Chapter
To appear in: J. Burack, T. Charman, N. Yirmiya, & P. Zelazo (Eds.), The development of autism: Perspectives from theory and research, Mahwah, NJ: Lawrence Erlbaum Associates.

A Re-examination of the Theory of Mind Hypothesis of Autism

Helen Tager-Flusberg, Ph.D.

University of Massachusetts and Eunice Kennedy Shriver Center

Acknowledgements: Preparation of this chapter was supported by grants from the National Institute on Deafness and Other Communication Disorders (RO1 DC 01234; PO1 DC 03610) and the National Institute on Neurological Diseases and Stroke (RO1 NS 38668). Address for correspondence: Center for Research on Developmental Disorders, Eunice Kennedy Shriver Center, 200 Trapelo Road, Waltham, MA 02452. Email: htagerf@shriver.org

The Theory of Mind Hypothesis of Autism

In 1985 a group of British researchers published a seminal paper titled: *Does the autistic child have a theory of mind?* (Baron-Cohen, Leslie, & Frith, 1985), igniting a new era of research on autism. Baron-Cohen and his colleagues found that the majority of children with autism failed a classic theory of mind test, in contrast to normally developing preschoolers and children with Down syndrome. Follow-up studies provided further support for their hypothesis that autistic children do not have a theory of mind: They fail to understand stories that involve deception, and do not use mental state terms such as *think* and *know* in their retelling of these kinds of stories (Baron-Cohen, Leslie, & Frith, 1986). The significance of the theory of mind hypothesis of autism, as it came to be known in the literature (Baron-Cohen, Tager-Flusberg, & Cohen, 1993), was that it not only explained the failure of children with autism on tasks tapping theory of mind abilities, but also provided a unified explanation for the primary diagnostic impairments in pretend play, social functioning, and communication (Baron-Cohen, 1988; Frith, 1989; Leslie, 1987). Yet over the past decade much of the excitement originally generated by work on theory of mind in autism has been dispelled. Several researchers are now skeptical about its significance as a theory that explains the primary symptoms that define this complex neurodevelopmental disorder. In this chapter I review this history, critically examining the issues that led to the current status of the theory of mind hypothesis of autism.

Early studies on theory of mind in autism were guided by ongoing work in cognitive science. Following commentary by the philosopher Dennett (1978) and others on studies of theory of mind in chimpanzees (Premack & Woodruff, 1978), much of the focus of developmental research initially addressed when typically developing children first understand false belief and related concepts of mind. Studies by Perner, Wellman, Flavell and their

colleagues (e.g., Flavell, Flavell, & Green, 1983; Perner, Leekam, & Wimmer, 1987; Wellman & Estes, 1986; Wellman & Bartsch, 1988; Wimmer & Perner, 1983) provided the major measures that became the standards in the field. Theories emphasized the child's acquisition of a representational understanding of mind, especially knowledge that a person's mind is opaque; its contents are not a direct reflection of reality and are not available to the minds of others. Research with false belief tasks demonstrated repeatedly that beginning around the age of four, normally developing children exhibit this understanding. Although modifications in the procedural administration of such tasks may push the developmental timing down a few months (e.g., Mitchell & Lacohée, 1991; Moses & Flavell, 1990; Sullivan & Winner, 1993; Zaitchik, 1991), the dramatic change in performance on these kinds of tasks at about the age of four is one of the most robust findings in the child development literature (Wellman, Cross, & Watson, 1999).

Research on theory of mind in children with autism reflected this emphasis on the acquisition of a representational understanding of mind by exploring their difficulties using a range of different tasks (Baron-Cohen, 2000a). Other studies were conducted within this conceptual framework that focused on language, communication, and pretend play (e.g., Baron-Cohen, 1987; Happé, 1993, 1994a; Tager-Flusberg, 1992, 1993). In these studies, the primary emphasis was on the autistic child's failure to appreciate mental states in themselves or others, and the implications of this failure for their everyday social and communicative functioning (Frith, Happé, & Siddons, 1994). Nevertheless the primary emphasis in the literature on theory of mind in autism is on the cognitive developments associated with a representational understanding of mind (Baron-Cohen, 2000a).

Challenges to the Theory of Mind Hypothesis

After a brief honeymoon period, during which time many researchers came to view the theory of mind hypothesis of autism as an important approach for understanding this enigmatic syndrome, criticisms began to surface. Questions were raised on a number of fronts:

- Are deficits on theory of mind tasks universal among individuals with autism?
- Are deficits on theory of mind tasks unique to individuals with autism?
- How can the theory of mind hypothesis explain the impairments that are evident in infants with autism, long before the emergence of a representational theory of mind?
- How can the theory of mind hypothesis explain some of the other features of autism, such as repetitive behaviors and interests or savant abilities?
- Can failure on theory of mind tasks be interpreted in terms of other constructs, such as executive functions or language?

Thus, despite its wide-ranging appeal, the theory of mind hypothesis came under attack in ways that could not easily be dismissed. From the earliest study (Baron-Cohen et al., 1985), it was clear that a minority of individuals with autism were able to pass classic theory of mind tasks. The number who passed varied from one study to the next, but even a small percentage must be accounted for in any theory. If autism involves a failure to develop a theory of mind, how could these well-defined research participants with autism pass the tasks? One straightforward explanation was that theory of mind deficits are not universal among people with this disorder, thus calling into question the specificity of this hypothesis.

Studies also began to emerge questioning the selectivity or uniqueness of theory of mind impairments in autism. It is now clear that non-autistic children and adolescents with mental retardation fail standard theory of mind tasks at a higher rate than would be expected give their

age and developmental level (Benson, Abbeduto, Short, Bibler-Nuccio, & Maas, 1993; Yirmiya, Erel, Shaked, & Solomonica-Levi, 1998; Zelazo, Burack, Benedetto, & Frye, 1996). The same is true for oral deaf children (de Villiers, 2000; Gale, de Villiers, de Villiers, & Pyers, 1996; Peterson & Siegel, 1995; 1998; Russell et al., 1998), blind children (Brown, Hobson, Lee, & Stevenson, 1997), children with specific language impairment (Cassidy & Ballaraman, 1997; Miller, 2000), and people with schizophrenia (Corcoran, 2000). If all these populations also have difficulty on theory of mind tasks, can theory of mind be interpreted as the unique deficit in autism?

Another concern with the theory of mind hypothesis of autism is the age at which autism symptoms are first identified. As noted earlier, much of the research on theory of mind in autism focuses on performance on tasks that normally developing children pass at around the age of four. Yet clearly autism is apparent much earlier than this. Indeed onset prior to the age of 3 is required in the current diagnostic criteria, according to DSM-IV (APA, 1994). Symptoms often are noted during infancy, which is long before the emergence of a representational theory of mind. Anecdotal evidence as well as empirical studies suggest that infants and toddlers with autism exhibit deficits in social responsiveness, empathy, play, joint attention, and imitation (e.g., Dawson & Adams, 1984; Gillberg et al., 1990; Mundy & Sigman, 1989; Ornitz, Guthrie & Farley, 1977; Volkmar, Sparrow, Goudreau, Cicchetti, Paul, & Cohen, 1987). Clearly not all the early appearing deficits in autism entail an appreciation of others' minds. For example, social responsiveness and primary intersubjectivity simply depend on appreciating and responding contingently to another person's presence or behavior (Klin & Volkmar, 1993) and their absence is not easily interpreted in terms of a deficit in a representational understanding of mind.

Not only do some symptoms of autism appear prior to the age at which children's theory of mind may be expected to develop, other symptoms of the disorder, some of which develop later, are not so clearly interpreted in terms of a primary impairment in theory of mind. Diagnostic criteria for autism include three distinct areas of impairment: social and communicative impairments – which have been interpreted within a theory of mind framework (cf. Baron-Cohen, 1988; Tager-Flusberg, 2000) – and repetitive behaviors and interests. It is not obvious how one might understand the relationship between a theory of mind deficit and this kind of limited behavioral repertoire, or obsessional interest in a narrow area such as train timetables or washing machines (for a different view, see Baron-Cohen, 1989). Furthermore, there are other features of autism that frequently are apparent, even though they are not part of the DSM-IV criteria. These include savant abilities (such as outstanding memory for facts, calendrical calculators, or artistic talent), deficits in emotional expression, inability to generalize, exceptionally good visual perceptual skills, and atypical sensory sensitivities. Impairments in theory of mind do not explain these features of the disorder either (Happé, 1999, this volume; Plaisted, 2000, this volume).

Finally, recent evidence suggests that in autism theory of mind deficits may not be the primary underlying impairment, that might be used to explain surface symptoms such as deficits in communication and social functioning (cf. Baron-Cohen, 1988; Happé, 1994b; Pennington, 1999; Tager-Flusberg, 1999). According to some researchers, failure on tasks that tap theory of mind abilities may be more directly interpreted in terms of more fundamental deficits in either executive functions or language. For example, Russell (1997) argued that theory of mind tasks entail executive functions, such as action monitoring or self regulation, which may explain why children with autism fail on these tasks. As an alternative explanation for the syndrome,

executive function impairments, especially in set shifting and planning may account for a range of both social and nonsocial problems, including the repetitive behaviors and interests that define autism as well as play deficits (Jarrold, 1997).

Other researchers (e.g., de Villiers, 2000; Eisenmajer & Prior, 1991; Tager-Flusberg, 2000) argue that language ability may be the underlying problem that children with autism have when they are given theory of mind tasks. Language ability, as measured on standardized tests of vocabulary or grammar, is closely related to theory of mind performance in children with autism (e.g., Dahlgren & Trillingsgaard, 1996; Happé, 1995; Sparrevohn & Howie, 1995; Tager-Flusberg & Sullivan, 1994). Some researchers suggest that this connection between language and theory of mind performance is the result of the language needed to understand the tasks and test questions (e.g., Bruner & Feldman, 1993). Others claim that there is deeper connection between language and theory of mind, especially a representational theory of mind. For example, de Villiers (2000; de Villiers & de Villiers, 2000; see also Tager-Flusberg, 1997) argues that the cognitive architecture required to represent propositional attitudes, in which the content of the proposition could be marked true or false, is isomorphic to the linguistic representations needed for sentential complement constructions, in which one clause is embedded in a matrix sentence (e.g*., Bobby <u>thought/ forgot/ knew/said/whispered</u> that the cake was in the cupboard*). Studies with autistic children find a close relationship between knowledge of the semantics and syntax of sentential complements and theory of mind performance (Tager-Flusberg, 1997; 2000). Perhaps deficits on theory of mind tasks are the result of limitations and impairments in the linguistic knowledge of children with autism.

Taken together, this set of arguments seems to provide a compelling case against the theory of mind hypothesis of autism. Is it really viable at this point to claim that autism involves

primary impairments in theory of mind? In the remainder of this chapter, I will argue that, despite these criticisms, the theory of mind hypothesis of autism provides a coherent view of many of the phenomenological features of autism that is not easily captured by alternative perspectives. Nevertheless, the challenges summarized here need to be taken seriously; in particular they provide a guide for how we might conceptualize the place of theory of mind impairments in a more comprehensive account of the autistic syndrome.

A Developmental Perspective on Theory of Mind

As noted earlier, much of the early work on theory of mind focused on the transition that takes place between the ages of 3 and 4 in normally developing children[1]. The primary change at this stage is from a non-representational understanding of mind to a representational understanding, for which false belief tasks are an excellent measure. This narrow emphasis, however, failed to provide a developmental framework for theory of mind in the field of cognitive development, and this failure carried over to research on theory of mind in autism. This problem is compounded by the fact that false belief and other related tasks are scored as either passing or failing. We are led to believe that theory of mind is something one does or does not have – it emerges spontaneously at a single point in time. Autism research was especially influenced by this narrowly defined approach to theory of mind (for similar critique, see also Charman, 2000; Dermott, this volume). Thus, the literature on autism often equates performance on a false belief task to the presence or absence of a theory of mind, reducing what should be a rich, complex unfolding mentalistic conception of people to a categorical capacity. This absence of a developmental perspective may be partially responsible for the criticisms of the theory of mind hypothesis discussed earlier. If so, we may be able to rescue this hypothesis by exploring the development of theory of mind and its impairment in autism.

The past few years witnessed a significant increase in studies on both early and later developments in theory of mind. False belief understanding is now viewed as just one developmental milestone along a pathway that can be traced back to the emergence of infants' interpretation of intentional action, and continues with the older child's ability to integrate concepts of intention, knowledge, mind and action to interpret morality, human personality, and non-literal language (Flavell, 1999; Wellman & Lagattuta, 2000). For some current cognitive theorists, theory of mind begins at birth with the newborn's ability to imitate facial expressions and orient to social stimuli including both faces and voices (e.g., Gopnik, Capps, & Meltzoff, 2000)[2]. These innate capacities are viewed as the laying the groundwork on which theory of mind develops over the course of infancy. By the age of 5 or 6 months, infants demonstrate that they interpret human actions (e.g., a moving hand) as goal-directed (i.e., as reaching for an object) or intentional (Woodward, 1996). In the second year of life, older infants have a more sophisticated conceptual view of people as having subjective experiences. For example, Repacholi (1998) showed that 14 month-olds differentiate between objects based on the emotional expressions directed to them by someone else. Baldwin's (1993) studies of early word learning also demonstrate that older infants use the direction of eye gaze to interpret referential intent. These early abilities to interpret other people's behavior as intentional are complemented by the infant's own intentional actions including communicative pointing, early language, and social referencing. The foundation of an early theory of mind – the capacity to impute mental states to others and to interpret action within a mentalistic causal framework – is in place by the second year of life.

The later toddler years are referred to as the "dark ages" of theory of mind development (Meltzoff, Gopnik & Repacholi, 1999) because little research is done on children at this stage.

But the gaps are beginning to be filled in (see for example Gopnik et al., 2000; Lewis & Mitchell, 1994; Meltzoff et al., 1999; Wellman and Lagattuta, 2000) with studies showing that the ability to interpret desire, emotion and perception, emerge at around 2 to 3 years of age, before the understanding of belief or other epistemic states. Parallel changes occur in language and communicative competence, as young children become increasingly good conversationalists, and demonstrate sensitivity to their listener's needs (e.g., Bloom, Rocissano & Hood, 1976; Shatz & Gelman, 1977; Shatz & O'Reilly, 1990). This line of research highlights the growth in the toddler's appreciation of other people with an expanding understanding of their mental worlds (Shatz, 1994).

This brief overview of early development serves to illustrate that the acquisition of a representational understanding of mind is simply one more step on a developmental pathway to a rich understanding of mind. It is also not the end point; children at age 4 who pass false belief tests still have much to learn about the mind and the mental life of themselves and other people. Studies on later developments in theory of mind have explored a range of tasks tapping a more advanced understanding of mind within the broader context of social cognition and metacognitive ability (Perner, 1988).

During middle childhood children come to a deeper appreciation of ambiguity (e.g., Gopnik & Rosati, 1997; Pillow, 1991) and a more mature understanding of the mind as an interpreter of knowledge (e.g., Flavell, Green, & Flavell, 1998). They develop a more sophisticated conception of the enduring nature of personality traits and how trait information may be important for interpreting the intentional nature of people's actions (Heyman & Dweck, 1998; Yuill, 1993, 1997). The central place of intentionality in making moral judgements and attributions also develops during this period (Mant & Perner, 1989). In addition, higher order

theory of mind abilities are important in explaining developmental changes in communication during middle childhood. For example, children's understanding of various forms of non-literal language such as irony or bluffing depends on this kind of knowledge (Sullivan, Winner & Hopfield, 1995), and changes in performance on referential communication tasks are partially attributed to more sophisticated theory of mind abilities (e.g., Bonitatibus, 1988). At the same time, adolescents continue to develop the capacity to read cues from people's faces about their internal states, especially cues to more subtle emotional and cognitive mental states (Baron-Cohen, Joliffe, Mortimore, & Robertson, 1997).

This brief overview, covering the full developmental range from birth to adolescence, serves as a reminder that the development of theory of mind cannot be reduced to a single period in the life span. When viewed from this developmental stance, the focus of the theory of mind hypothesis of autism needs to be more clearly conceptualized as impairments that cover the wider developmental scope, from the earliest emergence of social-intentional knowledge to the more complex social cognitive constructs that develop during later childhood and adolescence. Furthermore, the definition of impairment in this domain suggests that there is diminished capacity, rather than the complete absence of the capacity to interpret to view people as mental beings. Deficits in theory of mind in autism need to be defined as differences in the rate of developmental change in this domain both in comparison to other populations, and within the autistic child in comparison to other cognitive domains. Finally, more emphasis should be placed on individual differences in the degree of impairment among individuals with autism and on the underlying cognitive processes and mechanisms that mediate theory of mind processing in this population.

A New Model of Theory of Mind

The developmental perspective summarized here underscores the general consensus that theory of mind encompasses more than just a representational concept of mind. Reflecting this broader perspective, terms such as social intelligence or mentalizing ability (cf. Frith, Morton, & Leslie, 1991) are sometimes used as synonyms for theory of mind to refer to the capacity for viewing human behavior within a mentalistic framework. Yet as this conceptual domain expands to cover early emerging capacities in infants to more advanced social reasoning in adolescents and adults, it seems likely that theory of mind is composed of several interacting components, each associated with distinct underlying mechanisms for processing different aspects of social information. Thus, on this view, theory of mind is similar to other cognitive systems such as memory or language that are analyzed into their component subsystems (e.g., episodic vs. semantic memory; syntax vs. pragmatics)[3].

As a first step toward formulating a developmental model of theory of mind, I propose that there is an important distinction between basic social-perceptual and social-cognitive components (see also Tager-Flusberg & Sullivan, in press). The perceptual component refers to the on-line immediate judgement of a person's mental state, based on information available in faces, voices, and body posture and movement. The cognitive component refers to our capacity to make more complex cognitive inferences about the content of mental states that require integrating information across time and events. Support for this model may be taken from a variety of sources, including developmental and neurobiological research, as outlined in this section.

The social-perceptual component of theory of mind builds on the innate preferences of infants to attend to human social stimuli, especially faces and voices (e.g., Fernald, 1989, 1993;

Gopnik et al., 2000; Johnson & Morton, 1991; Mehler & Dupoux, 1994). The route to interpreting mental state information from these stimuli lies in the interaction of innately specified mechanisms with social information in the world, which is obtained through continued interactions with people. The social preferences of infants that promote continued interactions with people may be driven by affective motives – the intrinsic reward of social stimuli. By the latter half of the first year of life, infants use information from faces and voices to interpret the emotional state of other people; they may also use more subtle cues such as eye gaze to judge what another person is attending to (cf. Baldwin, 1993; Baron-Cohen, 1994; Repacholi, 1998). Thus, the perceptual component of theory of mind emerges first in development, and is available to infants for making a range of mental state judgments about other people. However, these on-line perceptual capacities continue to develop as children become more adept at using facial and prosodic information as cues to mental state, culminating for example, in the ability of adults to make very sophisticated judgements from just the eye region of the face (cf. Baron-Cohen et al., 1997). The social-perceptual component of theory of mind is probably not related to other cognitive systems, including language, although this speculation has not been systematically investigated.

The development of the social-cognitive component of theory of mind builds on the earlier emerging perceptual component. This component is involved in making mental state inferences that depend on integrating information not only from perceptual cues, but also from sequences of events over time. The social-cognitive component of theory of mind is more closely linked to other cognitive or information processing systems, such as working memory (needed for integrating information) and language. The development of the cognitive component of theory of mind begins during the early preschool years when children begin to talk and reason

about epistemic states (Bartsch & Wellman, 1995). It is firmly in place by four years of age, when young children are able to pass false belief and other related tasks. Other cognitive systems, especially language, may play an especially significant role in the development of this component of theory of mind (de Villiers, 2000; Hale & Tager-Flusberg, 1999). More advanced social-cognitive knowledge continues developing in middle childhood and early adolescence, as described earlier. These later developments involve the integration of constructs such as belief and intention and entail more complex social reasoning and inferencing skills.

Thus, in this model, there are two distinct components to a theory of mind, each with its own developmental time course, each dependent on different underlying cognitive mechanisms. In everyday life, the social-perceptual and social-cognitive capacities described here function in a complex interconnected way such that our mental state judgements, inferences, and reasoning entail both components. At the same time, traditional theory of mind tasks tap into the social-cognitive component more exclusively, by eliminating on-line social cues to mental state. More recently, the new experimental theory of mind paradigms that depend on dynamic stimuli (e.g., Repacholi & Gopnik, 1997) or at the least real faces (e.g., Baron-Cohen et al., 1997), also provide some measure of the social-perceptual component.

Converging evidence for this componential model of theory of mind comes from studies of brain function. Support for this model of theory of mind may be drawn from research on the neurobiological substrate of what Leslie Brothers (1990) refers to as the "social brain." The primary areas of the brain that are involved in making social-perceptual judgements include the amygdala and associated regions of medial temporal cortex. The amygdala is central to the processing of emotion (e.g., Adolphs, Tranel, Damasio, & Damasio, 1994; Adolphs, Tranel & Damasio, 1998) and other complex social stimuli (Brothers, Ring, & Kling, 1990; Perrett et al.,

1990). Functional brain imaging studies show that the amygdala and associated areas of the medial temporal cortex are activated in tasks tapping the recognition of facial expressions of emotions and other mental states (Baron-Cohen et al., 1999; Breiter et al., 1996) and the perception of biological or intentional motion (Bonda, Petrides, Ostry, & Evans, 1996). The brain areas that subserve the social-cognitive component of theory of mind include regions in the prefrontal cortex. The orbito-frontal cortex is involved in reasoning about the social appropriateness of action (Eslinger & Damasio, 1985) and in making lexical judgements about cognitive mental state terms (Baron-Cohen, Ring, Moriarty, Schmitz, Costa, & Ell, 1994). Areas in the medial frontal cortex are closely associated with other theory of mind abilities, especially tasks tapping advanced social-cognitive capacities (Fletcher et al., 1995; Goel, Grafman, Sadato, & Hallett, 1995). In summary, there is preliminary evidence that different neural substrates underlie the components of theory of mind described here (see also Frith & Frith, 1999). These brain regions form a unified neural system for processing a range of social information from basic perception of intentional motion to inferring the contents of other people's minds.

Autism and the Componential Model of Theory of Mind

In the final sections of this chapter I return to re-evaluate the theory of mind hypothesis of autism in light of this new model of theory of mind. The combination of both a componential and developmental framework provides a set of counter-arguments to many of the criticisms with the theory of mind hypothesis of autism as it was initially articulated (Baron-Cohen et al., 1993) and summarized at the beginning of this chapter.

Within the componential model, the theory of mind hypothesis of autism clearly encompasses a significantly broader range of phenomena than the original metarepresentational theories (cf. Leslie & Roth, 1993; Perner, 1993). The roots of the impairments in autism may be

seen in the social orienting deficits that are evident in infants (Dawson, Meltzoff, Osterling, Rinaldi & Brown, 1998; Klin, 1991; Osterling & Dawson, 1994), which are the foundation of the social-perceptual aspects of theory of mind. These deficits are correlated with their failure to perceive behavior in others as intentional or to appreciate others' perspectives, as exemplified in the joint attention deficits that are among the hallmark symptoms of the disorder (Mundy & Sigman, 1989; Mundy, Sigman, & Kasari, 1990, 1993; Travis & Sigman, this volume). Thus, children with autism below the age of three demonstrate significant impairment in the range of behaviors that are among the early developments in the social-perceptual component of theory of mind (cf. Klin & Volkmar, 1993). Autism involves fundamental deficits in these aspects of theory of mind. Even older high-functioning people with autism or Asperger syndrome perform poorly on tasks that measure the ability to read mental states from the eye region of the face (Baron-Cohen et al., 1997) or the attribution of intentional and social significance to ambiguous visual stimuli (Klin, Schultz & Cohen, 2000).

The majority of children with autism are also impaired on social-cognitive measures of theory of mind, as evidenced by their failure to pass false belief tasks (cf. Baron-Cohen, 2000a; Baron-Cohen et al., 1985), or to explain human behavior using mental state terms (Tager-Flusberg & Sullivan, 1994). From a developmental framework, these deficits in the cognitive aspects of theory of mind grow out of the earlier deficits in social-perception because these components are closely interconnected, with cognition building on social perception. At the same time, as noted earlier, false belief measures of theory of mind, along with other experimental tasks, suffer from the problem of grading performance in an all-or-none or categorical way. There are other ways of tapping the cognitive components of theory of mind using continuous variables, thus emphasizing the kind of developmental perspective that is so important to this

theory. For example, measures of discourse skills or other pragmatic abilities that depend on understanding other minds provide more sensitive measures of individual differences among children with autism (Tager-Flusberg, 1993). Tager-Flusberg and Anderson (1991) found that the ability to maintain a topic of conversation, and to add new information to the ongoing discourse varied among children with autism; but overall children with autism were significantly impaired in these abilities compared to matched controls with Down syndrome. Capps, Kehres and Sigman (1998) demonstrated that this aspect of communicative competence is significantly correlated with false belief performance in children with autism.

These kinds of non-categorical measures of theory of mind are also useful for exploring within population developmental asynchronies between theory of mind and other cognitive domains. This approach, referred to as the "fine-cuts approach" (Happé & Frith, 1996), provides additional evidence that cognitive aspects of theory of mind are specifically impaired in autism, in that the developmental patterns for this domain differ from other aspects of cognitive development. Thus, in our study of communicative competence in children with autism (Tager-Flusberg & anderson, 1991), we found that communicative competence showed a different developmental trajectory compared to other aspects of language development, as measured by mean length of utterance (MLU). Specifically, while MLU showed continuing growth over the course of the study, the ability to add new information to a conversational topic showed no developmental changes after an initial period of growth (Tager-Flusberg & Anderson, 1991). In other studies of language-related aspects of theory of mind in autism, we found similar kinds of unique developmental asynchronies. For example, there are asynchronies between the development of form and function for several linguistic constructions, including personal pronouns and questions (Tager-Flusberg, 1994). Even among different functional uses of

particular forms, such as negation, questions, and modal verbs, my data show that there are developmental asynchronies between those functions that do entail an understanding of other minds and those which do not (Tager-Flusberg, 1997). These language asynchronies are only found in children with autism and not in other populations, suggesting that this evidence provides strong support for the theory of mind hypothesis of autism.

Experimental studies also illustrate the fine-cuts approach to theory of mind in autism (cf. Happé, 1999). For example, children with autism are impaired in understanding minds as representational, but are unimpaired in their understanding of phoographs as representations (Charman & Baron-Cohen, 1992; Leekam & Perner, 1991; Leslie & Thaiss, 1991). More broadly, Baron-Cohen (2000b) argued that while theory of mind, or folk psychology is impaired in autism, folk physics (understanding the physical causes of events) is not. Taken together, this work showing that in autism we find uniquely asynchronous patterns of development in different cognitive domains is among the strongest evidence for the theory of mind hypothesis of autism.

At the same time, recall that one criticism of the theory of mind hypothesis is that there are some individuals with autism who do pass the cognitive tasks that tap a representational understanding of mind. How might we explain this on the model presented here? The cognitive component of theory of mind develops not only by building on the social-perceptual capacities that begin to emerge during infancy, but also in close interaction with other cognitive systems and information processing capacities. One possibility is that those children with autism who pass false belief tasks have acquired this cognitive capacity to interpret the contents of other minds via a different developmental pathway. Instead of building on earlier social-perceptual knowledge about the mental life of people, they exclusively rely on language (Tager-Flusberg,

1997, 2000) or more general logical reasoning skills to 'hack' out a solution to cognitively based theory of mind tasks (Happé et al., 1996; Leslie & Roth, 1993).

Support for the idea that children with autism may not develop theory of mind abilities in the same way as other children comes from several sources. Language ability, especially knowledge of sentential complements, is the single best predictor of false belief performance for children with autism (Tager-Flusberg, 2000). Earlier, I discussed the hypothesis that failure on false belief tasks may be the result of poor language rather than impaired theory of mind. On the contrary, only those children with autism who have the requisite linguistic knowledge can pass these tasks because more than other children they are especially dependent on language for providing the bootstrap into theory of mind. Further evidence that people with autism who pass theory of mind tasks do so using non-social cognitive and linguistic mechanisms comes from brain imaging studies. Happé and her colleagues found that adults with Asperger syndrome did not activate areas in the medial frontal cortex when listening to theory of mind stories, in contrast to normal adults (Happé et al., 1996). In these patients, theory of mind was associated with activation in frontal regions that are typically involved in general cognitive processing, located close to language-related areas in the left hemisphere.

I have outlined one proposal for how theory of mind develops in children with autism, within the framework of the componential model. On this model, autism is viewed as a disorder that is defined by fundamental impairments to the neurocognitive system that serves the social-perceptual component of theory of mind. The impairments are present during infancy, thus impeding the development of the ability to make on-line judgements of intentionality. In those individuals who have additional cognitive and linguistic deficits, the development of the social-cognitive component of theory of mind is also severely compromised. At the same time,

children who have relatively good language and general cognitive and information processing skills can acquire the capacity to pass tasks assessing a representational understanding of mind via these non-social cognitive routes.

Deficits in theory of mind are not unique to autism. As noted earlier, numerous populations have significant problems on false belief tasks. How might we interpret these deficits in other populations, especially in comparison to children with autism? Although other groups of children are developmentally delayed on false belief tasks, it appears that in autism the delays are more severe. For example, Happé (1995) found that children with autism were not likely to pass false belief tasks until they reach at least a verbal mental age of 8 or 9 years; compared to 4 for normally developing children. Children with mental retardation are also delayed (Yirmiya et al., 1998), but the mental age at which they pass these tasks is around 6 years (Tager-Flusberg, Sullivan, Joseph & Joffre, 1999). Oral deaf children begin to pass false belief tasks when they are about 7 years-old (Gale et al., 1996). Although the research is fairly limited, it appears that there are differences in the rates of development in the social cognitive component of theory of mind across different populations.

From a developmental perspective, I would argue that these differences in rate reflect differences in the developmental pathway. Thus, delays in passing false belief tests are linked to different kinds of deficits in the various groups of children that have been tested. For example, in mental retardation, it may be that the areas of deficit that most delay the development of theory of mind are general cognitive and language skills. In oral deaf children, it is the lack of access to language, which primarily influences the social-cognitive component of theory of mind. And in blind children, the lack of access to facial information very early on affects the

development of the social-perceptual component of theory of mind. These speculations lead to testable hypotheses that are based on the componential model of theory of mind.

Conclusions and Future Directions

Autism involves fundamental impairments in theory of mind. These impairments are evident early in development and are broad in scope. Reflecting back on the criticisms of the theory of mind hypothesis discussed earlier in this chapter, most were addressed in light of the componential model of theory of mind. Within this model we can explain many of the very early characteristics of autism that are evident long before the development of a representational understanding of mind. Furthermore, deficits in the on-line perception of mental states in other people are viewed as central and universal among people with autism across a wide age range (Klin et al., 1999; Tager-Flusberg & Sullivan, in press). While theory of mind deficits are not unique to autism, the etiology and developmental history of these deficits may be. Although performance on false belief tasks may well be interpreted as being closely related to other cognitive systems, especially language or executive functions, these other domains cannot explain the full range of theory of mind problems that are evident even in toddlers with autism.

At the same time it is also clear that autism does not only involve deficits in theory of mind, even within this broader componential framework. There are other features that are found in many people with autism that cannot be encompassed by the theory of mind hypothesis (cf. Happé, 1999; Plaisted, 2000). These include repetitive behaviors and obsessive interests in narrowly defined topics, excellent visual-spatial skills, savant abilities, and impaired language. Autism is a complex and heterogeneous disorder that should not be reduced to a single underlying cognitive impairment. From a genetic perspective we now know that several interacting independent genes cause autism. One current hypothesis is that each of these genes

(which may vary from one individual to another) contributes to different components of the autism phenotype (Bailey, Phillips, & Rutter, 1996; Santangelo & Folstein, 1999; Szatmari, 1999). Thus we could not expect that there is a single underlying psychological deficit in a disorder caused by several different genes.

The complexity and heterogeneity of autism pose a significant challenge for our theoretical models. We must appreciate the variability of the many different features that together make up the syndrome of autism, and most especially to view them all within a developmental framework. Our future research exploring the development of theory of mind impairments in this population should be undertaken with a clearer understanding of the other characteristics that define the disorder. In turn, research on theory of mind in autism will continue to provide important insights into the underlying neurocognitive architecture for this specialized domain of human cognition.

References

APA (1994). DSM-IV: Diagnostic and statistic manual of mental disorders. Fourth Edition. Washington, D.C.: American Psychiatric Association.

Adolphs, R., Tranel, D., Damasio, H., & Damasio, A. (1994). Impaired recognition of emotion in facial expressions following bilateral damage to the human amygdala. Nature, 372, 669-672.

Adolphs, R., Tranel, D., & Damasio, A. R. (1998). The human amygdala in social judgment. Nature, 393, 470-473.

Astington, J., Harris, P. L., & Olson, D. (Eds.), (1988). Developing theories of mind. Cambridge: Cambridge University Press.

Bailey A. Phillips W. & Rutter M. (1996). Autism: towards an integration of clinical, genetic, neuropsychological, and neurobiological perspectives. Journal of Child Psychology and Psychiatry, 37, 89-126.

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

Baron-Cohen, S. (1987). Autism and symbolic play. British Journal of Developmental Psychology, 5, 139-148.

Baron-Cohen, S. (1988). Social and pragmatic deficits in autism: Cognitive or affective? Journal of Autism and Developmental Disorders, 18, 379-402.

Baron-Cohen, S. (1989). Do autistic children have obsessions and compulsions? British Journal of Clinical Psychology, 28, 193-200.

Baron-Cohen, S. (1994). How to build a baby that can read minds: Cognitive mechanisms in mindreading. Cahiers de Psychologie Cognitive/ Current Psychology of Cognition, 13, 513-552.

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 (Eds.) Understanding other minds: Perspectives from developmental cognitive neuroscience (pp. 3-20). Oxford University Press: Oxford.

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 (Eds.) Understanding other minds: Perspectives from developmental cognitive neuroscience (pp. 73-82). Oxford University Press: Oxford.

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

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1986). Mechanical, behavioral, and intentional understanding of picture stories in autistic children. British Journal of Developmental Psychology, 4, 113-125.

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

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., Ring, H., Moriarty, J., Shmitz, P., Costa, D., & Ell, P. (1994). Recognition of mental state terms: a clinical study of autism, and a functional neuroimaging study of normal adults. British Journal of Psychiatry, 165, 640-649.

Baron-Cohen, S., Ring, H., Wheelwright, S., Bullmore, E.T., Brammer, M.J., Simons, A., & Williams, S. (1999). Social intelligence in the normal and autistic brain: An fMRI study. European Journal of Neuroscience.

Bartsch, K., & Wellman, H. (1995). Children talk about the mind. Oxford: Oxford University Press.

Benson, G., Abbeduto, L., Short, K., Bibler-Nuccio, J., & Maas, F. (1993). Development of theory of mind in individuals with MR. American Journal on Mental Retardation, 98, 427-433.

Bloom, L., Rocissano, L., & Hood, L. (1976). Adult-child discourse: Developmental interaction between information processing and linguistic knowledge. Cognitive Psychology, 8, 521-552.

Bonda, E., Petrides, M., Ostry, D., & Evans, A. (1996). Specific involvement of human parietal systems and the amygdala in the perception of biological motion. Journal of Neuroscience, 15, 3737-3744.

Bonitatibus, G. What is said and what is meant in referential Communication. In J. Astington, P. L. Harris, & D. Olson (Eds.) Developing theories of mind (pp. 326-338). Cambridge: Cambridge University Press.

Breiter, H. C., Etcoff, N. L., Whalem, P. J., Kennedy, W. A., Rauch, S. L., Buckner, R. L., Strauss, M. M., Hyman, S. E., & Rosen, B. R. (1996). Response and habituation of the human amygdala during visual processing of facial expression. Neuron, 17, 875-887.

Brothers, L. (1990). The social brain: a project for integrating primate behaviour and neurophysiology in a new domain. Concepts in Neuroscience, 1, 27-51.

Brothers, L., Ring, B., & Kling, A. (1990). Responses of neurons in the macaque amygdala to complex social stimuli. Behavioral Brain Research, 41, 199-213.

Brown, R., Hobson, P., Lee, A., & Stevenson, J. (1997). Are there 'autistic-like' features in congenitally blind children? Journal of Child Psychology and Psychiatry, 38, 693-704.

Bruner, J. & Feldman, C. (1993). Theories of mind and the problem of autism. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), Understanding other minds: Perspectives from autism. Oxford: Oxford University Press.

Capps, L., Kehres, J., & Sigman, M. (1998). Conversational abilities among children with autism and children with developmental delays. Autism, 2, 325-344.

Carruthers, P. & Smith, P.K. (Eds.), (1996). Theories of theories of mind. Cambridge: Cambridge University Press.

Cassidy, K. & Ballaraman, G. R. (1997). Theory of mind ability in language delayed children. Biennial Meeting of the Society for Research in Child Development, Washington D.C.

Charman, T. (2000). Theory of mind and the early diagnosis of autism. In S. Baron-Cohen, H. Tager-Flusberg, & D. Cohen (Eds.), Understanding other minds: Perspectives from developmental cognitive neuroscience, Second Edition (pp. 422-441). Oxford: Oxford University Press.

Charman, T., & Baron-Cohen, S. (1992). Understanding beliefs and drawings: A further test of the metarepresentation theory of autism. Journal of Child Psychology and Psychiatry, 33, 1105-1112.

Corcoran, R. (2000). Theory of mind in other clinical samples: Is a selective theory of mind deficit exclusive to autism? In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds). Understanding other minds: Perspectives from developmental cognitive neuroscience (pp. 391-421). Second Edition. Oxford: Oxford University Press.

Dahlgren, S. & Trillingsgaard, A. (1996). Theory of mind in non-retarded children with autism and Asperger's syndrome. A research note. Journal of Child Psychology and Psychiatry, 37, 759-763.

Dawson, G. & Adams, A. (1984). Imitation and social responsiveness in autistic children. Journal of Abnormal Child Psychology, 12, 209-226.

Dawson, G., Meltzoff, A. N., 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.

de Villiers, J. (2000). Language and theory of mind: What are the developmental relationships. In S. Baron-Cohen, H. Tager-Flusberg, & D. Cohen (Eds.), Understanding other minds: Perspectives from developmental cognitive neuroscience, Second Edition (pp. 83-123). Oxford: Oxford University Press.

de Villiers, J. & de Villiers, P. (2000). Linguistic determinism and false belief. In P. Mitchell & K. Riggs (Eds.), Children's reasoning and the mind. Hove, U.K.: Psychology Press.

Dennett, D. C. (1978). Beliefs about beliefs. Behavioral and Brain Sciences, 1, 568-570.

Eslinger, P., & Damasio, A. (1985). Severe disturbance of higher cognition after bilateral frontal lobe ablation: Patient EVR. Neurology, 35, 1731-41.

Fernald, A. (1989). Intonation and communicative intent in mothers' speech to infants: Is the melody the message? Child Development, 60, 1497-1510.

Fernald, A. (1993). Approval and disapproval: Infant responsiveness to vocal affect in familiar and unfamiliar languages. Child Development, 64, 657-674.

Flavell, J. H. (1999). Cognitive Development: Children's knowledge about the mind. Annual Review of Psychology, 50, 21-45.

Flavell, J. H., Flavell, E. R., & Green, F. L. (1983). Development of the appearance-reality distinction. Cognitive Psychology, 15, 95-120.

Flavell, J. H. Green, F. L., & Flavell, E. R. (1998). The mind has a mind of its own: Developing knowledge about mental uncontrollability. Cognitive Development, 13, 127-138.

Fletcher, P. C., Happé, F., Frith, U., Baker, S. C., Dolan, R. J., Frackowiak, R. S. J., & Frith, C. D. (1995). Other minds in the brain: a functional imaging study of "theory of mind" in story comprehension. Cognition, 57, 109-128.

Fodor, J. A. (1992). A theory of the child's theory of mind. Cognition, 44, 283-296.

Frith, U. (1989). Autism: Explaining the enigma. Oxford: Blackwell.

Frith, C. D. & Frith, U. (1999). Interacting minds: A biological basis. Science, 286, 1692-1695.

Frith, U., Happé, F., & Siddons, F. (1994). Autism and theory of mind in everyday life. Social Development, 3, 108-124.

Frith, U., Morton, J., & Leslie, A. M. (1991). The cognitive basis of a biological disorder: Autism. Trends in Neurosciences, 14, 433-438.

Gale, E., de Villiers, P., de Villiers, J., & Pyers, J. (1996). Language and theory of mind in oral deaf children. In A. Stringfellow, D. Cahana-Amitay, E. Hughes, & A. Zukowski (Eds.), Proceedings of the 20th annual Boston University Conference on Language Development Volume 1. Cascadilla Press: Somerville MA.

Gillberg, C., Ehlers, S., Schaumann, H., Jakobsson, G., Dahlgren, S.O., Lindblom, R., Bagenholm, A., Tjuus, T., & Blinder, E. (1990). Autism under age 3 years: A clinical study of 28 cases referred for autistic symptoms in infancy. Journal of Child Psychology and Psychiatry, 31, 921-934.

Goel, V., Grafman, J., Sadato, N., & Hallett, M. (1995). Modeling other minds. Neuroreport, 6, 1741-1746.

Gopnik, A. & Wellman, H. (1994). The theory theory. In L. A. Hirschfeld & S. Gelman (Eds.), Mapping the mind: Domain specificity in cognition and culture, (pp. 257-293). New York: Cambridge University Press.

Gopnik, A., Capps, L., & Meltzoff, A. (2000). Early theories of mind: What the theory theory can tell us about autism. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), Understanding other minds: Perspectives from developmental cognitive neuroscience (pp. 50-72). Second Edition. Oxford: Oxford University Press.

Gopnik, A. & Rosati, A. (1997). Perception, cognition, and young children's reversal of ambiguous figures. Biennial Meeting of the Society for Research in child Development, Washington, D.C.

Gordon, R. (1986). Folk psychology as simulation. Mind and Language, 1, 158-171.

Hale, C. M. & Tager-Flusberg, H. (1999). The influence of language on theory of mind: A training study. Manuscript under review.

Happé, F. (1993). Communicative competence and theory of mind in autism: A test of relevance theory. Cognition, 48, 101-119.

Happé, F. (1994a). An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. Journal of Autism and Developmental Disorders, 24, 129-154.

Happé, F. (1994). Autism: An introduction to psychological theory. London, England: University College London Press.

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

Happé F. (1999). Autism: Cognitive deficit or cognitive style? Trends in Cognitive Sciences, 3, 216-222.

Happé, F. & Frith, U. (1996). The neuropsychology of autism. Brain, 119, 1377-1400.

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.

Harris, P. L. (1992). From simulation to folk psychology: The case for development. Mind and Language, 7, 120-144.

Heyman, G. & Dweck, C. (1998). Children's thinking about traits: Implications for judgments of self and others. Child Development, 69, 391-403.

Jarrold, C. (1997). Pretend play in autism: Executive explanations. In J. Russell (Ed.), Autism as an executive disorder (pp. 101-140). Oxford: Oxford University Press.

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

Klin, A. (1991). Young autistic children's listening preferences in regard to speech: A possible characterization of the symptom of social withdrawal. Journal of Autism and Developmental Disorders, 21, 29-42.

Klin, A., & Volkmar, F. (1993). The development of individuals with autism: Implications for the theory of mind hypothesis. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds). Understanding other minds: Perspectives from autism (pp. 317-331). Oxford: Oxford University Press.

Klin, A., Schultz, R., & Cohen, D. J. (2000). Theory of mind in action: Developmental perspectives on social neuroscience. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds). Understanding other minds: Perspectives from developmental cognitive neuroscience (pp. 357-388). Second Edition. Oxford: Oxford University Press.

Leekam, S. & Perner, J. (1991). Does the autistic child have a metarepresentational deficit? Cognition, 40, 203-218.

Leslie, A. M. (1987). Pretense and representation: The origins of "theory of mind." Psychological Review, 94, 412-426.

Leslie, A. M. & Roth, D. (1993). What autism teaches us about metarepresentation. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), Understanding other minds: Perspectives from autism, (pp. 83-111). Oxford: Oxford University Press.

Leslie, A. M. & Thaiss, L. (1992). Domain specificity in conceptual development: Evidence from autism. Cognition, 43, 225-251.

Lewis, C. & Mitchell, P. (Eds.), (1994). Children's early understanding of mind: Origins and development. Hillsdale, NJ: Lawrence Erlbaum Associates.

Mant, C. & Perner, J. (1989). The child's understanding of commitment. Developmental Psychology, 24, 343-351.

Mehler, J. & Dupoux, E. (1994). What infants know: The new cognitive science of early development. Oxford: Blackwell.

Meltzoff, A., Gopnik, A., & Repacholi, B. (1999). Toddlers' understanding of intentions, desires, and emotions: Explorations of the dark ages. In P. Zelazo, J. Astington, & D. Olson (Eds.), Developing theories of intention: Social understanding and self-control (pp.17-41). Mahwah, NJ: Erlbaum.

Miller, C. (2000). False belief understanding in children with specific language impairment. Journal of Communication Disorders.

Mitchell, P. & Lacohée, H. (1991). Children's early understanding of false belief. Cognition, 39, 107-127.

Moses, L. & Flavell, J. (1990). Inferring false beliefs from actions and reactions. Child Development, 61, 929-945.

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 Press.

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.

Mundy, P., Sigman, M., & Kasari, C. 1993. The theory of mind and joint-attention deficits in autism. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), Understanding other minds: Perspectives from autism, (pp. 181-203). Oxford: Oxford University Press.

Ornitz, E., Guthrie, D. & Farley, A. (1977). Early development of autistic children. Journal of Autism and Childhood Schizophrenia, 7, 207-229.

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

Pennington, B. (1999). Dyslexia as a neurodevelopmental disorder. In H. Tager-Flusberg (Ed.), Neurodevelopmental disorders, (pp. 307-330). Cambridge, MA: MIT Press.

Perner, J. (1988). Higher-order beliefs and intentions in children's understanding of social interaction. In J. Astington, P. L. Harris, & D. Olson (Eds.), Developing theories of mind (pp. 271-294). Cambridge: Cambridge University Press.

Perner, J. (1993). The theory of mind deficit in autism: Rethinking the metarepresentation theory. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.). Understanding other minds: Perspectives from autism. (pp. 112-137). Oxford: Oxford University Press

Perner, J., Leekam, S., & Wimmer, H., (1987). Three-year-olds' difficulty with false belief. British Journal of Developmental Psychology,5 125-137.

Perrett, D., Harries, M., Mistlin, A., Hietanen, J., Benson, P., Bevan, R., Thomas, S., Oram, M., Ortega, J., & Brierley, K. (1990). Social signals analyzed at the single cell level: someone is looking at me, something touched me, something moved! International Journal of Comparative Psychology, 4, 25-55.

Peterson, C. & Siegal, M. (1995). Deafness, conversation and theory of mind. Journal of Child Psychology and Psychiatry, 36, 459-474.

Peterson, 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.

Pillow, B. H. (1991). Children's understanding of biased social cognition. Developmental Psychology, 27, 539-551.

Plaisted, K. (2000). Aspects of autism that theory of mind cannot easily explain. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds). Understanding other minds: Perspectives from developmental cognitive neuroscience (pp. 222-250). Second Edition. Oxford: Oxford University Press.

Premack, D. & Woodruff, G. (1978). Does the chimpanzee have a "theory of mind?" Behavioral and Brain Sciences, 1,

Repacholi, B. (1998). Infants' use of attentional cues to identify the referent of another person's emotional expression. Developmental Psychology, 34, 1017-1025.

Repacholi, B., Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month-olds. Developmental Psychology, 33, 12-21.

Russell, J. (1997). How executive disorders can bring about an inadequate 'theory of mind.' In J. Russell (Ed.), Autism as an executive disorder (pp. 256-304). Oxford: Oxford University Press.

Russell, P., Hosie, J. A., Gray, C., Scott, C., Hunter, N., Banks, J., & Macaulay, M. (1998). The development of theory of mind in deaf children. Journal of Child Psychology and Psychiatry, 39, 903-910.

Santangelo, S. & Folstein S. E. (1999). Autism: A genetic perspective. In H. Tager-Flusberg (Ed.), Neurodevelopmental disorders, pp.431-447). Cambridge, MA: MIT Press.

Shatz, M. (1994). A toddler's life: Becoming a person. New York: Oxford University Press.

Shatz, M. & Gelman, R. (1977). Beyond syntax: The influence of conversational constraints on speech modifications. In C. E. Snow & C. A. Ferguson (Eds.), Talking to children (pp. 189-198). Cambridge: Cambridge University Press.

Shatz, M. & O'Reilly, A. (1990). Conversational or communicative skill? A reassessment of two-year-olds' behavior in miscommunication episodes. Journal of Child Language, 17, 131-146.

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

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

Sullivan, K., Winner, E., & Hopfield, N. (1995). How children tell a joke from a lie: The role of second-order mental state attributions. British Journal of Developmental Psychology, 13, 191-204.

Szatmari P. (1999). Heterogeneity and the genetics of autism. Journal of Psychiatry and Neuroscience, 24, 159-65.

Tager-Flusberg, H. (1992). Autistic children's talk about psychological states: Deficits in the early acquisition of a theory of mind. Child Development, 63, 161-172.

Tager-Flusberg, H. (1993). What language reveals about the understanding of minds in children with autism. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), Understanding other minds: Perspectives from autism. Oxford: Oxford University Press.

Tager-Flusberg, H. (1994). Dissociations in form and function in the acquisition of language by autistic children. In H. Tager-Flusberg (Ed.), Constraints on language acquisition: Studies of atypical children, (pp. 175-194). Hillsdale, NJ: Erlbaum.

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 Publishing.

Tager-Flusberg, H. (1999). A psychological approach to understanding the social and language impairments in autism. International Review of Psychiatry, 11, 325-334.

Tager-Flusberg, H. (2000). Language and understanding minds: Connections in autism. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds). Understanding other minds: Perspectives from developmental cognitive neuroscience (pp. 124-149). Second Edition. Oxford: Oxford University Press.

Tager-Flusberg, H. & Anderson, M. (1991). The development of contingent discourse ability in autistic children. Journal of Child Psychology and Psychiatry, 32, 1123-1134.

Tager-Flusberg, H. & Sullivan, K. (1994). Predicting and explaining behavior: A comparison of autistic, mentally retarded, and normal children. Journal of Child Psychology and Psychiatry, 35, 1059-1075.

Tager-Flusberg, H. & Sullivan, K. (in press). A componential view of theory of mind: Evidence from Williams syndrome. Cognition.

Tager-Flusberg, H., Sullivan, K., Joseph, R., & Joffre, K. (1999). False belief understanding in individuals with mental retardation. Unpublished manuscript, Eunice Kennedy Shriver Center.

Volkmar, F., Sparrow, S., Goudreau, D., Cicchetti, D.V., Paul, R., & Cohen, D. J. (1987). Social deficits in autism: An operational approach using the Vineland Adaptive Behavior Scales. Journal of the American Academy of Child Psychiatry, 26, 156-161.

Wellman, H. (1990). The child's theory of mind. Cambridge, MA: MIT Press.

Wellman, H. & Estes, D. (1986). Early understanding of mental entities: A reexamination of childhood realism. Child Development, 57, 910-923.

Wellman, H. & Bartsch, K. (1988). Young children's reasoning about beliefs. Cognition, 30, 239-277.

Wellman, H., Cross, D., & Watson, J. K. (1999, April). A meta-analysis of theory of mind development: The truth about false-belief. Biennial Meeting of the Society for Research in Child Development, Albuquerque, N.M.

Wellman, H. & Lagattuta, K. H. (2000). Developing understandings of mind. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds). Understanding other minds: Perspectives from developmental cognitive neuroscience (pp. 21-49). Second Edition. Oxford: Oxford University Press.

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.

Woodward, A. (1996). Infants' reasoning about the goals of a human actor. International Society for Infant Studies, Providence RI.

Yirmiya, N., Erel, O., Shaked, M., & Solomonica-Levi, D. (1998). Meta-analyses comparing theory of mind abilities of individuals with autism, individuals with mental retardation, and normally developing individuals. Psychological Bulletin, 124, 283-307.

Yuill, N. (1993). Understanding of personality and dispositions. In M. Bennett (Ed.), The development of social cognition: The child as psychologist, (pp. 87-110). New York: Guilford Press.

Yuill, N. (1997). Children's understanding of traits. In S. Hala (Ed.), the development of social cognition, (pp.273-95). Hove, Sussex: Psychology Press.

Zaitchik, D. (1991). Is only seeing really believing? Sources of true belief in the false belief task. Cognitive Development, 6, 91-103.

Zelazo, P., Burack, J., Benedetto, E., & Frye, D. (1996). Theory of mind and rule use in individuals with Down's syndrome: A test of the uniqueness and specificity claims. Journal of Child Psychology and Psychiatry, 37, 479-484.

[1] In fact, from the earliest conference and published volumes in this field there was an interest in a developmental perspective on theory of mind – with studies looking at mental state understanding in children younger that 4, and later developments taking place in middle childhood (see Astington, Harris, & Olson, 1988; Wellman, 1990). This broader perspective was soon eclipsed by the intense focus on the changes occurring at the age of 4.

[2] There are, of course, a number of different rival theoretical accounts of theory of mind in the literature. These theories, the most prominent of which include nativism (e.g., Fodor, 1992; Leslie & Roth, 1993), the 'theory theory' (e.g., Gopnik & Wellman, 1994) and simulation theory (e.g., Harris, 1992; Gordon, 1986), offer different perspectives on the development of theory of mind. These theoretical controversies are not directly relevant to the main arguments

in this chapter, so I have chosen to emphasize the empirical studies that illustrate the broad range of phenomena encompassed by theory of mind.

[3] Although numerous alternative theories of theory of mind have been proposed (for a review see Carruthers & Smith, 1996), including one account of the component modules that make up a theory of mind (e.g., Baron-Cohen, 1995), none of these theories have taken a strong developmental perspective.