Memory, attention and interaction in early development

Exploring individual differences among typical children and children with autism

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Abstract

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This thesis aimed to study differences in early memory ability, social attention and interaction and how these different areas affect language and cognitive development. This was done using a longitudinal approach where a group of children were followed from infancy to childhood and also in a comparative study where a group of children diagnosed with autism spectrum disorder was compared to a group of typically developing children, matched on language age. *Study I* investigated typically developing infants and showed that recall memory (measured with deferred imitation), visual recognition memory and social communicative ability could explain a large part of the differences in early language acquisition, and also that recall memory made the strongest contribution to this explanation. *Study II* was a follow-up of the same children as in study I, and showed that a combined low performance on tests of both recall memory and social communication in infancy was related to poorer cognitive outcome beyond infancy, when the children had reached 4 years of age. In *study III*, deferred imitation and different aspects of social communication were investigated in children with autism and in comparison with typically developing children. The results revealed that children with autism and low language level showed reduced performance in all areas of social communication as well as on deferred imitation. Children with autism and a higher language level, however, performed on a similar level as the typically developing children on all but one measure of social communication, but they still showed reduced performance on deferred imitation. *Study IV* included the same children as study III, and their performance on pretend play as well as child-parents interaction during play was investigated in relation to language level, joint attention and deferred imitation. Pretend play was related to the child's language level, joint attention and deferred imitation. The way parents interacted verbally with their child differed between parents of children with autism compared to parents of typically developing children, but also on the child's language level.

The present thesis suggests that it is beneficial to investigate social and cognitive areas in combination if the aim is to understand how early abilities affect later development. The results contribute to the understanding of language development in autism and also point to the importance of considering the child's developmental level. Children with autism showed large individual differences in many different areas, and the results suggest that this was partly due to the child's language level.

Keywords: Memory, social communication, interaction, individual differences, autism spectrum disorder, language development

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Preface

This thesis is based on the following studies, referred to in the text by their Roman numerals:

I. Heimann, M., Strid, K., Smith, L., Tjus, T., Ulvund, S-E. & Meltzoff, A. N. (2006). Exploring the relation between memory, gestural communication, and the emergence of language in infancy: A longitudinal study. *Infant and Child Development,* 15, 233-249.

II. Strid, K., Tjus, T, Smith, L., Meltzoff, A. N. & Heimann, M. (2006). Infant recall memory and communication predicts later cognitive development. *Infant Behavior and Development,* 29, 545-553.

III. Strid, K., Tjus, T., Smith, L., Gillberg, C. & Heimann, M. (submitted). Social communication and deferred imitation in children with autism and typical development: Relation to language age.

IV. Strid, K., Tjus, T., Smith, L., Gillberg, C. & Heimann, M. (submitted). Pretend play and parents' comments in relation to joint attention and deferred imitation in children with autism

INTRODUCTION

Human infants are born with an interest and a motivation to socially connect to other people. They also possess the basic cognitive skills that make this early interaction possible. The cognitive and social growth that follows birth is impressive and not comparable to any other period in life, and by the end of infancy many advanced forms of social and cognitive abilities have found their basic forms. The child has by then begun to understand intentions of others, create symbols, understand goal-directed actions and has access to advanced memory processes. When the ultimate tool for social interaction – spoken language – is acquired, the basic structures for communication have already been functioning for quite some time.

Empirical data from the last 40 years has revealed a highly competent infant, and most theorists today agree that infants start out with a richer innate capacity than what was proposed by classic developmental theories of human development. However, there are different opinions on *how* competent and *how* conscious infants really are. While some argue that a lot of knowledge, or knowledge structures, are innate, others argue that knowledge mainly develops through experience; a discrepancy that partly mirrors the classic nature/nurture debate in developmental psychology. To separate innate abilities from those that are acquired, and to understand how early predictors affect later development, is not easy. Since infants are nonverbal, all infancy research depends on behaviours which are possible to observe, and the interpretation of these behaviours. This means that research only involves implicit measures, which makes infancy research sensitive to, and dependent on, methodology.

Children diagnosed with autism spectrum disorder have difficulties in areas of social interaction and communication, even if individuals differ widely in the degree of impairment. While some children with autism are socially withdrawn and might never develop spoken language, others are more interested in social interaction even if they find it difficult, and some even acquire good verbal skills. Children with autism are also impaired in some of the important skills that typical children develop in infancy, even if the degree, cause and consequence of these impairments is not fully understood.

This thesis investigates individual differences in social and cognitive abilities in relation to language and cognitive development, both in typically developing children and in children diagnosed with autism. The challenge is to better understand which abilities that underpins language and cognition, and how the developmental process that leads from early to later abilities works.

Infant development

The field of infant development has changed dramatically over the last 40 years. The vulnerability and the lack of motoric competence in infants led developmental psychologists to the conclusion that the earliest part of our lives was characterized by no self-awareness and no consciousness, and was described as a period of mental isolation. This view begun to change when Piaget introduced his theory of early cognitive development (Piaget, 1952). Piaget showed that infants are active in exploring their environment and that they have access to cognitive processes much more complex than previously believed. Despite this, Piaget turned out to have underestimated infant capacities. In the 70s, the development of new methodologies made it possible to reveal more advanced abilities at earlier ages. Where older methods often depended on motoric competence and required action from the infant, new ones were based on looking preference and habituation/dishabituation.

Competing theories of early development

Many of the new findings of infant competence cannot be explained by classic developmental theories but require a new theoretical framework. Alternative theories have emerged in the search for such a framework, and three competing theories are the *theory-theory*, the *modularity theory* and the *simulation theory*. These have different ways of explaining the early capacities in infancy and also how these capacities develop into more sophisticated abilities.

Theory-theory

From a theory-theory point of view, cognitive development in children is similar to theory development in science (Gopnik & Meltzoff, 1997). Children start out with immature theories, and use these theories to make sense of the world. When new data, through experience, no longer can be explained or predicted, the child's theory in that domain will change. As in science, children use their theories to understand the world, make predictions and explain what they experience (Meltzoff, 1999; Wellman, 2004). When the theory eventually does not work any more for the child, it is revised and replaced with a better, more accurate theory. Development can thus be viewed as a kind of testing of hypotheses, much in the same way as scientists test their theories (Gopnik, 2003). However, children do not use scientific thinking when they make predictions about the world, the kind of theories that children have should be seen more as informal theories. The theory-theory aims at explaining how children develop their understanding of both the physical and the social world. The theory also suggests that we understand ourselves and our own behaviour much in the same way as we learn to understand others. It is not easier to understand, for example, our own beliefs than the beliefs of others (Wellman, 2004). The theory also suggests that developmental change is a result of children being exposed to external stimuli and not of internal development (Hala & Carpendale, 1997).

Meltzoff (2005; 2007) suggests that infants have an innate mechanism that makes them recognise other people as "like me". This "like-me" mechanism is evident in infant imitation and constitutes an innate ability to understand the behaviour of other people and also to begin to create theories about the social world and others' mental states (Meltzoff, 2007). When infants observe others' behaviour they can map this to how they are thinking or feeling when they behave in a similar way, which gives infants a "jump-start" in their ability to understand others (Meltzoff, 2004b). Thus, theory-theory suggests that infants are born with initial theories and that they start to revise these theories as a result of their first experiences (Gopnik, 2003). One strength of this account is thus that it can explain both early infant competence as well as the developmental change that takes place during infancy (Wellman, 2004).

Modularity theory

A different explanation of early development is given by modularity theorists (Fodor, 1992; Leslie, 1991). Modular theory postulates that the maturation of innate neurocognitive structures, modules, is responsible for early development. These modules are domain-specific, which means that different aspects of development are independent of each other (Scholl & Leslie, 1999). It also means that one specific module can be selectively impaired, by e.g. neurological damage.

Baron-Cohen (1995a; Baron-Cohen & Ring, 1994) argues that infants' understanding of both dyadic and triadic interactions develop through domain-specific, modular mechanisms. One mechanism, the Eye-direction-detector makes the child aware of others' gaze, both directed at the child itself and at other things. This understanding of gaze is necessary in order to form dyadic interactions. A different mechanism makes triadic interactions possible; the Shared-attention-mechanism. The function of the Shared-attention-mechanism is to recognise that you and another person is attending to the same object or event (Baron-Cohen, 1995a).

The modular theory can easily explain the new findings of infant competence, since these are assumed to be innate. However, the theory has more difficulties explaining the qualitative change in development (Meltzoff, 1999; Wellman, 2004).

Simulation theory

Simulation theory argues that early development occurs through processes of mental simulation (Goldman, 1992; Harris, 1991; 1994). Children do not need to create theories about the world or the people in it, all they need is to understand themselves. Simulation theorists argue that we have privileged access to our own mental states and that we, trough a simulation process, can put ourselves in the situation of others (Hala & Carpendale, 1997). We can imagine what we would do or feel if we were in that situation and attribute those actions or feelings to the other person, through a kind of role-taking. The importance of imagination has made simulation theorists focus on pretend play as an early important skill (e.g. Harris, 1991) and its development is also seen as evidence that young children can step outside themselves and pretend to be someone else. Developmentally, children learn to make more accurate simulations as they get more experienced in role-taking and develop their imaginative capacity (Wellman, 2004).

Simulation theory can explain many of the early social abilities in infants. For example, if infants understand that they point at an object with the intention of sharing an experience with another person, they also understand the intention behind pointing gestures of others. However, critics of the simulation theory emphasise that young children often find it as difficult to understand their own mental states as it is understanding the mental states of others. This would suggest that we do not have privileged access to mental states just because they are our own (Gopnik, 1993), an assumption that is the major building-block of simulation theory.

Understanding the physical world

Infants can only understand what they can perceive, and a better understanding of infant perception has also made it possible to gain more knowledge about early cognitive development. The fact that infants prefer certain information to other, shows that they choose what they attend to and also that they distinguish between available information (e.g. Maurer, 1985). Infants also look longer at information that is new to them (e.g. Fagan, 1970), which means that we can create experiments to find out *when* information is considered new to infants. This has expanded our knowledge about what infants can discriminate, how long it takes them to process information, and how long they remember.

Piaget's general claim was that infants develop through their sensorimotor interaction with physical objects. They learn about the world through exploring objects and they have to physically manipulate objects in order to understand them. This means that they were not thought to be able to create representations of actions and objects but depended on the world here and now. However, newer research (see Muir & Slater, 2000) has revealed that infants have cognitive capacities more advanced than Piaget proposed, *especially* if the motoric demands are lifted from the cognitive tasks. For example, object permanence, the understanding that objects have their own existence in the world separated from the infant's view of it, was not thought to develop before the age of eight months in classic developmental theory. Piaget concluded that infants had only developed object permanence when they started to reach for hidden objects. If they did not, it was interpreted as if they did not understand that the hidden object continued to exist when it was not seen. More recent research has shown that the motor demands of the task was too difficult and masked the infant's cognitive competence. When using a looking paradigm, object permanence tasks are passed by infants as young as three to four months (e.g. Baillargeon, 1999). In a series of studies, Baillargeon (2000) has demonstrated that infants are surprised (shown by increased looking time) when they see a screen move through another (hidden) object. This is interpreted as if the infants know that the object behind the screen exists, even if it cannot be seen. Thus, infants show an understanding of object permanence earlier in life when the test does not require any motoric action. This means that infants develop an understanding of the physical world much earlier than previously proposed and, more importantly, this development does not seem to require object manipulation.

Using the same methodology, infants at four months show some basic understanding of gravity and they also know that one object cannot move through another object (Spelke, Breinlinger, Macomber, & Jacobson, 1992). They also have some early basic understanding of causality, e.g. if object A moves towards object B, and they make physical contact, object A causes object B to move. Already by two to three months, infants understand that this causal relation is violated if a barrier is present between the objects (Baillargeon, 2000). This develops further and by six months can infants also take into consideration that a small object has a smaller effect on an other object than a large object has (Baillargeon, 2000).

Studies of infant perception has revealed that infants prefer human voices (e.g. Vouloumanos & Werker, 2004) and human faces (e.g. Maurer & Barrera, 1981) to other kinds of sounds and objects. This means that they can both differentiate between animate and inanimate objects and that they choose one over the other. In the first months of life, infants cannot only distinguish between different faces and different expressions in the human face (Nelson, 1987), they also show a preference for their mothers' face (Bushnell, 2001). Thus, other people seem to constitute a very special kind of "objects" for humans already in the beginning of life:

> *"In their second month after birth their reactions to things and persons are so different that we must conclude that these two classes of objects are distinct in the infant's awareness"* (Trevarthen, 1979, p. 322).

Disagreements

Most researchers agree on what young infants understand of the physical world around them, but there are disagreements about how this should be interpreted and how this understanding has developed. The nativist side interprets these findings as evidence for e.g. innate representational ability and innate knowledge of continuity (Spelke, 1998, 1999) while the empiricist side means that this understanding develops through children's exploration of objects (Haith, 1998; Piaget, 1952). Other researchers stand somewhere between these positions and their general suggestion is that some knowledge or knowledge structure is innate, while other aspects are learned (e.g. Meltzoff, 2004b). The research results on causality, for example, can be interpreted as infants having an initial understanding about causal relations, but requiring *experience* about objects in order to understand how size and length matter to causality (Baillargeon, 2000).

There is a similar nature/nurture debate about early face recognition. One side argues that face recognition depends on the experience of human faces (e.g. Nelson, 2001) while the other side argues that this ability is already well developed at birth (e.g. Slater & Quinn, 2001). Following the later argument; early face recognition, and especially neonatal imitation of facial expressions, has been suggested as evidence that human beings are pre-programmed for social activities and have an innate motivation and ability to communicate and interact with other people (Hobson, 2004; Meltzoff & Moore, 1983; Trevarthen & Aitken, 2001).

Understanding the social world

When observing mothers and infants interacting, the reciprocal atmosphere of that interaction is obvious. The mother and infant use gaze and imitation to create an affective and rhythmic situation, which has many similarities with adult conversation and has also been called proto-conversational (Bateson, 1979). The term *primary intersubjectivity* refers to the proposed innate ability and motivation in the human infant that makes mutual interaction possible (Trevarthen, 1979; Trevarthen & Aitken, 2001). This means that human infants are born specifically receptive to the subjective states of other persons. Mother and infant are not only looking and smiling at each other, but modifying their behaviour in response to what the other person does, that is, the interaction is reciprocal. Even if there is data (e.g. Nadel, Carchon, Kervella, Marcelli, & Reserbat-Plantey, 1999) showing that infants are active participants in early social interactions – such as having expectations on the adult, detecting contingencies and responding to the social partner – some (e.g. Gergely & Watson, 1999) are still sceptical about the infants' consciousness of the social and communicative aspects of this dyadic interaction.

Dyadic interaction

The interaction between a mother and her infant is characterized by rhythm and intimacy (Zeedyk, 2006). Phases of face-to-face interactions are encouraged by the mother through smiles and increased gaze in such a way that they are prolonged (Trevarthen, 1979). Infants are active partners in this interaction and are sensitive to the contingency and quality of the interaction. They react with distress if the mother is not tuned in to the rhythm of the "conversation" and has already created predictive patterns of interaction and expectancies of a specific behaviour from the mother.

This social expectancy is shown in experiments using the still-face paradigm (Tronick, Als, & Adamson, 1979). These experiments show that infants as young as two months react with strong negative emotions when their mother shows a still face (Adamson & Frick, 2003). They typically try to get the mother to respond by looking more at her and maybe smile more, but when there is no reaction they give up and turn away from the mother, both with their eyes, face and body. The infants' reaction in this still-face situation is interpreted as if the infant has social expectancies of the interaction and responds with distress when these expectancies are not fulfilled (Ellsworth, Muir, & Hains, 1993; Nadel et al., 2000; Nadel & Tremblay-Leveau, 1999).

Infants do not respond with distress merely to another persons' inactivity or unresponsiveness, but also when interaction is out of tune. This is shown in an experimental situation using the “double-video-technique”, where the natural interaction is disturbed (e.g. Braarud & Stormark, 2006; Murray & Trevarthen, 1985; Nadel et al., 1999). In these studies, infants and mothers are interacting via a screen (the mother sees the infant on a screen and the infant sees the mother on a screen). When the video recording is live, ordinary interaction is present. But if the mother is recorded and her responses are shown to the infant with a thirty seconds delay, the infant shows negative affect and is disturbed by the lack of contingency of the mother (Hains & Muir, 1996; Murray & Trevarthen, 1985). This is taken as evidence that the infant is not simply responding to a positive and active adult, but is also sensitive to the contingency of the interaction and reacts when this is broken (Nadel et al., 2000).

Apart from the sensitivity of the typically developing infant, the sensitivity of the mother is equally important. Observations of clinically depressed mothers highlight the importance of having a sensitive and responsive social partner to interact with and also point to the fact that it is the dyadic pattern of early interaction that is important. Postnatal depression leads to reduced or slower responses to infants’ social cues and vocalizations (Bettes, 1988; Field, 2002) and this lack of a normal mother-infant interaction pattern affects both the infants’ behaviour (Field, 2002) and brain activity (Field, Pickens, Fox, & Newrocki, 1995) as well as their social and emotional development (Field, Diego, & Hernandez-Reif, 2006).

The discovery of an innate ability and motivation to imitate facial gestures in neonatal human infants (Meltzoff & Moore, 1977) has been taken as another evidence for primary intersubjectivity in infants. The imitative behaviour shows that infants respond in an adaptive way already from the first hours in life, which suggests that humans are born with a willingness and motivation to interact socially with others (Trevarthen & Aitken, 2001). Infants also imitate emotional facial expressions (Field, Woodson, Greenberg, & Cohen, 1982; Haviland & Lelwica, 1987) suggesting that humans have an early ability to emotionally connect to other people, detect and respond to emotions in others and, probably, learn about their own emotions through the emotions of other people (Hobson, 2004).

The pattern of early dyadic interaction is often characterized by turn-taking sequences, which continues in later triadic interaction as well as in adult conversation. This shows an innate, or early emerging, non-verbal communicative skill in infants to coordinate their attention with another person. Triadic turn-taking refers to situations where two people are engaged in taking turns and in infancy this often occurs in playing with objects, like throwing a ball back and fourth. These situations help the infant to understand the framework in which communication takes place between two people (Hobson, 2004). Very early, infants are also capable of vocal turn-taking with their mothers in which they make sounds and then are quiet while the other person speaks (Locke, 1995). Turn-taking – both vocal and with objects – could be seen as a nonverbal precursor for vocal dialogue.

Triadic interaction

A few months before their first birthday, infants begin to include objects in their interaction with others, combining the awareness of both objects and persons into a new form of self-person-object awareness. This has been termed *secondary intersubjectivity* (Trevarthen & Hubley, 1978) and signs of this new ability are infants' use of communicative gestures that refer to objects, such as pointing and gaze following. Before this stage of development, the infant relates to objects *or* persons. It is only when they can combine objects and people that infants begin to notice how other people interact and relate to objects. This ability marks a new level of infants' understanding of other peoples awareness of the world (Hobson, 2004), and is of crucial importance for social learning and the development of social cognition.

Joint attention

Joint attention occurs when a child and another person attend to the same object or event, and they both are aware that this attention is shared (Moore & Dunham, 1995). The capacity for joint attention has been proposed as an important precursor to language and social cognition and the processes involved in joint attention also provide the child with opportunities for social learning (Mundy & Sigman, 2006; Tomasello, 1995) and lay the foundation for more complex understanding of the social world (Fonagy, Gergely, & Target, 2007). The ability for joint attention probably serves different functions through life and is important both on an instrumental and a developmental cognitive level as well as for social motivation:

> *"periods of joint attention provide an important context for the mutual regulation of affect and of problem solving, for the negotiation of communicative intentions, and for the sharing of cultural meaning"* (Adamson, McArthur, Markov, Dunbar, & Bakeman, 2001, p. 439)

The earliest sign of the emergence of joint attention capacity is seen when infants start to follow another person's eye-gaze or pointing to objects in the surrounding. A later joint attention behaviour has developed when infants start to direct others' attention to objects they find interesting. Another form of joint attention skills is when infants try to modify another persons' behaviour with gestures, for example reaching for an object outside their own reach. Researchers sometimes look upon these different acts as separate and define them either as behaviours that are responses to somebody else, such as gaze or point following (Morales, Mundy, & Rojas, 1998) or behaviour that is initiated by the child, such as pointing or reaching (Desrochers, Morissette, & Ricard, 1995).

Gaze and point following. From 6 months of age, infants follow another person's gaze to objects in the surrounding environment (Corkum & Moore, 1998; Morales et al., 1998). This behaviour involves a triadic interaction between the infant, the other person and an outside object, but the question is if the infant understands the intention behind the other persons' looking. Instead of being driven by their understanding of others' intentions, it might be that infants simply follow where the adult is turning his head, because they have learned that it is usually something interesting there to look at. There is an on-going debate regarding how this early gaze-following should be interpreted and if it can be said to reflect true joint attention (Corkum & Moore, 1998; Tomasello, 1995). One way of trying to answer this question is to have adults turn to an object either with their eyes open or closed (Brooks & Meltzoff, 2002). If infant gaze- following should be interpreted as joint attention, they have to follow the eyes and not only the turning of the head. In the Brooks and Meltzoff study (2002) it was observed that infants by the age of 12 months looked at the target if the adult turned to it with open eyes but not if the person turned to the target with his eyes closed. However, younger infants have been shown to pay more attention to where the head is turning while older infants pay more attention to the eyes (Corkum & Moore, 1995) indicating that interpretations of gaze-following behaviour should be made with caution, at least in younger infants (Morales et al., 2000).

Gaze- and point-following demonstrates another developmental change in showing that older infants become more capable in locating the correct target of someone else's attention (Corkum & Moore, 1995; Delgado, Mundy, Crowson, Markus, & Schwartz, 2002). Before their first birthday, infants develop from only being able to locate targets within their own visual field (Butterworth, 1995), to also being able to locate targets outside their visual field (Butterworth, 2004; Deák, Flom, & Pick, 2000). This change indicates that the same underlying social skill (gaze- or point following in this case) manifests itself differently in different age groups.

Pointing. Joint attention skills that are initiated by the child (e.g. pointing) develop slightly later than behaviours that are responses to others (such as gaze-following). The capacity to direct another persons' gaze to objects of the infants' own interest develops sometime between 9 and 12 months (Carpenter, Nagell, & Tomasello, 1998; Smith & Ulvund, 2003; Tomasello, 1995). Infants can use the pointing gesture for different purposes, both for sharing attention and for requesting. When infants use imperative pointing the purpose is to change the behaviour of the other person, perhaps elicit aid in obtaining an object that is out of reach. However, infants can also use the pointing gesture in order to change or influence the others' attention or their goal. Even if these two gestures resemble each other, they have been suggested to serve different functions.

Declarative pointing has been suggested to be especially demanding. It has been argued (Mundy & Sigman, 2006; Tomasello, 2006) that declarative pointing, in contrast to imperative pointing, relies on the understanding of others as mental agents and is driven by a motivation to share attention and interest with other persons. In typically developing infants, the motivation to share attention and interest is probably strong and declarative gestures are common, in contrast to children with social impairments (e.g. Carpenter, Pennington, & Rogers, 2002) and primates (e.g. Tomasello, 2006). Critics (e.g. Desrochers et al., 1995) have argued that declarative pointing before 12 months is not really used to change the adults attention and does not involve the intentional understanding required for true declarative pointing. Experiments with 12-month-olds have revealed that the social context is crucial for how much the infant points (Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004).

Only when the adult was active in sharing the infants' attention to the event the infant pointed at, the infants' pointing increased. Liszkowski et al. (2004) interpreted this result as if the infant not only wants to direct the adults attention, but also wants to share this attention. In addition to imperative and declarative pointing, infants around 12 months also point simply to provide information to someone else (Liszkowski, Carpenter, Striano, & Tomasello, 2006). This shows that infants can detect what information the adult needs and that they are motivated to give that information.

The question of whether initiating and following joint attention are expressions of the same underlying mechanism or not is unsolved (Mundy & Gomes, 1998), but there are indications that joint attention initiated by the child might predict different capacities compared to responding behaviours (Charman et al., 2000; Morales et al., 2000; Mundy & Gomes, 1998; Sheinkopf, Mundy, Claussen, & Willoughby, 2004; Ulvund & Smith, 1996).

Understanding goals and intentions

An understanding of others' intentions is well developed when children accomplish "false-belief" tasks when they are about four years old (Wimmer & Perner, 1983). Underpinnings of this ability are seen in triadic interactions, but research has also shown intentional understanding in other areas such as goal-directed actions, at remarkably early ages (e.g. Woodward, 1998). There is research suggesting that infants in their first 6 months understand that actions by humans, as well as nonhumans, are driven by goals. Tests of goal-attribution have used the looking paradigm, which has revealed that infants increase their looking time (i.e. are surprised) when a human action is inconsistent with its goal (Woodward, 1998). However, results are contradictory when it comes to the question of whether young infants only attribute goals to actions that are performed by humans, or if they make the same attribution to actions made by robots (Kamewari, Kato, Kanda, Ishiguro, & Hiraki, 2005; Meltzoff, 1995a), or by moving boxes (Kamewari et al., 2005; Luo & Baillargeon, 2005). That is, if goal-attribution in infancy is specific to humans or not. It can be argued that infants, by the time they begin to follow and direct others attention, have acquired some understanding of others as intentional agents and that other people act on the basis of their own view of the world. Joint attention is an indicator that infants understand that others' perspective of the world can be followed, shared and directed. But other infant behaviour, such as selective imitation and goal-attribution, might show an early intentional understanding in a more direct way.

Studies have revealed that infants in their second year understand the intention behind an action and not only the action they actually observe (Carpenter, Akhtar, & Tomasello, 1998; Meltzoff, 1995a). Meltzoff (1995a) showed that 18-month-old infants understood the intention behind an action that the adult failed to perform. Instead of imitating the failure, they imitated the complete action. Carpenter et al. (1998) showed that 14-month-olds could differentiate between intended and accidental actions. Infants did not imitate actions followed by a "Whoops!", but they did imitate actions that were followed by an adult saying "There". In a similar fashion, 9-month-old infants show anger and distress towards an adult who is unwilling to give them a toy, but not towards an adult who is unable to do so (Behne, Carpenter, Call, & Tomasello, 2005), implicating an understanding of others as intentional agents.

Disagreements

One main disagreement about infants' understanding of their social world concerns how much of their behaviour that should be interpreted as intentional. Researchers mainly agree on what infants can and cannot do, but disagree about what mechanisms that underpin the behaviour. A variety of perspectives exist concerning the interpretations of the social behaviour seen in infants. While some interpret the behaviour as evidence for innate mentalising ability in humans, others argue that we interpret infant behaviour as meaningful and conscious much more often than what is reasonable.

One area of debate concerns early dyadic interaction and the role of the infant and the parent in these interactions. Trevarthen (1979), among others, represent one view in this debate, suggesting that infants understand the intention of communication, and by this, understand the inner mental states of others and also understand that others' behaviour is driven by their mental states. Other developmental theorists (see Zeedyk, 1996) would not ascribe infants with any intentionality at all. Their position is that the mother is responsible for the contingent pattern observed in the mother-infant interaction. The infants' behaviour *looks* social but it is really the mother who interprets her child's behaviour as meaningful and intentional, and thus makes the interaction look reciprocal. Still others (e.g. Gergely & Watson, 1999) are more cautious about how much intersubjective awareness we should ascribe to the infant and argue that many early abilities, such as proto-conversational turn taking, can be explained without giving the infant a mentalising ability or ability to attribute emotional states in others. Even if both parent and infant are attuned and like to engage in "conversation", the reason does not have to be that they are subjectively aware of, or share, each others emotional and mental states (Fonagy et al., 2007).

An explanation of infant social behaviour that does not involve mentalising abilities is given by Gergely (2004). He argues that infants innate interest in human faces and human voices, together with their sensibility to contingency, is enough to explain the behaviour of infants in early social interaction. For example, it is not necessary to give infants credit for having an understanding of others' intentions because they react with distress when they are faced with a broken interaction (as in the still-face-paradigm), since a change *in contingency* also can make infants react in this way (Gergely & Watson, 1999). Gergely (2004) further argues that this sensitivity to violation of contingency develops around three months of age. Before that, infants are searching for a "perfect" match of their behaviour, like in a mirror (Rochat & Morgan, 1995). It is only after three months that infants starts to show an interest in "non-perfect" matching, as in the case of mother-infant interaction where the mother and the infant imitate, take turns and tune in each other, but are not a perfect match of each other. Gergely (2004) claims that it has been difficult to replicate studies where infants younger than three months show a distressing behaviour in the still-face-test (Murray & Trevarthen, 1985) and that the reason is that such young infants are not yet interested in a non-perfect contingent pattern. However, this claim can be questioned since later research has been able to replicate the findings of contingent interactions in infants younger than two months (Braarud & Stormark, 2006; Nadel et al., 1999).

An assumed innate understanding of others' intentions has also been criticised by Tomasello (1999) who argues that infants begin to understand intentions in others around nine months, i.e. when they start to show true joint attention behaviour. Before that age, infants are able to, but typically do not, follow the gaze or pointing of others and they do not point at objects themselves even if they have the necessary motoric skills to do so. The reason is that before nine months infants do not understand or treat others as intentional agents that have goals of their own (Tomasello, 1999).

Memory development

It is difficult to imagine what life would be like without memory, but for a long time this ability was assumed to be lacking in infancy. Infants were not thought to have the necessary skills for forming personal memories or to recall personal experiences. This view, however, is being challenged today. The view on infants as competent and active has increased the interest in more direct infancy research and new methods have made it possible to test memory in nonverbal groups.

It has been hypothesised that our memory is built on different systems or processes and that these processes serve different kinds of memories (for review, see Rovee-Collier, Hayne, & Colombo, 2001). One system supports the memory needed for motor skills and habits as when we remember how to ride a bicycle. This is the procedural, non-declarative or implicit memory system and these kinds of memories are characterized as non-conscious and they often benefit from training. A second memory system requires representational ability and gives rise to personal or conscious memories, for example when we remember our last birthday. This is referred to as the nonprocedural, declarative or explicit memory system. Much of the support for the multiple memory system perspective comes from research on adults suffering from amnesia. Amnesic patients have severe difficulties in forming personal memories but can, at the same time, improve their skills in tasks that require procedural memory (Squire, 1987). This indicates that our memory is constructed of two systems occupying different parts of the brain, since one can be damaged while the other is unaffected.

The idea of two dissociable memory systems led to the conclusion that these systems also have different timetables, where the declarative memory system is supposed to develop later than the procedural system (Bachevalier & Mishkin, 1984; Schacter & Moscovitch, 1984). From birth, infants are only supposed to be capable of forming memories that rely on the procedural memory system, not personal memories like adults can. The assumption that different memory systems develop at different times relies partly on the phenomenon of infantile amnesia, i.e. adults' difficulties in accessing autobiographical memories before their first years of life (Bauer, Wenner, Dropik, & Wewerka, 2000; Hayne, 2004). The amount of memories from early childhood are less than could be expected from normal forgetting, which could be explained by the fact that memories formed in infancy are qualitatively different from later memories and that the system needed for supporting personal memories is not yet developed in infancy (Bachevalier & Mishkin, 1984; Schacter & Moscovitch, 1984). The assumption of two dissociable memory systems is also effected by the fact that it is very difficult to test early signs of declarative memory in a nonverbal population and for a long time the task was assumed impossible. Theoretically, this view has been strongly influenced by Piaget's developmental theory. He claimed that the representational capacity necessary for forming declarative memories develops at the end of the sensorimotor period, i.e. between 18 and 24 months. Before children reach this stage, they are not able to form memories of specific events (Piaget, 1952).

Later research on early memory development has begun to change the assumption that infants lack declarative memory capacity (Bauer, 2004). Evidence today shows that infants do have the necessary representational skills for forming declarative memories (Mandler, 1998), and they do pass memory tests that are considered equal to verbal declarative memory tests (McDonough, Mandler, McKee, & Squire, 1995). Although the phenomenon of infantile amnesia remains, later investigators have proposed different explanations to it. It does not seem to be a result of infants' inability to form declarative memories, but rather a problem of accessibility (e.g. Rovee-Collier, 2000; Simcock & Hayne, 2002). The focus in infant memory research has changed from investigating what adults remember from their infancy to investigating memory in infants. This has led to suggestions that both memory systems (if it is possible to talk about two systems) are present – in some form – early in life and, consequently, that infants have the capacity to construct declarative memories (Rovee-Collier et al., 2001). Especially the use of new methods to test infant memory has increased the understanding of memory capacity in infancy, which has forced older theories about memory development to be reconsidered (Courage & Howe, 2004; Fagan & Detterman, 1992; Meltzoff, 2004a).

Testing declarative memory in preverbal infants demands specific methodologies (e.g. Hayne, 2004) and two of the most common tests are described below. One relies on the imitative capacity in infants' and the other uses infants' preference for novelty. Both tests are most commonly considered to measure preverbal declarative memory; recall memory and recognition memory. It has, however, been suggested that these two memory tests capture different memory processes (i.e. declarative and procedural processes) (Gross, Hayne, Herbert, & Sowerby, 2001; Rose, Feldman, & Jankowski, 2004)

Deferred imitation

Piaget was first in recognising the importance of deferred imitation in cognitive development. He emphasized that the child's ability to imitate after a delay showed that the child had begun to create mental representations and could act according to stored representations (Piaget, 1962). Classically, the capacity for recall memory was assumed to develop after the sensorimotor period in infancy, at the end of the second year. This assumption was first revised when results were presented showing that 14-month-olds (Meltzoff, 1985) and 9-month-olds (Meltzoff, 1988b) were able to imitate after delay. Research has also found individual stability (Heimann & Meltzoff, 1996) where infants with low performance on deferred imitation at 9 months also performed low at 14 months. Today, research has shown that infants already at the age of 6 months pass the same deferred imitation test (Barr, Dowden, & Hayne, 1996; Collie & Hayne, 1999; Hayne, Boniface, & Barr, 2000; Heimann & Nilheim, 2004; Learmonth, Lamberth, & Rovee-Collier, 2004) and that recall memory is a continuously developing ability; infants at 6 months remember fewer items, fewer details and for a shorter period of time, compared to older infants (Jones & Herbert, 2006).

Imitation of actions with objects is used in the classic deferred imitation procedure (Meltzoff, 1985). In this procedure infants are presented with different objects and an experimenter performs specific actions on them. The infant is not allowed to handle the object, instead the object is removed and a delay is imposed. After the delay, the infant is offered the object and during a specific response time he or she is given the opportunity to handle the toys to produce the same action. Since the infants are only exposed to a brief action demonstration and are not allowed to handle the object prior to the test, it is commonly assumed that the memory used is of a more mature form (i.e. a declarative recall memory) than in other nonverbal memory tests (Flavell, Miller, & Miller, 1993; Meltzoff, 1995b). To be sure that the infant has not seen the demonstrated action in their every day life, studies usually include novel actions. In a seminal paper by Meltzoff (1988a) the experimenter had a panel of lights in front of him, bended forwards and touched the panel with his forehead, which made a light turn on. This action was completely novel to the infant and yet 67% of the 14-month-old infants who saw the action imitated after a one-week delay. A control group who did not see the action demonstrated had a 0% correct response showing that this is not an action that infants do spontaneously. This strengthens the assumption that infants can remember things they have only briefly been exposed to and that memory in this task is based on representation since the children have no prior motor practice of the action (Meltzoff, 2004a).

Developmental change

As described above, deferred imitation of actions with objects is possible to observe in infants from at least the age of 6 months. Deferred imitation, however, is an ability that changes as a function of age. Encoding, storing and retrieval within the deferred imitation paradigm is dependent on maturation and clear developmental changes can be observed.

When testing 9- and 14-month-olds the action demonstrated is typically presented three times to the infant. The first study that demonstrated the onset of deferred imitation at a lower age (Barr et al., 1996) showed that infants by the age of 6 months were able to imitate actions after a 24 hour delay, but only if they were exposed to the target action six times instead of three, which indicates that older infants learn faster than younger infants.

Memory flexibility also changes with age. Hayne et al. (2000) have reported that 6-month-olds do not imitate an action they have seen demonstrated in one context if the test session occurs in a different context, while this change has no effect on the 12-month-olds (Klein & Meltzoff, 1999). The Hayne et al. study (2000) also showed that both 6- and 12-month-old infants were disrupted in imitation when the object was changed (to a different puppet) but a change of object had no effect on the 18-month-olds. 18-month-old toddlers are also capable of deferred imitation when the demonstration has only been seen on television (Barr & Hayne, 1999), but this is not enough for the 12- and 15-month-olds. 14-month-olds have been shown to be unaffected in imitation when both the room and the object size are changed (Barnat, Klein, & Meltzoff, 1996) although a decrease in performance was noted when both room, size of object and colour of object were changed.

A developmental change is also evident when comparing the length of time possible between demonstration and testing; 6- and 9-month-olds can remember actions for 24 hours (Collie & Hayne, 1999; Hayne et al., 2000), while 12-month-olds can remember up to 4 weeks (Klein & Meltzoff, 1999) and 14-month-olds up to 4 months (Meltzoff, 1995b).

The deferred imitation paradigm has been used to measure recall memory even before 6 months. If the deferred imitation task includes a facial gesture instead of actions with objects, deferred imitation is evident in infants already at six weeks, and for as long as 24 hours (Meltzoff & Moore, 1994). This task does not require any motoric demands and it includes a known action (such as mouth opening) instead of a new event but still shows that infants have the capacity to remember and act on stored representations at the very beginning of life. Another study showed that infants can remember an action seen at three months, and imitate that action at six months (Campanella & Rovee-Collier, 2005). When the infants were three months old they saw two objects together repeatedly, creating an association between them. The infants then saw an action demonstrated on one of the objects (A) and were at this time not yet motorically capable of performing the action themselves. At six months, the infants could use this latent association and imitated the action they had seen demonstrated on object A, on object B. That is, the memory and association that were created at three months could be used three months later. Infants who had not seen the objects together at three months (and thus did not form an association between them), did not imitate the action on a different puppet (Campanella & Rovee-Collier, 2005).

Deferred imitation as a measure of declarative memory

The characteristics outlined above are considered as evidence that deferred imitation is a measure of declarative memory and comparable to adult tests of verbal recall (McDonough et al., 1995). The procedure used shows that infants can remember representations across modalities as well as other changes (Bauer et al., 2000), which is required in declarative memory tests. The target action is seen briefly and there is no possibility of training since the infant is not even allowed to touch the object prior to testing, which means that the memory is from a representation of an action rather than a motor skill learned by training. Another strong piece of evidence that deferred imitation taps declarative memory processes is the fact that amnesic patients who evidently have limited declarative memory do very poorly on deferred imitation tests (McDonough et al., 1995). Deferred imitation is also considered to measure recall memory rather than recognition because when the action has been demonstrated there is no evidence of that action, which means that it has to be recalled. The fact that some deferred imitation tests use multi-step sequences strengthen the idea that it is a recall memory test (Bauer, 2004).

Visual recognition memory

Another nonverbal memory test that can be used in infancy is the paired-comparison test (Fagan & Detterman, 1992), which measures the infants' visual recognition memory. This test exploits the fact that infants show a preference for novelty (Fagan, 1984), a fundamental capacity throughout life. At least from two months of age, infants pay more attention to information that is new to them compared to familiar information; they show a preference for novel information (for a review see; Bahrick & Pickens, 1995). This means that when infants differ in their fixation time between a novel and a previously seen target, they are assumed to remember the target they devote the least fixation to. When infants turn their attention away from the familiar picture they are assumed to have formed a representation of that stimuli (Rose et al., 2004), and it is this representation that they remember and use in the later comparison.

Tests of infants' visual recognition memory is based on individual processing speed (Fagan & Haiken-Vasen, 1997; Rose et al., 2004), which could partly explain individual differences in recognition memory tasks. Different studies (see Sigman, Cohen, & Beckwith, 1997) have shown that some infants need to look longer at a target, compared to other infants, before they reach the point where they demonstrate a preference for novelty. This difference is particularly evident in at-risk infants (e.g. preterm) who need longer time to encode information and also improve their novelty score when the familiarization time is increased (Rose et al., 2004).

Paired-comparison procedure

In one test of visual recognition memory (Fagan & Detterman, 1992) the infant sees two pictures of faces side by side on a computer screen. These pictures are shown for 10-20 sec. depending on the age of the infant being tested, since younger infants needs longer exposure time than older infants (Fagan & Detterman, 1992). After the familiarization period one of the pictures is shown together with a novel picture, and an experimenter records which picture the infant has focused his/hers attention to. The experimenter stands behind the computer and hidden by a screen so he can see the child's eyes while still avoiding to distract the child. Half-way through the test, the pictures left and right positions are changed, in order to control for side effects. This procedure is repeated by combining different pairs of novel and familiar faces. The measure that is primarily given is a novelty score (in percent) showing how much longer the infant looks at the novel pictures compared to the familiar ones, a score that usually falls between 57 and 60% in typically developing infants (Fagan & Detterman, 1992).

Predictions

Predictions from visual recognition memory have been made to different cognitive outcomes later in childhood in a number of different studies (McCall & Carriger, 1993; Moe & Smith, 2003; Rose, Feldman, & Wallace, 1992; Smith, Fagan, & Ulvund, 2002). McCall & Carriger (1993) found in their meta-analysis an average correlation of .45 between tests of visual recognition memory in infancy and developmental level at 2 to 8 years. One suggested explanation for this stability is that the processing skill used in tests of visual recognition by infants is the same skill that children or adults use to solve problems in intelligence tests (Fagan, 2000; Fagan & Haiken-Vasen, 1997). Accordingly, these infants, who are better in processing information, will also gain more knowledge through life and consequently score better on later IQ tests. Another explanation could be that infants differ in their ability to recognise unimportant information, i.e. they rapidly turn away from familiar information. If they only need short familiarization time and then turn their attention towards new information they could also be better at detecting the most informative information in the environment (Sigman et al., 1997), an important ability in later IQ tests.

Play

In the first months of life, infants start to engage in sensory play, where they explore the environment through their senses (sight, sound, smell, touch and taste) (Piaget, 1962). Children also start to engage in functional play in the first year of life, where toys or other objects are used in the function they have. In the second year of life, symbolic, or pretend, play begins to emerge (e.g. Lillard, 2004; McCune, 1995). Pretend play is usually defined as acting *as if* something is the case when it is really not (Leslie, 1987).

Pretend play

The difference between functional and pretend play is not entirely clear, mainly because it is difficult to know when a play act should be considered symbolic or not (Jarrold, Boucher, & Smith, 1993). For example, when a child is playing with toy cars it is not certain that he/she understands that the toy cars are symbols of real cars; they may simply be perceived as small, real objects (Baron-Cohen, 1987) and the situation should therefore be defined as functional play. Because different researchers use slightly different definitions, some results are difficult to compare.

Piaget (1962) was the first researcher showing interest in children's ability to pretend. He saw this symbolic competence as a cognitive ability, paying very little attention to the social context in which the play occurred. In contrast, Vygotskij (1978) meant that symbolic thinking develops within the child's social context and in interaction with others. This classic distinction in play theory still exists today; is symbolic thinking a result of cognitive maturation in the child, or is it created and learned in interaction with others?

One line of theory emphasizes the fact that development of pretend play requires an understanding of metarepresentation (Baron-Cohen, 1987; Leslie, 1987). When the child is using one object as if it was something else, he/she has to hold the real representations in mind at the same time as the pretended representation, i.e. a representation of a representation. Others argue that metarepresentation is not necessary for pretend play (Harris, 1994). Instead, the child only needs to be able to imagine what things could be like, and then pretend that they are. This does not require metarepresentation, but the child needs to be able to think hypothetically (Harris, 1994).

Another line of research emphasizes the social nature of pretend play and suggests that pretend play, as well as functional play, develops through imitative/cultural learning (Rakoczy, 2006; Rakoczy, Tomasello, & Striano, 2005). To imitate a pretend action is more difficult than to imitate a functional action, because the other persons' intention behind the action is more complex and more difficult to understand. For example, when the child sees another person acting as if a piece of wood is a car, the child has to be able to understand that the other persons' intention is to use the wood as a car, and then imitate that action. It is by observing others that children learn the culturally accepted way to use and create symbols, both in pretend play development, but also in the acquisition of language (Tomasello, 1999). Additionally, the ability to engage in pretend play with others provides the child with opportunities to practice social roles and also constructs a context where symbols are created and used (Travis & Sigman, 1998).

Many observations support the importance of social interaction in the development of pretend play. Results show that pretend play increases if the child plays with a parent instead of playing alone (Bornstein & Tamis-LeMonda, 1995; Fein & Fryer, 1995). In one experiment, the mother was either asked to play with her child in the usual way, or to sit near the child but occupied with filling out a form and talking to the experimenter. The experiment showed that both the level and the length of pretend play increased when the mother was available to play with the child (Slade, 1987). Another experiment compared children's social behaviour in different forms of play and found that the children looked more at the adult during pretend play as compared to instrumental play (Striano, Tomasello, & Rochat, 2001).

Another support for the importance of social interaction in pretend play is its strong relation to language development (for a review see; Lewis, 2003). Even if a child's functional play level has been related to the language level (e.g. Ungerer & Sigman, 1984) the strongest relation is found between language and pretend play (Lewis, Boucher, Lupton, & Watson, 2000; Tamis-LeMonda & Bornstein, 1994). For example, Lewis et al. (2000) found positive correlations between pretend play and both production and comprehension of language (.47 and .35, respectively). This could indicate that both pretend play and language depend on the development of symbolic understanding in children.

Language

The ultimate tool of social interaction and understanding is language and when a child learns to use language a new world of social opportunities opens. However, exchanging verbal information is not the only ingredient in communication. When we are engaged in conversation it includes interpretation of what is really being said, looking at facial expressions and gestures that accompany language, listening to what is not being expressed verbally and putting the conversation into context (what I know about the persons history, experiences and personality).

Some of the important communicative skills that infants develop before they master language have been described above. Gestures involved in the social interactions of joint attention episodes, such as pointing, soon become accompanied by sounds, sounds that later become words. Around the time of their first birthday most children have produced their first word, but typically infants comprehend several words before they have the ability to produce any themselves, and this is generally the case even when children grow older (Flavell et al., 1993). After the appearance of the first word children's vocabulary develops slowly until around 18 months and during this age, gestures and words (or sounds) are used in parallel (Volterra, Caselli, Capirci, & Pizzuto, 2005). There are large individual differences between children, but around 18 months many of them enter a period where new words are learned very rapidly. Children at this stage of language development can learn several new words every week, or even every day (Goldfield & Reznick, 1990). During this period, children start to use more words than gestures in their communicative production (Iverson, Capirci, & Caselli, 1994).

When children learn more words, they also start to combine two or more words, for example, nouns and verbs into utterances, which typically happens around 18 months (Berglund, 1999). In the beginning these utterances are very simple and not concerned with rules of grammar, although the combination of words shows that some sort of understanding of semantic relations must be present already at this age (Flavell et al., 1993). While a two-year-old talks about things that are here and now, already by the age of three children are capable of constructing utterances about what happened somewhere else or yesterday. By this age a child has already acquired more than a thousand words. With this large vocabulary, most children, sometime past the age of three, enter a period where they adapt the rules of grammar very rapidly (Bates, Dale, & Thal, 1995) and by the age of four, an adult-like language is present.

Autism spectrum disorder

Autism is a developmental disorder which was first identified in 1943 by Leo Kanner (Kanner, 1943). It is diagnosed in 5-20 out of 10 000 children and more often in boys than in girls (ratio about 3-5:1) (Frith, 1994; Gillberg, Cederlund, Lamberg, & Zeilon, 2006). The majority of autism cases are presumed to have genetic causes although the specific genetic marker is still unknown (Wing, 1997). Instead, the diagnosis is based on behavioural grounds and includes a triad of behavioural characteristics; impaired social interaction, problems with communication and restricted/stereotyped behaviour (Wing, 1997). One important aspect in autism is that it is a developmental disability, which means that it affects the child's whole development and also changes through development (Frith, 1994), which means that the impairment can differ in the same individual over time (Wing, 1997). As the child develops, some symptoms of the impairment can disappear or be mitigated, while other areas that were not impaired early in childhood can be detected later in childhood and adolescence. The reason might be that the child learns from experience and develop strategies to handle some difficulties, for example to avoid certain situations. It is also possible that some impairments do not appear early in childhood simply because there has been no such demands on the child. For example, starting school leads to new cognitive and social demands on the child, and some impairment can only now become problematic.

Main areas of disability

The child needs to be affected in three areas in order to receive the diagnosis autism spectrum disorder according to the two major manuals used; the International Classification of Diseases (ICD-10; WHO, 1992) and the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; APA, 1994).

First, the child needs to show impairment in social interaction with others. This might include a limited use of non-verbal gestures, such as joint attention and eye contact. Children with autism do not use eye contact in the same manner as typically developing children, that is, they do not use it as a part of social interaction. Even if a child with autism avoids eye contact, it does not mean the child is avoiding other people, it could instead be a sign of his inability to read intentions in others and to be aware of others consciousness (Frith, 1994). Impairments in social interaction can be manifested as a lesser interest in sharing attention with other people, something which is both common and rewarding for typical children (Carpenter, Pennington, & Rogers, 2001). As a consequence of their impairment in social and emotional sharing, children with autism often have problems with peers, such as making and keeping friends.

Second, communication needs to be an area of difficulty. Many children diagnosed with autism do not develop a spoken language to such an extent that it is useful as a tool for social interaction (Gillberg, 1991), and children that do develop language still have problems with some aspects of communication. Problems with the pragmatic aspects of language are common to all individuals with autism, regardless of intelligence or problems in other areas of language development (Frith, 1994). Not being able to understand the real meaning behind words makes normal conversation very difficult and children with autism tend to interpret every sentence literally, even if most sentences we use include much more information than the actual words that we use. It is also common in autism to have problems with pronouns and understanding the difference between here and there, characteristics that probably signal a wider problem with understanding the meaning of utterances and the intention of the sender (Frith, 1994). A lack of play behaviour, especially symbolic or pretend play, is also part of the communicative difficulties in autism. Children with autism are engaged in less play compared to typically developing children and they also play at a lower level than could be expected considering their mental level (Williams, 2003).

The third area in the autism triad is restricted, repetitive interests and behaviours. One of the main areas of autism that Kanner described in his seminal paper (Kanner, 1943) was that these children wanted the world to remain the same over time. Children with autism show a resistance against change and are often involved in routines and rituals. One explanation for this can be that as children with autism find the world fragmented and confusing it becomes very important to them to gain control over those areas that are possible to control (Frith, 1994). Problems with flexibility are expressed in different ways, for example in an abnormal fixation on one area of interest or particular parts of objects or in repetitive/stereotyped motoric behaviour (Wing, 1997).

Psychological models of autism

How is it possible to explain the primary deficit that could cause the triad of difficulties seen in autism? While it can be argued that this task is doomed to fail (Happé, Ronald, & Plomin, 2006) many different hypotheses have been put forward in order to try to explain the cause of the whole spectrum of the disorder, while others seek to find the primary cause of a particular behaviour seen in autism. The focus of the present thesis is on social communication (joint attention) and deferred imitation, but other main models are also briefly presented.

Intersubjectivity in autism

It is possible that an early deficit in functions that endorse intersubjectivity has a strong affect on social development, which leads to the different social behaviours seen in autism. If the early dyadic interaction between the infant and caregiver is less present or show a different pattern, this can lead to a different social development, which makes triadic interaction, language acquisition and the understanding of mentalising very difficult to acquire (Trevarthen & Aitken, 2001). Perhaps a limited or different cognitive, motivational or emotional function in infancy could explain the social limitations seen in older children with autism.

Autism is diagnosed after the infancy period, which makes it difficult to know if these children show atypical social behaviour as infants. Retrospective studies have been used where parents are asked to describe their child's behaviour in infancy. However, this method is limited since it is difficult for parents to ignore the child's present problems and the results might be affected by selective recall. In an attempt to overcome this limitation, studies (e.g. Osterling & Dawson, 1994) have taken advantage of the use of home video recording, which has provided new opportunities to analyse early social behaviour before the child is diagnosed with autism. These analyses have shown that by their first birthday children later diagnosed with autism show less social responsiveness and joint attention, they look less at other people's faces and they point less compared to typically developing infants (Osterling & Dawson, 1994). However, these studies analyse behaviour by the first birthday and do not give us information about infant behaviour before that age.

Another way of capturing infant behaviour in children with autism is to conduct population scanning studies and analyse infant behaviour in those children later diagnosed with autism compared to children with typical development. Early scanning instruments (e.g. the *CH*ecklist for *A*utism in *T*oddlers (CHAT)) have been used with high-risk populations, i.e. infants who have an older sibling with an autism diagnosis (Baron-Cohen, et al., 2000). Studies using the CHAT have shown that some children with autism can be identified already in their second year. Factors included in the CHAT that predict a risk for a later autism diagnosis are limited or absent joint attention and pretend play (Baron-Cohen, et al., 2000).

Imitation

Imitation is an important tool in infancy for connecting to other people, understanding communication and for social learning. Infants only a few hours old have the ability to imitate others (Meltzoff & Moore, 1983), suggesting an innate imitation-capacity in humans. Since imitation seems to be such a powerful behaviour in typical development, imitation in autism has been widely investigated and, by some, suggested to play an important part in trying to explain the deficits in autism (Rogers, Hepburn, Stackhouse, & Wehner, 2003). Imitation is not absent in autism, but when comparing children with autism to matched controls, children with autism often imitate less (Rogers et al., 2003). Imitation performance in autism depends on the type of action, the developmental level of the child, the severity of autism symptoms, the child's social responsiveness and initiating joint attention behaviours (Rogers et al., 2003). The large individual differences in imitation in autism can also predict later development. In the Rogers et al. study, the child's imitative ability at age three was a an important predictor for later development at age four, showing that children with good imitation skills showed more progress in both nonverbal and verbal skills. This could suggest that a deficit in imitation leads to less progress or that imitation is related to poorer cognitive development over time.

Another aspect of imitation that has been investigated in autism is the ability to recognise that you are being imitated. Several studies (e.g. Field, Field, Sanders, & Nadel, 2001; Heimann, Laberg, & Nordøen, 2006; Nadel, 2002) have shown that children with autism benefit from imitative interaction. If an adult or peer interacts with the child through imitation, i.e. imitate the actions, sounds and behaviours of the child, social behaviours and interest in others increase for the child with autism (Field et al., 2001). It has been suggested that being imitated develops social expectancies from others, leading to increased social behaviours in children with autism. The benefits of imitation can also depend on the kind of interaction created in an imitation situation. Imitation requires that the adult is totally attentive to the child and responds to everything the child does, which creates a close, reciprocal interaction. It has also been suggested that imitative interaction makes it possible for children with autism to recognize and understand the behaviour of the other person (Field et al., 2001).

The importance of imitation in development has been supported by recent neurological research. About ten years ago, a special kind of neurons, called mirror neurons, was discovered in macaque monkeys. The same neurons were activated when the monkey either performed an action or saw the action performed by someone else, e.g. when grasping a piece of food or when seeing someone else grasping a piece of food (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996). This discovery suggests that the power of imitative learning might have a neurophysical explanation.

Joint attention

A general deficit in joint attention abilities has been suggested as an explanation for the difficulties in social interaction and communication seen in autism. Research on joint attention in autism, however, has shown that not all joint attention behaviours are equally difficult for children with autism. Declarative gestures, such as pointing to share interest, are less common, and perhaps more difficult, compared to imperative gestures that serve more instrumental purposes, such as requesting a toy (Carpenter et al., 2002). It has been argued that declarative gestures serve social functions to a higher degree than imperative gestures, and that children with autism have more difficulties in producing gestures that are used to direct others' attention compared to directing others' behaviour. Sharing attention is more dependent on an understanding of others mental states as compared to, for example, a requesting gesture, where you only need to understand and interpret others' behaviour. It has also been suggested that children with autism have specific problems with declarative gestures that are initiated by themselves. The reason is that these episodes both involve a sharing of inner mental states *and* are motivated by the positive value this social sharing has for young children (Mundy & Sigman, 2006). One suggestion is that the motivational system that is required in dyadic interaction is also causing the impairment in triadic interaction such as joint attention (Mundy & Acra, 2006). This view is supported by results showing an especially robust impairment in initiating declarative joint attention (Mundy, Sigman, & Kasari, 1994; Sigman & Ruskin, 1999).

The relation between joint attention abilities and language acquisition in autism has been shown in several studies (e.g. Mundy, Sigman, & Kasari, 1990) and it is possible that a limited interest in, and ability for, joint attention can explain part of the language delay in autism. This relation can probably be explained both on a cognitive developmental, instrumental, and motivational level. That is, the relation between joint attention and language can depend on a similar underlying ability (such as intentional understanding) but it could also be the case that a joint attention deficit leads to reduced opportunities to participate in social interaction and that this lack of experience is responsible for the lower language level. Children often learn language in episodes of shared attention and if these episodes are limited or even absent, many learning opportunities get lost or become more ineffective (Frith, 1994). This could also help to explain the relation between joint attention and later theory of mind; both areas might depend on the same underlying ability but research (Hughes et al., 2005) additionally suggests that social influence is responsible for, at least part of, the development of theory of mind. Environmental variables such as maternal speech, number of siblings and peer influence are important for the development of theory of mind, suggesting multiple reasons for its development.

Other main psychological models of autism

Central coherence

Typically, we have a propensity to create coherence and when we process information we do it to extract meaning. New experiences do not exist as fragmented entities within us, but are instead placed in a context in order for us to make sense of them. A strong central coherence implies that we see and seek the “whole picture“ at the expense of details. A weak central coherence means that the cognitive drive to attend to the whole instead of the parts is lacking. Children with autism have been suggested to have a weak central coherence and it has also been suggested that this can explain much of the behaviours seen in autism (Happé, 1999). The idea of a weak central coherence came from results showing that children with autism do very well on tasks that require the ability to detect details in large pictures, or create patterns of single units (Frith, 1994). The theory of weak central coherence also suggests an explanation why children with autism seem to have an interest in things that typical children barely notice. All information that we receive is judged by us as being either relevant or not. Most information is not relevant, which means that we simply ignore it. Information that is judged as relevant is that which is meaningful to us. However, if you lack the ability to judge what is meaningful, you might instead focus on some odd detail and lose the overall meaning (Frith, 1994). Today the ambition of the weak central coherence theory is no longer to explain the whole spectrum of autism disorder, but is instead suggested to explain part of the cognitive impairment (Happé & Frith, 2006).

Executive functions

Executive functions include cognitive skills such as problem solving, working memory, flexibility and planning (Zelazo & Müller, 2004). Different tests are used to tap different aspects of executive function and several studies have found that people with autism show poor performance on many such tasks, and an executive dysfunction have been suggested as the cause of the symptoms seen in autism (e.g. Ozonoff, South, & Provencal, 2005). This model fits well with the flexibility difficulties seen in autism, but has also been suggested to explain social and communicative disabilities as well (Bennetto, Pennington, & Rogers, 1996). However, children with autism are not impaired on all executive function tasks (Zelazo & Müller, 2004) and the performance depends on the child's mental level (Griffith, Pennington, Wehner, & Rogers, 1999; Ozonoff et al., 2005), as well as language level (Ozonoff et al., 2005). A recent study (Pellicano, Maybery, Durkin, & Maley, 2006) found that only 50% of the children with autism had difficulties in the performance on tasks of executive function, questioning the universality of an executive dysfunction in autism. The uniqueness has also been questioned since other groups (such as ADHD and Tourette's syndrome) also show executive function problems (Rajendran & Mitchell, 2007).

Theory of mind

An impaired theory of mind has also been suggested to underlie the symptoms of autism. Theory of mind is the ability to understand mental states in oneself and in others, and also the ability to use this understanding in the interpretation of one's own and other's behaviour (Baron-Cohen, Tager-Flusberg, & Cohen, 2000). Children with autism show a lower performance on theory of mind tests compared to children with developmental delays, when the groups are matched on language age. However, tests of other, similar, causal relationships that do not include mental representations are typically mastered by children with autism (Frith, 1994). This has led to the assumption that children with autism interpret behaviour and not the intentions behind the behaviour. A specific deficit seems to be present in the ability to understand that others' thoughts differ from their own, but it is not all children that fail these tests (Happé, 1994). Instead, high-functioning individuals with autism often do very well on theory of mind tests, but still find it difficult to understand others intentions and beliefs in real life (Klin & Volkmar, 1997). Critics of the theory of mind hypothesis (e.g. Happé, 1995) argue that these tests can be learned on a cognitive level, and solved as a logical problem, without much understanding of the social aspects. The important relation between success on theory of mind tasks and verbal ability suggests that the success is a result of high intelligence and verbal ability, more than a genuine understanding of other persons' inner mental states (Happé, 1995). There are also different suggestions regarding how children develop a theory of mind, which have implications on the theory of mind hypothesis in autism. Some argue (e.g. Baron-Cohen, 1995b) that a specific theory of mind module exists and that this module could be affected in autism, while others argue (e.g. Tomasello, 1995) that theory of mind is only one step on the path of children's social development and that the theory of mind problem is a result of other, more basic, social problems.

Memory development

Some results suggest that individuals with autism have problems with declarative memory performance, but the results depend on what kind of information that should be remembered, how that information has been organised and in what context it has been presented (Renner, Klinger, & Klinger, 2000; Williams, Goldstein, & Minshew, 2006), which entails that it might not be a memory problem per se. For example, tests where individuals are asked to remember a list of words is typically more difficult if the words are unrelated than if they can be thematically composed or could be read as a sentence (Williams et al., 2006). However, individuals with autism do not seem to benefit to the same extent from these cues and instead remember the words as single words, without considering the context (Tager-Flusberg, 1991).

Working memory has been of particular interest since it is part of the suggested executive dysfunction in autism. Working memory is defined as the ability to hold information on line and use that on line information to guide your behaviour. However, studies of working memory in individuals with autism have revealed mixed results (Bennetto et al., 1996; Ozonoff & Strayer, 2001), partly depending on which task that is used. It has therefore been suggested that individuals with autism pass working memory tests if they do not involve complex cognitive processes. That is, the complexity of the working memory task, and not the memory demand, decides if the task is manageable or not (Williams, Goldstein, Carpenter, & Minshew, 2005).

Deferred imitation

As in infancy research, studying memory in autism is difficult since many memory tasks rely on other abilities as well, and declarative memory tests often rely on a verbal ability. To overcome this problem, the same nonverbal tasks that are being used with infants, such as deferred imitation, could also be beneficial to use in autism research. However, most research on recall memory that has used the deferred imitation paradigm has focused on how early infants can manage this task and how this ability develops (Jones & Herbert, 2006), less research has focused on atypical development, such as autism.

Deferred imitation in autism has generated limited investigation, and has mostly been studied in relation to immediate imitation (for review see; Williams, Whiten, & Singh, 2004) and not in relation to other memory tasks. Two studies have shown reduced performance on deferred imitation in children with autism compared to typically developing children (Dawson, Meltzoff, Osterling, & Rinaldi, 1998; Whiten & Brown, 1998) and one study has shown unimpaired performance (McDonough, Stahmer, Schreibman, & Thompson, 1997). The relation between deferred imitation and language has been investigated in one study of children with autism (Toth, Munson, Meltzoff, & Dawson, 2006) revealing a relation between immediate imitation and concurrent language ability at 3-4 years, and a relation between deferred imitation and the *rate* of language acquisition.

Even if deferred imitation is a test of recall memory that does not require the use of language, it still depends on other abilities apart from memory. The child does not only need to remember the action seen earlier, he/she also needs to be motivated to imitate that action. While it can be argued that all imitation has a social element to it, the imitation of actions with objects probably entails less social demands compared to the imitation of body movements or facial gestures, and this might limit the social affect on performance on deferred imitation tasks. Since deferred imitation probably is even more important than immediate imitation for social learning (since the child rarely has the opportunity to imitate immediately in real life situations), deferred imitation could be regarded as especially important in autism, because children with autism are limited in other areas connected with social learning, such as joint attention. There are also similarities between deferred imitation and joint attention tasks; both involve a triadic interaction between two persons and an object of mutual interest and attention (Jones & Herbert, 2006).

Play

The social interaction impairment in autism often has a severe impact on peer relations and friendships. Problems with interaction and communication affects the play competence in children with autism, but less engagement in play might *also* affect social development, since the child is given less opportunities to practice social roles and relationships (Travis & Sigman, 1998). Play development in children with autism is not only delayed but also shows a deviant pattern (Peeters, 1998). The interest in object manipulation seen in early infancy is less present in children with autism. Instead of investigating and exploring the possible use of objects, children with autism are more repetitive in their manipulation. In functional play, children with autism are more likely to use toys in a non-functional way, for example turning a car upside down and spinning the wheels instead of driving it (for a review see; Williams, 2003). Even if children with autism show an overall play impairment, they also have specific problems with play that include pretence, symbols and imagination, which is also included in the diagnostic criteria for autism spectrum disorder (APA, 1994).

Pretend play

Numerous studies have shown that children with autism have an impairment in pretend play even when their language level has been considered (for reviews see; Jarrold, 2003; Jarrold et al., 1993). This impairment, however, is far from absolute and some children with an autism diagnosis do engage in pretend play and many of the children perform pretend play under certain conditions. First, the difficulties with pretend play in autism seem to be a problem mainly with *spontaneous* play. When asked to pretend, children with autism perform as well as typically developing children (e.g. Charman & Baron-Cohen, 1997). Second, children with autism can also understand pretend play in others (Kavanaugh & Harris, 1994) and intervention studies show that pretend play can be learned (Stahmer, 1995).

The metarepresentational theory fits well with the combined impairment in both pretend play and theory of mind that is present in autism (Leslie, 1987). According to this theory, the ability to represent both a real and an unreal event at the same time underlies both abilities and thus explains why both are problematic in autism. However, the metarepresentational theory cannot explain why children with autism actually do understand and produce some pretend play (Jarrold, Carruthers, Smith, & Boucher, 1994), like under prompted conditions. It has instead been suggested that the pretend play impairment might be a problem with motivation; that children with autism choose not to pretend, even if they have the ability (Harris, 1989; Jarrold, 2003). This view has, in turn, been criticised because it can be argued that elicited or prompted pretend play does not involve symbolic understanding and should not be considered “real” pretend play. Instead, prompted pretend play could index imitation of others' actions or it could be a measure of the child's ability to guess the most correct behaviour, when he/ she is asked to produce a pretended act (Charman & Baron-Cohen, 1997). If this proves to be true, different explanations are needed for spontaneous and elicited pretend play.

Others (e.g. Harris, 1991) argue that pretend play and theory of mind does not require a metarepresentational ability. To understand false belief the child needs to simulate, or imagine how certain beliefs would ensue a certain behaviour or emotion and also be able to imagine how the same belief would make other people behave or feel. The link between pretend play and theory of mind in autism could be explained by a general simulation deficit and this theory could also explain why some pretend play is understood by children with autism, since not all forms of pretending require mental simulation (Harris, 1989).

Lack of pretend play has also been suggested to depend on the social deficit in autism (Jarrold et al., 1993). Pretend play requires an understanding of shared meaning and others' intentions, which is learned in interaction with other people. If the children find it difficult to create and engage in social relations, their pretend play would consequently be affected (e.g. Hobson, 2004). This is further supported by research showing that lower functioning children with autism are more impaired in pretend play, even when considering their lower mental age, compared to higher functioning children, perhaps because low functioning children are less able to engage in, and learn from, social interaction with others (Stanley & Konstantareas, 2007).

SUMMARY OF STUDIES

General and specific aims

The general aim of this thesis was to investigate individual differences in early social abilities and memory, and how they relate to later or concurrent language and cognition. This was done in study I and II by investigating memory abilities and social communication as predictors to early language acquisition and later cognitive ability in typically developing infants. In study III and IV the relation between recall memory/deferred imitation ability and social communication, together with pretend play and child-parent interaction, were investigated in relation to language age in a group of children with autism spectrum disorder and compared with typically developing children.

Study I

Early abilities in visual recognition memory and social communication have been shown to relate to language in several studies (e.g. Bornstein & Sigman, 1986; Mundy & Gomes, 1998). The same relation between language competence and early recall memory, as measured with deferred imitation, has not yet been investigated. The aim of study I was to explore if nonverbal recall memory, together with visual recognition memory and social communication, was related to early language acquisition. We expected all three infancy measures to be related to early language acquisition and further that they would tap differential cognitive abilities and thus give unique contributions to the prediction of language.

Study II

Study II was a follow-up study of the children in study I. The first aim was to investigate if the measures of early recall memory and social communication in the infancy period from study I were related to later language and cognition, when the children had reached 4 years. Such long-term predictions have been made of other early memory abilities but not of recall memory measured with deferred imitation. The second aim was to investigate if recall memory and social communication had a unique relation to later development and if they gave a better prediction if they were used in combined analyses as compared to being analysed separately.

Study III

In study III the aim was to investigate the same measures as in study I and II, i.e. deferred imitation and social communication, in a group of children diagnosed with autism spectrum disorder. The relation between deferred imitation, social communication and language level was investigated in a group of children with autism and then compared to a language-age-matched group of children with typical development. Whereas social communication is known to be affected in autism and also related to language acquisition in this group, deferred imitation has not been investigated to the same extent. We expected social communication and deferred imitation to be less present in children who were judged to have a lower language level, and that this would be more pronounced in children with autism compared to typically developing children.

Study IV

In study IV the focus was on individual differences in pretend play and parents' verbal comments during play, and also how these two variables relate to deferred imitation and social communication in children with autism and children with typical development. Based on previous research, we expected pretend play to be reduced in children with autism compared to typically developing children, but also in children with a lower language level, compared to children with a higher language level within both groups. We further expected parents' comments to differ as a function of the language level of the child.

Method

Participants

Study I and II

The same group of children participated in study I and II. Thirty children (17 girls) were observed three times during infancy. Their mean birth weight was 3755 grams, with a mean Apgar score of 9.8 and a mean gestational age of 40.2 weeks. All children had a normal birth and no known disabilities. The first observation during the infancy period was carried out when the children were approximately 6 months (M = 26.7 weeks, SD = 1.4), the second observation around 9-10 months (M = 40.7 weeks, SD = 1.3) and the third observation at 14-15 months (M = 62.5 weeks, SD = 2.9). Twenty-six children (16 girls) were observed again around their fourth birthday (M = 50.4 months, SD = 1.5).

Some data were lost during each observation (Table 1). During the first observation at 6 months, the data on visual recognition memory were lost for three children. At nine months, the data on the same test were lost for 6 children and one child did not complete the deferred imitation test. At 14 months, the information about language and communication was incomplete for three children. In the follow-up observation at four years, 26 of the children were able to participate. The data loss at the last observation was due to the fact that families had either moved or chosen not to participate.

Table 1. Data loss at the different observations

	6 months	9 months		14 months			50 months
	FTII[1]	FTII[1]	DI[2]	DI[2]	ESCS[3]	SECDI[4]	McCarthy[5]
1	√	√	√	√	√	√	√
2	√	√	√	√	√	√	√
3	–	√	√	√	√	√	√
4	√	√	√	√	√	–	–
5	√	–	√	√	√	–	√
6	√	√	√	√	√	√	√
7	√	√	√	√	√	–	–
8	√	√	√	√	√	√	√
9	√	–	√	√	√	√	√
10	√	√	√	√	√	√	√
11	√	√	√	√	√	√	√
12	√	√	√	√	√	√	–
13	√	√	√	√	√	√	√
14	–	√	√	√	√	√	√
15	√	√	√	√	√	√	√
16	√	√	√	√	√	√	√
17	–	√	√	√	√	√	√
18	√	√	√	√	√	√	√
19	√	–	–	√	√	√	–
20	√	√	√	√	√	√	√
21	√	√	√	√	√	√	√
22	√	–	√	√	√	√	√
23	√	√	√	√	√	√	√
24	√	–	√	√	√	√	√
25	√	√	√	√	√	√	√
26	√	–	√	√	√	√	√
27	√	√	√	√	√	√	√
28	√	√	√	√	√	√	√
29	√	√	√	√	√	√	√
30	√	√	√	√	√	√	√

[1] Fagan Test of Infant Abilities, [2] Deferred imitation, [3] Early Social Communication Scales, [4] Swedish Early Communicative Development Inventories, [5] McCarthy Scales of Children Abilities

Study III and IV

Twenty children diagnosed with autism according to DSM-IV criteria (APA, 1994) (18 boys and 2 girls) and 23 children with typical development (12 boys and 11 girls) participated in study III and IV. Chronological, language and mental age for the groups is listed in Table 2. Fifteen of the children with autism were diagnosed at the Child Neuropsychiatry Clinic (Sahlgrenska University Hospital), four were diagnosed by another neuropsychiatric team in northern Göteborg and one child was diagnosed by a paediatrician. The typically developing children were recruited from day-care centres in Göteborg. The children with autism and the typically developing children were matched for language age at group level. There was no significant difference in mental age between the groups (Table 2).

Table 2. Descriptive data for the groups in study II and IV. Means (SD).

	Autism (N = 20)	Typical (N = 23)	p [1]
Chronological age	66.8 (17.32)	35.0 (5.37)	< .001
Language age	29.7 (15.99)	35.6 (13.17)	ns
Mental age	45.2 (19.36) [2]	37.5 (9.16)	ns

[1] t-test

[2] N = 19 due to data loss

Estimated language age

Three tests were used in a hierarchic fashion for the estimation of language age in the autism group. Nine children took the Peabody Picture Vocabulary Test (PPVT) (Dunn & Dunn, 1997). This is a test of receptive language, which requires the child to point repeatedly at one out of four pictures. For eight children a parental report, the Swedish Early Communicative Development Inventories (SECDI), was used (Berglund & Eriksson, 2000; Eriksson & Berglund, 1999). For three children, who refused to comply or could not concentrate when assessed by the PPVT and who reached ceiling effect on the SECDI, language age was estimated by use of the expressive vocabulary part of Kaufmann (Kaufman & Kaufman, 1983).

The PPVT was used to estimate language age for 22 of the children with typical development. One child was assessed with the Kaufman as he refused to cooperate on the PPVT.

Estimating Mental Age

As part of the clinical assessment the Griffiths II test (Ahlin-Åkerman & Norberg, 1991; Griffiths, 1970) or the WPPSI (Wechsler, 1999) was administered when estimating mental age for 15 of the children with autism. For four children, the Raven's Coloured Matrices (Raven, 1976) were used, and one child with autism was not tested.

The children with typical development were assessed using the McCarthy Scales of Children's Abilities (McCarthy, 1972). The General Cognitive Index was used to calculate the mental age of participants in this group.

Procedure and measures

Study I

All children came to the department on three different occasions, each time in the company of a parent. The children were observed in a sparsely furnished room with video cameras, placed in two corners, that could be manipulated from a different room.

Deferred imitation (Recall memory)

During the 9- and 14-month observation, deferred imitation was used as a measure of recall memory. The procedure was adapted from Meltzoff (1988a; 1988b) and the same objects and actions were used. Each action was demonstrated three times during a 20 sec period. The children were not allowed to touch the objects during, or after, the demonstration, ensuring that the memory of the action seen was based on a representation and not a motor experience. After the demonstration a delay was imposed, and after the delay the participants were presented with the toys, one by one, to see if they would produce the target acts they had been shown. During this procedure the children were also videotaped.

At 9 months the children saw three different objects being manipulated by the experimenter. The first object consisted of two wooden rectangles connected with a hinge, and the action was to fold the two rectangles together. The second object was a black box with a black button hidden on top, and the action was to press the button, which produced a beeping sound. The third object was a plastic egg that produced a rattling sound when shaken, and shaking the egg was the target action. A memory delay of 8 to 10 min was imposed after the demonstration (M = 8.2 min; SD = 2.7; range: 5.7 – 17.5).

At 14 months, three different objects were used. The first object was a pull toy that consisted of two wooden cubes with plastic tubes extending from them. One tube was slightly narrower and fit inside the other, and the action was to pull them apart. The second object was a collapsible cup and the action was to show the cup in its unfolded position and then to press it down so it would close. The third action used two objects: one empty plastic cup and a string of beads, and the action was to pick up the beads and lower them into the plastic cup. The memory delay was approximately 12 min (M = 12.7 min; SD = 2.3; range 9.8 – 18.5).

Two research assistants coded the deferred imitation tasks independent of each other, and the agreement between them was assessed by Cohen’s kappa and yielded .85 at 9 months and .89 at 14 months.

Recognition memory

At the 6- and 9-month observation, the Fagan Test of Infant Intelligence (FTII) (Fagan & Detterman, 1992), which is used as a measure of recognition memory and information processing, was administered. The FTII is a paired-comparison test of visual novelty preference and the child sits in front of a computer screen that shows pictures of different faces. When a picture has been assimilated by the child it is paired with a novel picture. Ten of these problems are shown to the children at each age and the primary score given is a novelty score, showing the percentage of time that the child spends looking at novel pictures as compared to familiar pictures. This novelty score is used as a measure of the child’s visual recognition memory.

Social communication

The Early Social Communication Scales (ESCS) (Mundy, Hogan, & Doehring, 1996) was administered at 14 months. This is a structured assessment method where an experimenter and a child sit at a table playing with different toys. The method is designed to capture different nonverbal social communication skills in children aged 8 to 30 months and takes 15-20 minutes to complete.

The ESCS measures three different areas of social communication: joint attention, requesting and social interaction (Mundy et al., 1996). For each of these areas, the child can either initiate a bid for attention or respond to a bid from the experimenter, creating a total of six scales. The variables used in study I were initiating joint attention, responding to joint attention and turn taking abilities (which are part of the initiating social interaction scale).

The scoring system is based on frequencies of behaviours and ratio scores (Mundy et al., 1996). The ESCS provides an opportunity to calculate a separate ratio score for high-level behaviours initiating joint attention. The items that are scored as low-level behaviours on this scale occur when the child makes eye contact with the experimenter while he/she at the same time is touching a toy or alternates between looking at an active toy and looking at the experimenter. High-level behaviours are scored when the child points to something before the experimenter points or shows a toy to the experimenter. A high-level ratio score was computed by dividing the frequency of high-level joint attention bids by the total frequency of joint attention bids. Ratio scores (dividing the number of correct responses with the total number of trials) were also calculated for responding to joint attention. Behaviours scored include occasions when the child follows the experimenter's pointing, either to a picture in a book (6 trials) or to a poster on the wall (6 trials). Turn-taking is scored whenever the child initiates a turn-taking sequence with the experimenter. The child is given two different toys (a car and a ball) and is encouraged (with gestures) to roll the toy to the experimenter (obtaining a score of 0–2).

Three different persons scored the tapes. Reliability was assessed by rescoring three randomly chosen tapes (10% of the sample) and the agreement between them was $r = .94$ for joint attention and $r = .75$ for social interaction (turn-taking).

Language

The child's communicative skills were assessed at 14 months by using the Swedish Early Communicative Development Inventories (SECDI) (Eriksson & Berglund, 1999), which is a parental report. For this age group, the inventory "words and gestures" is the most appropriate. The parts of the inventory used in study I were "vocal comprehension" and "gestures produced".

Study II

All children came to the department and were observed in the same room as in study I. From study I, the measure of recall memory at 9 months and the measures from the ESCS at 14 months were used in the analysis. The nonverbal communicative skills measured with the ESCS used in study II were joint attention (initiating and responding) and object requesting (initiating and responding). The variable joint attention was created by combining initiating and responding joint attention behaviours (see study I), and the same combination between initiating and responding to object requesting created the variable object requesting.

Initiating object requesting is scored when the child makes eye contact with the experimenter when an active toy has stopped or disappeared, reaches for a toy, gives the experimenter a toy and points for request. For initiating object requesting, a high-level ratio score was calculated by dividing the frequency of high-level bids (giving and pointing) with the total number of bids. Responding to object requesting is scored when the child gives a toy to the experimenter after a request. The scoring agreement for this scale was r = .94 for initiating object requesting and r = .84 for responding to object requesting.

Cognitive ability

A general cognitive test was administered when the children were 4 years old; the McCarthy Scales of Children Abilities (McCarthy, 1972). This test consists of five different subscales: verbal, perceptual-performance, quantitative, memory and motor. All these subscales were used as well as the total score of all the subscales combined.

Receptive language

The children's receptive language at 4 years was measured with Peabody Picture Vocabulary Test (PPVT-III) (Dunn & Dunn, 1997).

Study III

All children came to the department twice, with one or two days between the visits. Each visit lasted approximately 1 – 1½ hour and each child was accompanied by at least one parent. The child was observed in the same room as in study I and II, and by the same experimenter on both occasions.

Deferred imitation

Deferred imitation was measured with actions on objects. Five of the objects and the same procedure as in study I and II were used (Meltzoff, 1988a, 1988b). For the egg, beads and collapsible cup, the same action was demonstrated and the same scoring was used. For the wooden rectangles, the experimenter used the elbow instead of the hand to fold them together and in the case of the black box, a pen, instead of the finger, was used to press the button. This slight change in procedure was made to include more unfamiliar behaviour, which was not the most practical or obvious way to reach the goal (the target action).

A research assistant together with another person coded all deferred imitation tasks independent of each other, and the observer agreement between them was assessed by Cohen's kappa (κ = .89).

Social communication

The ESCS (Mundy et al., 1996) was administered for all children at the beginning of their first visit. All six scales were used in the analysis. A research assistant coded all of the ESCS data. A different assistant coded 10% of the observations selected on a random basis, and the overall agreement between them was assessed by Cohen's kappa (κ = .76).

Study IV

The data in study IV were collected at the same visits as in study III and the measures of deferred imitation and social communication were the same. The ESCS scales used in the analysis were: initiating joint attention, high-level initiating joint attention and responding to joint attention.

Pretend play and parents' comments were assessed during a free play situation at the second visit where the child and one parent took part in a procedure adapted from Bloom (e.g. Bloom & Tinker, 2001). The play session was 24 minutes long and the experimenter interrupted the play twice (after 8 minutes and after 16 minutes) by entering the room, carrying with her additional toys. Only the last 8 minutes were coded and to ensure that this session was not affected by being last, the parent and child were not aware of how long the play session would continue or how many interruptions there would be.

Pretend play

Pretend play was defined as either object substitution (e.g. using a block as a car), adding a pretend property to a toy (e.g. the doll is hungry), pretending that something exists when it does not (e.g. there is a lion behind the curtain) or role-playing (e.g. the child pretends to be the mother) (Baron-Cohen, 1987; Leslie, 1987). Every time the child pretended according to these criteria, the duration of time the pretend play lasted was coded.

An undergraduate student coded all play situations for duration of pretend play. A research assistant coded 6 of the 43 children, selected on a random basis, and the agreement was assessed by Cohen's kappa (κ = .85).

Parents' verbal comments

The parents' verbal comments about objects or actions with objects were coded as one out of two categories, depending on the child's focus of attention. Comments about an object or an action with an object that the child attended to were coded as a *synchronized* comment and was only noticed ones during an interval of 10 sec, even if it occurred several times. Comments about an object outside the child's focus of attention were coded as an *unsynchronized* comment, and was only noticed ones during an interval of 5 sec, even if it occurred several times. The longer interval for synchronized compared to unsynchronized comments was due to difficulty to obtain acceptable agreement between coders. Three parent-child dyads (one in the autism group and two in the typical group) were excluded because the parents spoke a language unknown to the coder.

A graduate student coded all play situations for synchronized and unsynchronized comments. A research assistant coded 6 of the 40 children, selected on a random basis, and the agreement was assessed by Cohen's kappa (κ = .76) for both categories.

Main results

Study I

Visual recognition memory, recall memory and social communication were all positively related to communicative competence at 14 months. More precisely, visual recognition memory at 6 months, recall memory at 9 months, initiating joint attention at 14 months and initiating turn-taking at 14 months had significant positive correlations with gestures produced at 14 months, while visual recognition memory at 6 months, recall memory at 14 months and responding to joint attention at 14 months had, at least moderate, positive correlations with vocal comprehension at 14 months.

Regression analyses were conducted in order to find possible predictions of language ability, and also to investigate if cognitive and social variables in infancy made unique or mutual contribution to outcome. The best regression model included visual recognition memory at 6 months, recall memory at 9 months and turn-taking skills at 14 months, a model that explained 41% of the variance in gestures produced at 14 months. In this model, recall memory and turn-taking made significant contribution to gestural communication and of these two variables recall memory was the strongest. Such a strong regression model was not found when vocal comprehension was the outcome variable, the best model consisted of visual recognition memory at 6 months, recall memory at 14 months and responding to joint attention at 14 months. This model explained 29% of the variance in vocal comprehension with recall memory as the only significantly contributing variable.

Study II

The results revealed several significant positive correlations of social communicative skills at 14 months to cognitive ability at 4 years. The strongest relationships between the outcome 4 years and the results in infancy were noted for initiating joint attention and initiating object requesting. Multiple regression analysis did not succeed in explaining more of the variance than the variables did in separate correlations.

The results from study II identified one group of children with specific problems on a cognitive test at 4 years. This was the group who scored below the mean on both recall memory measured at 9 months and joint attention measured at 14 months. This group had significantly lower scores on the total scale, as well as on the subscales of the on McCarthy

Scales of Children's Abilities, when compared with the children who scored above mean on one or both of the infant measures.

Study III

Comparing the children with autism and the typically developing children revealed that children with autism showed a lower frequency on almost all social communicative measures, as well as on deferred imitation.

To explore how these differences were dependent on language age, the participants were divided using a mean split of language age. Children who scored below the mean were defined as Low and children who scored above the mean were defined as High. By this dividing procedure, four groups were created, 1) autism – low language age, 2) autism – high language age, 3) typical development – low language age and 4) typical development – high language age. Descriptive data of the subgroups are seen in Table 3.

Table 3. Descriptive data for the groups divided in high and low language age (LA). Means (SD).

	Low LA		High LA	
	Autism (n = 10)	Typical (n = 13)	Autism (n = 10)	Typical (n = 10)
Chronological age	63.1 (20.7)	32.9 (4.4)**	70.5(13.1)	37.8 (5.4)**
Language age	15.8 (3.9)	26.0 (5.6)**	43.5 (9.9)	48.1 (8.7)
Mental age	32.8 (15.5) [1]	33.8 (7.2)	56.4 (15.5)	42.4 (9.5)*

[1] n = 9

* $p < .05$ (t-test)

** $p < .01$ (t-test)

Comparing the two groups with a low language age showed a result very similar to the total group comparison, that is, children with autism performed at a significantly lower level compared to children with typical development both on social communicative measures and on deferred imitation. A different result was obtained when the high language age groups were compared; these groups performed on a similar level on all social communicative measures, except for initiating joint attention, which was still less frequent in children with autism. The result obtained on deferred imitation showed a lower result for the autism group in the high language age comparison.

Study IV

Study IV revealed that spontaneous pretend play was less present in children with autism compared to children with typical development. In addition, the children with autism that were engaged in pretend play had a significantly higher language age compared to the children with autism that did not show any pretend play. In order to investigate if pretend play differed as a function of the child's language age the same dividing procedure as in study III (see Table 3) was used in study IV. Children with autism judged to have a higher language age showed less pretend play compared to typically developing children, while no such difference was found when comparing children with autism and a lower language age to typically developing children. However, only two children with autism and low language age performed any pretend play.

The results also showed that parents' of children with autism used fewer synchronized comments compared to parents' of typically developing children. Comparing parents' comments in the groups with lower language age showed that parents of children with autism used less synchronized and more unsynchronized comments, compared to parents of children with typical development. No such difference was found in the high language age group comparison. Furthermore, the parents of children with autism and a low language age used the same amount of synchronized and unsynchronized comments in contrast to parents of children with autism and a high language age who used more synchronized comments. The same result came out for typically developing children, regardless of children's language age their parents used more synchronized comments.

Correlation analyses in the autism group revealed that pretend play was positively related to both deferred imitation and initiating joint attention. In the same group, parents' synchronized comments were positively related to high-level initiating joint attention, while parents' unsynchronized comments were negatively related to deferred imitation.

Discussion

Although the knowledge of early developing abilities in infants, and how early abilities predict later development, has grown dramatically over the past decades there are still many questions that remain to be answered. The general aim of the present thesis was to investigate individual differences in some early emerging abilities and how these relate to language and cognition. This was done by conducting a longitudinal study of typically developing infants and by a comparative study between children diagnosed with autism and children with typical development. The results contribute to previous knowledge about the development of language and cognition in childhood and point to some important predictors of later language and cognitive ability that can be found in infancy. The results also add to the understanding of language development in children with autism and how language development is related to individual differences in both social and cognitive abilities.

There are a growing number of studies showing that deferred imitation is within the infant's repertoire from the first year of life (e.g. Barr et al., 1996; Meltzoff, 1988b), which is much earlier than proposed by classic developmental theories. The ability to form mental representations and to store them in memory, as in the deferred imitation procedure, is regarded as important for social and cognitive development (Meltzoff, 1999; Piaget, 1952). However, few studies have explicitly investigated the predictive value of early deferred imitation for later development. The present thesis shows that individual differences in early deferred imitation probably can be used to predict later development. Deferred imitation was related to early emerging language skills in typically developing infants, but also to cognitive development later in childhood. Such an important predictive value has previously been shown by joint attention and visual recognition memory in infancy (e.g. Mundy & Gomes, 1998; Sigman et al., 1997), and this is also supported by the results in the present thesis. Study I and II, however, suggest that deferred imitation should be considered to be an equally important predictor. It is important to identify areas in early development that influence later development, for both clinical and theoretical reasons. Being able to identify children who are at risk of slower cognitive or language development improves the possibility of giving that child adequate support. The earlier this identification can be made, the better, which leads to the fact that it is especially valuable to identify tests that do not rely on verbal ability. From a theoretical point of view, developmental trajectories from early to later abilities help us understand how language is mastered, and how children develop their understanding of people around them. The results presented in the present thesis suggest that children who score low on tests of deferred imitation might be at risk of a slower cognitive development, but *only* when a low performance on deferred imitation was combined with a low performance on joint attention. In a deferred imitation test children observe the actions of another person, create a mental representation of that action, store it in memory and are later motivated to perform the action themselves. A reduced ability in deferred imitation probably shows a reduced capacity to learn from environment, which would affect the acquisition of language, as well as the child's overall cognitive development.

Deferred imitation is a measure of nonverbal recall memory and has revealed new insights into memory processes in infancy (Rovee-Collier et al., 2001). The fact that it relies on an ability to imitate has to be taken into consideration when investigating children with autism. Children with autism require, naturally, the same recall memory abilities as typically developing children in order to successfully perform imitation after a delay. However, imitation is less frequent in children with autism (Rogers & Pennington, 1991), and this might influence performance on the deferred imitation task, i.e. failure on a test of deferred imitation could depend on an imitation deficit rather than on the child's memory capacity per se. Before more research on deferred imitation in autism is available, especially in relation to other memory tests, it would be difficult to assume that deferred imitation is a valid measure of an overall recall memory capacity in this population. Nonetheless, the results from the present thesis point to the importance of deferred imitation in children with autism as well. Deferred imitation was the only measure, apart from initiating joint attention, which was reduced in the autism group regardless of the child's language level, which suggests a robust difficulty within this area of development. A relation between deferred imitation and pretend play was also evident in children with autism. Pretend play is suggested to rely on the ability to observe, remember, and imitate pretend acts of others (Rakoczy et al., 2005), implying that pretend play relies on the capacity for deferred imitation. The relation between these two areas shown in the present study might support the suggestion that pretend play is learned through the ability to imitate previously observed actions.

One aim of the longitudinal study was to investigate how combined variables in early development could increase the prediction of later development. This was observed when cognitive and social measures in infancy were combined, and two particular analyses supported this conclusion.

First, the best prediction from infant measures to the production of gestures at 14 months was revealed when visual recognition memory, deferred imitation and turn-taking were used in a regression model. These variables explained more of the variance when combined than in separate correlations. Visual recognition memory was measured at 6 months, deferred imitation at 9 months and turn-taking at 14 months, which further suggest that different abilities are important at different ages, if we want to predict language development. It is possible that deferred imitation would capture somewhat different underlying processes depending on the age of the child that is tested. Deferred imitation performed at 9 and 14 months yielded different relations to vocal and gestural communication. Deferred imitation at 9 months contributed to the production of gestures at 14 months, while this measure had no relation to vocal comprehension at 14 months. The opposite relation was true for deferred imitation when measured at 14 months. This was also true for visual recognition memory, which was measured both at 6 and 9 months, but only the 6-month assessment showed any predictive relation to outcome, a result that is supported by previous research (McCall & Carriger, 1993). The results from both memory measures in study I suggest that the same procedure could tap different abilities depending on the age when it is assessed. Regarding visual recognition memory, very different results were obtained from the same test when it was used with an interval of three months. The reason for this is probably that it depends on the time of emergence for a specific ability, which means that the test is better at capturing individual differences in children at that particular age. The Fagan procedure is probably more challenging at 6 months as compared to 9 months, while deferred imitation might be optimal to use for infants at 9 months of age if the aim is to capture variance in memory performance.

Second, the findings from study II revealed that scoring below the mean on *both* deferred imitation at 9 months and joint attention at 14 months yielded a lower result on a cognitive measure at 4 years, while scoring low on only one of the infant measures did not affect later performance in any negative way. This means that the combined low performance might capture something problematic in infancy that needs to be further investigated. It is possible that if a child has good skills in one area, this could compensate for the reduced performance in an other area. More serious problems are only evident if the child has reduced capacity in more areas than one. Interestingly, deferred imitation and initiating joint attention were the only variables that differed in the comparison between children with autism and children with typical development, in the groups that were judged to have a high language age (above 36 months for the children with autism). That is, these variables did not improve with a higher language level, suggesting that they might be particularly important in the development of autism. Initiating joint attention has begun to receive special attention in relation to autism (Mundy & Sigman, 2006), and the result from this thesis suggests that deferred imitation in autism might deserve similar attention. However, a longitudinal approach is needed to find out if this population is affected in cognitive development from a combined reduced performance in deferred imitation and joint attention, as noted in typically developing children in study II.

The fact that many of the early developing abilities were related to each other, or made mutual predictions of language development, may speak against a modular theory of development. This theory suggests that areas as different as deferred imitation and social communication would develop as isolated entities, and also that language would develop as an independent module. The result from this thesis instead suggests a much more complex picture of development, in which language acquisition is dependent on many different areas, and that these areas also influence each other.

Social communication and pretend play is assumed to be impaired in children with autism and is also part of the diagnostic criteria. Results from the comparative study (study III and IV) not only yielded large individual differences in children with autism, but also demonstrated that not all children show reduced (i.e. lower than typically developing children at same language age) performance in areas that are assumed to be generally affected. It was the children with a high language age who performed at the same level as typically developing children on tests of social communication, and the children with autism that performed pretend play had a higher language age than the children with autism who did not. Other areas that are seen as part of the autism diagnosis have also been shown to depend on the developmental level of the child. For example, theory of mind tasks are often mastered by children with autism if they have a high verbal ability (Happé, 1995). The present study shows a similar pattern for many social communicative measures, such as nonverbal requesting, responding to joint attention and pretend play.

A different result was obtained for initiating joint attention and deferred imitation, where children with autism showed reduced performance regardless of language level. Compared to other social communicative gestures, initiating joint attention has been suggested to be especially difficult for children with autism (Mundy & Acra, 2006), a claim which is supported by our results. The results especially point to the importance of separating different forms of social communicative abilities. Joint attention could be more difficult for children with autism because it depends more on social motivation and sharing experiences compared to other communicative gestures. Sharing experiences with others involves a sharing of positive affect in typically developing children, but not among children with autism (Kasari, Sigman, Mundy, & Yirmiya, 1990). This could make joint attention more socially rewarding for typically developing children and could also explain why children with autism are less motivated to engage in joint attention (Mundy & Sigman, 2006). Furthermore, joint attention, in contrast to other social communicative skills, involves to a higher extent, a change of own and others' minds. This means that joint attention gestures are not followed by any visible change in own or other people's behaviour as is the case for other social communicative gestures, such as requesting (Gergely, 2004; Mundy et al., 1996). Joint attention might therefore be especially difficult to learn and more dependent on social and intentional understanding, compared to other gestures.

The specific difficulty in autism to initiate, in contrast to responding to, social communication, could also depend on an inner motivation to share experiences with others. In sharing social attention, initiating is a more active and spontaneous behaviour on the part of the child, whereas responding behaviours involve the ability to be aware of, and respond to, someone else's social cues. To initiate and respond to social communication has also been suggested to reflect different underlying processes in typically developing children (e.g. Morales et al., 2000). This is supported by the results from study I, where initiating behaviours were related to the production of gestures, while responding behaviours were more related to vocal comprehension. For typically developing children at this age (14 months), producing gestures is probably a more active form of communication compared to vocal comprehension. Further support for this assumption was obtained from study II were initiating joint attention and initiating object requesting was positively related to later cognitive and language development, whereas responding to the bids of others, was not. However, it is possible that initiating behaviours are the best measure to use at this age (14 months) and that responding behaviours would have shown a better prediction had we investigated a different age-group.

The above arguments for the specific difficulty in autism for joint attention, are consistent with simulation theory (e.g. Harris, 1989). According to this theory, children with autism have problems with simulating others' mental states, not their behaviour. The consequence should be that gestures used to change another person's actions would not be as difficult as gestures used to change another person's mental state. This is also consistent with the theory-theory, which suggests a similar failure for children with autism to connect their own minds with the minds of others' (e.g. Gopnik, Capps, & Meltzoff, 2000). Theory-theory additionally suggests that children with autism fail to attribute the mental states in others to the mental states of themselves. Simulation theory would argue that difficulties with joint attention in autism could be explained solely by their problem with simulation from self to other. However, this means that simulation theory does not explain why responding to joint attention is less difficult than initiating joint attention. If understanding ones' own intentions come first and understanding others' intentions follows through a simulation process, understanding others' gestures (to follow pointing and gaze) would be more difficult than understanding and using such gestures oneself.

To estimate language age in children with autism is difficult, and the language profile might look different compared to that of typically developing children. As an example the production of language often surpasses language comprehension. As is often the case, the children in this study were heterogenic in terms of language. As a consequence, different language tests were used for different children in order to estimate language age, and these tests partly tapped into different areas of language development. The ambition was to use a test of receptive language in the estimation of language age for all children. However, this test turned out to be too difficult for some children, and others had difficulties with the test procedure. In addition, a parental report was used, which tapped the child's comprehension, or comprehension and production, of words. This parental report was possible to use for children with a language age below 28 months, which means that an additional test was used for the children who did not complete the receptive language test and had a language level above 28 months. The use of different language tests to estimate language age in the group of children with autism is a serious limitation to the interpretations of the results, and the language age of the children must be considered with caution. However, we believe that the group division probably can be considered with more certainty. If the original test was too demanding, the child was assessed with the parental report and ended up in the low language age group. It should be noted that, if the original test was not completed for reasons other than language demands, that child would reach ceiling effects on the parental report and would thus be assessed by use of the third test, and consequently end up in the high language age group.

The importance of joint attention and interaction in early development has been shown in several studies (e.g. Mundy et al., 1994; Tomasello & Farrar, 1986). Most studies have focused on how the social ability and behaviour of the child contributes to later language or cognitive development, but interaction always comprises, and is created by, more than one person. The results from study IV point to the complexity of joint attention and especially its dependence on both parties in the interaction and how it should be considered bidirectional. Study IV showed that parents' use of synchronized comments helps to create opportunities for episodes of joint attention. Since creating joint attention episodes is problematic for many children with autism, this group might be especially dependent on the behaviours of the parent. When a parent is labelling an object outside the child's focus, the child needs to redirect her/his attention to the adult in order to establish joint attention. If a parent instead labels an object that the child is already attending to, redirecting attention is not required for joint attention. The children in this study seem to have taken advantage of a parent who is good at creating episodes of shared attention since parents' synchronized comments was related to the use of more mature joint attention behaviours.

The above relation was only evident in children with autism, which suggests that parents' interaction style is influenced by the behaviour of the child they are interacting with. In the same way as an unresponsive mother (e.g. due to depression) has a significant impact on the child's behaviour and development in early infant-mother interaction (e.g. Field et al., 2006), an infant that is not responding to the mother probably affects her behaviour as well. This means that children with autism are affected both by their own problems with interaction *and* the fact that they themselves affect their environment in such a way that the quality of the interaction might not be optimal for their social development. Results from study IV showed that parents of children with autism overall used fewer synchronized comments compared to parents of children with typical development. Especially the parents' of children with autism who had a low language age differed from the rest; they used the same amount of unsynchronized and synchronized comments during play, a pattern that was not evident in any other subgroup, where parents' instead used more synchronized than unsynchronized comments. This supports the idea that children with autism, especially those with a low language level, affect their environment and might create an interaction pattern that includes fewer episodes of joint attention.

It is a challenging task to try and find out how different abilities varies and co-varies throughout development, and if, and how, early abilities will affect later development. All children are born with individual strengths and weaknesses, and they are also born into a specific culture and family at a specific time in history. Different aspects, within the child him- or herself, as well as within the environment, constantly influence each other throughout development, and trying to isolate specific areas and control variables in such a dynamic structure as human development, is difficult. However, this is done by trying to control as many of these different aspects as possible. One way of investigating how specific abilities affect different aspects is to study children that show reduced abilities, and see how they differ in their development from unaffected children. One such group is children with autism, who by their, in many ways, unique pattern of strengths and weaknesses have revealed invaluable insights into the complexity of human development. The growing understanding of how typical children develop might also help us understand the specific impairments in autism. Hopefully the present thesis will contribute to this understanding.

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