and social-cognitive components for typically developing 4- to 6-year-olds?

It is possible that the children who were competent within the social-cognitive domain acquired this ability at an earlier point within their development when the impact of social-perceptual processing skills would have been more influential. Furthermore, in taking a snapshot of social-perceptual processing across 4- to 6-year-olds, the age-range may not have been low enough or broad enough within a developmental context to sufficiently distinguish between children whose social-perceptual abilities were already well established compared to those children whose social-perceptual ability had just emerged - only 21% of children failed to score above chance on the Eyes task, confirming our earlier hypothesis that a higher proportion than 8% of 6- to 8-year-olds tested in Baron-Cohen, Wheelwright, Spong, et al.'s study (2001) would fail to score above chance. These concerns could be investigated in a future study which implements a longitudinal or cross-sectional design in younger children to examine how social-perceptual skills may develop into, or be built upon by, social-cognitive skills, and thus provide a clearer picture which is perhaps more sensitive to the developmental timing associated with these abilities.

This breadth of perspective is addressed in the next chapter as we look more broadly across the domains of social perception and social cognition.

Another possible explanation for the absence of a relationship between these two components in typically developing children could be that social-cognitive skills do build upon/are predicted by social-perceptual performance; however, it may be that the social-perceptual skills which are critical for social-cognitive development are more basic in nature than those examined in the current study. For instance, attribution of mental states through on-line judgement of emotions or thoughts expressed in the eyes, as represented by the Eyes task, provides a more advanced measure of social-perceptual processing than, say, joint attention or gaze-following. Thus it may be that earlier social experiences which expose the child to social-orienting situations and joint attention behaviours are more critical to subsequent social-cognitive development in childhood than more complex social-processing skills. Indeed, Clements and Perner (1994) suggested that children's eye gaze may reflect implicit knowledge of social-cognitive measures such as false belief and Baron-Cohen (1994, 2005) proposed that children's joint attention abilities are necessary but not sufficient for social-cognitive understanding. The relative importance of earlier and later social-perceptual skills for subsequent social-cognitive development could be investigated via a study which compares performance on tasks which tap these earlier and later skills, e.g., a gaze-monitoring task (Scaife & Bruner, 1975) and the Eyes Task (Baron-Cohen, Wheelwright, Spong, et al., 2001). Again, this line of thought will be pursued in the following chapter by extending the focus of investigation back from social perception to lower level aspects of social understanding.

Another alternative explanation for the absence of a relationship between the social-perceptual and social-cognitive domains in typically developing children is based on the idea that performance within both domains is mediated by a third factor such as language. Indeed, Tager-Flusberg and Joseph (2005) suggest that as well as a direct link from social perception to social cognition, language may mediate this relationship. Verbal IQ was not significantly related to either social perception or social cognition within the present study; however, it may be that more general language abilities such as syntax (e.g., de Villiers, 2000) and receptive vocabulary (e.g., Carlson, Moses, & Breton, 2002) are involved in linking social perception and social cognition. This point will be addressed further in the next chapter by investigating various aspects of language in conjunction with social perception and social cognition.

In summary, the absence of a significant relationship between social perception and social cognition contradicted the original hypothesis and the claims of Tager-Flusberg and colleagues (2000, 2005) and Baron-Cohen (1995). This unexpected finding is unlikely to be due to the new scoring system adopted to provide a continuous measure of social-cognitive ability since the original scoring system produced similar findings. However the absence of a link between social perception and social cognition may be due to testing a small sample size. Given this and the conjecture outlined above to explain the non-significant relationship, it was apparent that a broader and more complex investigation was required to explore these issues further. The following chapter provides a literature review of the issues surrounding these aspects of children's social understanding in the context of social cognition, social perception, social attention and language, before empirically testing the interrelationships between these four constituents.

Chapter 6

Exploring the componential model more broadly: What does a model of social understanding actually constitute for typically developing children?

Introduction

Various suggestions were proposed in the previous chapter to explain the absence of a relationship between social perception and social cognition in 4- to 6-year-olds. This chapter explored these suggestions further and broadened the scope of the thesis in order to address the overarching aim of the thesis: to elucidate the constituents and continuity of children's social understanding. In order to appreciate the wider scope of this investigation, prior to outlining and testing various hypotheses, this chapter first provides a more detailed review of the key literature within the domains of social cognition, social perception, social attention and language.

6.1 Measures of social cognition

Traditionally social cognition is the domain which has been focused upon when investigating children's social understanding. While the multitude of studies identifying the links between social relations and theory of mind has necessarily broadened the theoretical focus of children's social understanding beyond simply looking at their false belief understanding (Hughes & Leekam, 2004), equally it is important "not to overlook the specific importance that false belief understanding may have both as a conceptual development in and of itself..." (de Rosnay & Hughes, 2006, p. 12). The previous chapters have outlined the focus that has been given to false belief understanding and social cognition thus far and underlined the importance of this area within children's development. Chapter 2 described the

facilitative effect which ignorance has upon children's second-order belief performance. Recognising the need for greater specificity within false belief tasks, chapter 3 outlined false-belief stories which importantly excluded any ignorance questions. These composite social-cognitive stories were also developed to allow the testing of first-order and second-order mental states in parallel. This culmination saw the design of a composite first-order and second-order false belief methodology which produced levels of understanding comparable to studies which had assessed these aspects separately. Given this comparability alongside the apparent benefit of a composite story, and to allow continuity of methodology within the thesis, children's social cognition was tested here using two of the composite stories which had been developed in chapter 3.

While performance on the two composite false-belief stories was combined to create an aggregate score reflecting children's false belief understanding, these stories were also adapted here to provide an additional social-cognitive task. By simply using the same story format but adapting story questions to reflect children's understanding of first-order and second-order ignorance rather than belief , it was possible to tap into another aspect of children's social cognition. This additional focus also provided continuity from the themes discussed in chapter 2 and allowed further investigation of the relationship between the mental states of ignorance and belief. Both composite ignorance stories and both composite false belief stories are outlined in Appendix 6.1. Given the facilitative effect of ignorance upon belief understanding as discussed in chapter 2, it was expected that children who performed better within composite ignorance tasks would also display better performance within composite belief tasks. It was anticipated that the two composite tasks would provide a brief, yet sufficiently comprehensive measure of children's social cognition.

6.2 Reviewing the construct of social perception

Of the four constructs to be investigated, it is social perception and social attention which have been more recently introduced in the field and tend to be more ambiguous in nature. Although specified within the models of Tager-Flusberg and Sullivan (2000) and Tager-Flusberg and Joseph (2005) the domain of social perception remains an ambiguous constituent of children's social understanding. Tager-Flusberg and colleagues defined it as: the on-line immediate judgement of a person's mental state based on perceptual information (e.g., from the face or the voice) and posed the question of whether it was exclusively based on perception or always included some level of emotion processing. Tager-Flusberg and Sullivan suggested that affect is integral to this component given the role of the amygdala in processing of social-perceptual tasks (cf. Baron-Cohen, et al., 1999; Pierce, Muller, Ambrose, Allen, & Courchesne, 2001). This has been corroborated by neuropsychological studies which identify the amygdala as playing a central role in face processing (e.g., Whalen et al., 1998) and monitoring gaze direction (e.g., George, Driver, & Dolan, 2001). Yet, this latter finding considers joint attention type abilities rather than social-perceptual abilities and may partly explain why Tager-Flusberg and Joseph refer to such abilities within the specification of their social-perceptual component. However, it seems apparent that a higher level of processing is required for social perception in comparison to social attention – i.e. as mentioned by Tager-Flusberg and Sullivan, versions of Baron-Cohen, Wheelwright, Spong et al.'s (2001) Eyes Task are likely to provide a sensitive measure of children's social-perceptual abilities and require children to attribute mental states such as *excited* based on their perception of people's facial expressions or voices. Indeed, a recent study (Skwerer, Verbalis, Schofield, Faja, & Tager-Flusberg, 2006) defined social-

perceptual ability in terms of performance on the Eyes task. Conversely, as explained earlier, social attention (which Tager-Flusberg presents within the social-perceptual component) generally involves the child's emerging understanding of other people as intentional beings in terms of such abilities as joint attention and social referencing. Therefore, given the apparently more simplistic nature of processing within the social attention domain, it could be anomalous for Tager-Flusberg and colleagues to define a social-perceptual component which encompasses both levels of processing. For this reason, it seemed sensible to distinguish in this study between the domains of social perception and social attention (the latter construct being defined in terms of joint attention and social orienting as outlined in the following section). Support for this distinction is provided in a recent study (Morales, Mundy, Crowson, Neal, & Delgado, 2005) which examined social attention and social-perceptual type abilities separately and, consistent with previous findings, found that infants' joint attention abilities and ability to follow gaze at 6 months were both significantly correlated with emotion regulation strategy use at 24 months of age.

Interpreting the social-perceptual construct as originally defined by Tager-Flusberg and Sullivan (2000) with an emphasis on the online attribution of mental states, social perception is focused on here in terms of children's ability to attribute mental states to facial expressions. Few studies thus far have examined how social-perception relates to social attention or social cognition in typically developing children. However, informed by findings from studies of children with autism, Schultz (2005) argues that the development of social perception (processing of faces) and social-cognitive skills are supported by the amygdala and fusiform face area. Akin to Tager-Flusberg and Joseph (2005), Schultz proposed that these abilities are linked during development such that growth in social-perceptual skills provides an

important scaffold for social-cognitive development. The lack of association between children's social-perceptual abilities and social-cognitive skills in the previous chapter may have been due to the relatively small sample of children who were tested. Alternatively, this may have been due to the Eyes task which was used possibly not tapping into social-perceptual abilities per se. These concerns were addressed here through testing a large sample of children and by examining social perception more broadly than solely using the Eyes task (Baron-Cohen, Wheelwright, Spong, et al., 2001).

The construct of social perception was examined via two additional social-perceptual tasks – the Affect task and the Friendliness task. The animated full facial expression comprehension test (Affect) task first described in a study by Gagliardi et al. (2003) was developed to avoid ceiling effects since expressions such as happiness traditionally produce such levels of performance within facial expression recognition tasks (Vicari, Reilly, Pasqualetti, Vizzotto, & Caltagirone, 2000). The Affect task aimed to avoid this by virtue of varying the level of expression intensity within the presentation of faces (see the Method section for further detail). Although infants can display facial expression recognition abilities, previous studies have found that full development of these social-perceptual abilities does not occur until much later in life. However, no research had looked at these abilities across a wide age range. To address this void, Burt et al. (in submission) examined children's performance on the Affect task in a cross-sectional study of children between ages 4 to 14. Burt et al. found that these abilities developed throughout the age range, suggesting that using such a task with 4- to 5-year-olds would elicit a range of ability. Moreover, while expertise in verbally labelling basic emotions (anger, disgust, fear, happiness, sadness – the five expressions examined within the Affect task) would seem to be

achieved around this age (since related words are commonly used by the age of 4 (Wellman, Harris, Banerjee, & Sinclair, 1995)), a more recent study indicated that the ability to label anger, fear, disgust, and surprise improved with age from ages 5 to 6 through to 9 to10 (Vicari et al.). Furthermore, while there is inevitably a degree of language involved in such a task (in a similar manner to the Eyes task), since the development of facial expression recognition labelling improves well beyond the age of 5 (Vicari et al.) it is unlikely that linguistic skill can fully account for this. Therefore, the Affect task seemed an appropriate task to use with the typically developing 4- to 5-year-olds in this study as a measure of their social-perceptual abilities.

In the aim to provide a broad measure of children's social-perceptual abilities, the Friendliness task - based closely on a task used by Frigerio et al. (2006) - was also employed. This was similar to the two other social-perceptual tasks in that children had to inspect pictures of people's facial expressions, but required the child to infer the friendliness of the pictured person on the basis of their facial expression. Unlike the Affect task, yet like the Eyes task, the Friendliness task consists of static rather than animated faces. However, it is similar to the Affect task in that children have only 5 mental state labels (ranging from very friendly to very unfriendly) to choose from throughout the task rather than the multitude of mental state terms used in the Eyes task. The level of inference required to predict the person's friendliness suggests that it may be an intrinsically more complex test than the Affect task, but is likely to be linguistically simpler for 4- to 5-year-olds than both the Eyes and Affect tasks. Given the normal distribution of 5- to 6-year-olds' scores on the Eyes task as described in chapter 5, as well as the range in performance on Affect/Friendliness type tasks expected of 4- to 5-year-olds as described above, it was expected that the

three tasks employed here would elicit a range of social-perceptual ability in typically developing 4- to 5-year-olds and that these tasks would be strongly interrelated.

6.3 Discussing the new construct of social attention

The social attention construct was explored here primarily via joint attention ability. Joint attention can be defined as the ability to use nonverbal behaviour to share the experience of objects and events with others and is probably the simplest form of attention (Butterworth & Jarrett, 1991). Whether in terms of Baron-Cohen's (1994, 2005) models, Tager-Flusberg and Joseph's model (2005), or more recently, Carpendale and Lewis' (2006) theory, joint attention is presented some role or another in the development of children's social understanding. In both of Baron-Cohen's modular mindreading models, joint attention ability is subsumed within the shared attention mechanism (SAM) module which precedes the theory of mind mechanism (ToMM) – see Chapter 4 for a discussion of these mechanisms.

By viewing social understanding in its broader sense, Carpendale and Lewis (2004, 2006) also focus on possible early forms of social understanding acting as precursors to later social cognition. With a strong emphasis on the basic beginnings of social interaction, Carpendale and Lewis suggest that early social understanding skills emerge from triadic interactions between children and their parents or siblings, with the focus very much on action. Joint attention is integral to such interaction which provides a supportive context to then allow the child to construct socially available information. They also argue that the ability to talk about mental states within action will be critical to the child's development of social understanding. Therefore, although Baron-Cohen (1994, 2005), and Carpendale and Lewis (2006) suggest different mechanisms by which joint attention may manifest itself within the

wider context of social understanding, they each appreciate the benefit of a developmental perspective and acknowledge that joint abilities necessary for interaction are likely to be an early precursor to later more complex social understanding. Such a view is integral to the broader definition of children's theory of mind. As Flavell (2004) remarked on this broader venture: "One exciting future prospect is the possibility of telling longer and richer developmental stories in key sectors of theory-of-mind development." (p. 284).

While Baron-Cohen (1994, 2005) and Carpendale and Lewis (2006) suggest these mechanisms by which joint attention ability may figure within the context of children's social understanding, how do these correspond with empirical findings? Studies by Moore and Corkum (1994) and Tomasello, Kruger, and Ratner (1993) suggested that joint attention is at the origin of intentional understanding and this lays the foundation for more complex social understanding. Lee, Eskrit, Symons, and Muir (1998) reported that there was little evidence up to that point indicating when and how young children develop the ability to use triadic eye-gaze for more advanced social understanding like "mindreading". A study conducted by Charman et al. (2000) found that only a certain aspect of joint attention behaviour (gaze switches between adult and toy and looking to adult during an ambiguous task) at 20 months old was longitudinally associated with social cognition at 44 months. This led them to argue that joint attention, language and theory of mind may feature as part of a shared social-communicative representational system which becomes increasingly specialised and differentiated throughout development.

Therefore, some earlier forms of social understanding like certain aspects of joint attention may be early manifestations of later social cognition, but which become sufficiently different by ages 3 to 4 onwards such that they are no longer

significantly positively related. There may be a logical connection between joint attention and social cognition via language, but as Miller (2006) argues, there needs to be further investigation of a direct relationship between this aspect of social attention and social cognition. Despite the benefit of a longitudinal approach, Charman et al.'s (2000) findings were based on a small sample of children (n =13) and the theory of mind tasks were not representational. However, this importance of timing was corroborated in a study by Morales et al. (2000) in which they found a positive association between the ability to respond to joint attention bids and vocabulary development in 6- to 18-month-old infants but not in 21- to 24-month old children.

Since joint attention abilities typically appear from 10- to 14-months-old (Corkum & Moore, 1998) it may be expected that by ages 4 and 5, developmental timing is less important since joint attention ability would have been expected to reach ceiling level. However, while studies have shown that children can reliably determine others focus of attention by 18 months (Butterworth & Jarrett, 1991) and begin to use triadic eye gaze at 18 months for referential communication purposes such as word learning (Baldwin, 1993), no studies as yet have identified an upper age limit with 100% consistency in joint attention responses. Indeed, Leekam, Baron-Cohen, Perrett, Milders, and Brown (1997) found a similar success rate to infants with 75% of 5-year-olds correctly following the gaze of another person to a specific object or event. However, Leekam et al.'s finding was based on a small sample and although they had suggested that the lack of improvement in joint attention ability could be due to these older children being socially inhibited to follow the gaze of another person, they also suggested that a much larger sample would be required to determine if the 75% finding holds in 4- to 5-year-olds. Therefore, since the children

within the present study were 4- to 5-year-olds and since a large sample of children were to be tested, the joint attention measure selected was based on that of Leekam et al. It was expected that the children who were more responsive to attention bids would exhibit better social-perceptual, social-cognitive and language skills than the children who were less so.

It was also of interest to establish how joint attention ability may relate to another low-level attention-based aspect of social understanding: namely, social orienting. This involves the ability to orient attention to objects or events and differs from joint attention in that the object or event *itself* attracts the child's attention initially rather than the gaze of another person. A study by Swettenham et al. (1998) showed that typically developing infants shifted attention between an object and a person more than between an object and another object whereas children with autism showed the opposite pattern, indicating a natural propensity within typical development to focus upon social stimuli. Social orienting has been investigated further by Dawson, Meltzoff, Osterling, Rinaldi, and Brown (1998) and Dawson et al. (2004). Using an improved methodology in their latter study Dawson et al. also showed that there was a distinction between children's ability to orient to social and non-social stimuli. They tested this by presenting 8 sound stimuli consisting of 4 social sounds and 4 non-social sounds to 12- to 46-month-old typically developing children and 3- to 4-year-old children with autism. While the main experimenter interacted with the child, a second experimenter (in the background) presented each of these sounds three times in succession. Dawson et al. (2004) found that typical children reacted more quickly to social stimuli than non-social stimuli; however, this was not the case for children with autism. They also found a relationship between social orienting ability and joint attention ability in typically developing children (1-

to 3-year-olds). Leekam and Ramsden (2006) also found that children's dyadic social orienting abilities were strongly related to their triadic joint attention abilities. Therefore, given these findings and given the likely similarity in the levels of processing required for joint attention and orienting, a social orienting measure was included in this study for three reasons. Firstly, at least two measures of social attention were required in order to investigate this construct more broadly in and of itself, and in its relation to other aspects of social understanding using structural equation modelling. Secondly, an attempt was made to adapt and improve the methodology used by Dawson et al. (2004) as the author believed there was an inherent flaw in the nature of their method (discussed below). Thirdly, given that responses to social and non-social stimuli is markedly different in children with autism, using this task with typically developing children here enabled the cross-study comparison of social orienting abilities in children with autism in chapter 7. In terms of the typically developing children tested here, it was expected that joint attention and social orienting abilities would be significantly positively related.

6.4 Language links to social understanding

As outlined earlier, both Tager-Flusberg and Joseph (2005) and Carpendale and Lewis (2006) have articulated a significant role for language within the development of children's social understanding. Tager-Flusberg and Joseph have specified this within terms of language development (in particular, syntax) which then influences children's representational understanding. On the other hand, Carpendale and Lewis describe the role of language in terms of children's ability to talk about mental states within action, whereby the meaning of language is constructed within the child's interactions and ultimately leads to development of their social-cognitive abilities. Thus, via different mechanisms both theories suggest

that language development acts as a foundation for social-cognitive development (see also Garfield et al., 2001). This view contrasts with Bloom (2000) who suggests that language development depends on children's social understanding abilities, albeit in terms of early emerging aspects such as social attention and social perception rather than traditional social-cognitive understanding. Therefore, there are questions of causality and the direction of the relationship, both of which are further complicated depending on the concept of theory of mind which is applied (i.e. broad vs. narrow). The broad definition of theory of mind/social understanding as embraced here can reconcile findings in both directions by acknowledging that low-level abilities within social attention and social perception can facilitate word learning (Baldwin & Moses, 2001; Brooks & Meltzoff, 2005; Morales et al., 2000), and also recognising that language abilities such as syntactic skill can then facilitate more complex social understanding in terms of representational understanding as evidenced on false belief tasks (Astington & Jenkins, 1999; de Villiers & de Villiers, 2000). In an attempt to further delineate the role of language in children's social understanding, the last few years have seen several longitudinal and training studies delving into this area. So what do the empirical findings from these studies suggest about the link between language and social understanding?

Although the relation between early forms of social understanding and language is mentioned above (e.g., Brooks & Meltzoff, 2005) the majority of studies thus far, (whether intervention or longitudinal studies) have investigated how language relates to social-cognitive aspects of social understanding. Intervention studies by Hale and Tager-Flusberg (2003) and Lohmann and Tomasello (2003) gave preschool children training conditions which included focus on false beliefs or syntactic ability (via sentence complements). Both studies found that children who

had received syntax training had significantly improved false belief understanding by the end of training; in contrast the children who received false belief training only did not improve their language skills. These findings suggest that children's language, specifically syntactic ability, acts as a significant contributor to children's social cognition. This is corroborated by longitudinal research - after 4 training sessions, de Villiers and Pyers (2002) found that the strongest predictor of preschoolers' ability to understand false beliefs was mastery of tensed complements, again suggesting that such syntactic ability is likely to be a necessary precursor for successful false belief performance. In another longitudinal study, Slade and Ruffman (2005) tested a larger group of similarly aged children on various language and false belief tasks. Although Slade and Ruffman also found syntactic ability to be a contributor to children's later false belief understanding, syntax did not play a unique role and contrary to the aforementioned studies, they found a bidirectional relation between language and theory of mind. Thus, it is clear that certain aspects of language are necessary for children's social-cognitive development; however it is also apparent that early forms of social understanding can facilitate word learning and language development generally. Therefore, in the context of the present study it was important to examine language in conjunction with early and later aspects of social understanding.

In an attempt to further unravel the relationship between language and social understanding, a construct of language was examined in the current study in parallel with the three social understanding constructs. Reflecting on the empirical evidence, the two main aspects of language which were focused upon in this study were vocabulary acquisition and syntactic ability. The former was investigated since children's vocabulary acquisition appears to stem from early forms of social understanding (e.g., Baldwin & Moses, 2001) and the latter since this has been

implicated as a causal precursor to children's social-cognitive development (e.g., de Villiers & de Villiers, 2000). The British Picture Vocabulary Scale (2nd edition) (Dunn, Dunn, & NFER-Nelson, 1997) was used to measure children's vocabulary levels. Many studies have used this measure, demonstrating a link between children's verbal abilities and their false belief understanding (Carlson et al., 2002; Cutting & Dunn, 1999; Happé, 1995). In addition, using this measure enabled a group of children with autism to be verbally matched to a subset of the typically developing group in a similar study described in chapter 7.

To measure children's syntactic ability a parental questionnaire was used: the Children's Communication Checklist (2nd edition) (Bishop, 2003). This was used for three reasons: firstly, this produces a composite scale indicating general communication ability, but more importantly for the present investigation it assesses performance across individual scales of language including a syntax scale. Secondly, amid the battery of tasks which children were tested upon, it was desirable to use a measure which assessed children's abilities in an everyday setting – completion of this questionnaire by parents gave a valuable opportunity for a natural perspective on children's language. Thirdly, given the processing load involved for children in completing the range of social understanding and language tasks, it was beneficial to use a measure which could inform us of their language abilities without requiring further effort from the children. In addition to these two language measures, a final language measure was included – the Wechsler abbreviated scale of intelligence (WASI) (Wechsler, 1997) to broaden the investigation of children's language function. Using the short form of this test provides a brief measure of IQ based on an expressive vocabulary test and a non-verbal matrix reasoning test. Therefore, given the inclusion of this vocabulary measure and since IQ has been linked with

performance on false belief tests (e.g., Green, Pring & Swettenham, 2004), it was anticipated that this would provide a complementary insight, primarily into its relation with social cognition.

In order to fully address the central aim of clarifying the constituents of social understanding, this study required not only analysis of the relationships between the four components, but also analysis of the relationships *within* components. While social cognition and language are both relatively well-defined constructs, the other two components of Tager-Flusberg and Joseph's (2005) model, namely social attention and social perception, are comparatively new and as such are less clearly defined. For instance, Tager-Flusberg and Sullivan (2000) asked whether social perception was based exclusively on perception or whether it always entailed an affective component. Also, what Tager-Flusberg and Joseph call *attention to social information* has been termed here as *social attention*. This may seem congruent but their definition does not necessarily coincide with our view that social attention incorporates joint attention. It appears from Tager-Flusberg and Joseph's account that joint attention would be classified within the social-perceptual level of understanding. Furthermore, Tager-Flusberg and Sullivan describe the Eyes task (Baron-Cohen et al., 1997) as a measure of social-perception, yet this task is inherently different in nature to the kind of ability which would be required for joint attention. Therefore, although the social-perceptual component has existed since Tager-Flusberg and Sullivan first proposed it within their componential view, there has not been elucidation or expansion on the nature of this construct and the type of understanding it should encompass. Evidently, there are issues of definition and specificity which surround the domains they describe. Therefore, in conjunction with the central aim of the present chapter which was to examine the interrelationship

between constructs, I attempted to address the issue of definition *within* constructs by looking at performance across several tasks within each domain of social understanding (as well as language).

6.5 Summary of hypotheses

To reiterate, the overarching aim of the present study was to better understand the constituents of children's social understanding and how they relate to language. This is to be addressed through a comprehensive exploration of the interrelationships within and between the constructs of social cognition, social perception, social attention and language. *Within* constructs it was expected that the measures chosen would be positively correlated. Therefore, within social cognition it was expected that children's performance on composite false belief and composite ignorance tasks would be correlated; within social perception it was expected that performance across the Eyes task, Affect task, and friendliness task would be strongly related; within social attention it was expected that joint attention and social orienting abilities would be linked; and finally within language, abilities as measured on the BPVS, syntax scale of the CCC-2 and WASI were expected to be positively correlated.

In terms of the relationships *between* constructs, based on the above discussion of each construct and the general framework of Tager-Flusberg and Joseph's (2005) model, the following hypotheses were predicted. While we would expect a strong relationship between the social attention and social cognition constructs as has been clearly proposed by the literature on both typical and atypical development, it is not clear whether the association between social attention and social cognition would still be found on a concurrent basis in 4-to 5-year-olds. For typical children, cognitive and social developmental change might mean that infants 'grow out' of their reliance on social attention and do not use it alongside other forms

of social cognition – in other words, it might provide a building block developmentally but not be actually concurrently associated with social cognition when children are older. On the other hand, social and cognitive development may take a different path for children with autism so that the outcome in early and mid childhood might lead to a concurrent relation. However, because there is no clear indication in the literature whether a concurrent relationship would be found or not – in other words there is insufficient evidence to tell. Therefore, it is hypothesised in line with Tager-Flusberg and Joseph, and Baron-Cohen (1994) that: i) there will be a concurrent relationship between social attention and social cognition. ii) In a similar way and in terms of these componential models, a significant positive association would also be expected between the constructs of social attention and social perception. iii) Tager-Flusberg's original model and more recent model would both predict that children's social-perceptual and social-cognitive abilities would be strongly correlated. iv) and v) The model of Tager-Flusberg and Joseph would also suggest that both of these abilities are positively correlated with children's language competence. vi) Finally, it is hypothesised that language will be closely tied to children's social attention abilities and act as a potential mediator for later social understanding.

Method

Participants

127 typically developing children comprising 66 girls and 61 boys from 6 primary schools in the north of England and central Scotland participated in this study. Children's ages ranged from 4 years and 3 months to 5 years and 11 months, with a mean age of 5 years and 2 months (SD: 5 months). The size of the sample was necessary to meet the criteria necessary for conducting Structural Equation

Modelling (SEM) analysis (at least 10 subjects per variable, with 10 variables being measured) and to obtain adequate power. Using the G*Power analysis program (Erdfelder, Faul, & Buchner, 1996) in consultation with a statistician it was calculated that a power of 0.9 could be achieved with a medium effect size (0.15) by having a sample size no fewer than 108 children while exploring 4 constructs. The size of the sample comfortably met these criteria. None of the children participating in earlier studies took part in the present study.

2 Social-Cognitive Tasks

False-belief stories

Two combined first-order and second-order false-belief stories were used. These stories were developed and tested in earlier research with a different sample of children (see chapters 3 and 5). To recap: these stories were based on two characters and a particular object. Character A hides an object X and thinks that Character B still believes X to be in its original location. However, unbeknown to A, B sees A hide X in the new location. First-order and second-order false-belief questions appear at appropriate points in the narrative. Both are followed by justification questions and children are also asked one control question. The two composite false-belief stories and their corresponding questions are presented again in Appendix 6.1.

Ignorance stories

Children were given two composite first-order and second-order ignorance stories which were adapted to have the same structure as the composite false-belief stories. The only difference was that the test questions refer to characters knowledge states rather than beliefs, i.e. "Does A know that B knows where X is ..?" As for the false-belief stories, the ignorance stories were acted out with various props by the experimenter during the story-telling. The two ignorance stories and their

corresponding questions can also be seen in Appendix 6.1. Since the format of the 4 composite stories here was the same as those discussed in chapters 3 and 5, for consistency the same scoring procedure was implemented to allow comparison with the average composite false-belief scores described in earlier chapters and to offer a broad scale of social-cognitive understanding for the variables to be investigated in later analyses.

Scoring

To summarise the scoring procedure outlined in chapter 5: for all 4 social-cognitive stories, children were awarded one point for a correct response to first-order and second-order test questions. Correct justifications to first-order questions were awarded 2 points, while correct justifications to second-order questions were awarded 4 points. Thus, with a maximum of 8 points for each story, an average false-belief score (range: 0-8) and an average ignorance score (range: 0-8) was created. When an incorrect response to the control question was combined with incorrect justifications, the child's score for that particular story was marked as zero. Furthermore, to distinguish between children who answered all 5 story questions correctly from children who provide an incorrect response only to the control question, the children within this latter scenario had one point deducted (i.e. they would have a story score of 7, rather than 8 as obtained by children correctly answering all 5 questions). As was previously indicated in chapter 5, such a novel scoring system provides a wide-ranging possible score while importantly penalising children who give wrong answers to control questions and giving extra credit for the intricacy of the answer required for a correct justification response.

3 Social-Perceptual Tasks

Reading the Mind in the Eyes task (as previously used in chapter 5)

This child version of the Reading the Mind in the Eyes task (Baron-Cohen, Wheelwright, Spong et al., 2001) consisted of 28 pictures of human faces which display only the person's eye region. The child was required to pick one of 4 words situated around the picture that best described what the person in the picture is thinking or feeling, with only one of the four words being the correct answer. The general procedure of this task is described in chapter 5 (pp. 83-84). However, unlike in chapter 5 where the stimuli were presented on paper, stimuli were presented here via a computer screen with all pictures of equal size (approximately 13.9cm x 5.5cm) appearing individually in the centre of the screen. To recap, the child was asked to look carefully at the picture, with the four words appearing equidistant from the picture of the eyes, and then to choose the word which best described what the person in the picture was thinking or feeling. Beginning with a practice item, the words were slowly read out and pointed to by the experimenter to ensure that the child knew which word was which. The experimenter randomly varied the order in which each set of four words was read aloud to reduce the likelihood of the child responding due to a word being in a certain location. Given the younger age of the children here compared to those described in chapter 5, there was more need to explain to the child what some of the words meant – for example, the mental state "surprised" may be described to the child as: "A person might be surprised if they get a birthday party that they did not know about." The experimenter gave encouraging feedback without revealing whether the child had responded correctly or not. If the child was unsure of the best word to respond with, then the experimenter encouraged the child to guess, as per the task instructions.

Affect task

An adapted version of the Animated Full Facial Expression Comprehension Test (Affect) (Gagliardi et al., 2003) was used and differed from the original task only in the sense that the range of stimuli also incorporated the faces of two children, rather than solely adult faces – it was deemed that the adapted task would be more suitable for young children. The child was presented with pictures on a computer screen of people's faces that showed one of 5 basic emotions – happy, sad, angry, frightened and disgusted. The child had to choose one of the emotional states that they believed corresponded with each animated picture. Five practice trials were given prior to the presentation of 4 blocks and each block contained 21 trials. Five possible emotions were each trialled once within the practice session, and then presented in a randomized order within each block; *happy* was presented 5 times while the 4 remaining emotions were presented 4 times. Also, the pictures varied in terms of the degree to which the face was animated – each of the emotional expressions was animated from a neutral state to 25%, 50%, 75% and 100% of the point to which the expression was full-blown, depending on the intensity of expression which was required, at which point the picture was then 'frozen'. The additional one *happy* trial within each block was animated to 10% of its peak expression.

Procedure

Prior to administration of this task, the experimenter first explained to the child what would be presented on the screen and told the child to choose the emotion label corresponding to the expression that the child believed the pictured person to be feeling. To ease children's anxiety and to ensure the child understood the 5 emotions to be presented, the experimenter asked the child if they could explain and demonstrate each of the emotions. If the child showed any difficulty with this then

the experimenter gave an example of an occasion when someone might feel that particular emotion before demonstrating the appropriate facial expression. Once the child had indicated that they understood, the experimenter began the test. The picture of the face (measuring approximately 13.2cm x 8.5cm) was displayed in the centre of the screen with each of the 5 emotion labels to the left. Each of the pictures was one of 4 people – a man, a woman, a boy or a girl. If the child was unsure of an answer then the experimenter encouraged the child to guess as there was a chance they may choose the correct answer. Given the length of this task (approximately 15 minutes to complete), a short rest was allowed between blocks to allow the child to concentrate fully on the next block.

Depending on the child's competence, the answers chosen were either pointed to, spoken aloud, or if the child was comfortable using the computer mouse then entered directly by the child (after saying the answer aloud to ensure the child was clicking on the appropriate label). Children's answers for this test as well as the two other social perceptual tasks were stored in the computer and checked afterwards to determine their individual score for each task. As for the Eyes task, children received one point for every correct response, in this case giving a possible total score of 84.

Friendliness task

The format of this task was similar to the Affect task in terms of the presentation of pictures of faces on a computer screen and choosing emotion labels corresponding to the expression in the picture. However, this time the pictures were not animated and the child had to determine whether the person pictured looked friendly or unfriendly. Similarly to the Affect task, the child could choose from 5 labels, but on this occasion the labels varied along a scale from *very friendly* to *very unfriendly*. The other labels were *quite friendly*, *quite unfriendly* and *neither* – it was

explained to children to choose *neither* if the face looked neither friendly nor unfriendly or if the child was unsure and could not decide either way. As mentioned earlier, the wording of these 5 labels was likely to make this task linguistically simpler than the two other social-perceptual tasks, while still testing social understanding at a relatively complex level. Also, prior to beginning the task, the child was asked to explain what features would make a person friendly or unfriendly. If a child was unable to do this then the experimenter aided children's understanding by describing example situations in which a person may be friendly or unfriendly. The task itself consisted of 24 colour pictures, presented individually, showing either a male face (10.5 x 7.8cm) or a female face (9.6 x 8.7cm), with the 5 labels presented to the left of the picture with *very friendly* appearing as the top label sequencing down to *very unfriendly* as the bottom label. For each presentation the experimenter read the five words aloud randomly starting with either the uppermost or lowermost term until the point at which the child had evidently grasped the various terms and was able to offer their responses spontaneously. If children pointed to the response then the experimenter asked the child to also say their choice to ensure that the child was pointing at the response which was intended. For some children it was necessary to list all five possible responses throughout all of the pictures.

The picture stimuli that were presented within the Friendliness task represented a morph between neutral and angry faces. Previous work with similar stimuli (Frigerio et al., 2006) has shown that individuals see angrier faces as less friendly. In the current study, the slope of the regression line relating each child's ratings of the friendliness of each of the face stimuli (ratings between 1 *(least friendly*) to 5 (*most friendly*)) to the intensity of the anger in the face stimuli was used as the measure of sensitivity to the friendliness of people in the pictures. This was

scored in terms of a gradient with positive scores furthest from zero indicating that children were most adept at determining whether a person looked friendly or not.

2 Social Attention Tasks

Social orienting measure

The orienting measure used here was an adapted version of the task used by Dawson et al. (2004). Their paradigm involved the presentation of 8 stimuli – 4 social sounds (a person humming, calling child's name, clicking fingers and patting hands) and 4 non-social sounds (timer beeping, phone ringing, whistle blowing and horn blowing). In Dawson et al.'s study, while the child was interacting with the main experimenter, a second experimenter presented these sounds in the background. The social stimuli were produced directly by the experimenter, whilst the non-social stimuli originated from inanimate objects which were activated by the experimenter.

Adaptation of Dawson et al.'s (2004) social orienting measure

The adaptation of Dawson et al.'s (2004) task involved presenting 8 sounds – 4 social and 4 non-social – from a computer program and output through 2 speakers which were connected to the computer. This was done for two reasons – firstly, it was not practically feasible to have a second experimenter present for the testing sessions. Secondly, and more importantly, it seemed more logical to have the sounds appear from a standardised source rather than allow for the possibility of human error and/or the second experimenter's physical presence in priming the child to look toward a certain location. Thus, a computer program was designed which could deliver the 8 stimuli and just as Dawson et al. had done, each stimulus was delivered 3 times in succession with a 1 second interval between each repetition, resulting in approximately 6 seconds duration for each stimulus.

The sounds within our program were chosen to approximate those originally used by Dawson et al. and consisted of the following social sounds: (a) child yelling, (b) man coughing, (c) woman laughing, and (d) person whistling. The 4 non-social sounds within our program were: (a) timer beeping, (b) phone ringing, (c) car horn blowing, and (d) whistle blowing. The sound files for the orienting task were obtained from an internet website: http://www.sounddogs.com.©. Each sound file was edited using Creative Lab's Wave Studio. Since the original files were in 16-bit stereo format, these each had one channel deleted leaving only the left or right channel to ensure that each sound was only played out of one of two speakers. Given the wide variety of sounds used it would have been difficult to balance them with a decibel meter, so the sound levels of the files were balanced subjectively by ear so that the apparent loudness of each sound was the same. This was done by a technician and agreement on the loudness of the sounds was provided by two other judges.

Piloting the new measure of social orienting

Although the sound stimuli were selected to approximate those used by Dawson et al. (2004), it was important to ensure that our interpretation of the social vs. non-social nature of the sounds was valid. Therefore, the presentation of all 8 sounds via the computer program was piloted with 20 adult participants before running the study to ensure that the social and non-social sounds had been chosen sensitively and categorised appropriately. These participants received the stimuli in the same manner as presented in the experimental task. However, rather than actually orienting to the particular sounds, it was necessary for these adult participants simply to rate the stimuli in terms of how social or non-social they sounded on a 5-point scale ranging from 1 (*definitely non-social*) to 5 (*definitely social*). Across the sample

of 20 participants, the four social items received average ratings of 4.30 (s.d. = 0.73), 4.55 (s.d. = 0.51), 4.60 (s.d. = 0.60) and 4.55 (s.d. = 0.51), whilst the four non-social items received average ratings of 1.1 (s.d. = 0.31), 1.3 (s.d. = 0.47), 1.4 (s.d = 0.50) and 1.5 (s.d. = 0.51). Thus, the 8 sounds which were chosen appeared to be categorised appropriately. This allowed use of the adaptation of Dawson et al.'s measure with confidence that this would gauge children's ability to spontaneously orient to social and non-social sounds. Furthermore, producing these sounds electronically rather than via a second experimenter as Dawson et al. had done, enabled the procedure to be free from the potential priming effect of a physical human presence.

Procedure

To replicate Dawson et al.'s (2004) procedure each of these sounds was presented for a duration of one second three times and each sound had one second of silence added to the end to give the required interval between successive interstimulus sounds. In order to present the stimuli through speakers connected to the computer via the touch of a button, the 8 sounds were stored within a file which was run within a wavesequence program on a laptop. This program served to facilitate the standardised systematic presentation of the 8 sounds. It also allowed alternating delivery between left and right speakers, each time with the sound being presented via a covert touch on the mousepad of the laptop by the experimenter to activate the particular trial to ensure that the child's reaction to each stimulus could not be primed. During the presentation of all stimuli the experimenter ensured he was looking down at the floor to avoid influencing the child's reaction, while a webcam was set up to video the child's responses to each of the stimuli. Two social and two non-social sounds were delivered from each speaker in a counterbalanced order.

Each speaker was located approximately two feet away from the child at an angle of 30° to the left and right just behind the child. Both speakers were concealed to reduce the likelihood of the child discovering the origin of the sounds.

Scoring

In terms of scoring children's responses to the 8 orienting trials, a trial was successful (score of 1) if the child oriented their head and/or eyes within 30° toward the relevant sound within 6 seconds of the trial commencing. Therefore, the 6 second duration from the presentation of each sound was used as the period through which the child's response was observed (with reactions to the stimuli occurring outwith those 6 seconds being disregarded). However, despite this temporal criterion, it is important to note that the scores for children on this task reflect their *accuracy* to respond within the time limit. A trial was scored as a mismatch (score of -1) if the child first looked toward the opposite speaker during a trial. All trials were recorded on video and videos were then analysed for accuracy in responding to trials using the Observer Video-Analysis Program.

Joint Attention measure

The joint attention task was similar in nature to that used by Leekam et al. (1997) with typically developing 5-year-olds. Their task had been adapted from a similar task used with infants by Butterworth and Jarrett (1991) and Scaife and Bruner (1975). For the current study joint attention trials were carried out in a sparsely furnished room located in a quiet area of the child's school. Whilst sitting approximately 3 feet opposite the child, the experimenter conducted 6 joint attention trials. The sequence of the experimenter looking to the right, left and behind the child was repeated twice. On each occasion the experimenter would gain eye contact with the child before instantly turning his head and eyes to the appropriate target for 6

seconds whilst displaying a look of interest. In a handful of cases, it was necessary to call the child's name initially to establish eye contact with the child before proceeding with a trial. Targets to the right and left sides consisted of a 20cm x 20cm gold star and were located 3 feet to either side of the dyad at the experimenter's eye level, equidistant between the experimenter and the child. A further two *behind* trials were then carried out whereby the experimenter looked behind the child at a doorway as if to suggest someone was entering the room. There was a distance of approximately 6 feet between the child and the target behind. A webcam was located just behind and to the right of the experimenter (approximately one foot away) to ensure that there was a full view of the child's head and eyes. This recorded children's responses to each trial.

Scoring

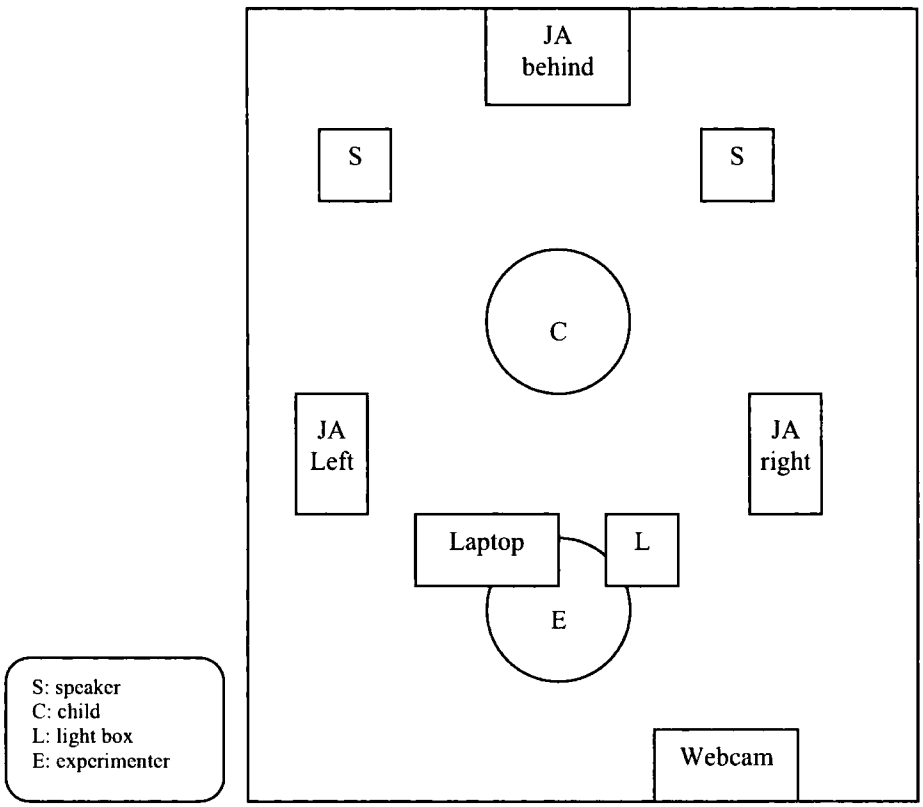
Responses were later scored as successful (match) if the child first turned his/her head and/or eyes toward the appropriate target (score of 1) within 6 seconds of the trial commencing. Additionally, since the children in this study were considerably older than those used in previous joint attention studies involving infants that scored responses within 6 seconds, children's joint attention abilities were also examined using a stricter criterion of 3 seconds to respond from onset of the trial. Also, in line with previous research (e.g., Corkum & Moore, 1998; Leekam, Hunnisett, & Moore, 1998; Morissette, Ricard, & Decarie, 1995) the presence of mismatches was considered in addition to matches in order to adopt a stricter measure of joint attention. Thus, a response was scored as a mismatch (score of -1) if the child first looked to the target opposite the one being fixated by the experimenter within the time criterion. The trial was scored as 'no response' (score of 0) if the child failed to react to the experimenter's bid for attention. At no point were the

details of the social attention tasks explained to the child as this may have compromised the integrity of the tasks. All social attention trials were interspersed between the social-cognitive stories and language tasks administered to children in order to make the attention trials appear as natural and unobtrusive as possible.

Use of Observer Video-Analysis Program and Reliability

The two social attention tasks were coded and scored using the Observer video-analysis program. A coding scheme was devised which categorised behavioural actions made by either the experimenter or the child. Codes were applied to represent the experimenter actions: i.e. 4 possible types of social orienting trials: left-side (of experimenter) social sound, right-side social, left-side non-social, right-hand non-social, and the 3 classes of joint attention trials: left-side of experimenter, right-side of experimenter, and behind child. Similarly, codes were applied to represent the child's actions, namely: match, mismatch, no response, and no trial. Response time between onset of trial (sound for orienting task or head turn for joint attention task) was recorded precisely using the Observer and the accuracy of response within either 6 or 3 seconds was scored and used in subsequent analyses. To check that the videos were being scored accurately and consistently, a reliability coder blind to the hypotheses coded 25% of the videos. Inter-rater reliability was substantial for the joint attention task: Cohen's kappa = 0.73 and was moderate for the orienting task: Cohen's kappa = 0.52. For a diagram depicting the set-up of equipment for both social attention tasks see Figure 6.1. (NB. The boxes containing the terms 'JA behind', 'JA left' and 'JA right' represent spaces where these targets were located rather than an object as such.)

Figure 6.1. *Diagram depicting set-up of equipment for social attention tasks*



Tests of Language and Cognitive Functioning

The British Picture Vocabulary Scale (BPVS-II) – Dunn et al. (1997) – was used to measure children's receptive vocabulary. The Children's Communication Checklist (CCC-2) – Bishop (2003) – was selected as a second more comprehensive measure of language because it has a pragmatic scale and a syntax scale which are not in the BPVS. Since the CCC-2 is completed by parents it also provided a more ecologically valid reflection of children's language abilities, in terms of their everyday communicative function. This 70-item questionnaire provided scores and percentiles for several subscales including: syntax, use of context, and semantics. These, along with other subscales, in turn lead to two composite scales: a general communication scale - which identifies children who are likely to have clinically significant communication difficulties - and a social interaction deviance scale which

can help to identify children with a communication profile characteristic of autism; providing further useful comparison with children with autism tested on social understanding and language in the following chapter.

Finally, the 2-subtest format of the Wechsler Abbreviated Scale of Intelligence (WASI) – Wechsler (1997) was used due to the large battery of tasks being used in this study and the resultant length of the testing sessions for children. As indicated by the WASI manual, the combined score for the vocabulary and matrix reasoning subtests provides a standardised short-form measure of general cognitive functioning. This variable was then included as a covariate in subsequent analyses.

Materials and Procedure

All the testing took place in a small quiet room within each of the schools. Due to the variety of schools, room size varied between 2 x 4m and 4 x 5m. Several pieces of equipment were required for the tasks including a laptop computer, 2 sound speakers, a webcam, 2 gold stars (20 x 20cm) and a light-box connected to a box with a button which when pressed activated an LED. This was displayed as a lit lamp on the video produced from the webcam. This light was used to signal to the experimenter the beginning and end of social attention trials and was out of sight of the child.

All children were tested on a range of social understanding tasks and tests of language and general cognitive functioning. This battery consisted of two tasks to measure social attention; three tasks to measure social perception; two social-cognitive tasks, the British Picture Vocabulary Scale (BPVS) and the Wechsler Abbreviated Scales of Intelligence (WASI). In addition, the Children's Communication Checklist-2 (CCC-2) questionnaire was distributed to parents of which 95 (74.8%) were returned.

Children were seen individually over two sessions approximately one week apart with the first occasion lasting approximately 45 minutes and the second one lasting approximately 35 minutes. The experimenter briefly explained to the child that they would be working with the experimenter on 2 occasions and he told the child that the first session would involve various computer-based tasks and listening to two false-belief stories, before checking that the child was happy to continue. During the first testing session the experimenter sat next to each child and worked with them through the computer-based tasks – 3 social-perceptual tasks – taking approximately 35 minutes. Then the experimenter sat opposite the child and told the child two false-belief stories, while acting these out with various props.

The second testing session began with two ignorance stories - these always followed the false-belief stories to ensure that the easier ignorance stories did not influence children's more complex false-belief understanding (as demonstrated in the study described within chapter 2). Given the age by which children normally pass second-order ignorance, it was not expected that children's ignorance understanding between the ages of 4 and 5 would be facilitated and thus over-inflated by their prior experience of false belief stories (particularly since there was generally a duration of one week between these sessions). As for the false belief stories, the ignorance stories were acted out and took approximately 10 minutes to complete before moving on to the BPVS and WASI (2-subtest format). During the administration of the psychometric tests, the experimenter conducted the social attention trials. At random intervals between questions on these tasks, the experimenter conducted 6 joint attention trials and 8 social orienting trials. For the joint attention trials the experimenter engaged the child in conversation and then at a convenient point when eye contact was obtained the experimenter immediately looked to the child's left or

right (at 90° from his midline), or behind the child. For the social orienting trials, the experimenter found a similarly convenient point to activate each trial. This was achieved, unbeknown to the child, by the experimenter pressing the mousepad on the laptop which then produced a sound which was repeated three times, with the 8 sounds alternating between the two speakers. The experimenter ensured that all of the social attention trials were completed before the last subtest of the WASI was complete. Since the positioning of equipment and webcam did not allow for the experimenter's head to be included in the video shot, a small light box was positioned so as to be in the range of the webcam. For each of the social attention trials, the experimenter pressed a button (unbeknown to the child) which then lit a red LED within the light box. On video footage this appeared as a bright white lamp lighting up and clearly signalled the beginning of each joint attention (and social orienting) trial.

Results

A complete dataset for the 127 children was achieved with the following exceptions: one child was not present for the second session of testing and so did not complete the two ignorance stories, the BPVS, the WASI or either of the social attention measures. Also, the video files for 6 children became corrupted and so their responses to joint attention and social orienting trials were not accessible. The only other missing data stemmed from the parental questionnaires due to a minority of parents (25%) who did not return the Children's Communication Checklist-2. In line with structural equation modelling procedures (as described later), the relevant variable mean value was imputed to each of the missing values (these missing values will be discussed in more detail within part 3 of the results when describing structural equation modelling analyses).

6.6 Results Part 1: Descriptive statistics and normality testing

Descriptive statistics for the social understanding and language tasks are detailed in Table 6.1 below separately for 4-year-olds and 5-year-olds.

Table 6.1

Mean accuracy scores and standard deviations of social understanding and language tasks for 4-year-olds and 5-year-olds

		4-year-olds (n = 40)	5-year-olds (n = 87)
Hypothesised Construct	Variable/Task	Mean *(s.d.)*	Mean *(s.d.)*
Social Cognition	ignorance	6.08 *(2.11)*	6.44 *(1.96)*
Social Cognition	false belief	4.43 *(2.68)*	4.94 *(2.49)*
Social Perception	affect	51.13 *(9.29)*	52.15 *(8.68)*
Social Perception	eyes	13.55 *(3.43)*	12.13 *(3.45)*
Social Perception	friendliness	23.74 *(17.80)*	27.38 *(16.14)*
Social Attention	orienting	5.94 *(1.90)*	6.57 *(1.62)*
Social Attention	joint attention	4.42 *(1.36)*	3.95 *(1.46)*
Language	BPVS	107.13 *(11.68)*	104.30 *(10.70)*
Language	syntax	8.87 *(3.00)*	8.57 *(3.10)*
Language/IQ	WASI	99.14 *(8.09)*	98.46 *(6.89)*

It can be seen that the performance of 4-year-olds and 5-year-olds is generally similar. The performance of children in general across the ten tasks is conveyed in Table 6.2 and is described below in more detail, beginning with the social-cognitive tasks.

Table 6.2

Mean accuracy scores and standard deviations of social understanding and language tasks

Hypothesised Construct	Variable/Task	Mean	Standard Deviation
Social Cognition	ignorance	6.33	2.00
Social Cognition	false belief	4.78	2.55
Social Perception	affect	51.83	8.85
Social Perception	eyes	12.57	3.50
Social Perception	friendliness	26.24	16.70
Social Attention	orienting	6.40	1.73
Social Attention	joint attention	4.09	1.44
Language	BPVS	105.19	11.05
Language	syntax	8.66	3.06
Language/IQ	WASI	98.67	7.27

Social-cognitive tasks

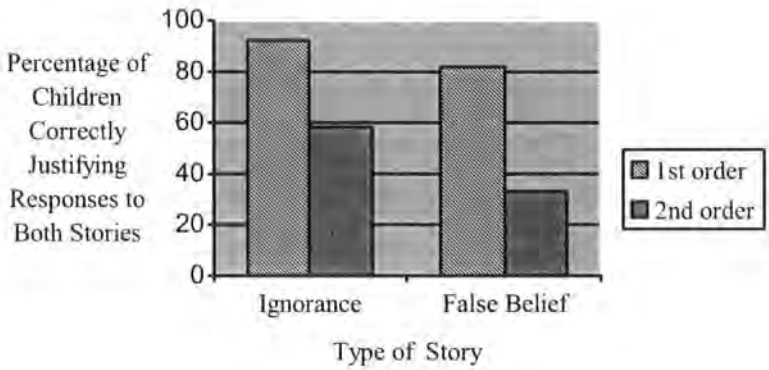
The means in Table 6.2 for the 2 false-belief stories and the 2 ignorance stories show that children found the ignorance stories to be easier. A paired-samples t-test indicated that this difference was significant: $t(126) = -7.18$, $p = 0.00$. Such a difference had been hypothesised since it had been demonstrated in chapter 2 that ignorance is a simpler concept for children to understand than belief in second-order belief tasks (and published as Coull et al., 2006). It had also been expected since it has been reported in the case of first-order belief tasks that children understand the concept of ignorance before they understand the concept of belief (Hogrefe et al., 1986). However, this is the first time it has been shown in a composite task.

A 50% criterion level was used to distinguish passers and failers on social-cognitive stories (i.e. obtaining at least 50% of the maximum score based on two combined first-order and second-order stories) to provide comparable criteria to that reported in chapter 5. Results showed that as expected, the vast majority (78.7%) of children passed combined first-order and second-order ignorance stories. Using the same criterion for false belief, a slight improvement was evident with 58% of children passing composite false belief stories compared to 47% of children in chapter 5. Therefore, both groups of typical children performed to comparable levels and although the children described in chapter 5 were slightly older, the children tested here formed a much larger sample and as such the present group were likely to provide greater indication of typical performance in 4- to 5-year-olds.

Comparing children's performance on a composite first-order and second-order false belief methodology with those tested in chapter 5, it was interesting to examine how these within-subject abilities held for ignorance and false belief at first-order and second-order levels. Figure 6.2 shows the percentage of children who correctly justified their test responses in both stories of each type. Supporting earlier evidence, it can be seen that children demonstrated greater understanding of ignorance stories compared to false belief. It is also apparent that the difference in understanding ignorance and false belief was more marked at the second-order level of understanding. This confirmed expectations since children's first-order understanding would be expected to have fully emerged in 4- and 5-year-old children, whether assessing ignorance or beliefs. In addition, previous research would suggest that 4 and 5-year-olds understanding of second-order ignorance would be considerably more advanced than their understanding of second-order false beliefs. This is corroborated by the finding that only 17.3% of children were unable to

correctly justify their responses to either of the two second-order ignorance questions while 46.5% of children were unable to do so in relation to either second-order false belief question.

Figure 6.2. *Percentage of children correctly justifying responses to both stories*



Social Perception

Performance on the Eyes task across the whole sample showed a normal distribution of scores, with a mean score of 12.57 (s.d. = 3.50), and scores ranging from 4 to 22, from a possible maximum score of 28. This distribution of scores was comparable to children's performance on the Eyes task described in chapter 5 (mean score = 12.1, s.d. = 3.44, range = 6 to 18) in which the majority of children scored above chance levels. Therefore, the current data would appear to substantiate the findings of similar performance levels found in the comparatively small sample of children tested on the Eyes task in chapter 5. While 4- to 5-year-olds displayed a range of success across this task suggesting that it was age-appropriate, it is true that the Eyes task has several complexities – it is heavily language-based consisting of numerous mental state terms, some of which are perhaps quite unfamiliar to young children such as *jealous* and *daydreaming*. Every effort was made to explain these to children prior to them informing the experimenter of their response, but inevitably there will have been some children who provided a wrong response not due to lack of

social-perceptual ability but due to lack of language ability. In addition, many of the correct responses in the Eyes task consist of a phrasing of words, e.g., "making somebody do something" which although quite abstract in nature, may have cued children's attention due to the disproportionate length of response compared to other target mental state terms such as *sad* and *angry*. For each child's response when they may have indicated via pointing - but in particular for those consisting of a phrase - the experimenter ensured the child spoke aloud their answer in order to be more sure that the child was responding with a clear answer in mind. Furthermore, since the experimenter verbally presented the four target items for each picture, it was possible that children generally responded with the last term uttered by the experimenter. However, the experimenter was sensitive to this possibility and if a certain pattern of responding seemed to be emerging the experimenter reminded the child of the various responses in a different order and reassured them that the correct response could be the first, second, third or fourth option spoken by the experimenter. Nonetheless, these complexities aside, children did perform generally well on the Eyes task and it was interesting to note that the 4-year-olds obtained a higher mean score than 5-year-olds, suggesting that this task is age appropriate, but requires responses and response procedures which may confound the task itself.

As Table 6.2 showed, the average mean score for children's performance on the Affect task was 51.8 from a potential maximum score of 84. The minimum score obtained was 28, i.e. the child correctly labelled 28 emotions of the 84 pictured faces, and the maximum score achieved was 70. Similarly to the Eyes task, the distribution of scores for this task was normal and given that children were required to choose between the same set of 5 mental state terms for the whole task, it is unlikely that language ability would have been as involved in children's responding as it perhaps

had been for the Eyes task. Children's performance on the Friendliness task also followed a relatively normal distribution: the mean gradient score - indicating the average sensitivity of the child to choose correctly between 'friendly' and 'unfriendly' labels- was 26.2, ranging from -34.4 (indicating very poor sensitivity) to 80.0 (extremely adept at choosing the correct label). Despite the broad range of ability on the Friendliness task, this task may have suffered from certain complexities in a way similar to the Eyes task. While the Eyes task had high language demands, this task was less language-intensive due to the same set of 5 terms for each face, but the concept of friendliness may have been difficult to grasp for some children – to decide on someone's friendliness purely on the basis of their facial expression is perhaps quite abstract for 4- to 5-year-olds. Indeed, some children tended to respond with the neutral, middle response in the list of 5 options more often than would be expected – this may have been due to uncertainty on deciding on someone's friendliness, in which case the middle term *neither* would have provided a safe response. Some children may also have found it do difficult to distinguish between the gradations of friendliness within the response set; for those children obviously struggling to consider all 5 options simultaneously, the experimenter initially spoke aloud three options: *friendly, unfriendly* or *neither* and then based on the child's response (e.g., friendly) would then ask: "Do you think the person is 'very' friendly or 'quite' friendly?" It was anticipated that this breakdown would facilitate a response from the child without cueing the child to a certain response. This procedure to enable some children's responding was subjectively determined by the experimenter and would perhaps not have been necessary for children of an age year or two older. Nonetheless, it was introduced in a minority of cases and the statistics

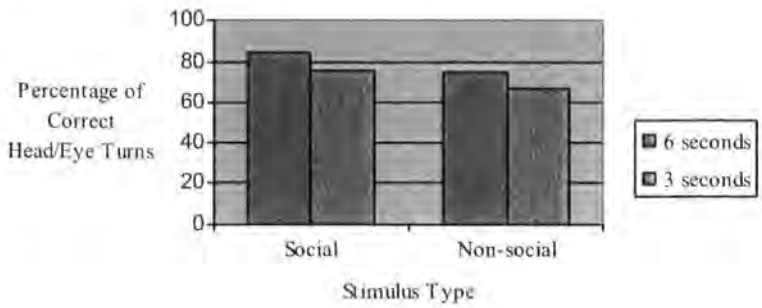
revealed a broad range of ability in 4- to 5-year-olds suggesting it was generally appropriate.

Social Attention

Table 6.2 conveyed that children correctly oriented to 6.4 (80%) of the 8 orienting trials, and correctly oriented to 4.1 (68%) of joint attention trials suggesting that the orienting task was easier for children than the joint attention task. Indeed, a paired samples t-test confirmed this difference was significant, $t(119) = -4.14$, $p = 0.00$. In addition, children responded to orienting trials more quickly on average than joint attention trials (2.20 seconds vs. 2.60 seconds), which perhaps indicated that the orienting trials were easier and more simplified for children than the joint attention trials.

For the orienting task, the mean number of correct head or eye turns exhibited by children in response to social vs. non-social stimuli can be seen in Figure 6.3. Their performance is considered not only within a 6 second criterion, but additionally for a 3 second criterion. This was also analysed to provide a picture of whether initial patterns of performance may vary from performance considered over a longer period of time. As can be seen in Figure 6.3, children more often oriented their attention correctly to social than non-social stimuli within both 3 seconds and 6 seconds.

Figure 6.3. *Percentage of correct head or eye turns within 6 or 3 seconds to social and non-social stimuli*



Given that the orienting task was an adaptation of the task used by Dawson et al. (2004), it was of interest to establish whether the current findings were comparable to those of Dawson et al. In Dawson et al.'s study, they found that typical children correctly oriented to approximately 70% of social stimuli and 80% of non-social stimuli. Using our 6 second criterion, the children here correctly responded to 85% of social stimuli and 75% of non-social stimuli. These levels of performance were comparable to Dawson et al. despite the fact that in their study they allowed a duration of 15 seconds for the child to respond. Given that the children tested here were slightly older, the 6 second criterion which was used to avoid potential ceiling performance appeared to be justified.

With regard to the joint attention task, children on average correctly focused their attention within the 6 second criterion to 4.09 trials (68%) and within the 3 second criterion to 3.76 trials (63%). To obtain an idea of the number of children passing or failing the joint attention task, we opted for a scoring criterion consistent with the level used by Leekam et al. (1997) since the children in their study were of a similar age to the children in this study. In that study, children were scored as 'passers' if they correctly responded to 2/3 trials. Therefore, children were classed as 'passers' if they correctly attended to at least 4/6 trials. Within the conservative 6 second criterion, 69% of children correctly attended to at least 4 of the experimenter's head turns, while 58% of children did so within 3 seconds. Both findings are relatively comparable to those of Leekam et al. (75% success rate) showing that although joint attention abilities first emerge in infancy, the ability to share joint attention with another person is not fully displayed in 4- to 5-year-olds – this may be due to habituation of responding or increasing social inhibition within the child.

Language

Given the large sample of children that was tested, it was unsurprising to obtain fairly normal distributions for both the BPVS standardised scores and the WASI IQ data with means of 105.19 and 98.67 respectively. Evaluation of the distribution of percentiles stemming from parental report of children's everyday communication abilities (using the CCC-2) revealed that almost 50% of the children were ranked no higher than the 33rd percentile in terms of their overall communicative competence compared to the standardised sample. As a result, based on children's percentiles on the index of overall communicative competence, the distribution was slightly negatively skewed.

As mentioned earlier, children's syntactic ability is strongly linked with their false belief understanding. Therefore, in order to investigate the possible role of syntax within social understanding - particularly social cognition - the syntax scale of the CCC-2 was isolated and focus was placed on the scaled scores and percentiles from this scale. Compared to the CCC-2 standardised sample, output suggested that 72% of the sample of 127 typically developing children would not feature in the upper half of the general population in terms of the parent's perception of their child's syntactic ability; however, the remaining 28% would be in the top 5% of the population.

This descriptive summary of ability levels on each of the tasks for the large sample of typically developing children has confirmed that the new tasks (such as the social-cognitive stories and social attention orienting measure) have produced comparable results to previous studies using similar yet different measures. In addition, this section has outlined the general performance of typical children on

more established tests, and having produced results which were expected given previous findings, this would appear to justify the choice of measures.

Normality of variables

Initial analyses of normality via histograms and normal Q-Q plots suggested that several of the variables were non-normal. The Shapiro-Wilk statistic confirmed that the only normally distributed variables were the Affect task, the Eyes task and the joint attention task. Both social-cognitive tasks were negatively skewed, while the Friendliness task was positively skewed. The orienting task was positively skewed, indicating that children tended to respond correctly to the majority of these trials within the 3 or 6 second period allowed. The WASI measure and syntax scale of the CCC-2 were also positively skewed. However, the BPVS measure appeared to be relatively normal despite the Shapiro-Wilk statistic. While 25% of the CCC-2's were not returned by parents, an independent t-test revealed that the group of children whose parents did not respond were not of a significantly lower IQ than the children whose parents *did* respond, ($t(125) = -1.43$, $p = 0.16$). This suggested that the CCC-2 respondents were likely to be broadly representative of the whole group, with similar IQ levels for children irrespective of parents' level of willingness to provide indication of their child's abilities.

6.7 Results Part 2: Correlation and factor analyses of the interrelationships within and between the four constructs

Given the indication of some non-normality within the dataset, nonparametric correlations were analysed (see Appendix 6.2) but these did not differ to the parametric correlations so all correlational analyses were conducted using Pearson's r. Although investigating across a fairly narrow age range, partial correlations while controlling for age were examined – the corresponding matrix (see Appendix 6.3) did

not differ from the bivariate correlation matrix. Also, given the extent of missing CCC-2 data (32 cases from 127), it was sensible to inspect correlation matrices both with and without imputed mean values for the missing data. Since there were no substantial differences between the two matrices, for completeness and for the purposes of the SEM to follow, analyses were based on data *with* imputed mean values for the missing data (to examine the correlation matrix without imputed values for missing CCC-2 data see Appendix 6.4). The resultant correlation matrix based on imputed values for missing CCC-2 data can be seen in Table 6.3. The value of the determinant (0.223) from the correlation matrix was greater than the necessary value of 0.00001 indicating that multicollinearity was unlikely to be a problem for these data. As Table 6.3 conveys, the correlation matrix appears to validate the choice of tasks believed to tap into each domain - both social attention tasks were significantly correlated: $r = 0.19$, $p < 0.05$; and both social cognition tasks were highly correlated: $r = 0.45$, $p < 0.01$. In addition, Table 6.3 shows that the social perceptual Affect task was significantly correlated with both other social perceptual tasks. However, although the social perceptual Eyes task was not significantly related to the Friendliness task, it was significantly correlated to both social cognition tasks and all 3 language tasks. This was perhaps not entirely surprising given the degree of language involved throughout the Eyes task. Similarly, the correlation of both social-cognitive tasks with both the BPVS and WASI is again likely to be due to the language involved in processing theory of mind stories. Table 6.3 also indicates that the three language variables form a potentially strong language construct with three significant intercorrelations, all $p < 0.01$.

Table 6.3

Correlations of all social understanding and language variables to be used in structural equation analysis

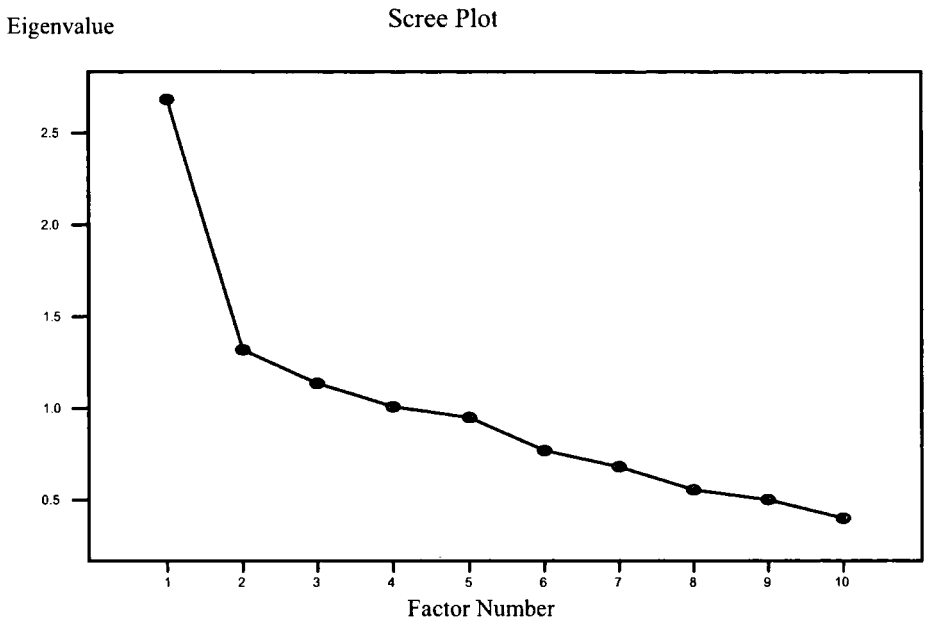
Indicator	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. Social attention – Orienting	1									
2. Social attention – Joint attention	.19*	1								
3. Social perception – Affect	.08	-.15	1							
4. Social perception – Friendliness	-.08	.05	.30**	1						
5. Social perception – Eyes	.10	-.04	.33**	.10	1					
6. Social cognition – False belief	.03	.05	.15	.11	.31**	1				
7. Social cognition – Ignorance	.12	.03	.07	.03	.26**	.45**	1			
8. Language – BPVS	.13	.02	.32**	.09	.35**	.30**	.29**	1		
9. Language - CCC-2 (syntax)	-.05	.03	.25**	.08	.20*	.13	.14	.35**	1	
10. Language - WASI	-.01	-.14	.14	.09	.27**	.28**	.24**	.50**	.23**	1
	*: significant at 0.05 level **: significant at 0.01 level									

Summarising the correlation matrix suggested that there was liable to be 4 relatively distinct constructs representing social cognition, social perception, social attention and language since the correlations within constructs were generally stronger than the correlations across constructs. However, due to strong associations between the social perceptual Eyes task and each of the language tasks, this task may not necessarily have reflected social-perceptual ability. These proposals were investigated in more detail via factor analyses.

To assess the factor structure of the dataset in more detail, factor analyses were conducted using principal axis factoring rather than principal components analysis as the former is more suited to structural equation modelling. In this study, it was primarily the links between latent constructs which were of interest in order to determine the interrelationships between social cognition, social perception, social attention and language. However, also of interest was how the tasks which were employed (i.e. the measured task variables) loaded on to their hypothesised constructs in order to determine how well the tasks measured the construct which they were purported to measure. Thus, based on a large, representative sample such as that of the present study, principal axis factoring was conducted to establish whether or not the selected tasks (indicators) measured their corresponding hypothesised latent construct.

Within the analysis output, a couple of statistics indicated that factor analysis was an appropriate procedure to further investigate the data. Firstly, the dataset had a Kaiser-Meyer-Olkin value of 0.68, indicating that the patterns of correlations were reasonably compact and were likely to result in distinct and reliable factors (Kaiser, 1974). In addition, Bartlett's test of sphericity statistic was highly significant, $\chi^2(45) = 182.64$, $p < 0.001$, suggesting that there were significant relationships between the variables included in the analysis, such that proceeding with factor analysis was an appropriate step. Using Kaiser's criterion of retaining factors with eigenvalues greater than 1, the output suggested that the data were best represented by a 4 factor structure. Indeed, the scree plot in Figure 6.4 illustrated that retaining 4 factors would be appropriate.

Figure 6.4. *Factor scree plot of all 10 social understanding and language variables*



Next, using Varimax rotation, to optimise the extracted factor structure, the output indicated that factor 1 explained 13.96% of the variance, with factors 2, 3 and 4 explaining 11.22%, 10.31% and 5.77% of the variance respectively. The resultant rotated factor matrix is presented below in Table 6.4. As this table illustrates, principal axis factoring yielded 4 relatively distinct factors. Together, these 4 factors accounted for 41.3% of the total variance. Factor 1 was predominantly a language based factor with all three language/IQ indicator variables loading most highly here. In addition, although the social perceptual Eyes task loaded on to Factors 2 and 3, it loaded most highly on to this language construct – this substantiated the earlier finding that the Eyes task was strongly correlated with each of the language tasks. The remaining factor structure appeared as originally hypothesised with the two other social-perceptual tasks loading on to Factor 2, which is likely to constitute a social perceptual dimension. Factor 3 was defined by high loadings for both social-

cognitive tasks, with the smaller fourth factor represented by both social attention tasks.

Table 6.4

Rotated factor matrix of all 10 social understanding and language variables

Indicator	*Factor*			
	1	2	3	4
Language – BPVS	.79			
Language/IQ – WASI	.59		.22	
Language – Syntax	.38			
Social perception – Eyes	.35	.26	.28	
Social perception – Affect	.24	.94		
Social perception – Friendliness		.30		
Social cognition – False belief			.77	
Social cognition – Ignorance	.24		.52	
Social attention – Orienting				.66
Social attention – Joint attention				.28
	Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalisation. All loadings > 0.2 are specified.			

Given both the low eigenvalue (1.01) and the small proportion of variance explained by factor 4, in combination with the finding within the correlation matrix

that neither of the social attention tasks were correlated with any of the measures outside of their within-construct correlation it could be reasonably argued that the fourth factor should be discarded. Although re-running the factor analyses without the two social attention tasks produced a different factor structure (see Appendix 6.5), the final phase of the analyses – structural equation modelling – proceeded on the basis of the original 4 factor structure, while acknowledging that the two social attention tasks may need to be omitted from the analysis in order to obtain a valid and parsimonious model.

6.8 Results Part 3: Structural equation modelling and regression analysis

Within structural equation modelling (SEM), the aim is to obtain a generic structural model which is both parsimonious and provides the best fit of the dataset. SEM is the only analysis that allows complete and simultaneous tests of all the relationships, enabling the constituents of social understanding to be examined thoroughly. Structural equation modelling grows out of and serves purposes similar to multiple regression but is a more powerful method of analysis which offers advantages such as: the inclusion of more flexible assumptions, the ability to model mediating variables and the desirability of testing models overall rather than coefficients individually. Distinguishing it from correlational analysis, ANOVA and regression, is the flexibility which SEM offers in terms of building causal models, though it does not necessarily provide statistical evidence of a causal link between variables (Kline, 1998). While correlational analysis indicated the associations which existed, this provided no idea of the direction of associations – only SEM can do that. Causality can only be inferred from the model which was originally constructed, not from the statistical test of that model. Furthermore, this type of analysis consolidated the factor analyses by providing firmer indication of whether or not the range of tasks

which were used tapped into the constructs which had been hypothesised. Using the Amos^{TM} (Analysis of MOment Structures) statistical software (version 6.0), it was possible to investigate the relationships between each of the latent variables – social cognition, social perception, social attention and social cognition, as well as the role which language/IQ plays in social understanding. As mentioned earlier, G*Power (Erdfelder et al., 1996) analysis indicated that the sample size of 127 children would be sufficient for examination of these four constructs via structural equation modelling.

Structural Equation Modelling Analysis

The correlation analyses conducted in part 2 of the results suggested that all relationships within constructs were positively correlated (with the exception of the social-perceptual Eyes and Friendliness link), and suggested a considerable level of interrelation between constructs – in particular, language was closely linked with social perception and social cognition; however, neither of the social attention tasks was related to any task within the three other constructs. These findings were substantiated within factor analyses, which suggested that the dataset could be explained in terms of four factors: Factor 1 consisting of all 3 language tasks and the Eyes task; Factor 2 consisting of the two remaining social-perceptual tasks; Factor 3 consisting of both social-cognitive tasks; and a minor fourth factor consisting of both social attention tasks. On the basis of this output from the factor analyses, attempts were made to run a structural equation model with the corresponding 4-factor structure within Amos. As suspected, given the lack of a relationship between social attention and each of the other constructs, as well as the low eigenvalue (1.01) which represented the construct of social attention within factor analysis, it was not possible to obtain a valid structural model when the 2 social attention tasks were included. It

was therefore necessary to omit this construct from all subsequent structural models. As will be revealed below, in order to arrive at a parsimonious model providing the best, accurate fit of the dataset, it was also necessary to make various structural modifications within the modelling procedure, resulting in three successive structural models.

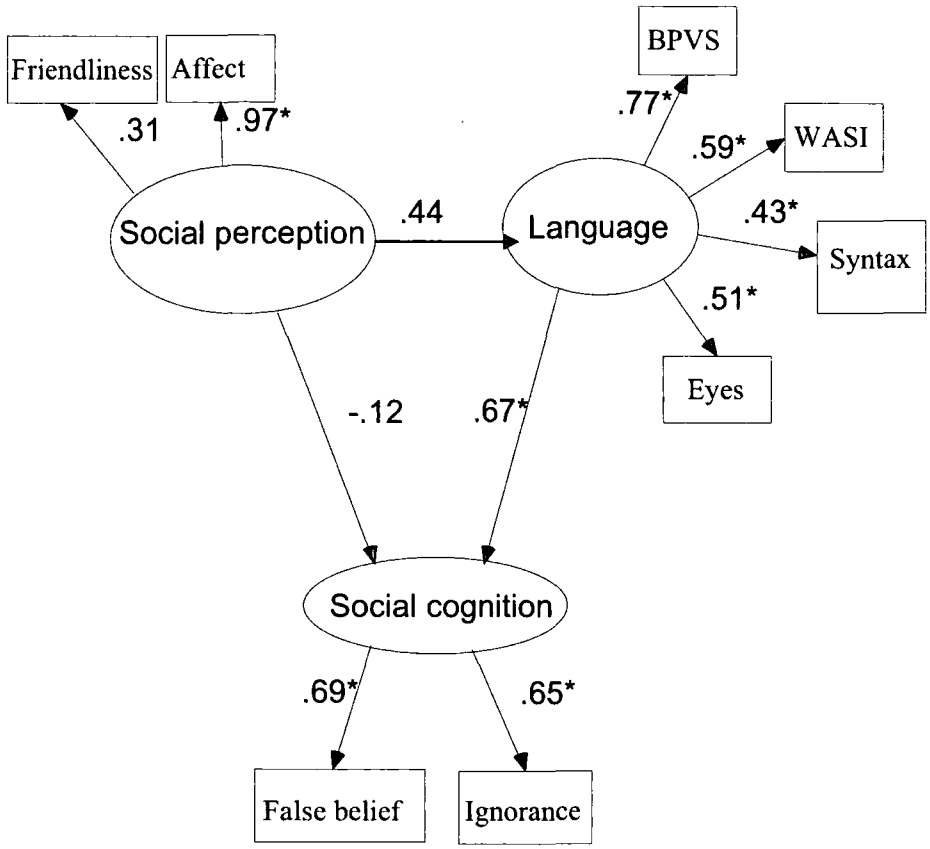
Given the above outcome regarding social attention, the first model to be investigated mapped directly on to the factor structure produced when the two social attention tasks had been omitted. The factor matrix previously outlined in Appendix 6.5 illustrated that when the social attention tasks were not included in the factor analysis, two factors emerged – one which primarily consisted of social cognition and language tasks, and a second factor which contained two social-perceptual tasks and the syntax measure. While this separation of factors was theoretically plausible whereby factor 2 abilities predicted factor 1 abilities; running of the model (illustrated with fit statistics in Appendix 6.6) conveyed that there was a significant difference between the model and the data. This indicated that the model did not adequately describe the dataset. Given that this model was informed by the reduced factor structure (obtained after excluding the two social attention tasks) and that the resultant two-factor matrix was considerably different to the factor matrix obtained earlier in factor analyses, it was more logical to proceed with structural equation modelling using the original factor structure while excluding the seemingly inconsequential fourth factor which consisted of both social attention tasks. Therefore, all subsequent modelling was based on the remaining 3 factors as described above in Table 6.4, which had the following factor structure: Factor 1 - BPVS, WASI, Syntax, and Eyes task; Factor 2 - Affect and Friendliness tasks; and Factor 3 - False belief and Ignorance tasks. Next, various structural models were

tested using this factor structure, with the need to improve the model iteratively to ensure that the final structural model was parsimonious and provided the best fit of the dataset. This was initiated by testing the previously discussed model of social understanding and language as predicted by Tager-Flusberg and Joseph (2005).

6.2 Testing the Tager-Flusberg and Joseph (2005) model

To recall, Tager-Flusberg and Joseph (2005) had proposed a model in which social perceptual ability predicted language and together these predicted children's social cognition (for original diagram refer back to Chapter 4, p. 73). Using their model as a framework, the aforesaid 3-factor structure (i.e. excluding social attention) was mapped on to the constructs of language, social perception and social cognition. Therefore, with apparent justification, Factor 1 containing BPVS, WASI, syntax measures as well as the Eyes task, was interpreted to be 'language', Factor 2 consisting of the Affect and Friendliness measures was interpreted to be 'social perception' and Factor 3 containing the composite ignorance and false belief tasks was interpreted to be 'social cognition'. It seemed counterintuitive from the start that a model consisting of a language construct containing the Eyes task, would be appropriate. However, this first needed to be tested to determine whether the data itself reflected such a structure, regardless of the theoretical prediction, as this was suggested by the factor analysis. Mapping of this factor structure on to Tager-Flusberg and Joseph's model produced the resultant structural model as depicted in Figure 6.5.

Figure 6.5 *Structural equation model of Tager-Flusberg and Joseph (2005) model*

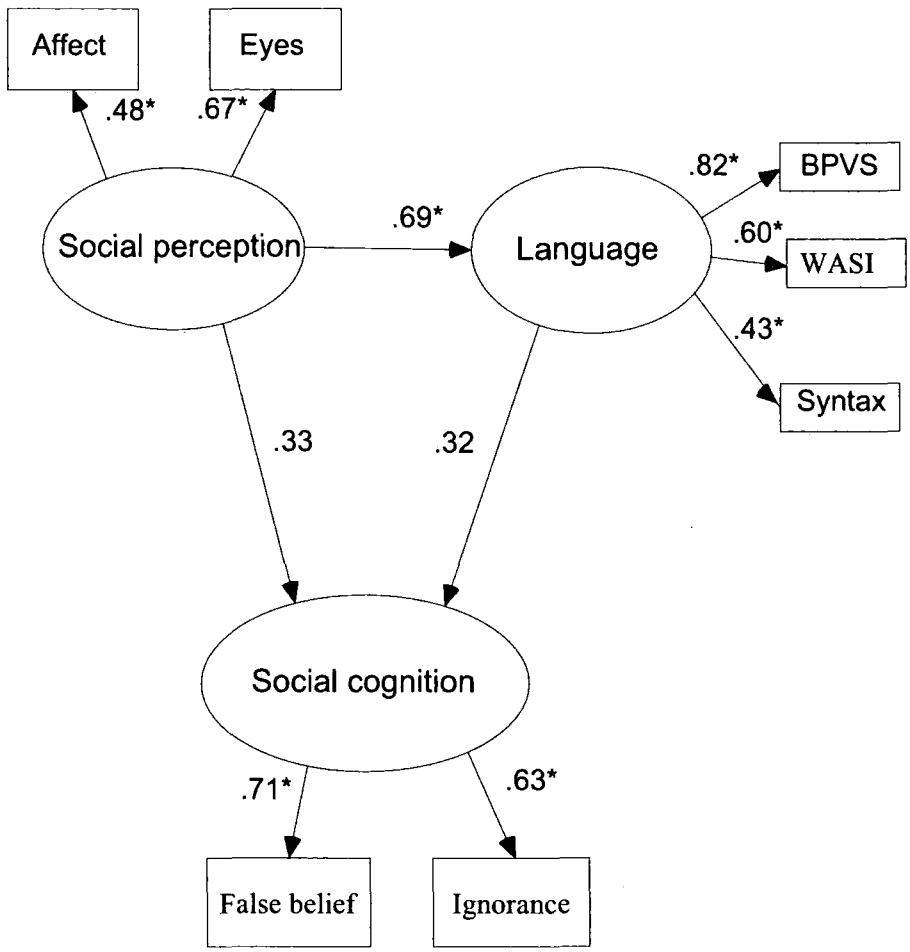


The model fit statistics for this interpretation of Tager-Flusberg and Joseph's model were: $\chi^2 = 13.1$, df = 17, p = 0.73, GFI = 0.97, CFI = 1.0, RMSEA = 0.00, AIC = 51.14 (a glossary explaining each of these fit statistics is presented in Appendix 6.7). Although these statistics were all quite favourable - suggesting that this model may fit the data well - it can be seen from Figure 6.5 that the only significant regression weight (denoted by *) linking *between* the constructs is the link between language and social cognition. Therefore, the model may be an acceptable fit, but since the links between social perception and language, and social perception and social cognition are not significant, this model is not very informative and cannot allow any firm conclusions to be drawn regarding the interrelationship of social perception, social cognition and language.

When proceeding with steps to iteratively improve the model, it was necessary to make two modifications. Firstly, further statistical analysis of the above model made it apparent that the Eyes task should load on to the social-perceptual construct rather than the language construct (as it had been featured in the previous model) since the Eyes task actually loaded more highly on to social perception than on to the language construct. Secondly, it was apparent from progressing from the last model which was tested through various iterations that the Friendliness task should be removed from subsequent analysis for two reasons. Firstly, for the lack of significance of the Friendliness task loading on to social perception and secondly, the fact that its inclusion created a need for a correlated error item between this task and the social-perceptual Affect task. This omission was justified given that the main goal in structural equation modelling is to develop a parsimonious, good-fitting model with unimportant parameters deleted (i.e. the Friendliness task). Therefore, given these modifications, it was necessary to re-run the model proposed by Tager-Flusberg and Joseph while taking these changes into account. The resultant model pictured in Figure 6.6 was noticeably different to the original test of the model (as appeared in Figure 6.5). Unsurprisingly, from the omission of the Friendliness task and the transfer of the Eyes task from the language construct to the social-perceptual construct, the links between constructs were now different. Now, language was significantly linked to social perception, in contrast to the original model (illustrated in Figure 6.5) in which language was significantly linked to social cognition. However, similar to the earlier model pictured in Figure 6.5, it was still the case that two of the three links between constructs were non-significant and consequently, as above, this model did not allow any conclusive statements to be made regarding the relationships between different constituents of social understanding and language.

Figure 6.6. *Updated structural model based on Tager-Flusberg and Joseph (2005)*

Fit statistics: $\chi^2 = 7.73$, df = 11, p = 0.74, GFI = 0.98, CFI = 1.00, RMSEA = 0.00, AIC = 41.73.



To summarise the modelling progress thus far; correlational analyses and factor analyses suggested that the various areas of understanding being examined (namely: social cognition, social perception, social attention and language) could be regarded as 4 distinct constructs. The correlation analyses suggested that social attention was unrelated to any of the three other domains, and this was underlined by factor analyses which conveyed that the tasks chosen to represent social attention, constituted a minor, fourth construct. These findings were then acknowledged within structural equation modelling statistical procedures through the omission of social

attention and the testing of models based on the original factor analyses (while excluding the non-significant social attention tasks). Thus, Tager-Flusberg and Joseph's model was explored using the factor structure: Factor 1 – BPVS, WASI, Syntax, and Eyes task; Factor 2 – Affect and Friendliness tasks; and Factor 3 – False belief and ignorance tasks. Regarding these factors as approximate constructs of language, social perception and social cognition respectively, the resultant structural model provided a reasonable fit of the whole dataset. However, links between constructs were not very informative, with the only significant link existing between language and social cognition and as such this revealed that the large dataset of performance across 10 tasks by 127 typically developing 4- to 5-year-olds could not be represented by the theoretical framework outlined by Tager-Flusberg and Joseph (2005). Thus, further statistical testing and structural modifications followed to iteratively arrive at the model of best fit. This involved moving the Eyes task to load on to a social-perceptual construct rather than a language construct and removing the Friendliness task from the model, while still adopting the framework advocated by Tager-Flusberg and Joseph. However, even with these structural modifications, testing of this new model revealed a better fit to the data than the model described above, but again non-significant links were found to exist between constructs. Therefore, in order to give the best approximate test of a model of social understanding which is inclusive of the various latent constructs, the next step was to reformulate the model of Tager-Flusberg and Joseph to arrive at a model of social understanding which wholly encompasses these constructs while providing the best fit of the dataset.

Given the non-significant model link between social perception and social cognition of the two previous models, the Tager-Flusberg and Joseph (2005) model

structure was modified accordingly within the SEM analysis procedure such that social perception was indirectly related to social cognition via language (i.e. there was now no direct link between social perception and social cognition). This structural modification was also congruent with earlier findings of strong correlations between social perceptual and language and between language and social cognition, from which language appeared to provide an integral link between social perception and social cognition. While contrasting quite markedly with Tager-Flusberg and Joseph's theoretical offering, the earlier correlational analyses and findings from the first two model outcomes as outlined above, both underline that a model which disregards a direct link between social perception and social cognition, should be tested at the very least. Furthermore, Tager-Flusberg and Joseph (p. 311) suggest that "the social-cognitive component of theory of mind builds on the earlier emerging perceptual component." However, Tager-Flusberg and Joseph do not suggest in what way this happens. It is quite possible that the way in which social perception and social cognition are linked is purely through the mediating construct of language. Therefore, this third structural model – which reflects a departure from Tager-Flusberg and Joseph's model by removing a link between social perception and social cognition, and embraces a potential mediating role of language between these two constructs - was tested and is presented below in Figure 6.7.

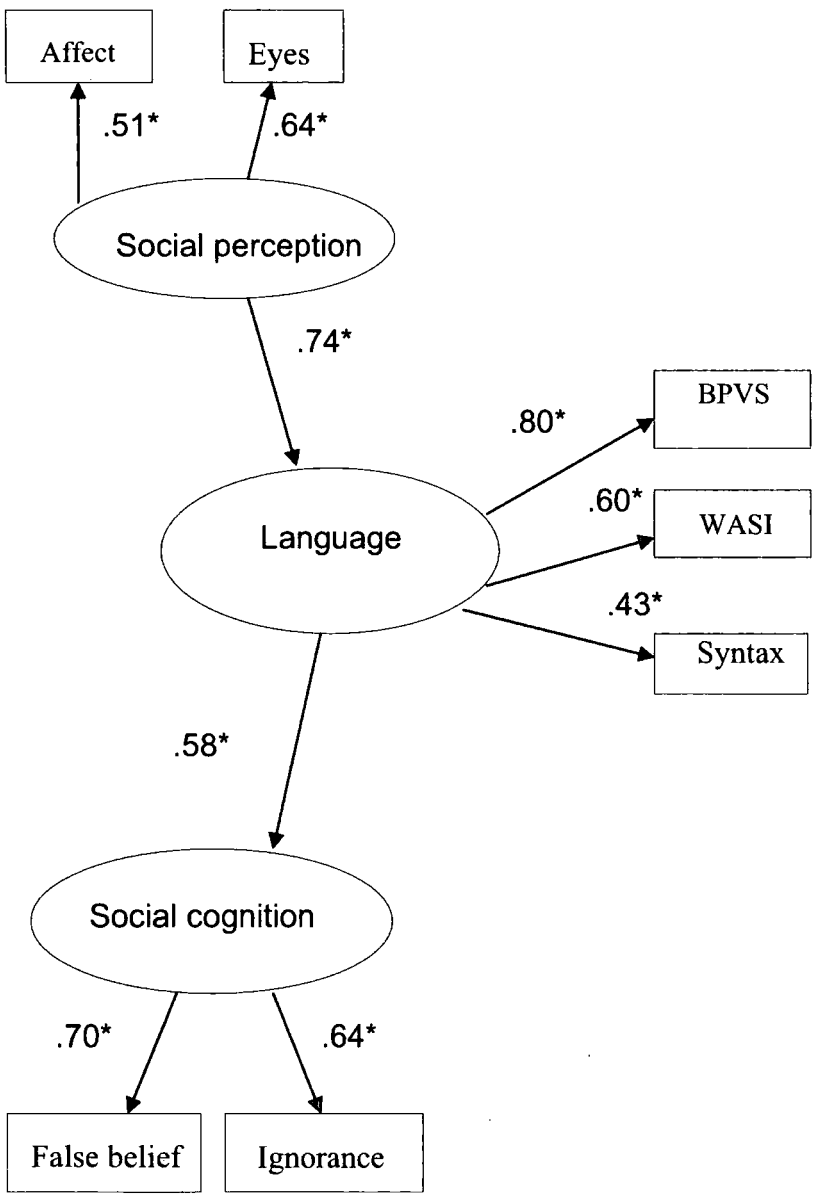
As can be seen below in Figure 6.7, the third and final structural model of this analysis exhibits the following fit statistics: $\chi^2 = 9.23$, df = 12, p = 0.68, GFI = 0.98, CFI = 1.00, RMSEA = 0.00 and AIC = 41.231. However, it is important to note a couple of points before interpreting this model further. All measures overestimate goodness of fit statistics for small samples (< 200), though RMSEA and CFI are less sensitive to sample size than others (Fan, Thompson, & Wang, 1999). As a result,

with a low chi-square value (as the one above is), this has an effect on the CFI and RMSEA values such that they are both at maximum fit levels due to rounding-up, not indicating a perfect fit per se, but at a level where they cannot distinguish between fit. However, given that additional model fit indices (such as the non-normed fit index) were not at maximum fit levels, this suggested that the model was not problematic. Furthermore, although the RMSEA value was 0.00, it was important to note that this value had a 90% confidence interval, ranging from 0.00 to 0.07. Therefore, the fit statistics for this model appeared to be very favourable; in particular the model was more parsimonious than previous models (indicated by the lowest AIC value). In addition, this new structural equation model had an advantage over previous models since both of the between-construct links were significant, whereas the earlier models were based on only one significant connection from the three links. Therefore, this highly parsimonious model which excluded the Friendliness task, both social attention tasks and had the Eyes task within a 'social-perceptual' construct provided an excellent fit to the dataset and all standardised regression weights between constructs and within constructs were significant (all $p < 0.01$) – indicating further improvement on the previous two models in which some of the links *within* constructs were non-significant. In addition, within the output for this model, assessment of normality revealed that there was non-significant multivariate kurtosis (value of Mardia's coefficient: 1.04, which is less than the critical value of 1.96 (values greater than 1.96 indicate there is significant non-normality)). Also, inspection of outliers within the model using Mahalanobis d-squared statistics revealed that no cases were particularly extreme compared to their nearest neighbours. Therefore, structural equation modelling suggests that a model in which social perception (omitting the friendliness task) predicts language which then

predicts social cognition, provides the best representation of social understanding and language abilities in typically developing 4 and 5-year-olds.

Figure 6.7 *Best fitting model of children's social understanding and language*

Fit statistics: $\chi^2 = 9.23$, df = 12, p = 0.683, GFI = 0.98, CFI = 1.00, RMSEA = 0.00, AIC = 41.23.



However, as noted by MacCallum and Browne (1993), there is usually more than one model that fits the data and has equivalent fit statistics, and equivalent models exist for almost all models. Indeed, in this case, an alternative yet similar model in which the same factor structure was adopted as in the model above, but in

which language predicted social perception and social perception predicted social cognition, produced equivalent fit statistics (see model and fit statistics in Appendix 6.8). If 2 or more models predict something equally well then it should be concluded that the more simple and parsimonious model is more likely to be the correct one. On this basis the latter model is more likely to be the definitive model since the statistic indicating parsimony (AIC) is lower (40.90, as opposed to 41.23) and the paths between constructs have marginally stronger regression weights than those in Figure 6.7. However, while this alternative model was acceptable, it could not be distinguished sufficiently from the prior model. In such cases, it is wise to base the final decision regarding structure on theoretical grounds (Lee & Herschberger, 1990). Therefore, given this rationale, the earlier literature review and the suggestions of structure from earlier correlation and factor analyses within part 2 of the results, the findings from this large dataset of abilities in typically developing children suggest a model of children's social understanding in which social perception has a direct path to language which is then linked directly to social cognition.

In an effort to support the above decision to opt for a model in which language mediates the relationship between social perception and social cognition, rather than opt for a model in which social perception mediates the relationship between language and social cognition, the data were examined further via regression analysis. Hierarchical regression of the three constructs was conducted with social cognition as the outcome and the construct of social perception entered into the model first with language entered into the model in the second step. This revealed that social perception accounted for 5% of the variance in social cognition, with language accounting for a further 10% of the variance. Subsequent ANOVA statistics revealed that the model described in the first step (i.e. social perception predicting

social cognition) was significant: $F(1, 125) = 6.52$, $p < 0.05$. However, the model described in the second step (i.e. consisting of social perception and language predicting social cognition) was significant at the 1% level: $F(2, 124) = 10.82$, $p = 0.00$. More crucially however, in terms of the standardised Beta values corresponding to the coefficient of the predictor variables, while social perception was a significant predictor of social cognition within step 1: ($t(125) = 2.55$, $p < 0.05$), it no longer made a significant contribution to the model once language was involved in step 2: ($t(124) = 1.02$, $p = 0.31$). Language, on the other hand, was a significant predictor of social cognition within step 2: ($t(124) = 3.80$, $p = 0.00$). These findings indicate that social perception is a significant predictor of social cognition via its relationship with language and vindicates the decision to opt for a model in which language mediates the relationship between social perception and social cognition, rather than an alternative model in which social perception may have mediated the relationship between language and social cognition.

Discussion

This chapter has described a comprehensive set of analyses in an attempt to address the main aim of the thesis: that is to provide clarification of the constituents of children's social understanding. Several key findings were apparent in relation to the relationships within and between constructs. Firstly, in terms of relationships within constructs, it was evident that the tasks chosen to tap into each construct were suitably similar, and suitably differentiated from tasks relating to separate constructs. The main exception to this was the Eyes task, which - unsurprisingly given earlier reservations - had strong links with language tasks. Nonetheless, in terms of the structural equation models, the Eyes task fitted best into the model when considered as a social-perceptual task alongside the Affect task. This coincided with the

Friendliness task being left out of the final structural model, perhaps due to it being too abstract or subtle in nature to have resembled the other social-perceptual tasks.

Otherwise however, all the within construct correlations were quite distinct, with both social attention tasks being closely related, both social-cognitive tasks being strongly linked and all three language tasks being interrelated. This provided support for the choice of tasks as well as the distinction between constructs. In particular, the decision to regard abilities such as joint attention as dissimilar to typical social-perceptual abilities such as required for the Affect task, and more similar to orienting abilities, appeared to be upheld within each stage of the analysis where joint attention consistently grouped with the orienting task rather than in the social-perceptual construct. This point marks a distinction between the model which was arrived at and the model as proposed by Tager-Flusberg and Joseph (2005). Essentially, their model has been used as a general framework for guiding the investigation of the current study. It is recognised that a departure was made from their model in terms of regarding joint attention ability here as more akin to social attention rather than social perception as conceived by Tager-Flusberg and Joseph. However, this change was made since the social-perceptual construct as defined by Tager-Flusberg and Joseph seemed broader than perhaps it needed to be. Intuitively, joint attention abilities such as following another person's gaze to an object and typical social-perceptual abilities such as "Reading the mind in the eyes" would seem to be inherently different skills. Making a distinction between these abilities was an a priori decision, which had the implication that Tager-Flusberg and Joseph's model was not being explicitly tested. However, such a change is in keeping with the main aim of the thesis which was to clarify the constituents of children's social understanding; thus seeming to make this conceptual distinction justifiable, until at

the very least, the data should indicate otherwise. As it emerged, regarding joint attention as a different type of ability to social perception was appropriate for the current study. That is not to say that the model proposed by Tager-Flusberg and Joseph is inaccurate - indeed it is liable to be more congruent within a longitudinal framework - however, proving or otherwise of Tager-Flusberg and Joseph's model was not the aim of the current endeavour. Rather, in the attempt to clarify the constituents of children's social understanding, at the very least the data point toward the need to distinguish social attention (including social attention) from social-perceptual abilities in 4- to 5-year-olds.

The other main outcome of the current study was to obtain insight into the relationships between constituents of social understanding. Thus, in terms of the relationships between constructs, the SEM produced a final model, supported by regression analysis, which suggests that language is integral to the link between social perception and social cognition. While both social-cognitive tasks were strongly linked with the Eyes task, but neither of the other social-perceptual tasks, both sets of tasks were strongly linked with language. Therefore, this slightly different model of social understanding from that proposed by Tager-Flusberg and Joseph, would support the idea that typically developing 4- to 5-year-olds who are skilled within social perception would have developed sufficient language skills, perhaps through social experiences with other people. Accordingly, the ability to use language to interact with others may then allow children to develop their awareness of other people's thoughts in various situations leading to increasing exposure, experience and expertise of their social-cognitive skills. Such continuity between constituents of children's social understanding is compatible with contemporary research discussed in the preceding literature review which suggests that language

can simultaneously stem from low-level social understanding (i.e. social perception), and lead to high-level social understanding (i.e. social cognition). Furthermore, it is important to note that the opportunity to discuss the possibility of language in such a dual role is only possible through consideration of the broader interpretation of theory of mind/social understanding as it has been embraced within this thesis.

Chapter 7

Is there a different path to social understanding for children with autism?

Having explored Tager-Flusberg and Joseph's model across chapter 6 and established an alternative model of social understanding and language for typically developing children, the overarching aim of the present chapter was to explore the relevance of the paths identified by these models for a group of children with autism. Ideally, this would allow an understanding of the interplay between the constituents of social understanding in children with autism and consequently provide valuable insight into how these children may or may not differ from typical children in the path to social understanding. In the process, this may indicate potential compensatory strategies which may be utilised by children with autism in arriving at some level of social-cognitive understanding. These outcomes would not only further our knowledge of this area of understanding in children with autism and assist in identifying possible areas of intervention, but would also complement our understanding of the function of these abilities within typically developing children. As well as the main aim outlined above, several subsidiary aims were investigated in parallel. For instance, one specific subsidiary aim was to investigate if children with autism have a deficit in orienting per se, or whether their impairment is specific to social stimuli. In addition, given that there are often discrepancies between task performance and everyday abilities in children with autism, a further aim was to explore the relationships between task-based performance, and autistic symptomatology and everyday adaptive functioning.

Introduction

Autism is a complex neurodevelopmental disorder that is characterised by three core features: impairment in social interaction, impairment in communication, and engagement in repetitive behaviours (DSM-IV, APA, 1994). People with autism generally have severe difficulty in interacting with others and understanding the social basis of interaction. Children with such difficulties are likely to exhibit inappropriate social behaviour, to have impairment in their capacity to share attention with others and to generally have a lack of social awareness. In parallel with the movement from cognitive, maturational explanations of theory of mind development to more encompassing accounts focusing on early emerging abilities as happened for typical children, theories describing theory of mind development for children with autism emerged in a similar fashion.

In some quarters it was originally thought that the social and communicative difficulties experienced by children with autism, could be explained by a specific cognitive impairment – namely, a problem with mentalising – i.e. understanding the mental representations of other people. Baron-Cohen et al. (1985) found that the majority of children with autism failed false belief tasks, in contrast to typically developing children and children with Down's syndrome. The failure of children with autism to exhibit theory of mind abilities in this study and many variations of the study thereafter using such social-cognitive measures led to the theory of mind hypothesis of autism. While this top-down explanation of the social deficits experienced by children with autism was very popular, it soon became apparent that it could not sufficiently explain autism. It was clear that the theory of mind hypothesis of autism was not universal as some children with autism were able to pass theory of mind tasks. It was also clear that such an explanation was not unique

to autism as many nonautistic children had problems with traditional theory of mind tasks (e.g., oral deaf children (Peterson & Siegal, 1998)).

In addition to the problems with the theory of mind hypothesis outlined above, it was clear that models in line with the ToM hypothesis of autism such as that proposed by Baron-Cohen (1995), could not explain the range of symptoms experienced by people with autism. As highlighted in chapter 1, work by Mundy and colleagues demonstrated that children with autism have problems with joint attention prior to their problems with representational aspects of theory of mind (e.g., Mundy & Sigman, 1989). Such studies helped to underline that the social and communication deficits experienced by children with autism could not be sufficiently explained by impairments in representational theory of mind understanding. In addition they indicated that social and communication deficits may stem from and be related to early occurring problems in social understanding development such as impaired orienting and joint attention abilities.

Baron-Cohen (1995) revised his original cognitive hypothesis of autism to account for the increasing evidence citing the social-pragmatic problems experienced by children with autism at an age when they had not yet reached the mental or chronological age by which social-cognitive skills normally developed. With the impetus very much on focusing attention upon so-called precursors to social cognition, Baron-Cohen's model (as outlined in chapter 4) suggested that children with autism had an impaired shared attention mechanism (SAM) which then led to an impaired theory of mind mechanism. Within this model, while children with autism were proposed to have intact modules for detecting intentionality and eye direction, Baron-Cohen argued that the impaired SAM was mainly responsible for the joint attention impairments seen in children with autism. In general terms, these

impairments would be expected to have profound consequences for social development since the acquisition of complex communicative skills (e.g., gaze following) requires children to actively attend to and make meaning of social stimuli such as facial expressions and direction of eye gaze.

While Baron-Cohen (1995) modified his model to take account of the evidence of early impairments in social understanding experienced by children with autism, his model retained its cognitive, maturational stance by virtue of its modular nature. In contrast to this absence of any mention of the impact of social experience upon developing social understanding, Klin et al. (2003) proposed their enactive mind approach to understanding the theory of mind difficulties experienced by children with autism. Recognising the need for psychological theory to propose a model of its developmental psychology with a focus on early emerging skills and processes which may have downstream effects, Klin et al.'s account emphasised the role in infancy of motivational predispositions to react to social stimuli. In typical development, these early predispositions then guide the child's understanding through to social cognition with social action providing the basis for such progression (i.e. there is a theoretical parallel with the action basis to the account of social understanding in typical development offered by Carpendale and Lewis). While Carpendale and Lewis simply suggest that the function of the epistemic triangle (around which the action is based) may operate differently for children with developmental disorders, Klin et al. offer greater insight into potential mechanisms underlying the manifestation of theory of mind difficulties in children with autism. They argue that the motivational predisposition to attend to social stimuli is attenuated in autism such that the relative salience and reward value associated with social stimuli is not naturally apparent (compare with TD group as discussed earlier).

As a result of this early emerging motivational deficit, children with autism would then have less opportunity for social experiences and exchanges. This could then create a developmental cascade (see Courchesne, 1997) in which children with autism increasingly fail to attend to social situations and stimuli which may then transact back with the environment and have direct effects upon absence from a whole range of social experiences and delayed or deficient social understanding..

In a similar vein to the origins of the motivational hypothesis outlined by Klin et al. (2003), Mundy and colleagues (1995-2001) focused on early emerging deficits in social understanding in autism. For instance, Mundy et al. argued that the social deficits seen in autism could originate in a neuropathologically based social orienting deficit whereby the opportunities for social interaction via gaze following and behaviours that are necessary for social and cognitive development, are not realised. Dawson and colleagues also supported this approach: in 1998 they explained autism via a bottom-up explanation in which the social-affective impairments were linked to impaired brain structures (e.g., the medial-temporal lobe). Expanding on this in 2004, Dawson et al. reported that while the typically developing infant's attention is drawn to imperfect contingent feedback (i.e. normal social interaction), the attention of children with autism is drawn to more consistent feedback (e.g., non-social stimuli). Therefore, with a failure to devote attention to social cues, Dawson et al. (2004) argued that children with autism miss vital opportunities for acquiring and practicing joint attention skills, which would then have subsequent adverse effects upon language and later aspects of social understanding such as social cognition. This hypothesis and the similar socially-based ones expressed by Mundy et al. and Klin et al. contrast sharply with the cognitive, maturational account of Baron-Cohen (1995)

which had proposed that it is the lack of a shared attention mechanism which is primarily responsible for the joint attention impairments seen in autism.

Taking each of these aforementioned theories into account it is apparent that early emerging abilities/impairments within attention and perception are fundamental to the range of social understanding deficits which are experienced by children with autism throughout childhood and onwards. While Tager-Flusberg and Joseph's (1995) model of social understanding was described earlier in the context of typical development, it is true that this model was first presented by Tager-Flusberg and Joseph in terms of autism. Following on from Tager-Flusberg's first componential model (2001), this more recent model provides a comprehensive framework which encompasses the basis of each theory listed above and provides an opportunity to test the proposed relationships between each aspect of social understanding and language. Within their 2005 model, Tager-Flusberg and Joseph suggested that children with autism have both impaired social-perceptual and social-cognitive knowledge and so the current study provides an opportunity to gauge their hypotheses. In addition, Tager-Flusberg and Joseph proposed their model from the perspective of how language can facilitate the acquisition of false belief understanding in children with autism. So their account also provides an opportunity to gauge the nature of possible compensatory paths to social understanding for children with autism.

Within both of the models proposed by Tager-Flusberg and colleagues (2001 & 2005), they suggest that the roots of the impairment in autism may be seen early in development when infants fail to attend to social stimuli. As a result of impairment to the neurocognitive system, these impairments impede the development of the ability to make online judgements of intentionality and perception of mental states. Thus, they argue that social orienting deficits are the foundation of the social-perceptual

aspects of theory of mind and that the deficits in social cognition experienced by children with autism grow out of earlier deficits in social perception. However, they also argue that for the small percentage of children with autism who are able to display social-cognitive understanding (i.e. on false belief tasks), this success arises via a different pathway – i.e. not via social-perceptual understanding but via language or more general reasoning skills to "hack" out a solution (e.g., Happé et al., 1996). Even the older, higher functioning individuals who are able to pass false belief tasks via this compensatory path are liable to continue to be impaired in tasks tapping social-perceptual understanding.

In attempting to explain how the path to social understanding/theory of mind for children with autism may differ to that for typically developing children, Tager-Flusberg and colleagues linked this into the relative exclusivity of language to arrive at social cognition, whereas they argued that typical children were able to develop social-cognitive abilities from their social-perceptual (and language) abilities. To investigate these model claims further and to complement the investigation of the previous couple of chapters, we now explore the relationships between these constituents of social understanding in children with autism. This will be achieved by again using the Tager-Flusberg and Joseph (2005) model as a template to frame the investigation. As well as analysing the autism group in depth, their performance across the four constructs of social cognition, social perception, social attention and language will be compared to a verbally matched subset of typically developing children. First however, in order to place Tager-Flusberg and Joseph's model within the autism evidence base, we now turn our attention to a review of the key literature within each of the four constructs under investigation – social cognition, social perception, social attention and language.

7.1 Social cognition in autism

As is apparent, the social and communication deficits experienced by children with autism have long been linked with traditional theory of mind difficulties within the domain of social cognition. Indeed, many studies have indicated via false belief tasks that the development of social understanding is significantly related to crucial aspects of social behaviour in children with autism (e.g., Watson, Nixon, Wilson, & Capage, 1999). While it is now generally agreed that these social-cognitive difficulties do not sufficiently explain the range of problems which children with autism experience, it is nonetheless important to continue researching their social cognitive skills and how these relate to other aspects of social understanding and possible compensatory paths such as that offered by language.

The influential study conducted by Baron-Cohen et al. (1985) which tested the social-cognitive skills of children with autism via false belief stories found that they are significantly worse than control subjects in understanding the thoughts and beliefs of others. However, they also found that a minority of individuals with autism were able to pass false belief tasks and many studies have replicated their findings (see Baron-Cohen, 2000, for a review). Further evidence of atypical performance within the social cognition domain by children with autism has been illustrated by Peterson, Wellman, and Liu (2005). In their study of one hundred and forty-five 3- to 13-year-olds – testing deaf children, children with autism and typically developing children on a social-cognitive scale – they found that all three groups followed the same developmental sequence but the autism group displayed a different sequence of understanding in the later stages of the progression. Reinforcing the idea that children with autism show a different pattern of development across social understanding, Carpenter et al. (2002) argued that joint attention skills are likely to emerge *after*

social cognition rather than before it. As well as social attention being implicated as a consequence *of* rather than a precursor *to* social cognition within an alternative path, the role of social perception within the different route to social cognition has been suggested by several studies. For instance, while a study of children with autism found normal levels of reference to desire in mother-child conversations (Tager-Flusberg, 1992), a study by Baron-Cohen, Campbell, Karmiloff-Smith, Grant, and Walker (1995) found that children with autism were impaired in their ability to understand desire within a face expression recognition test. Together these findings suggested that children with autism can achieve a level of social-cognitive understanding irrespective of their social-perceptual knowledge.

The above findings point towards the likelihood of a different developmental pathway for those children with autism who possess some social-cognitive understanding. Therefore, while social attention and social perception abilities may not be present or may be impaired, social cognitive understanding can still occur for children with autism. Much of the evidence in this area suggests that it is those children who have a higher level of language ability who can perform well on social cognitive tasks such as false belief stories (e.g., Tager-Flusberg, 2000). This has been supported by neuropsychological evidence – e.g., Siegal and Varley (2002) reported that children and adults with brain lesions were able to exhibit false belief understanding via the processing of language propositions. In summary, this section has demonstrated that while children with autism almost universally have profound difficulties in social-cognitive understanding, a minority of children can achieve some level of such understanding exclusively via language rather than the typical route of social attention and social perception. The following three sections focus in

turn on each of these three areas in relation to social-cognitive understanding in children with autism.

7.2 Social perception in autism

As indicated above and argued by Tager-Flusberg and Joseph (2005) in their model of social understanding, children with autism often demonstrate impairments in social perception. Much of the research within this area has implicated brain structures as underlying these social-perceptual deficits. For instance, Schultz (2005) summarised three different fMRI studies in autism which have all demonstrated the amygdala to be hypoactive during face-perception tasks (Baron-Cohen et al., 1999; Critchley et al., 2000; Pierce et al., 2001). This led Schultz to suggest that the social-perceptual deficits found in children with autism were due to atypical brain function within the amygdala and fusiform face area. As a result of this dysfunction, Schultz argued that individuals with autism spectrum disorder have a specific deficit in the domain of face processing rather than processing of objects (e.g., Joseph & Tanaka, 2003). Furthermore, he argued that this impairment was liable to be specific to facial expression perception (e.g., as tested on the social-perceptual tasks used throughout this thesis) rather than, for example, recognition of identity. Schultz asserted that faces are less emotionally stimulating for individuals with autism and resultantly these faces do not attract and sustain the attention of an individual with autism to the same extent as a typical person (e.g., Grelotti et al., 2005; Klin et al., 2002). Schultz's argument is congruent with the theoretical perspectives outlined earlier in the chapter which attempted to explain the social and communication deficits seen in autism. In the sense that they all refer to a neurological impairment which adversely affects the individual's motivation to respond to social stimuli, such theories can

embrace the biological and social dimensions thought likely to underpin the social-communicative deficits observed in autism.

In contrast to the views above which posit that the atypical processing of faces and their expression of emotion in autism is due to problems with motivation and social interaction, a paper by Behrmann, Thomas, and Humphreys (2006) proposes an alternative mechanism to underlie the face processing difficulties seen in autism. While Behrmann et al. acknowledge the motivational and social accounts that have been offered to explain the face processing difficulties seen in autism, they propose an alternative view based on the idea that such problems may be due to a visual perceptual impairment which is independent of their social function. However, while they agree that there is considerable evidence indicating atypical face processing in autism, they state that there is surprisingly little consensus concerning the source of such impairment. They refer to Dawson's work which focuses on the lack of motivation toward social stimuli and Behrmann et al. also refer to the work of Baron-Cohen and Belmonte (2005) which suggests that the social deficit may arise from general impairment in empathising and social cognition, and from precursors such as deficits in joint attention. However, Behrmann et al. argue that the root of social-processing impairments in autism may be due to basic perceptual difficulties as observed in the tendency for individuals with autism to focus on local features rather than to extract the overall meaning or gestalt of the stimulus. Such an argument is corroborated by recent findings (e.g., Happé & Frith, 2006) suggesting that the perceptual difficulties seen in autism may be independent of deficits in social behaviour and theory of mind abilities. However, Behrmann et al. did acknowledge that individuals with autism do seem to process faces as if they were objects, thus being unaware/unmotivated to regard the social basis to such stimuli. Therefore,

while children with autism may have problems with social perception in terms of face processing, this may not be specific to social interaction or have a motivational basis and could be due to a general impairment in visual processing.

In summary, this section has conveyed that there is consensus that children with autism have social-perceptual impairments and that this is particularly marked in terms of their ability to process faces and emotional expressions. While it is agreed that these are generally processed atypically, several different explanations have been offered to describe the underlying mechanism for such impairments for individuals with autism. Although Behrmann et al. propose the notion of more general visual impairment affecting children with autism in terms of their face-processing ability, most accounts more readily focus on the likelihood of an early-emerging social deficit underlying such impairment. Reviewing the literature within the area of social attention may provide extra insight into the nature of the mechanism underlying face processing in children with autism since abilities within social attention would be likely to precede their social-perceptual abilities or impairments.

7.3 Social attention in autism

The literature reviewed thus far within the domains of social cognition and social perception has revealed that children with autism generally have impairment in both areas of understanding. The interpretation of the term *social attention* within this thesis has been synonymous with abilities such as orienting to stimuli and sharing attention with others and would appear to be intrinsically simpler than social-perceptual abilities such as interpreting emotion from facial expressions. So what does the evidence look like for social attention abilities or impairments in children with autism? Based on the accounts of Dawson et al. (2004), Klin et al. (2003), Mundy and Neal (2001), and Tager-Flusberg and Joseph's (2005) model, it would be

expected that children with autism would be impaired within the domain of social attention, which would then have downstream effects upon their social-perceptual and social-cognitive understanding. With a recent, strong focus in autism within the area of social attention specifically, does the bulk of evidence support such a viewpoint? Much of the autism research in the domain of social attention has focused on the role of joint attention with less focus upon social vs. nonsocial orienting. Increasingly, research is focusing on the latter as such dyadic-type orienting occurs at a more simplistic level than triadic interaction and so precedes triadic joint attention function. This section will first review some joint attention findings in autism before detailing recent evidence on lower-level social/nonsocial orienting.

It is widely accepted that children with autism have difficulties with joint attention behaviours. Indeed, joint attention ability has been established as a fundamental social-communication impairment in autism which is present by 1 year of age and as such, it is included within the diagnostic criteria for autism (APA, 1994). Leekam et al. (2000) found that children with autism initiate few joint attention behaviours and respond less to adult bids of attention than children with other disabilities. Miller (2006) reviewed the literature on developmental relationships between language and different aspects of social understanding and concluded that early joint attention deficits seen in autism seem to be a crucial aspect of their communicative development. While Carpenter et al. (2002) asserted that when children with autism do develop joint attention abilities, they appear in the typical order of sharing, following, then directing others' attention, Dawson et al. (2004) argued that since instances of joint attention in autism are rarely supported by a shared exchange of emotion, the nature of joint attention and communication will generally be different in autism. Resultantly, children with autism would be less

liable to extract meaning from such interaction and so this would then affect their pragmatic language development.

Numerous studies have demonstrated links between joint attention and language ability in children with autism. A longitudinal study by Sigman and Ruskin (1999) found that the joint attention skills of children with autism were concurrently associated with vocabulary development and predicted long-term gains in expressive language ability. Further evidence of the strong positive link between language ability and social attention was provided in a study which demonstrated that 100% of children with autism with a verbal mental age over 4 years of age were able to spontaneously follow another person's gaze (Leekam et al., 2000). Assessing this link via an intervention, Bono, Daley and Sigman (2004) investigated whether joint attention abilities may moderate the relationship between amount of behavioural intervention and language development in children with autism. They found that joint attention skills were associated with greater language development and the relationship between intervention amount and language gain was dependent on ability to respond to joint attention bids. In addition, more recently Leekam and Ramsden (2006) tested joint attention ability (in terms of gaze following) experimentally and via observation and found very strong developmental effects that were related to verbal mental age. Each of the above studies conveys the strong link which exists between joint attention ability and language development in children with autism.

Corroborating the evidence above for such a link, Dawson et al. (2004) found in their comprehensive study that joint attention was a significant predictor of language in children with autism. Whilst this finding obtained from structural equation modelling (SEM) analyses was noteworthy in itself, Dawson et al.'s study

provided several other findings of interest. They also found that combined impairments in joint attention and orienting were found to best distinguish young children with autism from those without autism. In addition, their SEM revealed that orienting ability was indirectly linked to language ability through their relation to joint attention in children with autism. Also, as they noted within their study, at that time there were few experimental studies on social orienting impairment in autism. Following on from an earlier study (Dawson et al., 1998), Dawson et al. (2004) improved the methodology and replicated their earlier finding that children with autism were less likely to orient to both social and nonsocial stimuli than matched controls, and displayed a more severe impairment in relation to social stimuli. Several other studies have highlighted the issue of a discrepancy between orienting to social and nonsocial stimuli in autism. For instance, Swettenham et al. (1998) showed that 20-month old toddlers with autism looked more briefly at people and longer at objects than developmentally delayed or typically developing toddlers. Also, in the study by Leekam et al. (2000), children with autism were less responsive than developmentally delayed controls in orienting to attention bids, but only when these were social. Slightly aside from the procedure of orienting but still conveying discrepant social/nonsocial processing, it has been demonstrated that children with autism have a relatively intact ability to point referentially to nonsocial stimuli compared to more socially-oriented pointing (Bruinsma, Koegel, & Koegel, 2004).

In summary, this section on social attention has conveyed that joint attention is a source of significant impairment in children with autism and that ability levels of this behaviour are strongly positively correlated with concurrent and later language abilities. In addition, reviewing some of the recent literature on orienting abilities has illustrated that children with autism are significantly impaired in their ability to orient

their attention to stimuli in comparison to developmentally delayed children or matched typical children. This deficit is particularly marked for social stimuli and it has been demonstrated that children with autism generally have a spontaneous preference for nonsocial rather than social stimuli. These findings are congruent with earlier description of various theoretical accounts of the social basis to early emerging interaction deficits experienced by children with autism. This reinforces the suggestion that children, or rather infants, with autism, are liable to have neurological impairments which affect their motivation to attend to and perceive social stimuli such as faces, or results in atypical processing such that the attention of children with autism is drawn to consistent rather than non-consistent feedback from stimuli. Whatever the nature of the underlying mechanism for the early emerging social deficits experienced by children with autism, it seems logical that such deficits reduce the opportunities for typical everyday social interactions. By then transacting back between their environment and developing brain, these early atypical exchanges mark the beginning of a maladaptive and atypical path through social understanding from social attention to social cognition. However, as this section and the social cognition section have conveyed, some children with autism can obtain a certain level of social cognition via relatively intact language abilities, which may link back to early joint attention abilities. The next and final section of this literature review looks at the role of language in social understanding for children with autism.

7.4 Language in autism

As was explained at the outset of this chapter, deficits in communication are among the core diagnostic symptoms which identify autism. While difficulties in pragmatic understanding are common in individuals with autism, the range of ability in other aspects of language can be much more variable. Individual differences in

areas such as syntactic understanding and vocabulary acquisition can lead to a range of ability across social understanding. Within certain accounts of autism (e.g., the theory of mind hypothesis), the variability in language ability has been regarded as shaping rather than stemming from or coinciding with people's social-cognitive abilities. However, as complex as the link has been shown to be for typically developing children, the link between language and social understanding for children with autism is similarly as complex. Previous sections on social attention and social cognition have illustrated the close ties which exist between these domains and language for children with autism. Evidence suggests that children with autism can exhibit relatively intact levels of social-cognitive understanding while being impaired in social attention and social perception. In the absence of typical routes to social cognition via social attention and social perception, language has been shown to be influential in compensating for these impairments to arrive at more typical understanding within social cognition. Therefore, much of the research examining language and social understanding in autism has examined the relationship between language and social cognition.

While social attention and social perception impairments are particularly marked in children with autism, language is closely entwined with social cognition by virtue of the comparative success which tends to exist between measures from both domains. For instance, Eisenmajer and Prior (1991) found that pragmatic ability and verbal mental age were greater in children with autism who were able to pass false belief tasks. Also, several studies have demonstrated a positive correlation between false belief understanding and vocabulary knowledge in children with autism (e.g., Happé, 1995; Sparrevohn & Howie, 1995). In addition, as explained within the section reviewing social cognitive understanding in autism, children with

autism who are more able in areas of language such as syntactic ability can often display more intact levels of social-cognitive understanding. For example, while Tager-Flusberg and Sullivan (1994) found that vocabulary scores were significantly correlated with false belief performance in children with autism, they found that false belief ability was more strongly correlated with children's syntactic abilities. Such relationships between syntax and false belief understanding correspond closely with those identified in typically developing children (e.g., de Villiers & Pyers, 2002).

While it is agreed that links exist between social cognition and language in both typical and atypical development, the nature of the relationship in autism is debated as it was for the typical children described earlier. In the absence of social attention and social perception, some researchers argue that language ability is required in order for children with autism to be able to cope with the verbal demands of false belief tasks – and these children utilise language in a non-intuitive, cumbersome way to be able to "hack-out" solutions and exhibit social-cognitive understanding (e.g., Happé, 1995). In accordance with the account of social understanding in typical development (e.g., Carpendale & Lewis, 2006), a different perspective asserts that language and social-cognitive understanding are closely linked in autism due to the fact that both aspects of understanding are grounded in the context of social interaction and conversational discourse (e.g., Garfield et al., 2001).

Aside from the perspectives above, one view - which is also popular within typical development - explains the success of a minority of children with autism on false belief tasks in terms of their syntactic language abilities. Indeed, Tager-Flusberg (2000) found that knowledge of sentential complements was the single best predictor of false belief performance for children with autism. The importance of syntactic

ability for false belief understanding has been underlined in the context of typical development – theoretical and empirical work by de Villiers and de Villiers (2000) in particular has demonstrated the influence of syntactic understanding upon false belief understanding. In autism however, syntactic understanding of sentential complements has been argued to provide a more exclusive role in facilitating social-cognitive understanding. In their model of social understanding in autism, Tager-Flusberg and Joseph (2005) suggest that children with autism can exhibit false belief understanding via their syntactic language ability which compensates for impairments within social attention and social perception. Thus, sufficient understanding in the use of sentence complements can provide children with autism with insight into their function and provide the opportunity to reason logically about false belief stories, and by bootstrapping a fragile notion of false belief understanding in this way, it is possible to bypass the typical route to such understanding. Therefore, while typical children would be expected to draw upon abilities within social attention, social perception and language in understanding social cognition, children with autism may achieve success on social-cognitive tasks exclusively on the basis of their language abilities. However, it remains true that success on structured false belief tasks often does not necessarily correspond with success in negotiating everyday social interactions (Travis, Sigman, & Ruskin, 2001).

In summary, it seems apparent from the evidence above that language is crucial for children with autism if they are to have any ability in understanding the mental states described in false belief stories. While the majority of children with autism have impairments in most aspects of social understanding – i.e. social cognition, social perception and social attention as well as language, the review of the evidence here has revealed that a minority of children with autism are able to pass

social-cognitive tasks. This minority generally rely on their language ability (often in terms of syntactic understanding) to bolster a fragile concept of false beliefs and social cognition. However, even those children with autism who have some level of social-cognitive understanding due to their language ability generally do not find that this understanding necessarily transfers to understanding the thoughts and beliefs of others in online everyday social situations. Nonetheless, language has been shown to be the single most significant prognostic factor for long-term cognitive, social and adaptive outcomes in autism (Howlin, Mawhood, & Rutter, 2000). Furthermore, since language has been shown to compensate for impairments in lower-level social understanding, it is an important area to study when considering atypical routes to social understanding in children with autism.

7.5 Summary and hypotheses

Reviewing the main literature in the domains of social cognition, social perception, social attention and language has conveyed the extent of impairment within the domains of social understanding and language for children with autism. Traditionally, researching this population has focused on social-cognitive difficulties and performance deficits on false belief tasks to the extent that the theory of mind hypothesis was once a plausible explanation of autism. However, recent research has illustrated that children with autism have difficulties with social orienting and joint attention prior to their problems with social-cognitive understanding. These findings coincided with accounts which focused on early emerging impairments in the domains of social attention and social perception. While deficits in these areas are almost universal in autism, some children with autism are able to compensate for these impairments by way of their language abilities. In these cases (such as found in high-functioning autism and Asperger syndrome) individuals with autism can use

their relatively intact language skills to enable some understanding of social cognition as evidenced on false belief tasks. However, even in this atypical route to some level of social-cognitive understanding, it is often the case that success on false belief tasks does not correspond with success in on-line everyday social interactions.

This chapter will test the predictions which follow from Tager-Flusberg and Joseph's (2005) model, while simultaneously testing the final model which resulted from the structural equation modelling for the large sample of typical children within chapter 6. Tager-Flusberg and Joseph interpreted the research field of social understanding in autism in the following way within their model. They suggested that in autism, there is fundamental impairment from infancy onwards in social-perceptual abilities. As pointed out within chapter 4, Tager-Flusberg and Joseph's definition of social perception jointly encompasses both social attention and social perception; in contrast these abilities have been explicitly distinguished within this thesis. Irrespective of the more inclusive structure of Tager-Flusberg and Joseph, it follows that this domain of ability is impaired in autism from an early age and resultantly, such deficits in social attention and social perception lead to profound impairment in their social-cognitive understanding. However, they argue that a minority of children with autism are able to develop the ability to succeed on false belief tasks despite social-perceptual deficits via their language ability, particularly semantic and syntactic understanding of verbs of communication. Thus on the basis of their model and the 4 distinct constituents of social understanding which the group of children with autism were tested upon, the following hypotheses were made. It could be predicted from their model that social attention and social perception – while distinguished here – would be strongly correlated since Tager-Flusberg and Joseph group these domains together and believe this component is fundamentally

impaired. Since the children with autism to be tested here were not particularly high-functioning it was expected that language and social cognition would be interrelated with social attention and social perception, by virtue of all eliciting low levels of ability. However, in cases where language abilities were relatively intact, it would be expected that this would correspond with improved social cognition, and resultantly, if a relatively strong link was found between language and social cognition, this may be expected to coincide with weaker links between social attention and social perception with these domains.

On the basis of the evidence reviewed above and the model of social understanding resulting from the SEM for the large cohort of typical children in chapter 6, slightly different predictions may be made compared to those pertaining to Tager-Flusberg and Joseph's (2005) model. Firstly, the new model would not predict the strong link between social attention and social perception; this contrasts with the prediction stemming from the model of Tager-Flusberg and Joseph. Secondly, while the role of language in facilitating the false belief understanding for children with autism is not questioned, it seems reasonable to assert that those children with autism who have relatively intact language abilities may also have some level of social-perceptual understanding in addition to possible compensated social-cognitive ability. This assertion is based on the premise that some children with autism can interact with others at a perceptual level (albeit atypically and generally non-socially), which may then provide some opportunity to understand the language of communication. Furthermore, the social-perceptual tests used within this study require a certain level of language ability in order to process the thoughts and feelings which feature throughout the test, so a significant link between social perception and language is a possibility in the context of the new model. Testing the

four constructs of social cognition, social perception, social attention and language for children with autism here will provide an interesting test of the relevance of Tager-Flusberg and Joseph's (2005) model and of the usefulness of the new model from chapter 6 for paths to social understanding in autism. It would seem that both models would predict that these language-matched groups should not differ significantly in terms of their social-cognitive abilities, although this may pertain more to our model as opposed to Tager-Flusberg and Joseph's model as they argue the case for the exclusive role of syntactic language ability. Nonetheless, given the apparent central role of language in terms of both models for typical children and children with autism, the comparison of groups of typical children and children with autism matched on language should provide a valuable insight into the nature of compensation in the social understanding abilities of children with autism which is provided by language.

Method

Participants

24 children with autism - 18 males and 6 females - were tested in the present study. All children were diagnosed with autism and were located in autism-specific schools or schools with a specialist autism unit. Children were recruited from 3 schools via parental opt-in consent. Chronological ages ranged from 4 years and 5 months to 17 years and 7 months, (mean: 13 years and 0 months; SD: 3 years and 10 months). However, for purposes of matching these children to a subset of typically developing children from the previous study, children's verbal mental ages (as measured on the BPVS) spanned a more restricted range: 3 years and 1 month to 12 years and 1 month (mean: 6 years and 11 months; SD: 2 years and 7 months).

Materials and Procedure

Ethical approval for this study was granted by the National Autistic Society, after which, parents of children with autism were recruited via opt-in consent from national NAS or NAS-accredited schools. In each of the three schools that participated, children with autism whose parent had consented were tested by the experimenter in small compact rooms (of similar dimensions to those described in the previous chapter). In order to compare social understanding and language abilities of children with autism to the large group of typically developing (TD) children described in the previous chapter, the experimental design of this study was the same as that employed for the TD study. Therefore, the materials and equipment which were used here were exactly the same as those used in the previous study.

In order to provide a valid comparison of the social understanding and language abilities of children with autism to those of the TD children, all children with autism were given the same battery of tasks as the TD children. Therefore, each child with autism was tested on two social-cognitive tasks, three social-perceptual tasks and two social attention tasks as outlined in chapter 6. They were also tested on the BPVS to obtain verbal mental ages which could be matched to the TD children. As for the TD children, children with autism also received 2 subtests of the WASI – namely, vocabulary and matrix reasoning.

Similar to parents of TD children, parents of the children with autism were asked to complete the Children's Communication Checklist-2. In addition, to provide more information on the symptomatology of children with autism in our sample, parents were also asked to complete the Social Communication Questionnaire (SCQ) (Rutter, Bailey, & Lord, 2003). This measure provides a dimensional measure of ASD symptomatology in terms of abilities or impairments within the domains of

reciprocal social interaction, language and repetitive behaviours. Consisting of 40 items, this test offered a straightforward and quick way for parents to indicate their child's language and social behaviours. A cut-off score of ≥ 15 indicates the likelihood that an individual has an autism spectrum disorder and gives some insight into symptom severity.

Also, to provide us with further indication of the symptomatology of children with autism, a final questionnaire was issued: the teachers who worked most closely with the children were asked to complete the classroom edition of the Vineland Adaptive Behaviour Scales (VABS) (Sparrow, Balla, & Cicchetti, 1985). This provided a standardised assessment of a wide range of children's everyday social and non-social behaviours. Sparrow et al. define adaptive behaviour as performance of the daily activities required for personal and social sufficiency. The questionnaire contains 244 items (measuring across 4 domains: Communication, Daily Living skills, Socialisation, and Motor skills) and takes about 30 minutes for teachers to complete. Opting for the Classroom edition provided a measure which was both economical (in terms of time saved interviewing parents) and ecological (in terms of a comprehensive summary of everyday abilities as perceived by an individual working closely with the child on a daily basis).

The procedure of testing children with autism was the same as the procedure used to test the typically developing children. There were only three exceptions: firstly, it was necessary to test some children with autism over 3 rather than 2 sessions in order to ensure that their concentration levels were less likely to adversely affect their task performance. Secondly, in a few instances, testing occurred in the presence of the child's support worker (though this presence remained understated for the majority of the time). Neither of these exceptions affected children's

performance adversely or otherwise. Finally, during administration of a handful of joint attention trials it was necessary to call the child's name in order to gain initial attention prior to the onset of the trial. Otherwise, the overall procedure followed in the same fashion as was described within chapter 6.

Results

The results section is divided into three parts: part 1 focuses primarily on the general performance of children with autism across all tasks. However, within this section, some comparison will be made with the overall typical sample of children tested earlier within the thesis on the same battery of tasks. Part 2 then briefly examines the relation between the task-based abilities for the whole autism group and their autistic symptomatology to determine the nature of any discrepancy between their performance on structured tasks and function in everyday tasks. These first two sections provided an opportunity to illustrate the level of ability or impairment across a range of social understanding and language tasks in children with autism. Part 3 then consolidated the preceding two results sections and grounded the abilities of children with autism in the context of typical development by focusing analyses more explicitly on possible different paths through social understanding for children with autism in comparison to typically developing children. This was investigated by matching children with autism to a subset of the large sample of typically developing children documented in chapter 6. Matching children on their language ability as evidenced on the BPVS enabled direct comparison of these two groups of children across all 3 of the constituents of social understanding which have been investigated throughout this thesis.

7.6 Results part 1: General performance of children with autism across social understanding and language tasks

A full data set was achieved with the following exceptions: one child did not cooperate in listening to the false belief or ignorance stories and did not complete the friendliness task. 4 other children did not cooperate in completing the eyes task. Finally, one child completed 2 of the 4 sections of the social-perceptual Affect task, and so her score was averaged over the whole task. With regard to the number of questionnaires which were returned from a total of 24, 17 Children's Communication Checklist-2 and 19 Social Communication Questionnaires were completed and returned by parents, and 22 Vineland Adaptive Behaviour Scale questionnaires were completed and returned by teachers. While missing values were replaced within the large-scale study of typically developing children reported in the previous chapter, missing values were not replaced within the present study given the smaller sample size and the heterogeneous nature of abilities in children with autism.

Next, the normality of the dataset was examined using histograms, q-q normality plots and Shapiro-Wilk statistics. The graphs suggested that several of the variables were skewed, including: the Affect and friendliness tasks, both social-cognitive tasks and the BPVS and syntax measures. The distributions for the remaining variables appeared to be relatively normal. This interpretation was supported by Shapiro-Wilk statistics: only the orienting task, joint attention task, Eyes task and WASI test had non-significant values, indicating that these variables were normal. Shapiro-Wilk statistics for the remaining variables were significant at the 5% level. Given the extent of non-normality within the dataset, the relationship between variables was analysed using non-parametric correlations (Spearman's rho).

Prior to correlation analysis however, descriptive statistics are outlined below in Table 7.1 for all the variables which children with autism were tested on (except the Social Communication Questionnaire and the Vineland Adaptive Behaviour Scales – these will be summarised in Part 2 of the results). As mentioned at the outset of the results section, the differences in social understanding between the group of children with autism and typically developing children will be examined explicitly via a language-matched dataset in part 3 of the results. However, for the benefit of providing an initial picture of differences in paths to social understanding, this part will highlight some of the similarities and contrasts in ability between children with autism and the large group of typical children.

As Table 7.1 shows, as was expected, children with autism performed more poorly across all the social understanding and language variables than the typically developing children who were tested on these variables within chapter 6. From simply looking at the differences in group means, it appeared that children with autism are particularly impaired in the areas of social cognition and language, with performance on social attention and social perception tasks eliciting less of a group difference. Table 7.1 conveys that the social-perceptual mean scores for children with autism did not differ greatly from those obtained for the typically developing group. Meanwhile, for the two social-cognitive tasks it can be seen that in a similar way to the typical children described in chapter 6, children with autism found the composite ignorance tasks to be easier than composite false belief tasks. However, as expected, children with autism showed relatively poor performance on both composite social-cognitive tasks with mean levels below 50% on both variables. In terms of performance on the three language variables, children with autism showed marked deficits in comparison with the typically developing children.

Table 7.1

Means and standard deviations of performance on the 10 social understanding and language variables for children with autism

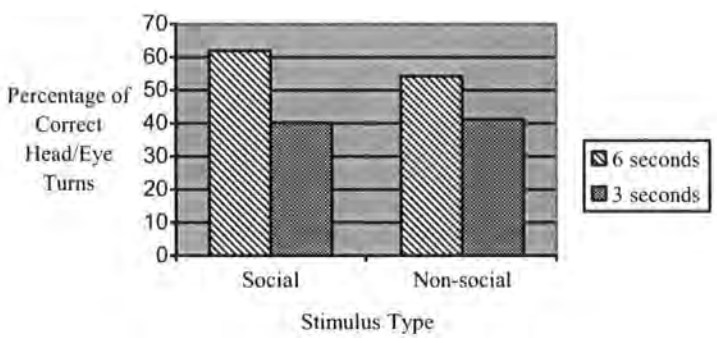
Variable/Task	Mean (Mean of TD children in chapter 6)	Standard Deviation
orienting	4.70 (6.40)	1.94
joint attention	3.57 (4.09)	1.70
affect	47.54 (51.83)	14.10
eyes	11.88 (12.57)	3.41
friendliness	25.56 (26.24)	15.15
ignorance	3.60 (6.33)	2.79
false belief	1.38 (4.78)	1.82
BPVS	61.54 (105.21)	22.56
syntax	2.00 (8.66)	2.40
WASI	74.00 (98.67)	12.46

However, in terms of general task performance, the area of most interest in the group of children with autism was the social attention construct, in particular the range of performance on the adapted version of Dawson et al.'s (2004) orienting task. From Table 7.1 it can be calculated that children with autism correctly responded to a similar percentage of orienting and joint attention trials – 59% and 60% respectively. This pattern contrasts with the findings obtained for the typically developing group in which children correctly responded to 80% of orienting trials and 68% of joint attention trials.

Before graphically comparing children with autism and typical children's performance on the adapted version of Dawson et al.'s orienting task, Figure 7.1

presents the percentage of trials on which children with autism responded to social vs. non-social orienting trials within 6 seconds and the more stringent classification of 3 seconds (as it was defined alongside the 6 second criterion within the methodology section of chapter 6). As Figure 7.1 shows, within 6 seconds of the delivery of trials, children with autism correctly oriented their attention on average to a higher percentage of social (62%) than non-social (54.3%) stimuli. However, within the 3 second criterion, this direction was reversed: children with autism correctly attended to 40.25% of social trials and 41.25% of non-social trials.

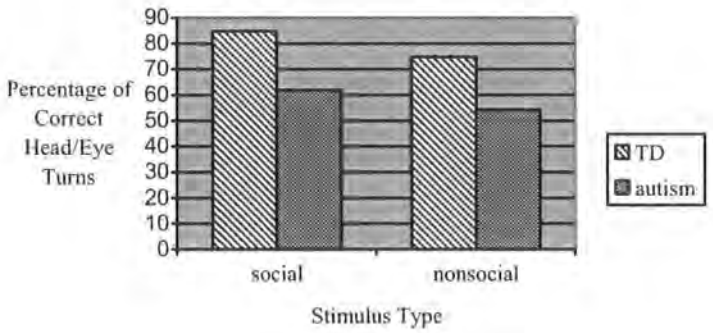
Figure 7.1 *Percentage of correct head or eye turns to social and non-social stimuli by children with autism*



To compare the orienting abilities of children with autism and the typically developing children described in chapter 6, Figure 7.2 summarises the percentage of correct head/eye turns to social vs. non-social orienting trials by the group of children with autism and the whole group of typical children (n = 127) within the 6 second criterion. This figure illustrates that children with autism more frequently failed to orient their attention to both types of stimuli, and that this impairment was more severe for social stimuli. Furthermore, these findings were more extreme when the 3 second criterion was used: TD children correctly oriented to 76% of social stimuli compared to only 40.3% of children with autism (i.e. a difference of almost 36%),

while TD correctly oriented to 66.5% of non-social stimuli compared to 41.25% of children with autism (i.e. a difference of 25%). The general picture provided by these differences is congruent with the nature of the differences outlined in the original Dawson et al. (2004) task, suggesting that the adapted version of the task is comparable. However, due to the discrepant sample sizes between the autism group (N =24) and the large typical group (N=127), as well as the fact that Dawson et al. compared an autism group with a matched typical group, the explicit comparison between the findings from the current study and those of Dawson et al. will be examined within part 3 of the results which outlines the explicit comparison between children with autism and typical children based on matched groups of equal size.

Figure 7.2 *Percentage of correct head or eye turns to social and non-social stimuli within 6 seconds*



In terms of joint attention abilities, analysis of the accuracy in responding revealed that children with autism correctly responded to fewer joint attention trials than typically developing children within both the 6 seconds and 3 seconds criteria. Approximately 60% of trials were correctly responded to by children with autism, while 68% of trials were responded to correctly by typically developing children – this difference was not significant, $\chi^2(1) = 1.61$, $p = 0.20$. However, within the more stringent criterion of 3 seconds, approximately 16% fewer trials were correctly

responded to by children with autism (47.2% for children with autism vs. 62.7% for typically developing children) and this difference was significant, $\chi^2(1) = 5.17$, $p = 0.02$. Therefore, compared to typically developing 4- to 5-year-olds, children with autism were significantly impaired in their ability to respond to bids of joint attention, but only within the more stringent 3 second criterion. This may suggest that the discrepancy between sharing attention with others is less marked as the time from trial onset increases. Nonetheless, using the joint attention passing criteria as used by Leekam et al. (1997) and as adopted within the previous chapter (i.e. at least 4/6 successful joint attention trials), it was found that 45.8% of the autism group correctly attended to at least 4/6 trials compared to 69% of typically developing children. This difference between groups in passing at least 4/6 joint attention trials was significant, $\chi^2(1) = 10.82$, $p < 0.01$. In sum, given the general difficulties exhibited by children with autism in the domain of social attention, both social attention tasks produced findings for the autism group which were expected in comparison to typically developing children's abilities.

Correlation analysis of social understanding and language variables

As mentioned earlier, due to several skewed variables, the data were analysed using Spearman's rho correlations. The nonparametric correlations were only marginally different to the parametric correlations - within the parametric correlation matrix, syntax was significantly associated to the Eyes task and ignorance was not associated with the Eyes task, otherwise all other significant correlations were congruent across both matrices. However, despite these two discrepancies, given the small sample size as well as the number of skewed variables, nonparametric analyses were selected. Table 7.2 presents the resultant nonparametric correlation matrix.

Table 7.2

Nonparametric correlation matrix of 10 social understanding and language variables in children with autism

Indicator	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. Social attention – Orienting	1									
2. Social attention – Joint attention	-.17	1								
3. Social perception – Affect	-.30	-.10	1							
4. Social perception – Friendliness	-.09	.00	.47*	1						
5. Social perception – Eyes	.32	-.33	.64**	.40	1					
6. Social cognition – False belief	.22	-.22	.41*	.38	.24	1				
7. Social cognition – Ignorance	.30	-.16	.50*	.50*	.43*	.81**	1			
8. Language – BPVS	.14	-.01	.44*	.59**	.30	.43*	.41*	1		
9. Language - CCC-2 (syntax)	.01	-.32	.64*	.31	.40	.27	.44	.31	1	
10. Language - WASI	-.17	-.29	.60*	.34	.39	.39	.40*	.66**	.50*	1
	*: significant at 0.05 level **: significant at 0.01 level									

Interestingly, it can be seen that the ability of children with autism to respond to social attention trials (whether via the orienting or joint attention task) was not significantly related to any other variables – this was congruent with the findings for the large typically developing (TD) group of children described in the previous chapter. However, in contrast to the findings for the TD group, there was no association between the two social attention tasks – this may be due to the smaller sample size of the autism group, but this idea will be explored further in the matched

analyses later in this section. Further examination of Table 7.2 revealed that the social-perceptual Affect task was significantly related with every variable other than the social attention tasks. Indeed, it was highly correlated with both other social-perceptual tasks and its strong link with the syntax measure seems particularly noteworthy given that this language measure was based on only the 17 children whose parents responded to the CCC-2 questionnaire. The apparent importance of the link between the social-perceptual Affect task and syntactic ability is underlined by the absence of a significant relationship between syntax and any other variable.

Similar to findings for TD children within the previous chapter, the social-perceptual tasks appear to cluster together well for children with autism with all intra-correlations being significant at least at the 5% level. Furthermore, these tasks would appear to hold together more strongly than for the typically developing sample since performance on the Eyes and Friendliness tasks was significantly associated for the autism group but not for the whole sample of TD children. The two social-cognitive tasks were also strongly correlated for children with autism, $r = 0.80$, $p < 0.01$. While performance of children with autism on the composite ignorance task was significantly related to most other variables (other than the social attention tasks), the composite false belief variable was only related to the Affect, ignorance and BPVS tasks. However, the reduced number of significant links for this social-cognitive measure with other variables in comparison to the composite ignorance task suggested that the non-normality of false belief understanding for children with autism was likely to be sufficiently skewed to gloss over potential significant relationships. Despite the skewed nature of their false belief understanding, finding that this ability was significantly related to language abilities (BPVS) of children with autism and finding that their performance on the other social-cognitive task was

related to each of the three social-perceptual tasks as well as the two experimental language-based tasks, suggested an intertwining of these three abilities (i.e. social perception, language and social cognition) in children with autism. Finally, the language/IQ construct appeared to hold together relatively well for the autism group with their performance on the WASI task being significantly linked to both BPVS performance and syntactic ability.

While many of the same relationships identified within the typically developing group of children were found here with children with autism (on first inspection certainly), the more heterogeneous nature of the group of children with autism in terms of age suggested that it would be necessary to conduct partial correlations while controlling for age. These are displayed below in Table 7.3. When controlling for age, the partial correlation matrix did not differ greatly from the original correlation matrix displayed in Table 7.2. The only differences were that after partialling age out, the links between Eyes and Friendliness tasks, and between Eyes and ignorance tasks were not significant, while there was now a significant correlation between the Eyes and syntax measures. These differences may suggest that once the age of children with autism has been taken into account, their performance on the Eyes task is explained more by language ability and less by social-perceptual or social-cognitive performance (two language measures are significantly correlated with the Eyes task, whereas the social-perceptual Affect task provides the only other significant link with Eyes task performance).

Table 7.3

Partial correlation matrix of 10 social understanding and language variables while controlling for chronological age

Indicator	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. Social attention – Orienting	1									
2. Social attention – Joint attention	-.20	1								
3. Social perception – Affect	-.27	-.13	1							
4. Social perception – Friendliness	-.10	.11	.56**	1						
5. Social perception – Eyes	-.24	-.31	.68**	.38	1					
6. Social cognition – False belief	.09	-.21	.41*	.26	.18	1				
7. Social cognition – Ignorance	.24	-.14	.48*	.44*	.29	.82**	1			
8. Language – BPVS	-.10	-.10	.64**	.69**	.39	.73**	.79**	1		
9. Language - CCC-2 (syntax)	.04	-.29	.52*	.31	.50*	.15	.30	.38	1	
10. Language - WASI	-.16	-.31	.55*	.34	.41*	.40	.46*	.57**	.54*	1
	*: significant at 0.05 level **: significant at 0.01 level									

Both correlation matrices thus far have suggested that language (particularly BPVS performance) plays a strong role within the social-perceptual and social-cognitive abilities of children with autism and the link between their social-cognitive and verbal abilities has been evidenced many times (see earlier discussion). Given these points, partial correlations while controlling for BPVS standard scores are presented below in Table 7.4. (In depth analyses based on matched typically

developing and autistic samples in terms of BPVS age equivalents (i.e. verbal mental ages) are discussed in Part 3 of this results section).

Table 7.4

Partial correlation matrix of social understanding and language variables while controlling for verbal mental age

Indicator	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. Social attention – Orienting	1									
2. Social attention – Joint attention	-.20	1								
3. Social perception – Affect	-.22	-.18	1							
4. Social perception – Friendliness	.00	.13	.30	1						
5. Social perception – Eyes	-.18	-.35	.59**	.19	1					
6. Social cognition – False belief	.31	-.31	-.11	-.29	-.13	1				
7. Social cognition – Ignorance	.54**	-.23	-.02	.00	.02	.62**	1			
8. Language BPVS	-.03	-.05	.32	.37	.02	.22	.24	1		
9. Language CCC-2 (syntax)	.10	-.31	.41	.14	.41	-.16	.06	.16	1	
10. Language - WASI	-.12	-.29	.43*	.18	.23	.15	.21	.57**	.45	1
	*: significant at 0.05 level **: significant at 0.01 level									

This partial correlation matrix suggests that once language is taken into account (i.e. children's verbal mental ages) then the only remaining significant relationships are primarily within constructs – i.e. two social-perceptual tasks remained highly correlated: Affect-Eyes: $r = 0.59$, $p < 0.01$; both social-cognitive tasks were

significantly correlated: $r = 0.62$, $p < 0.01$; and the language measures were highly correlated: BPVS-WASI: $r = 0.57$, $p < 0.01$ and despite the small sample size which existed for the syntax measure, this was highly (though not significantly) correlated with the WASI: $r = 0.45$, $p = 0.079$. In terms of significant relationships *between* constructs, Table 7.4 reveals that the social attention orienting measure was significantly correlated with the social-cognitive ignorance task, $r = 0.54$, $p < 0.01$. This finding was interesting because of the absence of a significant relationship between either of the social attention tasks and any other variable in earlier analyses within the present study or indeed at all within the large group of typically developing children described in the previous chapter. Otherwise, the only two significant correlations both point to relationships between the constructs of social perception and language: Affect-WASI: $r = 0.43$, $p < 0.05$; and at the 10% level of significance, Friendliness-BPVS: $r = 0.37$, $p = 0.086$. The suggestion of such relationships between constructs as indicated by the correlations between tasks was investigated in greater detail in the following section, Part 2, alongside the investigation of whether or not there is a discrepancy between these task-based abilities and everyday function as suggested by the Vineland Adaptive Behaviour Scales and the Social Communication Questionnaire.

7.7 Results part 2: Autism symptomatology and relationships between construct aggregate scores for social understanding and language

Since the size of the autism sample was not sufficient to enable structural equation modelling to be conducted, it was not feasible to examine the factor structures and loading of tasks on to constructs as was possible for the large typically developing group of children tested in chapter 6. Nonetheless, in an effort to provide comparison to the modelling of relationships obtained in the previous chapter to the

relation of such abilities in the present study, aggregate scores were calculated for each child with autism for each latent construct (i.e. social attention, social perception, social cognition and language). From the aggregate score for each child on each construct, it was possible to analyse how these (total) constructs of ability related to one another, in a bid to determine if the relationships between aspects of social understanding and language bore any similarity to those obtained in the structural equation model for the large sample of typically developing children. Earlier correlation analysis, even after partialling language out, had suggested similar within-construct structures to those obtained for the typical group – i.e. both social-cognitive tasks were strongly correlated; the social-perceptual Affect and Eyes tasks were highly correlated and the language measures were strongly linked. Therefore, given the similar within-construct structure found in chapter 6 to that identified here for the autism group, aggregate scores for each construct for the autism group were calculated accordingly by summing the variables which appeared in the final structural model of social understanding for typically developing children. Since the final model structure in chapter 6 had only two social-perceptual tasks (namely the Affect and Eyes tasks), the scores from these two were summed to create the aggregate score (i.e. excluding the Friendliness task) for the construct of social perception. As the constructs of language and social cognition consisted of 3 and 2 tasks respectively within the final structural model of social understanding for typical children, the aggregates for these constructs were obtained here by summing the following tasks: BPVS standard score, WASI IQ score and syntax scaled score for the language construct; and the average false belief composite and average ignorance composite scores for the social cognition construct. In addition, although the construct of social attention did not appear in the final model of social understanding

in chapter 6, it was included here for completeness in the unlikely event that the aggregate score for this construct was related to one of the other constructs. The aggregate score for social attention was equal to the sum of the overall score for children with autism to correctly respond to 6 joint attention and 8 orienting trials.

Analyses of normality for each of the aggregate scores via histograms and Shapiro-Wilk statistics revealed that each of the constructs was normally distributed with the exception of social cognition. Therefore, nonparametric correlations were calculated. However, before looking at the relationships between constructs, the relation of these abilities to children's autism symptomatology as indicated by the Social Communication Questionnaire (SCQ) and Vineland Adaptive Behaviour Scales questionnaire (VABS) was investigated. Of the 19 SCQ's which were returned, 14 of the children with autism had scores which were greater than or equal to the cut-off of 15, indicating that their profile was strongly suggestive of autism symptomatology in terms of their impairments within the domains of reciprocal social interaction, language and repetitive behaviours. From the 22 VABS questionnaires which were returned, the overall scale of adaptive behaviour and individual scales of Communication, Daily Living Skills, and Socialisation were analysed in terms of children's age equivalents. Table 7.5 displays descriptive statistics for each of these scales of the VABS. On average, it can be seen that children with autism had overall adaptive behaviour scores equivalent to typically developing 5- to 7-year-olds (recall that children's chronological ages within the present study ranged from 4 years and 5 months to 17 years and 7 months, mean = 13 years and 0 months). Indeed, for all 22 of the children whose teachers responded, the perceived level of adaptive behaviour resulted in an age equivalent which was considerably lower than their chronological age. Furthermore, Table 7.5 conveys that

children's socialisation skills (comprising their interaction with others, their abilities within play and leisure time, and their responsibility and sensitivity to others) were particularly impaired, comparable to the social skills of typically developing 4- to 5-year-olds.

Table 7.5

Descriptive summary of children's age equivalents on the VABS scales

VABS scale	*Mean*	*Minimum*	*Maximum*	*SD*
Adaptive behaviour	70	26	142	33
Communication	73	27	150	33
Daily living skills	78	27	138	36
Socialisation	58	14	156	39
	Based on 22 returned questionnaires. All figures are in months.			

In terms of how the range of children's adaptive behaviours and communication skills encompassed by the above questionnaires related to their abilities across the various constructs of social understanding and language, nonparametric correlations were used to investigate these relationships. Table 7.6 presents the range of correlations between abilities tapped by the questionnaires and abilities as defined by the construct aggregates of social attention, social perception, social cognition and language. Social attention and language abilities were not significantly related to any of the social skills or behaviours identified within the SCQ or VABS. There is a marked contrast in how the two other constructs relate to the VABS. The social-perceptual abilities and social-cognitive abilities of children with autism were significantly related to several different aspects of their adaptive behaviour, in particular their socialisation skills. This finding is interesting yet not

surprising given that children's socialisation and interaction with others would be likely to require and then transact back on their abilities to gauge other people's feelings from facial expressions and predict other people's behaviour on the basis of the child's knowledge and beliefs.

Table 7.6

Nonparametric correlations between SCQ, VABS and aggregate constructs of social understanding and language for children with autism

	Social attention	*Social perception*	*Social cognition*	*Language*
SCQ	-.29	-.24	-.16	.04
VABS – Adaptive Bhvr.	.03	.62**	.56**	-.01
VABS - Communication	.03	.62**	.47*	.06
VABS - Daily living	-.21	.59**	.42	-.12
VABS - Socialisation	-.05	.71**	.61**	.16
	*: significant at 0.05 level **: significant at 0.01 level			

Focusing now on the relationships between the 4 aggregate constructs mentioned above, nonparametric correlations for these are presented in Table 7.7. Confirming earlier analysis it can be seen from Table 7.7 that social attention abilities were not related to social perception, social cognition or language in children with autism. Similarly, social cognitive abilities were not significantly related to abilities within other domains. However, the relationship between social cognition and both social perception and language did approach significance ($p = 0.07$ and $p = 0.06$ respectively), suggesting that a larger group of children may have resulted in significant relationships between these constructs. Regardless of the sample size,

Table 7.7 conveys that the constructs of social perception and language were significantly related, p = 0.007. This finding is congruent with the strong link between social perception and language which was identified for typically developing children via structural equation modelling in the previous chapter.

Table 7.7

Nonparametric correlation matrix of construct aggregate scores for children with autism

Construct (N=24)	*Social attention*	*Social perception*	*Social cognition*	*Language*
Social attention	1			
Social perception	-.35	1		
Social cognition	.15	.38[1]	1	
Language	-.06	0.54**	0.39[2]	1
	**: significant at 0.01 level [1] : p = 0.07; [2] : p = 0.06			

Furthermore, given that the link between overall language abilities and overall social cognition neared significance, as well as the relationship between social perception and social cognition, together the above findings suggest that a similar model to the aforementioned structural model may be applicable to children with autism, whereby social perceptual abilities predict language ability which then predicts social-cognitive abilities.

The above aggregate construct findings for the autism group can be neatly juxtaposed next to a correlation matrix resulting from similar analysis of the 127 typically developing children tested in chapter 6. The nonparametric correlations

between the aggregate constructs for the whole typically developing group are displayed in Table 7.8. This conveys that when the construct task structure of the final model was applied to create the construct aggregates for the typical group, that language was strongly correlated with constructs of social perception and social cognition. This link between social perception and social cognition would have been expected to be based on language from the structure of the final model, but obviously the correlational analysis below – unlike the structural equation modelling – was unable to provide an idea of the direction of the relationship between these constructs.

Table 7.8

Nonparametric correlation matrix of construct aggregate scores for group of 127 typically developing children

Construct (N=127)	*Social attention*	*Social perception*	*Social cognition*	*Language*
Social attention	1			
Social perception	.06	1		
Social cognition	-.06	.19*	1	
Language	-.07	0.33**	0.37**	1
	**: significant at 0.01 level, *: significant at 0.05 level			

In sum, although the only significant relationship between aggregate constructs for the autism group was the link between social perception and language, there was indication that a larger sample size may have resulted in a significant relationship between language and social cognition as was obtained for the typical group of children. Therefore, from the correlation analysis conducted in Part 1 on the

relationships between individual tasks for the autism group and from the correlations between aggregate constructs conducted in this part, there is some indication of congruence in findings across the large group of typical children and the smaller group of children with autism. As such, the final structural model from chapter 6 may have compatibility for autism findings and indicate a similar path structure to social understanding as was found for typically developing children. However, in order to examine this possibility in more detail and to explicitly compare social understanding abilities in children with autism to the typically developing children tested in chapter 6, Part 3 now turns to analyses which examine a subset of the sample of typically developing children who were individually matched in terms of language ability to the group of children with autism.

7.8 Results part 3: Comparing children with autism to a language matched group of typically developing children on constructs of social understanding

Thus far language has appeared to be at the heart of most of the interplay between different aspects of social understanding in typical development and autism. Therefore, the final stage of analysis within this thesis focused on differences in social understanding between a subset of the autism group who were matched on language ability to an equally-sized subset of the typically developing group of children who featured in the preceding few chapters. Using matching procedures advocated by Jarrold and Brock (2004), children were individually matched in terms of their receptive vocabulary ability. Matching of the groups via language was done to allow for legitimate analysis of the potential difference in paths to social understanding for children with autism in comparison to typically developing 4- to 5-year-olds. Nineteen of the 24 children with autism had verbal mental ages which could be sufficiently matched to a subset of the typically developing children from

the previous chapter. Indeed, 14 of these 19 matches were exact matches while 4 of the other 5 matches differed only in terms of a few months, and the final match differed by 8 months. To check that there was no significant difference between the two groups in terms of their BPVS age equivalents, an independent samples t-test was conducted. With a mean BPVS age equivalent of 69.58 months (s.d. = 18.93) for the group of children with autism and 68.95 (s.d. = 18.03) for the subset of typically developing children, the t-test revealed that the groups did not differ significantly, $t = 0.105$, $df = 36$, $p = 0.92$, suggesting the two groups were suitably matched in terms of language ability.

Having established that the autism and typical groups of children were matched on language ability, the next step was to analyse whether there were any significant differences between them in performance across the tasks tapping the three main domains of social understanding. Given non-normality within the autism dataset, differences in the matched sample were investigated using Mann-Whitney analysis and the various statistics are displayed below in Table 7.9. Table 7.9 conveys that the subset of children with autism responded correctly to significantly less orienting trials than typically developing children.

Table 7.9

Mann-Whitney analysis of the difference in performance between children with autism and typically developing children matched on language ability

Variable/Task	Mean rank		U	Sig.
	CWA	TD		
orienting	12.22	24.78	49	0.00
joint attention	17.11	21.00	135	0.27
affect	15.71	23.29	108.5	0.04
eyes	14.67	19.74	100	0.14
friendliness	16.95	22.05	132	0.16
ignorance	13.13	25.87	59.5	0.00
false belief	12.05	26.95	39	0.00
syntax	8.18	21.37	9.5	0.00
WASI	10.89	28.11	17	0.00
BPVS[1]	19.58	19.42	[1] matching variable	

Further examination of this finding via Mann-Whitney analysis (see Table 7.10 below) for each of the aspects of the orienting task (i.e. social vs. nonsocial sounds and 6 second criterion vs. 3 second criterion) revealed that the autism group responded correctly to significantly less trials than the typical group in each category. However, the difference between the groups was less marked ($p < 0.05$ rather than $p < 0.01$) for the nonsocial trials and in particular the difference was weakened in terms of the 6 second criterion. Nonetheless, the differences between the two groups remained significant across both social and nonsocial stimuli, and conveyed that despite similar language abilities, children with autism are impaired in their ability to orient their attention to non-social and particularly social sounds. The nature of these

statistically significant differences concurs with the findings of the matched autism sample described by Dawson et al. (2004) in which they concluded that children with autism were less likely to orient to both social and nonsocial auditory stimuli and that this orienting impairment was more severe for social stimuli.

Table 7.10

Mann-Whitney analysis of the difference in orienting abilities within 6 seconds and 3 seconds between children with autism and typically developing children matched on language ability

Variable/Task	Mean rank		U	Sig.
	CWA	TD		
6 sec. total orienting	12.22	24.78	49	0.00
6 sec. social	12.14	24.86	47.5	0.00
6 sec. nonsocial	14.67	22.33	93	0.02
3 sec. total orienting	11.89	25.11	43	0.00
3 sec. social	10.94	26.06	26	0.00
3 sec. nonsocial	14.22	22.78	85	0.01

The finding that children with autism were not significantly impaired in comparison to typical children in responding correctly to joint attention trials – within either the 6 or 3 seconds criteria - corroborates the earlier finding discussed in part 1 of the results in which there was not a significant difference in this ability between the whole group of children with autism and the whole group of typical children. Also, children with autism performed significantly less well than the TD group on both social-cognitive measures and both other language/IQ measures. Conversely, the groups did not differ in terms of their social-perceptual abilities other than their performance on the Affect task with the typically developing children

scoring significantly more highly. Although the TD group scored more highly on the Eyes and Friendliness tasks than children with autism, these differences were not significant. This finding would appear to provide further foundation to the claim that social-perceptual abilities are closely tied to language in children with autism.

In sum, the above findings suggest that children with autism matched to typical children were significantly impaired in their social-cognitive ability and their other language/IQ abilities compared to typically developing children. However, children with autism had some level of ability within the social attention domain (namely joint attention) and exhibited comparable abilities to typically developing children within the social-perceptual domain. This similarity in social-perceptual ability between language-matched groups of children may reinforce the notion of a strong social-perceptual-language link as argued for in the new model of social understanding rather than the weaker bond between these abilities as outlined in Tager-Flusberg and Joseph's model.

In order to investigate the differences in social understanding more broadly between these two language-matched groups, the comparison of construct aggregates as defined previously was examined via correlation analysis and Mann-Whitney analysis. Shapiro-Wilk statistics had indicated that there was non-normality in the social-cognitive aggregate construct for both groups as well as non-normality in the social attention construct for the typically developing group; therefore it was necessary to proceed with nonparametric statistics. Spearman rho correlation statistics for both groups of 19 children confirmed earlier findings for the complete groups: namely, the only significant correlation for the group of children with autism was for the relationship between social perception and language, rho: 0.59, $p < 0.01$. For the matched group of 19 typically developing children, language was

significantly related to both social perception (rho: 0.70, $p < 0.01$) and social cognition (rho: 0.60, $p < 0.01$). Finally, to examine differences in the three different aspects of social understanding between the two groups matched on language, Table 7.11 displays the main statistics from the Mann-Whitney analysis. Table 7.11 reveals that children with autism, although matched on receptive language skills to a group of typically developing children, were significantly impaired in their social attention skills and social-cognitive understanding. Interestingly, in contrast, the social-perceptual abilities (as defined by the construct structure of the final model of social understanding in chapter 6) of children with autism were not significantly lower than the level of ability of typical children.

Table 7.11

Differences between language matched groups of children with autism and typical children on social cognition, social perception and social attention

Aggregate construct	Mean rank		U	Sig.
	CWA	TD		
social attention	13.37	25.63	64	0.00
social perception	16.11	22.89	116	0.06
social cognition	12.03	26.97	38.5	0.00

Furthermore, given the statistic approaching significance for social perception, it was thought necessary to more closely examine the lack of a difference in social-perceptual ability between the autism group and the matched typical group. Since the statistic above was based on only two social-perceptual tasks, the difference between the two groups was then examined based on the aggregate construct of social perception consisting of all three social-perceptual tasks (i.e. now including the Friendliness task as well as the Eyes and Affect tasks). Similar Mann-Whitney

analysis revealed again that there was no significant difference in social-perceptual ability between children with autism and matched typical children, $U = 123$, $p = 0.09$, suggesting that children with autism are not impaired within the domain of social perception. However, since $p < 0.1$ and since the effect size for the difference between the two groups was 0.60 (Cohen's d – the calculation is outlined in Appendix 7.1) this is suggestive of a trend, which would have revealed a significant difference between the groups had a larger sample size been compared.

Finally, in relation to how paths to social-cognition may vary for children with autism in comparison to typically developing children, stepwise regression analysis was conducted. With social cognition as the outcome variable and social perception and language as possible predictors (social attention was not included given its lack of influence throughout this thesis), the regression output confirmed that neither social perception or language were significant predictors of social cognitive ability in children with autism. In contrast, for the matched group of typically developing children, language was (as expected from earlier results) the only significant predictor of their social-cognitive ability: $R^2 = 0.365$, $t(17) = 3.13$, $p < 0.01$. This analysis confirmed the general theme of the findings described throughout this chapter – namely that the route to social cognition and ultimately social understanding in general, is different for children with autism in comparison to typically developing children despite being matched on language.

7.9 Results summary

In summary, each of the three parts to the results section has individually contributed noteworthy findings and together they have provided a detailed insight into social understanding in children with autism. Part 1 - which described their general performance across social understanding and language tasks – suggested that

the group of children with autism tested here were particularly impaired in the areas of social cognition and language. Nonparametric correlation analysis within constructs suggested that the tasks which held together well to define constructs within chapter 6, were grouped together similarly for children with autism – performance on tasks clustered together well within each of the constructs, in particular the social-perceptual construct was strongly intra-correlated. Correlation matrices, even when controlling for age, suggested that language (particularly BPVS) was strongly linked with social-perceptual and social-cognitive abilities for children with autism. Once language had been partialled out, significant relationships tended to exist within, rather than between, constructs. However, two social-perceptual tasks were individually strongly linked with language-based tasks, further indicating a possible link between social-perception and language for this group.

Part 2 then examined the relationships between task-based abilities and measures of autistic symptomatology. One interesting finding from this section conveyed that several aspects of measurement from the Vineland Adaptive Behaviour Scale – in particular, socialisation skills - were significantly related to aggregate scores for the social-perceptual and social-cognitive constructs – but not to aggregate constructs scores for language or social attention. Also of interest for the whole autism group was the strong significant link found to exist between the social perception and language constructs; links from social cognition to these constructs merely approached significance.

Part 3 then built upon the previous two parts by exploring social understanding abilities in children with autism who were matched on language ability to a subset of the typical group tested previously in chapter 6. Firstly, in terms of task performance, analyses suggested that children with autism were significantly

impaired in comparison to language-matched typical children on the orienting task, the affect task, both social-cognitive tasks and the two other language measures. Secondly, analysis of the difference in relationships between aggregate constructs for the matched groups indicated that the only significant relationship for children with autism rested upon the link between social perception and language. In contrast, for the matched group of typical children, ability across the language construct was strongly linked to both social perception and social cognition. Finally in terms of the differences between the matched groups on social understanding as defined by the overall constructs, analyses revealed that children with autism performed significantly less well than matched typical children in the areas of social cognition and social attention. The results were less conclusive in relation to a social-perceptual impairment in autism, but were suggestive that a statistically significant difference between children with autism and typical children would have been found in a larger sample size.

Discussion

The original hypotheses will be addressed by summarising the key findings across the 3 parts of the results section for each construct. Therefore, beginning with the apparent lowest level of social understanding – social attention – the first point focuses on the performance of children with autism on the adapted version of Dawson et al.'s (2004) orienting task. The main findings from using our adapted version corroborated the findings of Dawson et al., namely, children with autism responded to significantly fewer orienting trials than typical children, and this difference was greater in relation to social stimuli. This was the case in comparison to both the overall group of 127 typically developing children and the subset of this group who were matched to children with autism in terms of their language ability.

In comparison to both groups, differences in orienting were more extreme in relation to social stimuli both within the 6 seconds and 3 seconds criteria. Nonetheless, it is important to note that this does not necessarily indicate a general autism impairment in orienting to social stimuli per se. When the pattern of responses to social and nonsocial stimuli was examined in isolation for the autism group, the statistics provided an interesting profile of ability – they showed that children with autism were able to orient their attention to stimuli on the majority of occasions and that when considered over a greater length of time (i.e. 6 seconds), they actually oriented their attention correctly to more social than nonsocial trials. This conveys that children with autism are not necessarily "impaired" in their ability to orient to social stimuli. The opposite pattern of responding over a shorter time-frame indicates that their attention may be drawn to nonsocial stimuli suggesting a preference in autism for nonsocial stimuli which concurs with eye-tracking evidence documented by Klin et al. (2003) in which children with autism focus on nonsocial aspects of the environment as opposed to social stimuli. However, as the current findings suggest, over a more prolonged period of time, children with autism may have orienting abilities which are more similar to typically developing children than would otherwise be initially indicated.

Further reinforcing the notion that children with autism may not have a specific impairment in the domain of social attention, an interesting finding was that children with autism were not significantly worse in responding to joint attention bids than the typical children – both in terms of the overall typical group and the matched group. Indeed, they correctly attended to the majority of joint attention trials indicating that these children did not have a severe impairment in this area. While levels of performance on the two social attention tasks for the autism group were

better than had been expected, it remains true that they did contrast with the pattern found for typical children – as well as performing more highly on both tasks than the autism group, the typical children responded more successfully and quickly to orienting trials compared to joint attention trials. Indeed, when the passing criterion of at least 4/6 joint attention trials (Leekam et al., 1997) was applied, the number of children with autism who met this level was significantly fewer than the number of typical children who achieved this level of performance. Also, as the group of children with autism exhibited a contrasting pattern of performance this suggests that they may use atypical processing strategies, albeit perhaps more successfully as suggested here, than as documented in much of the autism literature.

As described above, some of the findings for the autism group within the domain of social attention were unexpected. In terms of the social-perceptual domain, there were several results which were surprising and interesting by the nature of the similarity to those found for typically developing children. For instance, when considering the autism group as a whole, it was interesting to note that their performance on the social-perceptual Affect task was significantly related to performance on every other task (other than the social attention tasks which were unrelated to all tasks). It was also interesting to note that the relationship between syntactic ability (as provided by the CCC-2) and the Affect task was the only significant link including the syntax measure. However, after controlling for age, the Eyes task was also significantly linked to the syntax measure. These significant findings between social-perceptual measures and syntax were all the more surprising given that these results were based on a small number of syntax scores. They serve to underline the likelihood of a close relationship between social perception and language in children with autism.

Part 2 of the results presented another couple of interesting findings regarding social perception. Firstly, the construct aggregate for social perception was significantly correlated with all aspects of the Vineland Adaptive Behaviour Scale, in particular the scale denoting socialisation skills. This was suggestive of a more key role of social perceptual abilities in the everyday social interactions of children with autism. Secondly, examination of the relationships between aggregate constructs revealed that the only significant link which existed was that connecting social perception to language. This tied in with some of the findings highlighted above, but was nonetheless unexpected since social cognition, rather than social perception, has been identified in previous autism research as the primary link between social understanding and language (e.g., de Villiers, 2005). However, as hypothesised at the outset in relation to the new model of social understanding, a link between social perception and language for children was a realistic possibility. Due primarily to the considerable degree of language required to proceed through the social-perceptual tasks, but also to the likelihood that children with autism may use some of their perceptual abilities – albeit atypically – to facilitate interactions with others, finding a significant link between social perception and language was perhaps not so unexpected.

Finally, results from the matched-group analyses indicated that although the sample of typical children scored more highly than children with autism on each of the three social-perceptual tasks, only the Affect task elicited a significant difference between the two groups. Overall, the social-perceptual findings for children with autism provided inconclusive evidence of a social-perceptual impairment in autism. However, the apparent trend for children with autism to perform less well than matched typical children within this domain of understanding, substantiated by the

medium effect size, suggests that a larger sample would have revealed this to be an area of impairment for children with autism. This would be in line with much of the literature and theory which suggests that children with autism are fundamentally impaired in the social-perceptual domain (e.g., Tager-Flusberg and Joseph, 2005). Nonetheless, given that children with autism would seem to be more severely impaired compared to typical children within the domain of social attention, this perhaps underlines the relevance in distinguishing between what may be different domains of understanding.

As was discussed earlier, children with autism traditionally have been researched on their theory of mind/social-cognitive understanding. The current research has echoed many of the findings from those studies – children with autism performed significantly less well than typical children on both social-cognitive measures – this was found in comparison with both the whole typical group and the language matched typical sample. Furthermore, the more skewed nature of the false belief measure compared to ignorance for children with autism may explain why false belief understanding was related to fewer other task variables. However, the false belief measure was significantly related to BPVS language ability when controlling for age. Furthermore, the linking of ignorance to both experimental language measures and all 3 social-perceptual measures suggest a close intertwining of social perception, language and social cognition in children with autism. However, these relationships disappeared after controlling for age, suggesting that the child's age was primarily responsible for linking social cognition to social perception or language. Furthermore, when the social-cognitive aggregate construct was examined in relation to the other aggregate constructs, the link from this to both social perception and language aggregate constructs was not significant at the 5% level, but

did approach significance. Therefore, it's likely that a larger sample of children with autism would have resulted in significant links between social cognition and social perception or language. However, the lack of a significant relationship between social cognition and language was surprising given the many studies which have highlighted links between these areas in autism. Perhaps if there had been a less skewed distribution of social-cognitive scores or if high-functioning children with autism had been tested then there may have been more likelihood of obtaining a significant link between social cognition and language in the size of sample described here, which was nonetheless a substantial number of children for an autism study.

The final construct to be discussed was language. It had become apparent from reviewing the other constructs that contrary to expectation, language was closely linked to the social-perceptual construct and not to the social-cognitive construct. Indeed, when controlling for age, matrices providing the correlations between each of the individual tasks for the whole group of autism revealed several links between language and social perception (and social cognition). However, once language (i.e. BPVS verbal mental age) had been partialled out, the only significant relationships tended to exist within rather than between constructs, suggesting that this measure of language ability could explain much of the significance of links between constructs. Given this and since this measure of language provided the basis for matching the children with autism to the sample of the typical group, it was possible that similar paths between language and social perception or social cognition would be identified for the two matched groups. As indicated from earlier findings, the language-matched groups of typical children and children with autism differed significantly in terms of their social attention and social cognition and given

a larger sample size, they would most likely have differed in terms of social-perceptual ability.

Therefore, overall a picture has been provided of a group of children with autism whose social-perceptual abilities were strongly linked with their language abilities. This was an unexpected finding based on the model of social understanding in autism offered by Tager-Flusberg and Joseph (2005). However, by virtue of distinguishing between social attention and perception, and perhaps by using social-perceptual tasks which were heavily loaded in terms of language, the social perception-language link was perhaps more of a realistic possibility. This study has also shown that having language abilities which were matched to those of typical children, does not lead to similar levels of social-cognitive understanding, as was hypothesised. However, as receptive language abilities rather than syntactic language ability provided the basis for matching, this reinforces the idea that like typical children, general language proficiency in the area of word learning may result from social-perceptual abilities for children with autism (e.g., Baldwin & Moses, 2001). However, unlike typical children, this level of language ability is not sufficient to provide children with autism with the expertise in social situations to then learn about others in a social-cognitive sense. Thus, the current findings, via the lack of a link between language and social cognition, remain open to the claim that in order for children with autism to display social-cognitive understanding in structured tasks, they need to have sufficient understanding of communication verbs and general syntactic skills.

In the absence of compensated social-cognitive skills (i.e. this variable was negatively skewed), it is unsurprising that regression analyses on predictors of social cognition produced no significant predictor for the group of children with autism.

However, for the matched typical sample, language - unlike social perception - was found to be a significant predictor of social cognition. This was expected given the structural model of chapter 6 which consisted of language as a mediating variable between social perception and social cognition. However, for the benefit of understanding a possible different path to social cognition for children with autism, it is clear that receptive language skills do not lead to typical levels of social cognition, and further reinforces the likelihood that children exhibit social-cognitive understanding by atypical routes.

The role of syntax in facilitating social understanding (social cognition) within the current study is unclear – the matched groups differed significantly on this measure, so it is unclear how much the social-cognitive abilities of children with autism could have been compensated despite social attention difficulties if their syntactic abilities had matched those of typical children. Given the earlier discussion of the role of syntactic language abilities in compensating for deficits which children with autism experience prior to social cognitive understanding, it is a distinct possibility that typical and autism groups who were matched on syntactic ability would have had similar social-cognitive abilities. Thus, it is possible that such a study would find a strong link between language and social cognition. While there is considerable utility in conducting such a study, its requirements were beyond the scope of this body of work - with a focus throughout this thesis primarily on social understanding rather than language, it was necessary to choose language measures which were succinct and, where possible, which could be administered outside of the testing sessions. Therefore, selecting a parental questionnaire to provide the measure of syntactic ability seemed an appropriate choice. Furthermore, within the timeframe to work with an autistic population, it was more feasible to match groups on the

accessible measure offered by the BPVS. It is acknowledged that matching using a comprehensive syntax measure rather than receptive language measure may have produced considerably different findings; indeed, using a different syntax measure may well have provided a more comprehensive, less-skewed profile of children's language abilities in this sense and in turn provided greater insight into the path to any form of social-cognitive understanding.

It is important to reinforce that for children with autism any success in structured social-cognitive tasks does not necessarily correspond with success in everyday life (Frith, Siddons, & Happé, 1994). In the current study, several scales of the Vineland Adaptive Behaviour Scale were significantly positively correlated with the aggregate constructs of social perception and social cognition. This was unsurprising given the extent of social-cognitive impairment. However, given the less-conclusive finding of social-perceptual impairment, it was surprising that this was positively correlated with all of the adaptive scales, most noticeably 'socialisation'. It seems possible to suggest that a fairly low level of adaptive behaviour is necessary for social-perceptual abilities, whereas a much higher level of adaptive behaviour coincides with the complexity of social cognition – this would explain the strong correlations between adaptive scales and social perception and social cognition.

In summary, the most compelling of findings was the link between social perception and language for children with autism which contradicted claims surrounding the model of Tager-Flusberg and Joseph (2005). This revealed that children with autism are not as impaired in this domain as social attention and social cognition. This points to the utility in distinguishing between the domains of social attention and social perception. Despite similar performance on language (primarily

within the BPVS measure) this did not result in similar levels of performance within the social-cognitive domain. This further underlines the likelihood that a different aspect of language – i.e. syntactic comprehension – provides an exclusive route to social cognition for children with autism; compensating for earlier deficits in social understanding to provide enough logical insight for children with autism to apply appropriate reasoning to social-cognitive false belief tasks. Such success would appear to come exclusively via syntactic language abilities as argued by Tager-Flusberg and Joseph (2005) and shown in several studies (de Villiers, 2000). Consideration of this concept along with the present finding that social-perceptual abilities of children with autism are closely tied to a different aspect of language (i.e. word learning) parallels with the notion of a differential role of language across social understanding as suggested for typical development (Tager-Flusberg and Joseph). Therefore, this suggests a degree of similarity in the path through social understanding for both children with autism and typically developing children, with two exceptions: 1) unlike typical children, children with autism are impaired in their social attention capacities; and 2) social cognition can only be arrived at via an exclusive route in autism, while it can also be influenced by social perception and other aspects of language in typical development. These are important differences in paths through social understanding for children with autism in comparison to typical children and acknowledgement of such differences relies on the use of a broad concept of social understanding as has been advocated throughout this thesis. *Theory of mind* as a catch-all term glosses over important distinctions and inevitably reduces such research to a narrow frame of reference. 'Social understanding' and distinction of the various domains therein offers a broader, richer insight which provides better reflection of the very nature of such understanding.

PART 3 –

RE-EXAMINING PATHWAYS TO CHILDREN'S SOCIAL UNDERSTANDING

Chapter 8

General discussion and conclusions

The overarching aim of this thesis has been to clarify what social understanding is rather than how it develops. The wealth of existent research has delved into the latter issue, while very few studies have focused on either what constitutes social understanding or on the continuity between its different constituents, resulting in conceptual ambiguity. In addition, it was suggested in the introduction to this thesis that the contemporary nature of the term 'social understanding' brought with it an obligation to understand what it envelops before we can properly understand how and when it develops. Therefore, in a bid to redress the imbalance of the research focus and further our understanding of what social understanding actually consists of and to investigate continuity (or discontinuity) across a range of aspects of social understanding, this thesis focused on three main areas: social cognition (traditionally known as theory of mind), social perception and social attention. Language was also investigated throughout this thesis given the wealth of research which has demonstrated the close links between language and different aspects of social understanding. In order to comprehensively investigate these four areas, the componential model proposed by Tager-Flusberg and Joseph (2005) – which encompasses each of these areas - provided a suitable framework for this endeavour. With this in mind, the thesis was split into two parts: part 1 took a methodological stance which was necessary in order to verify that the social-cognitive measures which were to be used throughout the thesis provided a valid reflection of the complexity of this level of social understanding. Part 2 was theoretically driven and encompassed a range of studies examining paths between different aspects of social understanding in typical children and children with autism.

The chapters subsumed by both of these parts are summarised briefly below prior to a general discussion of the issues and questions which have arisen throughout this work, as well as discussion of the limitations of this thesis and implications for future research.

8.1 Summary of Part 1: Methodological chapters

As highlighted above, the aim of Part 1 of this thesis was to arrive at measures of social cognition which were both valid and comprehensive. While existent measures of social cognition such as the false belief stories designed by Sullivan et al. (1994) could have been used within this thesis as they continue to be used in contemporary research (e.g., Steele, Joseph, & Tager-Flusberg, 2003), the author's reservations regarding the sensitivity of this measure led to the methodological investigation of Part 1. Chapter 2 within Part 1, examined whether the false belief stories of Sullivan et al. inflated the measurement of children's complex social-cognitive understanding by way of their inclusion of questions based on the concept of ignorance. Comparison of typically developing 4- to 6-year-olds on stories which either included an ignorance question or not and either using Sullivan et al.'s stories or new stories designed in this thesis – revealed that preceding the crucial (second-order) false belief question with a corresponding ignorance question facilitated children's false belief performance. It may have been that such a focus on this simpler level of conceptual understanding was enough to bolster a child's fragile concept of false belief understanding. However, greater false belief success for those children who had been asked about ignorance does not necessarily imply that those children had sufficient false belief reasoning skills. Thus, given that ignorance is an easier concept for children to understand than belief (which develops up to 2 years later than ignorance), this chapter conveyed that the social-cognitive stories of

Sullivan et al. - by including ignorance questions – do not necessarily tap into the representational skills required for false belief understanding. Therefore, chapter 2 showed that false belief stories need to be carefully designed and sensitively selected, without any inclusion of ignorance questions if they are to purely measure false belief understanding rather than more general, lower-level social-cognitive understanding. Furthermore, those studies which do use false belief stories while explicitly including a focus on ignorance, need to - at the very least - acknowledge that an individual's success on such stories may not necessarily be indicative of their false belief understanding. This would seem to be particularly important for neurobiological studies attempting to identify brain regions which correspond to specific social-cognitive processing (e.g., see Saxe & Powell, 2006). A similar point can also be made more generally given the broad perspective of this thesis – namely, that neurobiological studies attempting to locate brain areas which represent aspects of social understanding should be specific about which particular constituent of social understanding they are investigating, rather than blending constituents together or simply assuming that different aspects correspond to similar brain areas.

Having realised that second-order ignorance and second-order belief should ideally be kept separate within social-cognitive stories and having vindicated the decision not to simply use pre-existing measures of social cognition, chapter 3 built upon chapter 2 by using the new second-order false belief stories (which had been designed in chapter 2) as the basis for a composite measure of social cognition. This measure could simultaneously assess first-order and second-order mental states in the same child within one story and was believed to offer three main benefits. Firstly, to provide greater insight into consistency of ability across both levels of understanding than would be obtained by testing them separately – i.e. it is likely that such a

methodology which examines first-order and second-order in parallel within the same test may provide a unique opportunity to discover individuals' respective first-order and second-order theory of mind abilities, whilst avoiding task confounds which would be likely to arise from testing children on separate social-cognitive tasks on separate occasions. Secondly, since part 2 of the thesis involved testing children on a vast array of social understanding tasks, such a composite task would help to ease the test battery load for both the experimenter and children. Thirdly, such a composite measure was developed in the hope that the framework of the composite story could transfer to testing other mental states to enable greater comparability between the social-cognitive abilities required to understand concepts such as belief and ignorance. Results from this study showed that the composite false belief methodology led to first-order and second-order belief performance in 4- to 6-year-olds which was comparable to previous studies which had examined these levels of understanding separately. Also, as expected, the composite task demonstrated that first-order understanding is a necessary but not sufficient capacity to allow children to consistently understand second-order beliefs.

Together, the chapters in Part 1 of the thesis confirmed the need to tap into false belief understanding using false belief stories which omit ignorance questions and gave indication that the composite false belief task provides a quick, consistent and effective measure of children's first-order and second-order understanding in parallel. In addition, these chapters indicated that such methodology would be suitable for detailed investigation of these abilities alongside other aspects of social understanding in 4- to 5-year-olds within Part 2 of the thesis.

8.2 Summary of Part 2: Theoretically-oriented chapters

Part 2 of the thesis then used the composite social-cognitive measure alongside measures of social perception and social attention within the broader concept of social understanding, as well as language measures, to focus upon the central question of the thesis: 'What are the constituents of children's social understanding?' To attempt to answer this question, Part 2 required a thorough, theoretical investigation into the nature of models of social understanding/theory of mind, the nature of the constructs which are encompassed by the broader term, and the nature of the paths between these constructs. Therefore, reflecting the breadth of focus upon aspects of social understanding, Part 2 of the thesis drew upon several studies to investigate the potential constituents underpinning such understanding.

Beginning with a theoretical focus, chapter 4 described and illustrated several componential models of social understanding including the original componential model: Tager-Flusberg and Sullivan (2000), as well as Baron-Cohen's modular model (1994, 2005), and Tager-Flusberg and Joseph's (2005) model. The framework of this final model guided the investigation throughout the chapters of part 2, selected as such for the following reasons: being a contemporary model it incorporated up-to-date research; it encompassed language and the three areas of social understanding under investigation within this thesis; it accounted for findings from the perspective of autism and since it offered a clear, comprehensive structure underlying children's social understanding it provided the ideal framework to pursue the main question of the thesis. Furthermore, since the relations in this model had previously not been simultaneously tested, there was added incentive to examine the nature and interrelation of the components of the model. The claims which surround their model

regarding both typical children and children with autism provided testable hypotheses which were then explored over the next three chapters.

Chapter 5 began the empirical investigation into the constituents of children's social understanding and examined a hypothesis which features in both of Tager-Flusberg's models (2000, 2005); namely that the social-cognitive and social-perceptual levels of social understanding are positively linked in typically developing children. Using the adapted and extended versions of social-cognitive tasks as had been developed within Part 1 of the thesis, several false-belief stories were used to test the social-cognitive domain while the Eyes task was used as the social-perceptual task. Contrary to the original hypothesis, results from 4- to 6-year-olds who were tested on these tasks, indicated that these components were not significantly related in typically developing children. This finding contradicted the initial hypothesis as well as claims stemming from other componential models such as Baron-Cohen (1994). Several explanations for this were proposed, including the small sample size, the potential mediating role of language, the possibility that the tasks were not specific enough to tap into either domain, and the prospect that individual differences in these abilities were less discernible by ages 5 and 6. Accordingly, to explore these ideas further and to widen the investigation across a range of children's social understanding, chapter 6 included each of these lines of enquiry and marked the real empirical movement of this thesis into a broader outlook on children's social understanding.

Chapter 6 reviewed the key literature within the four key areas under investigation: social cognition, social perception, social attention and language. The literature reviewed, alongside the model offered by Tager-Flusberg and Joseph (2005), served to indicate several testable hypotheses regarding relationships

between and within the four constructs. Thus, chapter 6 examined abilities within the two main componential domains of social cognition and social perception, but expanded this focus to also include investigation of children's abilities within the constructs of social attention and language. This was conducted via a large sample of typical children in order to be able to conduct structural equation modelling analysis which provided insight into the interplay between the constituents of social understanding and the possible heterotypic or homotypic continuity between low-level social understanding and higher-level understanding. Such comprehensive analysis offered via structural equation modelling provided a test of Tager-Flusberg and Joseph's model, although it is acknowledged that their model is longitudinal and the current investigation was limited to the exploration of these abilities concurrently. Resulting analyses revealed that the framework of their model was not congruent with the structural equation model which provided the best fit. This particular dataset suggested that the model of best fit was represented by a framework consisting of a direct path from a social-perceptual construct to a construct of language, with a path then directed from this language construct to a construct of social cognition.

Therefore, in terms of concurrent abilities, the dataset suggested a model of social understanding - contrasting that of Tager-Flusberg and Joseph - in which language mediated the relationship between the lower-level domain of social perception and the higher-level domain of social cognition. Furthermore, the model of best fit excluded a social attention construct – which was corroborated by a pervasive lack of association between this construct and the three other constructs. Such an outcome vindicated the decision to distinguish between social attention and social perception. Social attention as a construct was not significantly related to social perception or either of the other constructs and suggests – at least in the

context of concurrent abilities - that social attention abilities may be qualitatively different to other social understanding abilities in 4- to 5-year-olds. Such an interpretation conforms to the idea that there is heterotypic continuity between particularly low-level and high-level aspects of children's social understanding. Of course, the concurrent nature of the present investigation cannot be extrapolated to what could be said *longitudinally* about the link between social attention and other aspects of social understanding. It may well be the case that a longitudinal exploration of these relationships (and from an earlier age) would uncover significant relationships between social attention and other variables. Indeed, a longitudinal investigation would be constructive in determining the accuracy or relevance of Tager-Flusberg and Joseph's (2005) model. Nonetheless, discovering that the construct of social attention was internally consistent in terms of the tasks correlating together, but unrelated to all other construct tasks, does underline the motivation behind the central premise of the thesis: i.e. it is important to consider possible constituents of children's social understanding under the initial assumption that they are distinct, before in-depth exploration can indicate otherwise. Furthermore, such consideration would seem to be particularly important when the constituents are newly-coined and less clearly defined as remains the case for social attention and social perception.

Chapter 6 also conveyed that language ability provided the integral link between low-level social understanding (i.e. social perception) and higher level social understanding in the form of social cognition. Such an outcome is compatible with research indicating that language can have differential roles in social understanding when different levels of social understanding are considered. For instance, research indicating that social-perceptual type abilities can facilitate word

learning (e.g., Baldwin & Moses, 2001) and research indicating that other aspects of language (e.g., syntax) can facilitate social-cognitive abilities (e.g., de Villiers & Pyers, 2002), are both congruent with the final structural model in chapter 6. However, these opposing research strands and such an interpretation of the final structural model produced here can be reconciled only by interpreting social understanding in broad terms, as was argued in chapter 1.

While all previous chapters had investigated social understanding in typically developing children, chapter 7 complemented the preceding work by illustrating the nature of the constituents of social understanding and any continuity between them, in children with autism. Having arrived at a final structural model based on typically developing 4- to 5-year-olds within chapter 6, the final empirical chapter offered an opportunity to determine whether the paths between the constituents of social understanding differed in a group of children with autism. Through comparison of levels of ability for children with autism versus the large typical group of children it seemed apparent that children with autism were impaired within the areas of social attention and social cognition. However, in order to compare this group of children more evenly to the typical children tested in chapter 6, a subset of the large typical group were individually matched on language to children with autism in the final analyses. These revealed several interesting results, including the finding that children with autism did not display significantly worse understanding in the domain of social perception than the language-matched typical children. This result contrasted sharply with expectations and the claims of Tager-Flusberg et al. who suggested that children with autism are fundamentally impaired in their social-perceptual understanding. However, while no significant difference was found between the matched groups in terms of their social-perceptual ability, it is true that

the difference was significant at the 10% level and this finding was based on a relatively small sample. Indeed, the medium effect size of 0.6 for this finding suggested that if a larger sample size had been explored then a significant difference would have been found between the groups. Nonetheless, it was surprising to find some ability within this construct relative to other constructs for children with autism; however this may have been due to the degree of language which was required to process information in the social-perceptual tasks. Thus, these tasks while being primarily social-perceptual and entailing an affective component, by virtue of their language demands, may have allowed children with autism who were matched on language ability to hack out correct responses (in an analogous way to that proposed by Happé (1995) in the context of social-cognitive tasks). Alternatively, it may be that the distinction made within this thesis between social attention and social perception lends itself to a suitable separation of ability and impairment in autism – i.e. while children with autism had relatively intact social-perceptual abilities, the significantly lower performance within the social attention construct compared to language-matched typical children provides further support for distinguishing between these domains.

The autism findings suggest that the social-perceptual performance of children with autism, while correlating strongly with language competence, was not associated with success in the social-cognitive domain. Given this and given what we know about the differential role of language between low-level and high-level social understanding in typical development, it seems reasonable to argue that a similar level of language ability in autism is not sufficient to influence social-cognitive understanding. Rather, what may be required, as argued by Tager-Flusberg and other researchers (e.g., de Villiers, 2000) is a level of syntactic ability to compensate for

atypical processing of low-level social information. Therefore, similar success in social cognition may only arrive exclusively when syntactic comprehension of sentence complements and communication verbs is sufficient to facilitate false belief performance in structured tasks. This research unfortunately cannot fully support or refute that claim due to the restricted breadth of measurement of syntactic ability (i.e. based on a scale of 8 items from a general communication questionnaire). Such a measure of syntactic ability was necessary due to practical testing considerations, but it would appear to be a reasonable claim that such ability – tested in terms of communication/cognition verb comprehension - may provide an exclusive path to social-cognitive understanding in children with autism, as illustrated in, for example, a couple of studies reported by Tager-Flusberg and Joseph (2005). Complementing this interpretation, this research does show that, unlike in typical development, abilities within receptive word comprehension are not sufficient for social-cognitive success in autism.

8.3 Social understanding rather than theory of mind

The preceding chapters together have illustrated first and foremost that the traditional interpretation of theory of mind is insufficient in encompassing the range of social understanding children require in developing as effective contributors to everyday social interaction. While the broader interpretation of theory of mind (as first outlined in chapter 1) provides a better reflection of the richness and complexity involved in understanding the minds of others, the term itself, nonetheless, is imbued with ambiguity. As outlined in the introduction, while this research community has raced to understand precursors to traditional theory of mind in efforts to delineate the developmental progression to social-cognitive mastery, the clamour to do so has left in its wake a field which perhaps no longer knows what theory of mind actually

refers to. Does it refer to attention to social stimuli? Does it refer to perception of other people's facial expressions? Does it refer only to representational understanding required to process the thoughts and beliefs of others? Or does it refer to all of these? Of course, the traditional use of the term referred exclusively to the third interpretation; however, with the broadening of the field, and the tendency for studies to apply the phrase interchangeably to the whole gamut of these skills leading up to social cognition, 'theory of mind' is now an opaque term lacking specificity. Furthermore, given the more basic, social nature of the precursor abilities which theory of mind appears to subsume, the methodical, internal, non-social connotations of the phrase, suggest that such a theoretical term is even less appropriate as an umbrella term for the social skills which it attempts to encompass.

Given the apparent ambiguity associated with the phrase theory of mind, it would seem apt for the field to systematically replace it with a more encompassing, contextually-appropriate term such as social understanding. Originally offered by Dunn (1988), but essentially resurrected by Carpendale and Lewis (2004, 2006) in their social constructivist account, the term social understanding necessarily incorporates reference to the social experience which permeates children's developing minds. In addition, this broader term as described by Carpendale and Lewis in their work, is used in parallel with their account which encompasses early abilities such as following gaze direction right through to higher-order understanding of false beliefs. It is for these reasons, and given the broad perspective adopted throughout this thesis, that social understanding was the chosen term to describe abilities across a range of constructs from social attention through to social cognition. Moreover, it is important for future studies to clarify what aspects of social understanding are under investigation, particularly if this occurs within the frame of

theory of mind. As pointed out previously in chapter 4, in order to fully comprehend the developmental process by which children can effectively engage in social interaction, in terms of which abilities appear when, it would seem prudent to first clarify *what* the abilities actually are. However, the research field of children's social understanding can benefit from such clarification only if researchers as a whole can be more consistent, systematic and transparent in the terminology which is used.

8.4 Constituents and continuity of social understanding in typical and atypical development

As indicated above, the benefit of a broader approach to children's social understanding has brought with it a lack of definition – studies not only blanket potentially disparate aspects of social understanding under phrases such as theory of mind/social intelligence/mentalising but often inherently different abilities have been confused by the same terminology or similar abilities confused by different terminology. For example, contemporary studies refer on the one hand to social cognition in the first year of life encompassing abilities such as joint attention (e.g., Striano & Reid, 2006); while on the other hand, studies refer to such abilities as social attention and explicitly distinguish it from social cognition as it is traditionally regarded (e.g., Wellman et al., 2004). Such incongruity is rife within the field and recognition of the resulting ambiguity which permeates the evidence base was the impetus in the central aim of attempting to clarify just what these abilities within social understanding actually are. While it is true that there may not have been a need to break social understanding down into distinct areas of ability, at the same time it would seem unwise to simply accept the status quo and continue using similar terms interchangeably to describe different abilities. To all intents and purposes, continuing with such a scenario in an ever burgeoning field of research is liable to lead to further

mystification and will ultimately be counter-productive. Therefore, while the majority of the field continue to – importantly – research the developmental progression to social cognition, the present thesis – importantly - attempted to meet the long-overdue need to add clarity to the potential distinctions between constituents of social understanding.

This thesis necessarily adopted descriptive terms such as social attention, social perception and social cognition for areas of understanding in order to be able to investigate and identify relationships between and within constructs. By their very nature, these terms are arbitrary and the constructs investigated are by no means definitive. Nonetheless, the use of structural equation modelling to test such relationships necessitated the identification of constructs to reflect potential constituents. This procedure, alongside the exploration of a componential model of social understanding (Tager-Flusberg & Joseph, 2005) served as useful means to investigate the distinctions and interplay between low-level and high-level aspects of social understanding and how these relate to language. One of the main findings from the final structural model indicated that social attention abilities such as joint attention and social orienting were unrelated to any other aspect of social understanding or language. This finding was important in conveying the inappropriateness in grouping together apparently different abilities under one term. For example, Tager-Flusberg and Joseph classify both social attention abilities as defined here and social-perceptual abilities together, while the current evidence would suggest that these abilities are inherently different. It follows that these should be classified as distinct constituents of social understanding, perhaps indicating heterotypic continuity from social attention to social perception and beyond. Of course, this may be due to concurrent examination of these abilities, and longitudinal

research into this area would be more harmonious with Tager-Flusberg and Joseph's model and may reveal significant relationships between social attention and later aspects of social understanding. Certainly, some research has shown a longitudinal link between social attention and social cognition (e.g., Wellman et al., 2004), but given the relative newness of social attention and social perception, it is unclear whether or not a longitudinal study would uncover a lack of association as was the case concurrently for these constructs.

Structural equation modelling also indicated that the other constituents were likely to be distinct yet closely related to each other, with language ability integral to the link between children's social perception and social cognition. The model of social understanding for typical children in the current study was best represented by a path from social perception to language and then a path from language to social cognition. This contrasted with the model of social understanding proposed by Tager-Flusberg and Joseph (2005) in which they additionally suggest a direct link between social perception and social cognition. However, finding in this research that the constructs of social perception and social cognition were significantly positively correlated suggests that the mediating role of language between social perception and social cognition was perhaps strong enough to minimize that relationship. Therefore, the models perhaps do not differ greatly in terms of the concurrent links between social perception, language and social cognition. Regardless, it would appear that social-perceptual abilities such as judging other people's facial expressions during social interactions, may provide children with enough context or social clues to acknowledge and begin to comprehend some words used by their conversational partner. Further support for such low-level social-perceptual abilities constituting social understanding and facilitating vocabulary acquisition was given in a recent

article (Baldwin & Moses, 2001) where a child's ability to learn novel words was contingent on their ability to perceive that the speaker's social clues (e.g., gaze direction and facial expression). Thus, with sufficient word comprehension abilities, children can begin to understand other aspects of language such as verbs of communication and verbs of cognition, which may then provide enough awareness for children to display social-cognitive understanding. Such breakdown of constituents and description of the continuity between these aspects is congruent with the broader definition of children's social understanding. Furthermore, this corroborates the evidence suggesting a dual role of language in terms of low-level social understanding (social perception) leading to one aspect of language ability (namely word comprehension) and then a different aspect of language (namely syntactic ability) leading to high-level social understanding (social cognition). As reflected on by Leekam (2005), such an explanation of a differential role of language at different levels of understanding is only possible via the broader definition of social understanding and would not be possible with the traditional notion of theory of mind.

While the new model of social understanding produced in the current thesis may essentially be the same as that of Tager-Flusberg and Joseph (2005) in terms of the mediating role of language between social perception and social cognition, the earlier argument in the thesis proposing a complete distinction between social attention and social perception, contrasted sharply with the claims of Tager-Flusberg and Joseph. They classed joint attention (regarded here as falling within the domain of social attention) as social perceptual ability, while simultaneously regarding tasks such as Baron-Cohen, Wheelwright, Spong, et al.'s Eyes task (2001) as a social-perceptual task. The evidence from this thesis certainly suggests that these abilities

should be classed as distinct when considered concurrently, although longitudinally this distinction may be more blurred. Furthermore, chapters 6 and 7 reviewed a vast literature across both typical and atypical development with regard to social attention and social perception; this conveyed the amount of existent literature describing each level of understanding quite separately - description of their function within these reviews suggested that these are theoretically distinct constructs. Therefore, while Tager-Flusberg and Joseph (2005) may be correct in longitudinally classifying a social-perceptual construct which encompasses seemingly lower-level abilities such as joint attention, it would be worth exploring this link longitudinally to verify this either way.

In relation to autism, the current work suggests that children with autism matched on language ability are not as severely impaired within social perception as they are in within the domain of social attention and social cognition. While it is true that there is a degree of language required to process the social-perceptual tasks, there is no denying that these tasks are fundamentally perceptual based and rely on the individual inferring an expression from a complicated array of physical features, which individually do not give the expression away. Even if it was argued that the expression is understood primarily in the eyes (Calder et al., 2002) and that children can obtain the correct answer by looking at this one feature (i.e. piecemeal rather than gestalt processing), then this would make this task even more difficult for children with autism, given research which shows that children with autism understand feature correspondence from the eyes but not the social relevance which eyes can convey (Ristic et al., 2005). Therefore, whichever way this finding of social-perceptual ability in children with autism is interpreted, it is worthy of further investigation. Given the relatively small sample size and indication of medium effect

size, it is likely that a difference would be found within comparison of larger groups. Ideally future research can investigate this likelihood by testing a larger number of children on various social-perceptual tasks and comparing their performance to language-matched typical children.

Despite similar verbal mental ages and a degree of social-perceptual ability in children with autism, this did not coincide with social-cognitive success as it did for typical children. This contrast in paths to social cognition was expected given the a priori arguments that the minority of children with autism who can display social-cognitive abilities do so by exclusively relying on syntactic abilities. While evidence has shown that children with autism can use their knowledge of syntactic complementation skills to process representational social-cognitive tasks, the lack of social-cognitive success for the autism group in the current research would appear to reinforce that idea. Indeed, the matched groups differed significantly on the syntax measure which was used, with the typical children scoring more highly. While this might suggest that the typical children relied on such syntactic ability to process the representational false belief stories, nonparametric correlations had indicated that these measures of ability were not significantly related. While there was a similar lack of association between these tasks for children with autism, this may have been due to the small sample size ($n = 14$), or may have been due to the relatively restricted range of the syntax scale from the Children's Communication Checklist-2 (CCC-2). Either way, the syntactic abilities of children with autism may have provided an exclusive path to social cognition if a syntax measure had been possible to use which measured comprehension of complements for communication verbs (de Villiers & Pyers, 2002). However, such a specific, experimental measure was not feasible to incorporate into the child's already laden task battery – the CCC-2

parental questionnaire on the other provided a useful, convenient, albeit narrow, indicator of children's syntactic skills.

In summary, the concurrent examination of the constituents of children's social understanding has revealed four key points. Firstly, social attention was unrelated to social perception, social cognition and language – perhaps indicative of heterotypic continuity from this construct to higher-level understanding. This may be due to the concurrent investigation of these abilities at an age which may be less sensitive to variability in social attention. The current evidence suggests that joint attention abilities and face-processing emotional understanding should be regarded as inherently different abilities when considered concurrently; however, it is unclear if this would also be the case within a longitudinal investigation. Secondly, structural equation modelling revealed that language ability was integral to the relationship between social perception and social cognition. While these components as originally introduced in Tager-Flusberg and Sullivan's model (2000), were related, their respective relationships with language were stronger and underlined the centrality of language ability to children's developing social understanding.

Thirdly, with regard to autism, the findings generally corroborated the vast literature which suggests that the path to social cognition is atypical for children with autism. More specifically, analyses revealed that children with autism, matched on receptive word comprehension to typical children were significantly impaired in the domain of social cognition. These findings, alongside the outcome indicating children with autism were significantly impaired in their syntactic ability compared to language (BPVS) matched typical children, appear to substantiate the claims that children with autism arrive at some level of social-cognitive success exclusively via the compensatory route offered by syntactic comprehension. Fourthly, this research

has suggested that children with autism are perhaps not as impaired in the social-perceptual domain as was originally thought. Tager-Flusberg and Joseph (2005) had claimed "...in autism the social-perceptual component of theory of mind is fundamentally impaired." (p. 311). The current research suggests that this is not as clear-cut and reinforces the underlying premise to this thesis – namely, that the constituents of social understanding are currently not fully understood and that there is a pressing need to clarify such aspects of understanding. Such endeavour, as has been pursued throughout this thesis, will increase the likelihood that models of social understanding accurately represent the complex paths to social cognition in typical and atypical development.

8.5 Limitations

As expressed at the outset of this thesis, a longitudinal investigation would have been a fruitful approach to delineating children's social understanding abilities and would have been more harmonious with the claims from the model of Tager-Flusberg and Joseph; however such a protracted time-scale was beyond the scope of this thesis. As a result, this thesis focused on concurrent rather than longitudinal relationships, which nonetheless provided valuable insight into the breakdown of constituents of social understanding. Ideally however, research in the future will embrace a similar investigation to that of chapter 6 – i.e. using structural equation modelling as an analytic tool – but also investigating each of the constituents of social understanding from an early age (i.e. joint attention abilities in infancy) and following these through at least to the age when children regularly pass second-order false belief stories. Such a venture would require a span of at least 5 years, but the richness and conviction in findings which would be obtained from such research would prove invaluable to further delineating the constituents of social understanding

and language and determining the variation in continuity between these abilities over time. For instance, it may well be that the pervasive lack of association between social attention and the other constructs in this thesis was due to a lack of sensitivity of social attention tasks in 4- to 5-year-olds by which time social attention may be less important, but which could, for example, otherwise link longitudinally from infancy to social cognitive skills around 4 to 5 years of age.

As mentioned above, the findings indicated that children with autism were significantly impaired in social cognition despite some social-perceptual ability and word-learning abilities. This outcome leaves open the realistic possibility that syntactic knowledge of verbs of communication provide an exclusive route to social-cognitive success for children with autism. The measure of syntactic ability used in this thesis (the syntax scale of the Children's Communication Checklist-2) was chosen to provide a measure from parents, both which indicated the child's general syntactic ability on a daily basis and which by its nature did not require any extra testing time in addition to the already full testing battery which children experienced. Such a measure is obviously broader than a specific test measuring comprehension of sentential complements (e.g., de Villiers, 2000; de Villiers & Pyers, 2002) and limits the conviction with which it can be said in this thesis that syntactic understanding of verbs of communication does facilitate social-cognitive performance for children with autism. Nonetheless, the present results do by extension support such a claim and it would be useful for a future similar study to incorporate a sentential complements task into the kind of longitudinal investigation recommended above.

8.6 Future directions

As expressed above, longitudinal investigation of the paths between different aspects of social understanding would be a worthy enterprise. It is interesting to

wonder what differences may exist between such an investigation and the concurrent exploration of the constituents of social understanding throughout this thesis. There is evidence that current research *is* considering potential longitudinal links across social understanding. Racine, Carpendale and Turnbull (2006) examined the relations between the ways 48 mothers and their 3- to 5-year-olds talked about a conflict depicted in a picture book and their children's concurrent and subsequent level of social understanding. Social understanding at the first time-point was positively associated with social understanding 30 months later. Therefore, there is evidence that research is looking longitudinally at relations in social understanding, but this should go further by beginning with infant abilities (e.g., joint attention, orienting to stimuli) and following this through to comprehension of first-order and second-order beliefs and beyond.

The importance of a developmental dimension is undoubted to advance our understanding – social attention needs to be brought into the frame at a much earlier age when abilities within this domain are evolving and changing into different aspects of the same or different type of understanding – e.g., is there homotypic or heterotypic continuity between an infant's abilities to habituate to human intentional action and their ability to initiate joint attention with another person? Furthermore, by using structural equation modelling as a tool to model relationships between constituents, would a general construct of social attention be implicated longitudinally with social perception and/or social cognition? Would children's social-perceptual abilities at one time point be significantly associated with a certain aspect of language (e.g., word learning) at another point? Would this then coincide with increased syntactic knowledge at one point which then links to certain aspects of social cognition one or two years later? There are many questions and many

possibilities; irrespective of using structural equation modelling to explore concurrent versus prospective pathways to social cognition, these may be best considered in the context of non-linear models. That is, given that developmental pathways are often not straight, using non-linear models (e.g., dynamic systems (Smith & Thelen, 2003)) may offer the kind of framework which better reflects the transactional, dynamic nature of the development of social understanding.

While future research may benefit from the kind of theoretical enterprise outlined above, the present work offers avenues for future research to explore in terms of interventions to children's social understanding. For instance, the facilitative role of ignorance upon false belief understanding as described in chapter 2 could be explored via a training study to determine whether children can improve their understanding of complex, higher-order social cognition by focusing on more basic social-cognitive skills. Furthermore, such endeavour would be complemented neatly by exploration into the subsequent effects on social interaction skills, to determine if facilitation of understanding applies purely in an experimental setting or whether it transfers to the dynamics of everyday social interaction. Ideally then, future studies will examine social interaction alongside the different constituents of social understanding, using measures of interaction such as children's level of engagement with peers (Travis, Sigman, & Ruskin, 2001) which are ecologically valid and provide useful comparison with structured laboratory tasks. Given the points which have been made throughout this thesis asserting that the term 'social understanding' necessarily reflects the social basis to such comprehension, it is important that future studies use such ecological measures of social behaviour and interaction where possible. This will further our knowledge of the extent to which the complex paths

along social understanding reflect the social interactions which children experience in everyday life.

8.7 Conclusion

The quote of Tager-Flusberg and Sullivan (2000) used in the preface to this thesis outlined the need for research to "formulate a model of theory of mind, or...social knowledge" given that the "absence of such a model has led to the broadening of the concept of theory of mind with little regard to potentially important theoretical distinctions that have implications for underlying mechanisms within this broad domain". While Tager-Flusberg and colleagues had since proposed such models, these were never really explicitly explored in terms of the structure of various constituents and the continuity between them; thus allowing a similar level of conceptual ambiguity to endure. It is hoped that this thesis has gone some way into filling this void and furthering our understanding of what this broad domain constitutes, with the hope that future research will embrace such distinctions when investigating developmental pathways and mechanisms underlying children's social understanding.

References

American Psychiatric Association. (1994). *DSM-IV: Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.

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

Astington, J. W., & Gopnik, A. (1991). Theoretical explanations of children's understanding of the mind. *British Journal of Developmental Psychology, 9,* 7-31.

Astington, J. W., & Jenkins, J. M. (1999). A longitudinal study of the relation between language and theory-of-mind development. *Developmental Psychology, 35,* 1311-1320.

Baldwin, D. (1993). Infants' ability to consult the speaker for clues to word reference. *Journal of Child Language, 20,* 395-418.

Baldwin, D. A., & Moses, L. J. (2001). Links between social understanding and early word learning: challenges to current accounts. *Social Development, 10,* 309-329.

Baron-Cohen, S. (1989). The autistic child's theory of mind: A case of specific developmental delay. *Journal of Child Psychology and Psychiatry, 30,* 285-287.

Baron-Cohen, S. (1994). The Mindreading System: new directions for research. *Current Psychology of Cognition, 13,* 724-750.

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind.* Cambridge, MA: MIT Press.

Baron-Cohen, S. (2000a). Theory of mind and autism: A fifteen year review. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen, *Understanding other minds: Perspectives from developmental cognitive neuroscience* (2nd ed.). Oxford: Oxford University Press.

Baron-Cohen, S. (2000b). Autism: Deficits in folk psychology exist alongside superiority in folk physics. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen, *Understanding other minds: Perspectives from developmental cognitive neuroscience* (2nd ed.). Oxford: Oxford University Press.

Baron-Cohen, S. (2005). The empathising system: A revision of the 1994 model of the Mindreading system. In B. Ellis, & D. Bjorklund (Eds.), *Origins of the Social Mind.* NY: Guilford Publications.

Baron-Cohen, S., & Belmonte, M. K. (2005). Autism: A window onto the development of the social and the analytic brain. *Annual Review of Neuroscience, 28,* 109-126.

Baron-Cohen, S., Campbell, R., Karmiloff-Smith, A., Grant, J., & Walker, J. (1995) Are children with autism blind to the mentalistic significance of the eyes? *British Journal of Developmental Psychology, 13,* 379-398.

Baron-Cohen, S., Jolliffe, T., Mortimore, C., & Robertson, M. (1997). Another advanced test of theory of mind: evidence from very high functioning adults with autism or Asperger syndrome. *Journal of Child Psychology and Psychiatry, 38,* 813-822.

Baron-Cohen, S., Leslie, A., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*, 37-46.

Baron-Cohen, S., Ring, H. A., Wheelwright, S., Bullmore, E. T., Brammer, M. J., Simmons, A., & Williams, S. C. (1999). Social intelligence in the normal and

autistic brain: an fMRI study. *European Journal of Neuroscience, 11,* 1891-1898.

Baron-Cohen, S., Tager-Flusberg, H., & Cohen, D. J. (1993). *Understanding other minds: Perspectives from autism.* Oxford: Oxford University Press.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "Reading the mind in the eyes" test revised version: A study with normal adults, and adults with Asperger Syndrome or High-functioning autism. *Journal of Child Psychology and Psychiatry, 42,* 241-251.

Baron-Cohen, S., Wheelwright, S., Spong, A., Scahill, V., & Lawson, J. (2001). Are intuitive physics and intuitive psychology independent? A test with children with Asperger Syndrome. *Journal of Developmental and Learning Disorders, 5,* 47-78.

Behrmann, M., Thomas, C., & Humphreys, K. (2006). Seeing it differently: visual processing in autism. *Trends in Cognitive Sciences, 10,* 258-264.

Bennett, M., & Matthews, L. (2000). The role of second-order belief understanding and social context in children's self attribution of social emotions. *Social Development, 9,* 126-130.

Bishop, D. V. M. (2003). *The Children's Communication Checklist-2.* London: Psychological Corporation.

Bloom, P. (2000). *How children learn the meanings of words.* Cambridge, MA: MIT Press.

Bloom, P. & German, T. P. (2000). Two reasons to abandon the false belief task as a test of theory of mind. *Cognition, 77,* B25–B31.

Bono, M. A., Daley, T., & Sigman, M. (2004). Relations among joint attention, amount of intervention and language gain in autism. *Journal of Autism and Developmental Disorders, 34,* 495-505.

Bowler, D. M. (1992). "Theory of mind" in Asperger's Syndrome. *Journal of Child Psychology and Psychiatry, 33,* 877-893.

Brooks, R., & Meltzoff, A. N. (2005). The development of gaze following and its relation to language. *Developmental Science, 8,* 535-543.

Broomfield, K. A., Robinson, E. J., & Robinson, W. P. (2002). Children's understanding about white lies. *British Journal of Developmental Psychology, 20,* 47-65.

Bruinsma, Y., Koegel, R. L., & Koegel, L. K. (2004). Joint attention and children with autism: A review of the literature. *Mental Retardation and Developmental Disabilities Research Reviews, 10,* 169-175.

Burt, D. M., Montirosso, R., Frigerio, E., Peverelli, M., Borgatti, R., & Perrett, D. I. (in submission). *The development of facial expression recognition labelling in children between 4 and 14 years old.* Manuscript submitted for publication to the Journal of Child Psychology and Psychiatry.

Butterworth, G. (1991). The ontogeny and phylogeny of joint visual attention. In A. Whiten (Ed.), *Natural theories of mind* (pp. 223-232). Oxford: Blackwell.

Butterworth, G., & Jarrett, N. (1991). What minds have in common is space – spatial mechanisms serving joint visual-attention in infancy. *British Journal of Developmental Psychology, 9,* 55-72.

Calder, A. J., Lawrence, A. D., Keane, J., Scott, S. K., Owen, A. M., Christoffels, I., & Young, A. W. (2002). Reading the mind from eye gaze. *Neuropsychologia, 40,* 1129-1138.

Carlson, S. M., Moses, L. J., & Breton, C. (2002). How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. *Infant and Child Development, 11,* 73-92.

Carpendale, J. I. M., & Lewis, C. (2004). Constructing an understanding of mind: The development of children's social understanding within social interaction. *Behavioural and Brain Sciences, 27,* 79-96.

Carpendale, J. I.M., & Lewis, C. (2006). *How children develop social understanding.* Oxford, UK: Blackwell.

Carpenter, M., Akhtar, N., & Tomasello, M. (1998). Fourteen- through 18-month-old infants differentially imitate intentional and accidental actions. *Infant Behaviour and Development, 21,* 315-330.

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

Carpenter, M., Pennington, B. F., & Rogers, S. J. (2002). Interrelations among social-cognitive skills in young children with autism. *Journal of Autism and Developmental Disorders, 32,* 91-106.

Chandler, M. J. (1988). Doubt and developing theories of mind. In J. W. Astington, P. L. Harris, & D. R. Olson (Eds.), *Developing theories of mind* (pp. 387-413). New York: Cambridge University Press.

Chandler, M., Fritz, A. & Hala, S. (1989). Small-scale deceit: Deception as a marker of two- , three- , and four-year-olds' theories of mind. *Child Development, 60,* 1263–1277.

Chandler, M. J., & Hala, S. M. (1994). The role of personal involvement in the assessment of early false-belief skills. In C. Lewis & P. Mitchell (Eds.),

Children's early understanding of mind: Origins and development (pp. 403-425). Hove, UK: Erlbaum.

Chapman, M. (1991). The epistemic triangle: Operative and communicative components of cognitive development. In M. Chandler & M. Chapman (Eds.), *Criteria for competence: Controversies in the conceptualization and assessment of children's abilities* (pp. 209-228). Hillsdale, NJ: Lawrence Erlbaum Associates.

Charman, T. (2003). Why is joint attention a pivotal skill in autism? *Philosophical Transactions of the Royal Society of London (B), 358,* 315-324.

Charman, T., Baron-Cohen, S., Swettenham, J., Baird, G., Cox, A., & Drew, A. (2001). Testing joint attention, imitation, and play as infancy precursors to language and theory of mind. *Cognitive Development, 15,* 481-498.

Cicchetti, D. (1984). The emergence of developmental psychopathology. *Child Development, 55,* 1-7.

Clements, W. & Perner, J. (1994). Implicit understanding of belief. *Cognitive Development, 9,* 377-397.

Cole, K., & Mitchell, P. (2000). Siblings in the development of executive control and a theory of mind. *British Journal of Developmental Psychology, 18,* 279-295.

Corkum, V., & Moore, C. (1998). The origin of joint visual attention in infants. *Developmental Psychology, 34,* 28-38.

Coull, G. J. (2001). *Second-order belief attribution: An investigation of the role of story complexity, working memory, language ability and sibling influence.* Unpublished undergraduate thesis, University of Dundee.

Coull, G. J., Leekam, S. R., & Bennett, M. (2006). Simplifying second-order belief attribution: What facilitates children's performance on measures of conceptual understanding? *Social Development, 15,* 260-275.

Courchesne, E. (1997). Brainstem, cerebellar and limbic neuroanatomical abnormalities in autism. *Current Opinion in Neurobiology, 7,* 269-278.

Critchley, H., Daly, E., Bullmore, E., Williams, S. C. R., Van Amelsvoort, T., Robertson D. M., Rowe, A., Phillips, M., McAlonan, G., Howlin. P., & Murphy D. G. M. (2000). The functional neuroanatomy of social behaviour: Changes in cerebral blood flow when people with autistic disorder process facial expressions. *Brain, 123,* 2203-2212.

Cutting, A. L., & Dunn, J. (1999). Theory of mind, emotion understanding, language, and family background: Individual differences and interrelations. *Child Development, 70,* 853-865.

Dawson, G., Meltzoff, A., Osterling, J., Rinaldi, J., & Brown, E. (1998). Children with autism fail to orient to naturally occurring social stimuli. *Journal of Autism and Developmental Disorders, 28,* 479-485.

Dawson, G., Toth, K., Abbott, R., Osterling, J., Munson, J., Estes, A., & Liaw, J. (2004). Early social attention impairments in autism: Social orienting, joint attention, and attention to distress. *Developmental Psychology, 40,* 271-283.

Dennett, D. C., (1978). Beliefs about beliefs. *Behavioural and Brain Sciences, 4,* 568-570.

de Rosnay, M., & Hughes, C. (2006). Conversation and theory of mind: Do children talk their way to socio-cognitive understanding? *British Journal of Developmental Psychology, 24,* 7-37.

de Villiers, J. G. (2000). Language and theory of mind: What are the developmental relationships? In S. Baron-Cohen, H. Tager-Flusberg & D. J. Cohen (Eds.). *Understanding Other Minds: Perspectives from Developmental Cognitive Neuroscience* (pp. 83–123). New York: Oxford University Press.

de Villiers, J. G. (2005). Can language acquisition give children a point of view? In J. W. Astington & J. A. Baird (Eds.), *Why language matters for theory of mind* (pp. 186-219). Oxford: Oxford University Press.

de Villiers, J. G., & de Villiers, P. A. (2000). Linguistic determinism and the understanding of false beliefs. In P. Mitchell & K. Riggs (Eds.), *Children's reasoning and the mind* (pp. 189-226). Hove, UK: Psychology Press.

de Villiers, J. G., & Pyers, J. (2002). Complements to cognition: A longitudinal study of the relationship between complex syntax and false-belief understanding. *Cognitive Development, 17,* 1037-1060.

Dunn, J. (1988). Sibling influences on childhood development. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 29,* 119-127.

Dunn, J., Brown, J., Slomkowski, C., Tesla, C., & Youngblade, L. (1991). Young children's understanding of other people's feelings and beliefs: Individual differences and their antecedents. *Child Development, 62*, 1352-1366.

Dunn, L. M., Dunn, L. M., & NFER-Nelson (1997). *The British Picture Vocabulary Scale: Second edition*. NFER-Nelson, UK.

Eisenmajer, R., & Prior, M. (1991). Cognitive linguistic correlates of theory of mind ability in autistic-children. *British Journal of Developmental Psychology, 9,* 351-364.

Erdfelder, E., Faul, F., & Buchner, A. (1996). GPOWER: A general power analysis program. *Behaviour Research Methods, Instruments, & Computers*, *28*, 1-11.

Fabricius, W. V. & Imbens-Bailey, A. L. (2000). False beliefs about false beliefs. In P. Mitchell & K. Riggs (Eds.). *Children's Reasoning about the Mind* (pp. 267–280). Hove, UK: Psychology Press.

Fan, X., Thompson, B., & Wang, L. (1999). Effects of sample size, estimation method, and model specification on structural equation modelling fit indexes. *Structural Equation Modelling, 6,* 56-83.

Flavell, J. H. (2004). Theory of mind development: Retrospect and prospect. *Merrill-Palmer Quarterly Journal of Developmental Psychology, 50,* 274-290.

Fonagy, P., Redfern, S., & Charman, T. (1997). The relationship between belief-desire reasoning and a projective measure of attachment security (SAT). *British Journal of Developmental Psychology, 15,* 51-61.

Frigerio, E., Burt, D. M., Gagliardi, C., Cioffi, G., Martelli, S., Perrett, D. I., & Borgatti, R. (2006). Is everybody always my friend? Perception of approachability in Williams syndrome. *Neuropsychologia, 44,* 254-259.

Frith, U., Siddons, F., & Happé, F. (1994). Autism and theory of mind in everyday life. *Social Development, 2,* 108-124.

Gagliardi, C., Frigerio, E., Burt, D. M., Cazzaniga, I., Perrett, D., & Borgatti, R. (2003). Facial expression recognition in Williams Syndrome. *Neuropsychologia, 41,* 733-738.

Garfield, J. L., Peterson, C. C., & Perry, T. (2001). Social cognition, language acquisition and the development of theory of mind. *Mind and Language, 16,* 494-541.

George, N., Driver, J., & Dolan, R. J. (2001). Seen gaze-direction modulates fusiform activity and its coupling with other brain areas during face processing. *Neuroimage, 13,* 1102-1112.

Gopnik, A., & Astington, J. (1988). Children's understanding of representational change and its relation to the understanding of false belief and the appearance-reality distinction. *Child Development, 59*, 26-37.

Gottlieb, G. (1998). Normally occurring environmental and behavioural influences on genetic activity: From central dogma to probabilistic epigenesis. *Psychological Review, 105,* 792-802.

Green, S., Pring, L., & Swettenham, J. (2004). An investigation of first-order false belief understanding of children with congenital profound visual impairment. *British Journal of Developmental Psychology, 22,* 1-17.

Grelotti, D. J., Klin, A. J., Gauthier, I., Skudlarski, P., Cohen, D. J., Gore, J. C., Volkmar, F. R., & Schultz, R. T. (2005). fMRI activation of the fusiform gyrus and amygdala to cartoon characters but not to faces in a boy with autism. *Neuropsychologia, 43,* 373-385.

Hale, C. M., & Tager-Flusberg, H. (2003). The influence of language on theory of mind: a training study. *Developmental Science, 6,* 346-359.

Happé, F. (1995). The role of age and verbal ability in the theory of mind task performance of subject with autism. *Child Development, 66,* 843-855.

Happé, F., Ehlers, S., Fletcher, P., Frith, U., Johansson, M., Gillberg, C., Dolan, R., Frackowiak, R., & Frith, C. (1996). "Theory of mind" in the brain. Evidence from a PET scan study of Asperger Syndrome. *Neuroreport, 8,* 197-201.

Happé, F., & Frith, U. (2006). The weak coherence account: Detail-focused cognitive style in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 36,* 5-25.

Harris, P. L. (1991). The work of the imagination. In A. Whiten (Ed.), *Natural theories of mind* (pp. 283-304). Oxford: Blackwell.

Hobson, R. P. (1993a). *Autism and the development of mind.* Hove, UK: Lawrence Erlbaum Associates.

Hobson, R. P. (1993b). Understanding persons: The role of affect. In S. Baron-Cohen, H. Tager-Flusberg & D. J. Cohen (Eds.), *Understanding other minds: Perspectives from autism* (pp. 204-227). Oxford, UK: Oxford University Press.

Hogrefe, G. J., Wimmer, H. & Perner, J. (1986). Ignorance versus false belief: A developmental lag in attribution of epistemic states. *Child Development, 57,* 567–582.

Howlin, P., Mawhood, L., & Rutter, M. (2000). Autism and developmental receptive language disorder - a follow-up comparison in early adult life. II: Social, behavioural, and psychiatric outcomes. *Journal of Child Psychology and Psychiatry, 41,* 561-578.

Hughes, C., Deater-Deckard, K., & Cutting, A. L. (1999). 'Speak roughly to your little boy'? Sex differences in the relations between parenting and preschoolers' understanding of mind. *Social Development, 8,* 143-160.

Hughes, C., & Leekam, S. (2004). What are the links between theory of mind and social relations? Review, reflections and new directions for studies of typical and atypical development. *Social Development, 13,* 590-619.

Jarrold, C., & Brock, J. (2004). To match or not to match? Methodological issues in autism-related research. *Journal of Autism and Developmental Disorders, 34,* 81-86.

Jenkins, J. M., & Astington, J. W. (1996). Cognitive factors and family structure associated with theory of mind development in young children. *Developmental Psychology, 32,* 70-78.

Joseph, R. M., & Tanaka, J. (2003). Holistic and part-based face recognition in children with autism. *Journal of Child Psychology and Psychiatry and Applied Disciplines, 44,* 529-542.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika, 39,* 31-36.

Karmiloff-Smith, A. (1998). Development itself is the key to understanding developmental disorders. *Trends in Cognitive Sciences, 10,* 389-398.

Karmiloff-Smith, A., Klima, E., Bellugi, U., Grant, J. & Baron-Cohen, S. (1995). Is there a social module? Language, face processing, and theory of mind in individuals with Williams syndrome. *Journal of Cognitive Neuroscience, 7,* 196–208.

Klin, A., Jones, W., Schultz, R., & Volkmar, F. (2003). The enactive mind, or from actions to cognition: lessons from autism. *Philosophical Transactions of the Royal Society of London (B), 358,* 345-360.

Klin, A., Jones, W., Schultz, R., Volkmar, F., & Cohen, D. J. (2002). Visual fixation patterns during viewing of naturalistic social situations as predictors of social competence in individuals with autism. *Archives of General Psychiatry, 59,* 809-816.

Kline, R. B. (1998). *Principles and practice of structural equation modelling.* NY: Guilford Press.

Lee, K., Eskritt, M., Symons, L. A., & Muir, D. (1998). Children's use of triadic eye gaze information for "mind reading". *Developmental Psychology, 34,* 525-539.

Lee, S. & Hershberger, S. (1990). A simple rule for generating equivalent models in covariance structure modelling. *Multivariate Behavioural Research, 25,* 313-334.

Leekam, S. R. (1991). Jokes and lies: Children's understanding of intentional falsehood. In A. Whiten (Ed.). *Natural theories of mind* (pp. 159–174). Oxford: Basil Blackwell.

Leekam, S. R. (2005). Language comprehension difficulties in children with autistic spectrum disorders. In K. Cain, & J. Oakhill (Eds.), *Cognitive bases of children's language comprehension difficulties*. New York: Guilford.

Leekam, S., Baron-Cohen, S., Perrett, D., Milders, M., & Brown, S. (1997). Eye-direction detection: A dissociation between geometric and joint attention skills in autism. *British Journal of Developmental Psychology, 15,* 77-95.

Leekam, S. R., Hunnisett, E., & Moore, C. (1998). Targets and cues: Gaze-following in children with autism. *Journal of Child Psychology and Psychiatry, 39,* 951-962.

Leekam, S. R., Lopez, B., & Moore, C. (2000). Attention and joint attention in preschool children with autism. *Developmental Psychology, 36,* 261-273.

Leekam, S. R., & Perner, J. (1991). Does the autistic child have a metarepresentational deficit? *Cognition, 40,* 213-218.

Leekam, S. R. & Prior, M. (1994). Can autistic children distinguish lies from jokes? A second look at second-order belief attribution. *Journal of Child Psychology and Psychiatry, 35,* 901–915.

Leekam, S. R., & Ramsden, C. A. H. (2006). Dyadic orienting and joint attention in preschool children with autism. *Journal of Autism and Developmental Disorders, 36,* 185-197.

Leslie, A. M. (1987). Pretence and representation – the origins of theory of mind. *Psychological Review, 94,* 412-426.

Lewis, C., Freeman, N., Hagestadt, C., & Douglas, H. (1994). Narrative access and production in preschoolers' false belief reasoning. *Cognitive Development, 9,* 397-424.

Lewis, C., & Osborne, A. (1990). Three-year-olds' problems with false belief: Conceptual deficit or linguistic artefact? *Child Development, 61,* 1514-1519.

Lohmann, H., & Tomasello, M. (2003). The role of language in the development of false belief understanding: a training study. *Child Development, 74,* 1130-1144.

MacCallum, R. C., & Browne, M. W. (1993). The use of causal indicators in covariance structure models – some practical issues. *Psychological Bulletin, 114,* 533-541.

Meins, E., Fernyhough, C., Russell, J., & Clark-Carter, D. (1998). Security of attachment as a predictor of symbolic and mentalising abilities: A longitudinal study. *Social Development, 7,* 1-24.

Meins, E., Fernyhough, C., Wainwright, R., Clark-Carter, D., Das Gupta, M., Fradley, E., & Tuckey, M. (2003). Pathways to understanding mind: Construct validity and predictive validity of maternal mind-mindedness. *Child Development, 74,* 1194-1211.

Meins, E., Fernyhough, C., Wainwright, R., Das Gupta, M., Fradley, E., & Tuckey, M. (2002). Maternal mind-mindedness and attachment security as predictors of theory of mind understanding. *Child Development, 73,* 1715-1726.

Miller, C. A. (2006). Developmental relationships between language and theory of mind. *American Journal of Speech-Language Pathology, 15,* 142-154.

Milne, E., Swettenham, J., Hansen, P., Campbell, R., Jeffries, H., & Plaisted, K. (2002). High motion coherence thresholds in children with autism. *Journal of Child Psychology and Psychiatry, 43,* 255-263.

Minshew, N. J., Turner, C. A., & Goldstein, G. (2005). The application of short forms of the Wechsler intelligence scales in adults and children with high functioning autism. *Journal of Autism and Developmental Disorders, 35,* 45-52.

Moore, C., & Corkum, V. (1994). Social understanding at the end of the 1st year of life. *Developmental Review, 14,* 349-372.

Morales, M., Mundy, P., Crowson, M. M., Neal, A. R., & Delgado, C. E. F. (2005). Individual differences in infant attention skills, joint attention and emotion regulation behaviour. *International Journal of Behavioural Development, 29,* 259-263.

Morales, M., Mundy, P., Delgado, C. E. F., Yale, M., Messinger, D., Neal, R., & Schwartz, H. K. (2000). Responding to joint attention across the 6- through 24-month age period and early language acquisition. *Journal of Applied Developmental Psychology, 21,* 283-298.

Morissette, P., Ricard, M., & Decarie, T. G. (1995). Joint visual-attention and pointing in infancy – a longitudinal study of comprehension. *British Journal of Developmental Psychology, 13,* 163-175.

Mundy, P., & Neal, R. (2001). Neural plasticity, joint attention, and a transactional social-orienting model of autism. In L. Glidden (Ed.) *International review of research in mental retardation: Vol. 23. Autism* (pp. 139-168). New York: Academic Press.

Mundy, P., & Sigman, M. (1989). Specifying the nature of the social impairment in autism. In G. Dawson (Ed.), *Autism: Nature, diagnosis and treatment.* New York: Guilford Publications.

Mundy, P., Sigman, M., & Kasari, C. (1990). A longitudinal study of joint attention and language development in autistic children. *Journal of Autism and Developmental Disorders, 20,* 115-123.

Osterling, J., & Dawson, G. (1994). Early recognition of children with autism: A first study of first birthday home videotapes. *Journal of Autism and Developmental Disorders, 24,* 247-257.

Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1991). Executive function deficits in high-functioning autistic individuals – relationship to theory of mind. *Journal of Child Psychology and Psychiatry, 32,* 1081-1105.

Ozonoff, S., Rogers, S. J., & Pennington, B. F. (1991). Asperger syndrome: Evidence of an empirical distinction from high-functioning autism. *Journal of Child Psychology and Psychiatry, 32,* 1107-1122.

Perner, J. (1991). *Understanding the representational mind.* Cambridge, MA: The MIT Press.

Perner, J. & Horn, R. (2003). Ignorance or false negatives: Do children of 4 to 5 years simulate belief with 'not-knowing = getting it wrong?' *Journal of Cognition and Development, 4,* 263–273.

Perner, J. & Howes, D. (1992). 'He thinks he knows': And more developmental evidence against the simulation (role-taking) theory. *Mind and Language, 7,* 72–86.

Perner, J., Leekam, S., & Wimmer, H. (1987). Three year olds' difficulty with false belief: The case for a conceptual deficit. *British Journal of Developmental Psychology, 5*, 125-137.

Perner, J., Ruffman, T., & Leekam, S. R. (1994). Theory of mind is contagious: You catch it from your sibs. *Child Development, 65*, 1228-1238.

Perner, J. & Wimmer, H. (1985). 'John thinks that Mary thinks that . . .': Attribution of second-order beliefs by 5- to 10-year-old children. *Journal of Experimental Child Psychology, 39*, 437–471.

Peterson, C. C., & Siegal, M. (1998). Changing focus on the representational mind: Deaf, autistic and normal children's concepts of false photos, false drawings and false beliefs. *British Journal of Developmental Psychology, 16,* 301-320.

Peterson, C. C., & Siegal, M. (2000). Insights into theory of mind from deafness and autism. *Mind and Language, 15,* 123-145.

Peterson, C. C., Wellman, H. M., & Liu, D. (2005). Steps in theory-of-mind development for children with deafness or autism. *Child Development, 76,* 502-517.

Pierce, K., Muller, R. A., Ambrose, J., Allen, G., & Courchesne, E. (2001). Face processing occurs outside the fusiform 'face area' in autism: evidence from functional MRI. *Brain, 124,* 2059-2073.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioural and Brain Sciences, 4,* 515-526.

Prior, M., Eisenmajer, R., Leekam, S., Wing, L., Gould, J., Ong, B., & Dowe, D. (1998). Are there subgroups within the autistic spectrum? A cluster analysis of a group of children with autistic spectrum disorders. *Journal of Child Psychology and Psychiatry, 39,* 893-902.

Racine, T. P., Carpendale, J. I. M., & Turnbull, W. (2006). Cross-sectional and longitudinal relations between mother-child talk about conflict and children's social understanding. *British Journal of Psychology, 97,* 521-536.

Ristic, J., Mottron, L., Friesen, C., Iarocci, G., Burack, J. A., & Kingstone, A. (2005). Eyes are special but not for everyone: The case of autism. *Cognitive Brain Research, 24,* 715-718.

Ruffman, T., Perner, J., Naito, M., Parkin, L., & Clements, W. A. (1998). Older (but not younger) siblings facilitate false belief understanding. *Developmental Psychology, 34,* 161-174.

Ruffman, T., Slade, L., & Crowe, E. (2002). The relation between children's and mothers' mental state language and theory-of-mind understanding. *Child Development, 73,* 734-751.

Ruffman, T., Slade, L., Rowlandson, K., Rumsey, C., & Garnham, A. (2003). How language relates to belief, desire, and emotion understanding. *Cognitive Development, 18,* 139-158.

Russell, J. (1996). *Agency: Its role in mental development.* Hove, UK: Lawrence Erlbaum Associates.

Rutter, M., Bailey, A., & Lord, C. (2003). *The Social Communication Questionnaire* (1st edn). Los Angeles: Western Psychological Services.

Saxe, R., & Powell, L. J. (2006). It's the thought that counts: Specific brain regions for one component of theory of mind. *Psychological Science, 17,* 692-699.

Scaife, M. & Bruner, J. S. (1975). The capacity for joint attention. *Nature, 253,* 265-266.

Schultz, T. (2005). Developmental deficits in social perception in autism: the role of the amygdala and fusiform face area. *International Journal of Developmental Neuroscience, 23,* 125-141.

Siegal, M. & Varley, R. (2002). Neural systems involved in 'theory of mind.' *Nature Reviews Neuroscience, 3,* 463–471.

Sigman, M., & Ruskin, E. (1999). Continuity and change in the social competence of children with autism, Down syndrome, and developmental delays. *Monographs of the Society for Research in Child Development, 64(*1, Serial No. 256).

Skwerer, D. P., Verbalis, A., Schofield, C., Faja, S., & Tager-Flusberg, H. (2006). Social-perceptual abilities in adolescents and adults with Williams syndrome. *Cognitive Neuropsychology, 23,* 338-349.

Slade, L., & Ruffman, T. (2005). How language does (and does not) relate to theory of mind: A longitudinal study of syntax, semantics, working memory and false belief. *British Journal of Developmental Psychology, 23,* 117-141.

Smith, L. B., & Thelen, E. (2003). Development as a dynamic system. *Trends in Cognitive Sciences, 7,* 343-348.

Sodian, B. (1991). The development of deception in young children. *British Journal of Developmental Psychology, 9,* 173-188.

Sparrevohn, R., & Howie, P. (1995). Theory of mind in children with autistic disorder: Evidence of developmental progression and the role of verbal ability. *Journal of Child Psychology and Psychiatry, 36,* 249-263.

Sparrow, S. S., Balla, D. A., & Cicchetti, D. V. (1985). *Vineland adaptive behaviour scales: Classroom edition.* Circle Pines, MN: American Guidance Service.

Steele, S., Joseph, R. M., & Tager-Flusberg, H. (2003). Brief report: Developmental change in theory of mind abilities in children with autism. *Journal of Autism and Developmental Disorders, 33,* 461-467.

Striano, T., & Reid, V. M. (2006). Social cognition in the first year. *Trends in Cognitive Sciences, 10,* 471-476.

Sullivan, K., & Winner, E. (1993). Three year olds' understanding of false belief: The influence of trickery. *Journal of Experimental Child Psychology, 56,* 135-148.

Sullivan, K., Zaitchik, D. & Tager-Flusberg, H. (1994). Preschoolers can attribute second-order beliefs. *Developmental Psychology, 30,* 395–402.

Swettenham, J., Baron-Cohen, S., Charman, T., Cox, A., Baird, G., Drew, A., Rees, L., & Wheelwright, S. (1998). The frequency and distribution of spontaneous attention shifts between social and non-social stimuli in autistic, typically developing and non-autistic developmentally delayed infants. *Journal of Child Psychology and Psychiatry, 39,* 747-754.

Tager-Flusberg, H. (1992). Autistic children talk about psychological states: Deficits in the early acquisition of a theory of mind. *Child Development, 63,* 161-172.

Tager-Flusberg, H. (1997). The role of theory of mind in language acquisition: Contributions from the study of autism. In L. Adamson & M. A. Romski (Eds.), Communication and language acquisition: Discoveries from atypical development (pp. 133-158). Baltimore, MD: Paul Brookes.

Tager-Flusberg, H. (2001). A re-examination of the theory of mind hypothesis of autism. In J. Burack, T. Charman, N. Yirmiya, & P. Zelazo (Eds.), *The development of autism: Perspectives from theory and research* (pp. 173-193). Mahwah, NJ: Erlbaum.

Tager-Flusberg, H., Boshart, J., & Baron-Cohen, S. (1998). Reading the windows to the soul: Evidence of domain-specific sparing in Williams syndrome. *Journal of Cognitive Neuroscience, 10,* 631-639.

Tager-Flusberg, H., & Joseph, R. M. (2005). How language facilitates the acquisition of false-belief understanding in children with autism. In J. W. Astington & J. A. Baird (Eds.), *Why language matters for theory of mind* (pp. 298-318). Oxford: Oxford University Press.

Tager-Flusberg, H., & Sullivan, K. (1994). Predicting and explaining behaviour: A comparison of autistic, mentally retarded and normal children. *Journal of Child Psychology and Psychiatry, 35,* 1059-1075.

Tager-Flusberg, H., & Sullivan, K. (2000). A componential view of theory of mind: Evidence from Williams syndrome. *Cognition, 76,* 59-89.

Tomasello, M., Kruger, A. C., & Ratner, H. H. (1993). Cultural learning. *Behavioural and Brain Sciences, 16,* 495-511.

Travis, L., Sigman, M., & Ruskin, E. (2001). Links between social understanding and social behaviour in verbally able children with autism. *Journal of Autism and Developmental Disorders, 31,* 119-130.

Vicari, S., Reilly J. S., Pasqualetti, P., Vizzotto, A., & Caltagirone, C. (2000). Recognition of facial expressions of emotions in school-age children: the intersection of perceptual and semantic categories. *Acta Paediatrica, 89,* 836-845.

Volkmar, F. R., Lord, C., Bailey, A., Schultz, R. T., & Klin, A. (2004). Autism and pervasive developmental disorders. *Journal of Child Psychology and Psychiatry, 45,* 135-170.

Watson, A. C., Nixon, C. L., Wilson, A., & Capage, L. (1999). Social interaction skills and theory of mind in young children. *Developmental Psychology, 35,* 386-391.

Wechsler, D. (1997). *The Wechsler abbreviated scale for intelligence.* San Antonio, TX: The Psychological Corporation.

Wellman, H. M. (1990). *The child's theory of mind.* Cambridge, MA: MIT Press.

Wellman, H. M. (1991). From desires to beliefs: Acquisition of a theory of mind. In A. Whiten (Ed.), *Natural theories of mind* (pp. 19-38). Oxford: Blackwell.

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory of mind development: The truth about false belief. *Child Development, 72,* 655-684.

Wellman, H. M., Harris, P. L., Banerjee, M., & Sinclair, A. (1995). Early understanding of emotion - evidence from natural-language. *Cognition and Emotion, 9,* 117-149.

Wellman, H. M., & Liu, D. (2004). Scaling of theory of mind tasks. *Child Development, 75,* 523-541.

Wellman, H. M., Phillips, A. T., Dunphy-Lelii, S., & LaLonde, N. (2004). Infant social attention predicts preschool social cognition. *Developmental Science, 7,* 283-288.

Whalen, P. J., Rauch, S. L., Etcoff, N. L., McInerney, S. C., Lee, M. B., & Jenike, M. A. (1998). Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge. *The Journal of Neuroscience, 18,* 411-418.

Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition, 13,* 103-128.

Winner, E. & Leekam, S. R. (1991). Distinguishing irony from deception - understanding the speakers second-order intention. *British Journal of Developmental Psychology, 9*, 257–270.

Woolfe, T., Want, S. C., & Siegal, M. (2002). Signposts to development: Theory of mind in deaf children. *Child Development, 73,* 1472-1492.

Appendices

Appendix 2.1

Versions of two additional stories used to examine role of ignorance upon belief understanding, and list of appropriate and inappropriate justifications

Additional story example 1

Kirsten and Joe are playing at the beach. Joe goes for a swim in the sea while Kirsten stays on the beach. Kirsten sees that Joe has left his chocolate bar in his bag in the direct sunlight. Kirsten decides to do Joe a favour by moving the chocolate from his bag and putting it into the icebox.
Probe Question 1. "Is Joe in the sea?" *Yes.*
Probe Question 2. "Did Kirsten leave the chocolate to melt in the sun?" *No.*
Probe Question 3. "Why did Kirsten move the chocolate to the icebox?" *To help Joe.*
While Kirsten was putting the bar of chocolate in the icebox, Joe was looking towards the beach and saw Kirsten moving the chocolate from his bag and putting it in the icebox. But Kirsten doesn't see Joe watching her put the chocolate in the box. She doesn't see him! Joe then leaves the water and walks toward Kirsten.
Nonlinguistic control question. "Does Joe know that Kirsten moved the chocolate to the icebox?" *Yes.*
Second-order ignorance question. "Does Kirsten know that Joe knows where the chocolate is?" *No.*
Memory aid: Now remember, Kirsten doesn't know that Joe saw her move the chocolate.
Second-order false-belief question. "Where does Kirsten think Joe will look for the chocolate?" *Bag.*
Justification question. "Why does Kirsten think Joe will look for the chocolate in the _____?" *Because she doesn't know that Joe saw the chocolate in the box.*

Additional story example 2

Jack and Katie have been given a cake to share from their Dad. Jack wants all of the cake for himself so he hides the cake in the cupboard when Katie isn't looking. Katie says to Jack, "When I finish my homework I'll have my half of the cake." But remember, Jack wants all the cake for himself. So instead of telling Katie the cake is in the cupboard, Jack says "Katie, I've put the cake in the fridge for when you want it."
Probe question 1. "Did Jack put the cake in the fridge?" *No.*
Probe question 2. "Did Jack tell Katie he put the cake in the fridge?" *Yes.*
Probe question 3. "Why did Jack tell Katie that he put the cake in the fridge?" *He played a trick on Katie so he would get more cake.*
Now, Katie says to Jack, "I'm going upstairs to finish my homework." Katie leaves the kitchen and then remembers that she has left her pen there. She goes back to the kitchen and sees Jack taking some cake from the cupboard not the fridge! Katie says to herself, "Aah, Jack didn't leave the cake in the fridge he hid it in the cupboard." Jack does *not* see Katie watching him take some cake from the cupboard.
Nonlinguistic control question. "Does Katie know that Jack hid the cake in the

cupboard? *Yes.*
Now, Dad sees Jack in the kitchen. He asks Jack if him and Katie are enjoying the cake. Jack says it is really tasty but that Katie is having her cake later. Dad asks Jack, "Does Katie know where the cake is?"
Second-order ignorance question. "What does Jack say to Dad?" *No.*
Memory aid. Now remember, Jack does not know that Katie saw him take some cake from the cupboard.
Then, Dad says to Jack, "Where does Katie think the cake is?"
Second-order false-belief question. "What does Jack say to Dad?" *Fridge.*
Justification question. "Why does Jack say that?" *Because he doesn't know that Katie saw the cake in the cupboard.*

Justifications

Appropriate justifications conveyed that the child was able to recognise the relevant information and reason that character A will wrongly predict where/what character B thinks because A is unaware of what B knows and therefore A has a mistaken belief about B's belief.

i. *Embedding of mental state:* Explicit embedding of one character's mental state within another character's mental state, e.g., 'Sally doesn't know that Paul knows where the robot is.'

ii. *Nesting of crucial information within another character's belief:* Important information regarding what character B has found out unbeknown to character A is contained in A's mental state, e.g., 'Sally doesn't know that Paul saw her hide the robot.'

iii. *Location:* Original location of critical object is mentioned, e.g., 'Paul had left the robot in the box.'

iv. *Note:* Due to the slightly different format of the standard stories, rather than a justification category regarding location, justifications were categorized in terms of an explicit reference to surprise or deception, e.g., 'Because Mum wanted to surprise Peter with the puppy.'

Inappropriate justifications conveyed that the child could not grasp the significance of the relevant information.

i. *First-order reasoning:* Irrelevant knowledge of one of the characters is mentioned, e.g., 'Sally/Paul knows that the robot is in the cupboard.'

ii. *Zero-order reasoning:* Unnecessary focus on actual location of object, e.g., 'That's where the robot is.'

iii. *Irrelevant information:* e.g., 'Paul got the robot for his birthday.'

iv. *Nonsensical response:* e.g., 'The cupboard is over there.'

Appendix 3.1

Three alternately themed versions of composite social-cognitive task

Story A

Scene 1: Jack and Kim are building a sandcastle in the sandpit in the garden. Kim has made a flag to put in the sandcastle when it is finished.
Scene 2: Kim is thirsty so she puts the flag into the bucket and goes inside to the kitchen for a drink.
Scene 3: While Kim is inside, Jack decides to play a trick on Kim and move the flag from the bucket and bury it in the sand.

First-order false belief question: Where does Kim think the flag is?
Justification question: Why does Kim think the flag is in the _____?

Scene 4: While Jack was burying the flag in the sand, Kim watched from the patio-door and saw Jack burying the flag in the sand. But Jack doesn't see Kim watching him bury the flag in the sand. He doesn't see her!
Scene 5: Kim then comes back out to the garden.

Second-order false belief question: Where does Jack think Kim will look for the flag?
Justification question: Why does Jack think Kim will look for the flag in the _____?
Control question: Where will Kim look for the flag?

Story B

Scene 1: Lucy and Joe are playing at the beach. Lucy goes for a swim in the sea while Joe stays on the beach.
Scene 2: Joe sees that Lucy has left her chocolate bar in her bag in the hot sunlight.

Scene 3: While Lucy is away swimming, Joe decides to help Lucy out by moving the melting chocolate from her bag and putting it into the icebox.

First-order false belief question: Where does Lucy think the chocolate bar is?
Justification question: Why does Lucy think the chocolate bar is in the _____?

Scene 4: While Joe was putting the bar of chocolate in the icebox, Lucy was looking towards the beach and saw Joe moving the chocolate from her bag and putting it in the icebox. But Joe doesn't see Lucy watching him put the chocolate in the box. He doesn't see her!
Scene 5: Lucy then leaves the water and walks towards Joe.

Second-order false belief question: Where does Joe think Lucy will look for the chocolate bar?
Justification question: Why does Joe think Lucy will look for the chocolate bar in the _____?
Control question: Where will Lucy look for the chocolate bar?

Story C

Scene 1: Alex is playing in the garden while his sister, Lynn, is playing with her doll in the garden.
Scene 2: Lynn gets cold so puts the doll in her wendy-house before she goes inside to get a coat.
Scene 3: While Lynn is inside her house, Alex decides to play a trick on Lynn by moving the doll into the dog kennel.

First-order false belief question: Where does Lynn think the doll is?
Justification question: Why does Lynn think the doll is in the _____?

Scene 4: While Alex was moving the doll into the dog kennel, Lynn watched from the back door and saw Alex moving the doll into the kennel. But Alex doesn't see Lynn watching him hide the doll in the kennel. He doesn't see her!
Scene 5: Lynn then goes back out to the garden.

Second-order false belief question: Where does Alex think Lynn will look for the doll?
Justification question: Why does Alex think Lynn will look for the doll in the _____?
Control question: Where will Lynn look for the doll?

Appendix 6.1

2 versions of composite false belief story and 2 versions of composite ignorance story

Composite false belief story: example A

Scene 1: It's Paul's birthday. Paul and Sally are in his toy-room. He is showing Sally his favourite new present – a robot.
Scene 2: Paul puts the robot back in the box with the lid on and then has to go outside.
Scene 3: While Paul was away, Sally decided to play a trick on Paul and move the robot from its box and hide it away in the cupboard.

First-order false belief question: Now, where does Paul think the robot is?
Justification question: Why does Paul think the robot is in the _____?

Scene 4: While Sally was hiding the robot in the cupboard, Paul passed by the window and saw 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!
Scene 5: Paul then returns to the toy-room.

Second-order false belief question: Where does Sally think Paul will look for the robot?
Justification question: Why does Sally think Paul will look for the robot in the _____?
Control question: Where will Paul look for the robot?

Composite false belief story: example B

Scene 1: Lucy and Joe are playing at the beach. Lucy goes for a swim in the sea while Joe stays on the beach.
Scene 2: Joe sees that Lucy has left her chocolate bar in her bag in the hot sunlight.
Scene 3: While Lucy is away swimming, Joe decides to help Lucy by moving the melting chocolate from her bag and putting it into the icebox.

First-order false belief question: Where does Lucy think the chocolate bar is?
Justification question: Why does Lucy think the chocolate bar is in the _____?

Scene 4: While Joe was putting the bar of chocolate in the icebox, Lucy was looking towards the beach and saw Joe moving the chocolate from her bag and putting it in the icebox. But Joe doesn't see Lucy watching him put the chocolate in the box. He doesn't see her!
Scene 5: Lucy then leaves the water and walks towards Joe.

Second-order false belief question: Where does Joe think Lucy will look for the chocolate bar?
Justification question: Why does Joe think Lucy will look for the chocolate bar in the _____?
Control question: Where will Lucy look for the chocolate bar?

Composite ignorance story: example A

Scene 1: Jack and Kim are building a sandcastle in the sandpit in the garden. Kim has made a flag to put in the sandcastle when it is finished.

Scene 2: Kim is thirsty so she puts the flag into the bucket and goes inside to the kitchen for a drink.
Scene 3: While Kim is inside, Jack decides to play a trick on Kim and move the flag from the bucket and bury it in the sand.

Control question: Where has Jack moved the flag to?
First-order ignorance question: Does Kim know where the flag is now or does Kim not know?

Scene 4: While Jack was burying the flag in the sand, Kim watched from the back door and saw Jack burying the flag in the sand. But Jack doesn't see Kim watching him bury the flag in the sand. He doesn't see her!
Scene 5: Kim then comes back out to the garden.

Second-order ignorance question: Does Jack know that Kim knows where the flag is?
Justification question: Why does Jack (not)/ know that Kim knows where the flag is?
Control question: Where will Kim look for the flag?

Composite ignorance story: example B

Scene 1: Alex and Katie have been given a cake to share from their Dad.
Scene 2: Alex puts the cake in the cupboard and then goes upstairs.
Scene 3: While Alex is away, Katie feels greedy and hides the cake in the fridge.

Control question: Where has Katie moved the cake to?
First-order ignorance question: Does Alex know where the cake is now or does Alex not know?

Scene 4: While Katie was moving the cake to the fridge, Alex came downstairs and saw Katie moving the cake to the fridge. But Katie doesn't see Alex watching her hide the cake in the fridge. She doesn't see him!
Scene 5: Alex then comes back into the kitchen.

Second-order ignorance question: Does Katie know that Alex knows where the cake is?
Justification question: Why does Katie (not)/know that Alex knows where the cake is?
Control question: Where will Alex look for the cake?

Appendix 6.2

Nonparametric correlation matrix of all indicator variables

Indicator	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. Social attention – Orienting	1									
2. Social attention – Joint attention	.19*	1								
3. Social perception – Affect	-.04	-.19	1							
4. Social perception – Friendliness	-.13	-.03	.32*	1						
5. Social perception – Eyes	.06	-.02	.29*	.07	1					
6. Social cognition – False belief	.07	.06	.07	.06	.31**	1				
7. Social cognition – Ignorance	.07	.07	.04	.02	.22*	.47**	1			
8. Language – BPVS	.09	.02	.30**	.10	.31**	.27**	.29**	1		
9. Language - CCC-2 (syntax)	-.02	.04	.20**	.06	.15	.06	.12	.32*	1	
10. Language - WASI	-.07	-.17	.15	.12	.26**	.22*	.25**	.50**	.21	1
	*: significant at 0.05 level **: significant at 0.01 level									

Appendix 6.3

Partial correlation matrix of all indicator variables when controlling for age

Indicator	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. Social attention – Orienting	1									
2. Social attention – Joint attention	.20*	1								
3. Social perception – Affect	.09	-.16	1							
4. Social perception – Friendliness	-.07	-.03	.30**	1						
5. Social perception – Eyes	.09	-.02	.34**	.13	1					
6. Social cognition – False belief	.04	.04	.15	.09	.33**	1				
7. Social cognition – Ignorance	-.13	.02	.06	.01	.28**	.44**	1			
8. Language – BPVS	.12	.03	.33**	.11	.34**	.31**	.31**	1		
9. Language - CCC-2 (syntax)	-.05	.03	.25**	.10	.19*	.13	.15	.35**	1	
10. Language - WASI	-.00	-.14	.14	.09	.28**	.28**	.23**	.50**	.23**	1
	*: significant at 0.05 level **: significant at 0.01 level									

Appendix 6.4

Correlation matrix of all indicator variables when missing CCC-II data

Indicator	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. Social attention – Orienting	1									
2. Social attention – Joint attention	.19*	1								
3. Social perception – Affect	.08	-.15	1							
4. Social perception – Friendliness	-.08	.05	.30**	1						
5. Social perception – Eyes	.10	-.04	.33**	.10	1					
6. Social cognition – False belief	.03	.05	.15	.11	.31**	1				
7. Social cognition – Ignorance	.12	.03	.07	.03	.26**	.45**	1			
8. Language – BPVS	.13	.02	.32**	.09	.35**	.30**	.29**	1		
9. Language - CCC-2 (syntax)	-.05	.03	.28**	.09	.24*	.14	.16	.43**	1	
10. Language - WASI	-.01	-.14	.14	.09	.27**	.28**	.24**	.50**	.27**	1
	*: significant at 0.05 level **: significant at 0.01 level									

Appendix 6.5

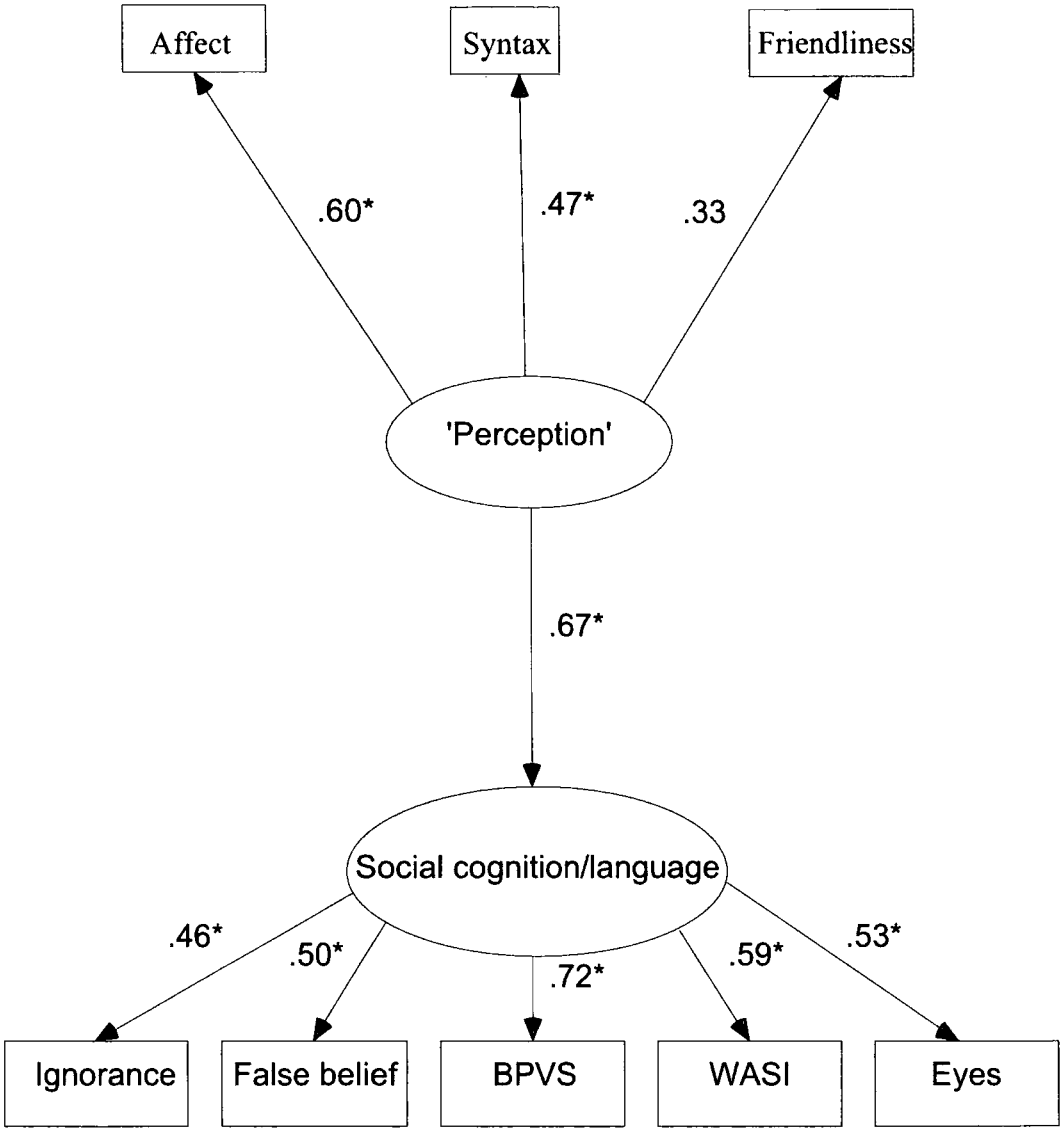
Factor structure when excluding both social attention tasks

Indicator	*Factor*	
	1	2
Social cognition – Ignorance	.60	
Social cognition – False belief	.59	
Language – BPVS	.58	.37
Language/IQ – WASI	.52	
Social perception – Eyes	.43	.33
Social perception – Affect		.76
Social perception – Friendliness		.33
Language – syntax	.28	.31
	Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalisation. All loadings > 0.2 are specified.	

Appendix 6.6

Structural equation model produced when based on modelling factor structure as appears in Appendix 6.5

Model statistics: $\chi^2 = 32.1$, df = 19, p = 0.03, GFI = 0.94, CFI = 0.9, RMSEA = 0.07, AIC = 66.11



Appendix 6.7

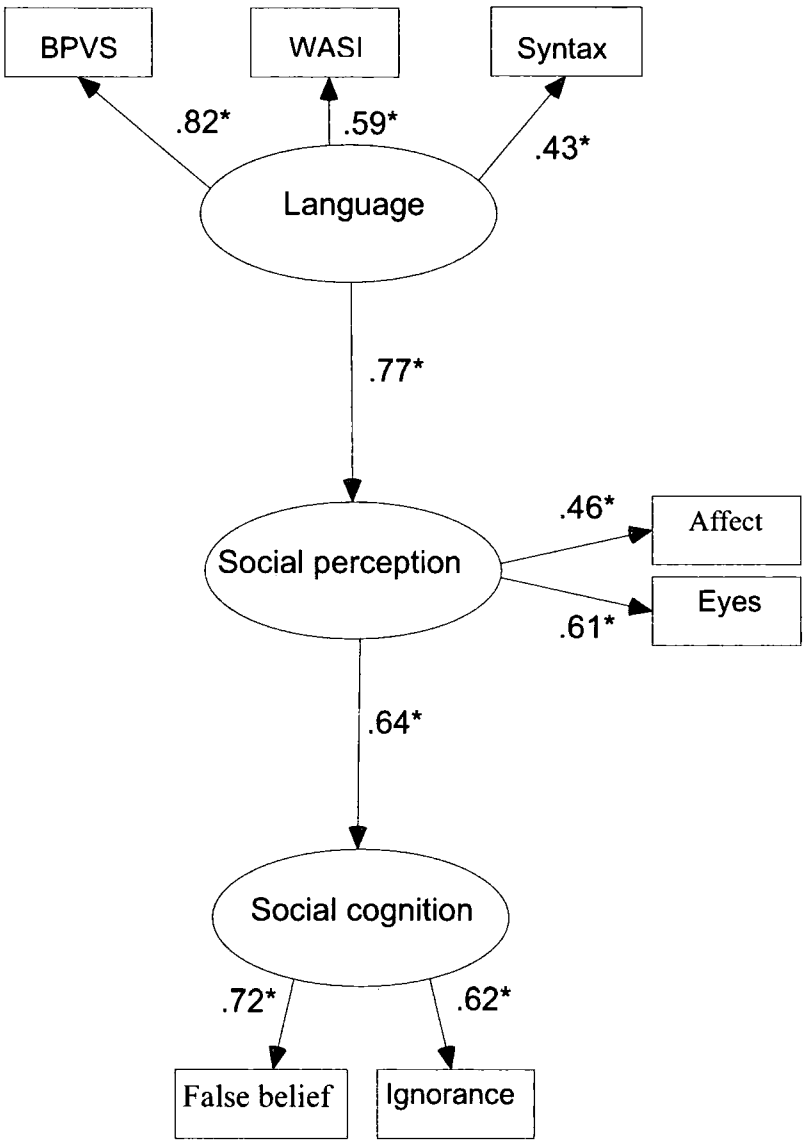
Glossary of fit statistics used in structural equation modelling

SEM fit statistic	Definition
χ^2, p-value	Provides a measure of the difference between the model's covariance structure and the observed covariance matrix. The p-value corresponding to χ^2 should be non-significant to indicate that the model is an acceptable fit.
GFI (Goodness-of-fit Index)	GFI is the percent of observed covariances explained by the covariances implied by the model. By convention, this value should be equal to or greater than 0.9 to accept the model.
CFI (Comparative Fit Index)	This statistic compares the existing model fit with a null model which assumes the latent constructs in the model are uncorrelated. This value should be equal to or greater than 0.9 to accept the model.
RMSEA (Root Mean Square Error of Approximation)	The RMSEA statistic computes the average lack of fit per degree of freedom. The model provides a good fit to the data if this value is less than 0.05.
AIC (Akaike Information Criterion)	The AIC value reflects the discrepancy between model-implied and observed covariance matrices. An AIC value close to zero reflects good fit and when comparing two AIC values, the lower one reflects the model with the better fit.

Appendix 6.8

Equivalent structural equation model as alternative to final structural model

Model fit statistics: $\chi^2 = 8.9$, df = 12, p = 0.71, GFI = 0.98, CFI = 1.00, RMSEA = 0.00, AIC = 40.90.



Appendix 7.1

Calculation of effect size for social-perceptual difference (using Cohen's d)

$$d = \frac{mean_1 - mean_2}{\sqrt{(s.d._1^2 + s.d._2^2)/2}}$$

Thus, $d = \frac{94.7 - 79.56}{\sqrt{(29.25^2 + 20.35^2)/2}}$ $\quad d = \frac{15.14}{\sqrt{634.84}}$ $\quad d = 0.60$