

Mental representation and language access:

Evidence from deaf children with different
language backgrounds

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Abstract

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The present work investigated the relationship between mentalizing skills on the one hand and different language experiences and cognitive characteristics on the other hand. The aim of *study I* was to determine whether access to sign language as the medium of instruction in school influences mentalizing abilities among deaf children. The deaf children recruited either grew up in deaf or hearing families. Some of the children attended a school following the oralist method, another group of children attended a school with a bilingual approach. In *study II* the effects of working memory skills on the relation between language of instruction and understanding false-belief were examined. *Study III* aimed at testing if differences in mentalizing skills between different groups of deaf children, as reported previously, were mirrored in corresponding differences in executive functions. *Study IV* was designed to examine the relation between hearing children's mentalizing skills and their caregivers' insight into their children's social reasoning. Results from *study I* indicated that, when it comes to mentalizing abilities, the deaf children of deaf parents, i.e. so-called, native signers, who attend a school prioritizing education in sign language outperform the native signers from an oralist school and the deaf children from hearing homes attending either a bilingual or an oralist school. Taken together, *studies II and III* revealed that the deaf children's mentalizing abilities were not dependent on individual differences in verbal working memory or executive functioning skills such as inhibitory control or attentional flexibility. There were no differences regarding results on the digit span task between the bilingual and the oralist native signers, or between the bilingual and the oralist late signers. There were no differences between any of the deaf or hearing groups on the two inhibitory control tasks and all the deaf groups performed equally well on the Wisconsin card sorting task. The main finding of *study IV* was that mothers who were more accurate in predicting their children's reasoning in distressing social situations had children who had higher mentalizing scores. This relation still remained after chronological age and receptive vocabulary scores were controlled for. Taken together, the results emphasize the importance of continuous access to fluent conversations in a shared language between the child and those closest to him or her, both at home and at school, for the development of understanding other minds.

Keywords: mentalizing skills, theory-of-mind, social interaction, deafness, sign language

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Introduction

The ability to identify with others and to understand that other people have mental lives just like us is the cornerstone of human interaction. When communicating with each other we are in the habit of construing others' intentions and beliefs, and trying to understand what is going on in their minds. We ascribe to others thoughts and feelings and on the basis of this we are able to predict their actions. Tomasello (2000) has argued that all cultural learning has been made possible due to this single form of social cognition. Each child with the ability to identify with others also has access to the cumulative cognitive development of past generations.

The understanding of other people's mental life has been called a "theory-of-mind", although "mind-reading" or "mentalizing" skills are frequently used synonymously, depending on the user's theoretical convictions. In the last 25 years the question of how we develop mentalizing abilities has attracted great attention within philosophy, psychology, linguistics and primate studies. The widely replicated finding, based on passing the standard false-belief tasks, is that typically developing 4-year-olds, unlike 3-year-olds, understand that another person holds his or her own beliefs about the world and will act according to these beliefs (e.g. Baron-Cohen, Leslie, & Frith, 1985; Perner, Leekam, & Wimmer, 1987; Wimmer & Perner, 1983). Wellman, Cross and Watson (2001) conducted a meta-analysis of over 178 separate studies and concluded that there occurs a genuine conceptual change in the understanding of others' minds during the preschool years, with variations between different cultures being minor and insignificant.

As the term "theory-of-mind" (ToM) suggests, one main explanation concerning the development of mentalizing abilities has been that children form their understanding of the world and of other people in much the same way as scientists form theories. Since the late 1990s, however, more emphasis has been placed on the social part of mentalizing development, exploring how coming to understand other minds relates to early social interaction and language development. Within this perspective, deaf children with various conversational experiences constitute interesting groups for research since they offer an opportunity to disentangle some of the variables thought to be of importance for the development of mentalizing skills.

Understanding other minds

Theoretical positions

The nature and origins of developing mentalizing abilities have been, and still are, the target of a considerable theoretical debate. One influential view has long been that the development of theory-of-mind is in some way theory-like. The so-called theory-theorists see the child as developing a set of principles about the world and other people in much the same way as scientists form theories by experimentation

and observation. Such theories are seen as ‘defeasible’ (Gopnik, 1993), i.e. they can be changed and revised. A change occurs when accumulating experience and hypothesis-testing suggests a modification of old principles. Thus, according to ‘theory-theory’ a child undergoes a ‘paradigm-shift’ around the age of four when it passes the false-belief test. The proponents of theory-theory also claim that we do not have direct first-person access to our own mental states but have to construct an understanding of these in the same way that we construct an understanding of others’ mental states. This view is supported by the fact that when 3-year-olds are not able to report the false beliefs of others, they are equally ignorant of their own previous false beliefs (Gopnik, 1993). Researchers adopting this theoretical position have postulated a number of landmarks in the development towards an adult-like understanding of minds. Wellman and Liu (2004) have identified various items where, for most children, a pass on a later item follows passes on all earlier items. In this way understanding desires (understanding that two persons can have different desires for the same object) precedes understanding beliefs (understanding that two persons can have different beliefs about the same object), and differentiating between real and apparent emotions (understanding that a person can feel one thing but display a different emotion) is considered to be the most difficult task during the pre-school years.

Another approach to explaining the development of mentalizing abilities is to assume that mental concepts are innate. Within the “modularity theory” (e.g. Leslie, 1994) the emergence of mental understanding is understood as being dependent on biological maturation of cognitive structures, or modules, in the brain. In other words, the concepts of mental representation are developed within the cognitive structures in much the same way as colour concepts are introduced by the mechanisms of colour vision. One does not form theories of what colour is or need to discover theories of particular colours (Leslie, Friedman, & German, 2004). According to the view of modularity theorists, mentalizing abilities are governed by the stage-like development of domain-specific modular mechanisms. While this so-called “theory-of-mind mechanism” (ToMM) leads to an early development of mental understanding, effective reasoning about mental concepts is additionally dependent on the development of an information-processing device, referred to by Leslie et al. as a “Selection Processor” (SP). This processor is responsible for performing executive functions such as inhibiting a pre-potent response, which among other things is important for performance on false-belief tasks.

Yet another way of explaining theory-of-mind development involves emphasizing children’s introspective awareness of their own mental states (Flavell, 1999). This theory, known as “simulation theory”, states that we have privileged access to our own inner world. All that is needed is the capacity to reason by analogy and to imagine the mental states of other people through a kind of role-taking process. The idea of mental simulation originally comes from children’s pretend play. In the same way as an 18-month-old child can use one object to represent

something else, a 4-year-old can imagine someone else's inner states (Lewis & Carpendale, 2002).

Carpendale and Lewis (2004) suggest what they argue to be yet another, a fourth alternative in studying theory-of-mind development. Here the role of social interaction has been put into focus in the understanding of developmental changes. In this kind of constructivist account, social understanding is seen as occurring in triadic interactions where (a) children's knowledge builds upon communication together with (b) others about (c) the world. Engaging in reciprocal interaction as well as exposure to talk about mental states is pointed out to be cornerstones in the development of social understanding.

False beliefs

In order to demonstrate that someone can ascribe mental states like thoughts and beliefs to oneself and others it is useful to construct a situation where a belief is incorrect. The by far most commonly employed method when assessing children's mentalizing abilities has been to use a so-called false-belief task. This task was originally developed by Wimmer and Perner (1983) based on the suggestions made by Dennett (1978) on Premack and Woodruff's (1978) article concerning chimpanzees' theory-of-mind abilities. There are now two main versions of the false-belief task. In the *Unexpected Location* task, a story character places an object (e.g. chocolate) in one location. While he or she is away the object will be transferred to a new location. The child who is tested has seen the transference, but has to figure out that the story character will look for the object where he or she falsely believes it is located, and not where it actually is. Thus, the child is asked a test question "Where will [Maxi] look for the chocolate?" accompanied by two control questions, "Where did [Maxi] first put the chocolate" and "Where is the chocolate now?" (Wimmer & Perner, 1983). In the *Unexpected Content* task, the child is shown a familiar candy box and is asked what he or she thinks is inside. Having been shown that something other than candy is inside, the child is then asked what someone else who has not looked inside would think the box contains. Again the child has to understand that others behave according to their own beliefs about reality, even when these are inaccurate. To pass the task the child also has to correctly answer a question about his or her own false belief, "When I first asked you, before we looked inside, what did you think was in the box?" and to correctly answer the question "What is really in the box?" (Perner et al., 1987). These classic and well-known procedures have been frequently used in many studies with various modifications.

In contrast to the tasks testing the understanding of false mental representation, a task testing the understanding of false physical representation has been developed by Zaitchik (1990). This task was constructed in order to demonstrate that possible difficulties with solving false-belief tasks might be due to difficulties in understanding the concept of representation in general. In this task an experimenter

first takes a photo of the child using a Polaroid camera, and together they then watch the developing photograph. Next, the child is shown a teddy bear holding a banana. The experimenter then takes a photograph of the teddy bear. While the photograph is placed to develop face down, the assistant replaces the banana with an apple. The child is then shown two photos taken beforehand, and asked to point to the photo that matches the developing photograph. Two control questions are then asked, “What was the teddy bear holding before?” and “What is the teddy bear holding now?” In the original study typically developing 4- to 5-year-old children performed at chance level on this task while passing the false-belief tasks (Zaitchik, 1990). Later studies have, however, contradicted the suggestion that typically developed children would find the false-belief tasks easier than the false-photograph task (Peterson & Siegal, 2000). Instead, the false-photo task has proved to be constantly easier than the false-belief tasks.

Relationships with social interaction

The above mentioned theories, i.e. theory-theory, modulation theory and simulation theory, have been criticized for being individualistic and for not taking into account the role of social interaction in developing mentalizing abilities (Carpendale & Lewis, 2004). In the last decade there has been a growing interest in examining the relationships between performance on false-belief tasks and different social and contextual factors. To this end, number of siblings in the family has been shown to correlate with children’s mentalizing abilities (Jenkins & Astington, 1996; Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki, & Berridge, 1996; McAlister & Peterson, 2007; Perner, Ruffman, & Leekam, 1994). Jenkins and Astington explain this finding with the increased possibilities of interactions that a larger number of siblings provide. They also believe that the intimacy of sibling relationships is especially suitable for acquiring intimate kinds of knowledge such as knowledge of others’ beliefs. Lewis et al. (1996) found, however, that the frequency of daily interactions with older relatives was a stronger predictor of insight into others’ mental states. Harris (1992) stressed the role of multiple viewpoints offered to a child by several possible interlocutors, facilitating the growing insight into other minds. Variables concerning family background, such as parental education and occupational class have also been shown to contribute to the development of social cognition (Cutting & Dunn, 1999). Children from middle-class families in this particular study performed significantly better than children from working-class families on the false-belief, affective labelling (naming four felt faces portraying happy, sad, angry and frightened expressions), and affective perspective-taking tasks (understanding of the links between particular situations and emotions). Furthermore, attachment security has been shown to have an impact on mentalizing skills (Fonagy, Redfern, & Charman, 1997). This supports the view that theory-of-mind development is an inter-subjective process. Meins et al. (2002) have, however, found that a mother’s use of mental state talk to her children, rather than attachment security in general,

was correlated to children's false-belief performance. They further found that only those mental state comments in a play situation that actually matched with the child's concurrent state of mind, rather than usage of mental state comments in general, were related to the children's later ToM performance (Meins et al., 2003). They propose that mothers' appropriate comments on mental states draw attention to the existence of mental states, and help later to make sense of these inner experiences by combining them with external linguistic comments. Similarly, Peterson and Slaughter (2003) have shown that mothers' tendency to explain everyday social events to their children in terms of mental states, as assessed with a questionnaire, was related to their 4- to 5-year-olds' theory-of-mind performance. Ruffman, Slade and Crowe (2002) found a causal relationship between mothers' earlier mental-state utterances in a picture-describing task and the children's later theory-of-mind understanding. Taken together, these studies suggest that the development of mentalizing abilities is supported by the kind of family talk that in one way or another draws attention to others' internal lives.

Language and mentalizing ability

The relationship between mentalizing abilities and language development is complex, depending on the aspects of language and mentalizing that are taken into account. For these reasons, Astington and Baird (2005) divide language into functional and structural parts. As one of the functions of language, besides representation, is communication, the aspect of conversational pragmatics is thought to be the crucial issue by some researchers. Proponents of this view suggest that children begin to understand that other people have minds with different perspectives by participating in everyday conversations with other family members. The most important thing is not the content of the conversation but the experience of exchanging different views with people through disagreements and misunderstandings. Tomasello (2000) has emphasized that the constant shifting of perspectives in the back-and-forth discourse with others provides the main motor in the development towards a theory-of-mind. He also believes that the conflicts and disputes, occurring mainly between siblings when they both desire the same toys, or when they want to engage in the same activity at the same time or have conflicts involving beliefs, are of particular importance. Similarly, Dunn and Brophy (2005) have argued that it is not only the talk about mental states that is important for theory-of-mind understanding, but rather the context and purpose of the talk, as well as with whom one has this kind of conversation. They have shown among other things that mothers' "causal talk" was associated with later emotional understanding in their children. However, the children performed more successfully on later cognitive assessments if the causal talk had taken place in the context of play, comforting or joking, and not in the context of controlling. Moeller and Schick (2006) found a specific effect of mothers' use of mental state terms on their deaf children's false-belief performance. Nelson (2005) describes the development of

mentalizing abilities as entering a “community of minds”: To understand other minds is to learn to participate through language in a shared belief system. In the same vein, Hobson (2004) suggests that social understanding emerges pre-lingually as a result of interacting with others. According to him, to understand others’ subjective experiences, one has to relate to these others with emotions. A pre-linguistic child’s active involvement in dyadic and triadic interactions is thus a starting point for understanding mental states and developing language about the mind.

On the structural level some researchers have focused on the lexical semantics of mental state terms, arguing that these play an important role in theory-of-mind development. While the proponents of the pragmatics view emphasize the reading of other’s intentions in communication, those focusing on the semantics view propose that it is the exposure to mental state terms in communication that is relevant for the development of theory-of-mind. Olson (1988) suggests that before children acquire language, their behaviour cannot be characterized in intentional terms at all. When an observer ascribes mental states to a pre-linguistic child (“Baby thinks the mother is going to leave”), it is only for the convenience of the observer doing the ascribing; the mental states are not true. It is only when children learn to talk that they also learn to organize their perceptions in terms of mental states. Beliefs and intentions are, according to Olson, only “the psychological counterparts of saying things” (p. 423). Similarly, Lewis and Carpendale (2002) question the division of language and theory-of-mind. They suggest that thinking about a mental world is not separate from learning to talk about a mental world and that these two are inextricably intertwined. Much like learning the sense of multiplication develops at the same time as the child learns how to multiply, he or she begins to understand mentalizing at the same time as he or she learns to talk about mental states.

De Villiers and de Villiers (2000) have argued that the syntactical structure of language is required in order to develop an understanding of other’s mental states. The idea is that for expressing or thinking about mental states an embedded proposition called a complement is necessary: “he thought (the chocolate was in the cupboard)”. Here, the overall sentence can be true but the embedded complement can refer to a proposition that is false. Only after learning this type of syntax are discussions of what is going on in other minds possible. Thus, complementation allows representation of someone’s mental world, which can be distinct from our own mental world.

Bearing in mind that our knowledge about children’s mentalizing skills is mostly derived from their ability to pass certain tasks, a further aspect of the connection between theory-of-mind and language concerns task performance. Some researchers’ direct attention to the difference between competence and performance and to the possibility that linguistic and other cognitive task requirements may mask children’s underlying conceptual understanding of the mind (de Villiers & de Villiers, 2000). Children usually have to listen to a story or understand an

experimenter explaining task materials. They may understand false beliefs, but due to the linguistic complexity of the task, still fail to answer correctly. In this case language development has no crucial role in the underlying conceptual development, but rather has an indirect influence through its impact on performance. Some authors have for example argued that children may have difficulties with the conversational aspects of the false-belief tasks (Siegal & Beattie, 1991). They have shown that asking “Where will Maxi *first* look for his chocolate” rather than “Where will Maxi look for his chocolate”, helps even 3-year-olds pass this task. Similarly, Lewis and Osborne (1990) demonstrated that 3-year-olds passed the unexpected content false-belief task when the test question was temporally specified, “What will [name of friend] think is in the box *before I take the top off?*” However, Yazdi, German, Defeyter, and Siegal (2007) found that ‘look first’ question enhanced the performance of both 3-year-olds and older, 4- to 5-year-old children. If there had been a conceptual change in understanding of false-belief around the fourth-birthday (Wellman et al., 2001) only children who are closest to that age could have been helped by the ‘look first’ question. This argument is also applicable to the research in Lewis and Osborne (1990). Instead the development of false-belief-understanding could be explained both in terms of conceptual competence and performance factors.

Also important when discussing the relationship between language and theory-of-mind development are the aspects included in theory-of-mind. Lohmann, Tomasello, and Meyer (2005) and Tomasello (2000) are concerned with two levels of social understanding. They differentiate between the understanding of others as intentional agents with goals and perceptions, and the understanding of others as mental agents with goals and beliefs. They further claim that the first level, the understanding of others as intentional agents, is necessary for the development of language. People use language mainly to influence other persons’ attention and for this reason one needs to comprehend that other persons have intentions in the first place. The second level of social understanding, the understanding of others as mental agents whose behaviour is governed by beliefs, grows out of linguistic interactions. In this case, contrary to the first level, language precedes and promotes the understanding of other’s mental states. Different aspects of language development thus become important at different levels of theory-of-mind development.

In summary, in order to obtain a complete picture of the relationship between language and mentalizing skills, the theoretical positions mentioned above can be seen as complementing each other. For infants to be able to start interacting with others a rudimentary pragmatic understanding is necessary. By becoming involved in interpersonal communication, children then have the possibility of learning mental-state terms and sentential complements. In this way, they gradually begin to get a grip of the concept of mental states, to obtain awareness about other perspectives and then to learn to represent others’ false beliefs.

Theory-of-mind and executive functions

Numerous studies have investigated the links between mentalizing abilities and other more domain-general cognitive processes. One approach to studying this relationship considers which aspects of the executive functions could be involved in mentalizing. Hughes (1998) has suggested a three-part model where executive functions fall into three distinctive factors: working memory, inhibitory control and attentional flexibility. Carlson, Moses, and Claxton (2004) have found that inhibition tasks were correlated with theory-of-mind performance in preschool children and that this correlation remained even after the effects of age, vocabulary and planning skills were partialled out. Hala, Hug, and Henderson (2003) demonstrated that executive functioning tasks that combined inhibitory control and working memory correlated significantly with the false-belief tasks.

Another question within this area concerns whether executive functions can be seen as affecting children's ability to express their mentalizing abilities, or if these abilities are crucial for the emergence of mentalizing abilities (Carlson & Moses, 2001; Sabbagh, Xu, Carlson, Moses, & Lee, 2006). According to the expression account children fail in theory-of-mind tasks due to executive difficulties that mask the competence that they already possess. The classic false-belief task typically requires a child to inhibit his or her own pre-potent response, taken care of by the Selection Processor (SP) in Leslie's (2004) model, in order to correctly answer the test question. The emergence account explains the link between theory-of-mind and executive functions in terms of more deep-seated problems with the latter. Here the executive skills are thought to be necessary for comprehending and reasoning about mental states. In a cross-cultural study with Chinese and U.S. hearing preschoolers, Sabbagh et al. (2006) found that Chinese 3,5-year-olds performed as well as U.S. 4-year-olds on the executive functioning tasks, but they still performed worse than U.S. children on ToM tasks. The authors conclude that as good executive functioning by itself was not sufficient to perform well on ToM tasks, other factors might be necessary to promote ToM development, i.e. the opportunity to discuss mental states. Thus, these results show that the relation between ToM and executive functions is not attributable only to the executive demands that ToM tasks require. Similar results were found by Woolfe, Want and Siegal (2002) with a deaf sample. In this study the native and the late signers performed equally well on the Wisconsin Card-Sorting task, while the late signers were significantly worse on the false-belief tasks. Thus, the advantage of the native signers in ToM tasks could not be explained by differences in executive functioning.

Mentalizing in atypical children

Wimmer and Perner (1983) demonstrated that typically developing children around their fourth year pass the false-belief task and can thus be said to have acquired a basic theory-of-mind. Children with autism, however, were shown to have remarkable problems with taking the other's perspective (Baron-Cohen et al., 1985).

At the same time, children with Down's syndrome succeeded on the same tasks, suggesting that children with autism experience problems when it comes to mentalizing that are not simply cognitive. As autism has a neurodevelopmental background, these findings pointed to a neurological basis for theory-of-mind.

Research with other atypically developing children, first with deaf children (Peterson & Siegal, 1995), proposed that communicative experiences could be related to differences in mentalizing skills between various groups of children. Deaf children of hearing parents were shown to perform on a lower level on the false-belief tasks than deaf children who grew up within a deaf family. This research concluded that fluent interaction between parents and children is crucial for developing insight into other minds. Recent findings of delayed theory-of-mind development among children with visual impairment (Hobson, 2004) and children with severe speech and physical impairment (Falkman, Dahlgren Sandberg & Hjelmquist, 2005) seem to support the importance of exposure to and participation in conversation when it comes to understanding other minds. In the present thesis therefore the focus is on deaf children who grow up in environments with different access to language and conversations, deaf children in Italy, Estonia and Sweden who grow up with deaf or hearing parents and are instructed in spoken or signed language at their school.

Deafness

There are approximately 70 children born deaf each year in Sweden (SDR, 2007). Across all age groups there are 8 000 – 10 000 deaf people in Sweden, i.e. persons who were born deaf or have become deaf before acquiring a language. Together with those who have become deaf after language acquisition as well as hearing children of deaf parents, there are around 30 000 users of sign language in Sweden (SDR, 2007). In Estonia 8 – 10 children are born deaf each year (Laipea, Miljan, Sutrop, & Toom, 2003). The total number of deaf people in Estonia is estimated to be 1 400, while there are approximately 4 500 sign language users in total. In Italy the number of deaf people is estimated to be 60 000, including all categories of deafness, and the total number of prelingually deaf people is about 50 000 (ENS, 2007). The educational situation for deaf children in Italy varies considerably, not least due to the strong oralist tradition which was dominant until about twenty years ago (ENS, 2007). Today, therefore, one can find oralist schools as well as bimodal/bilingual ones. According to different sources the number of deaf people varies considerably, probably due to deaf people with various degrees of hearing impairment being included as well as to people differently considering themselves as belonging to the deaf community or not.

Around five to six percent of deaf children have deaf parents and 90 percent of deaf parents have hearing children. A basic distinction can be made between hearing loss that is present at birth, i.e. pre-lingual deafness, and that which is acquired post-

lingually, i.e. after the child has begun to acquire a language. In this thesis, only pre-lingually deaf children are included.

There were about 500 children and 1 000 adults with cochlea implants (CI) in Sweden in August 2007 (Barnplantorna - The Swedish Cochlea Implant Children Organisation, personal communication, August 29, 2007). In Estonia 56 children and 13 adults had a CI in August 2007 (Implantaadilaste Selts, 2007). Twelve of the Estonian school-age children were attending a deaf school, while 11 children were educated in mainstream schools.

Deaf education

The Swedish Sign Language was officially accepted by the Swedish government as a language in its own right in 1981. Before this deaf children were mostly educated according to the oralist method with lipreading and the use of the spoken language. Education in the six special schools for the hearing impaired in Sweden is coordinated by the National Agency for Special Schools for the Deaf and Hard of Hearing (SPM). These special schools offer students instruction in sign language or speech, with the possibility of choosing different instructional languages for different subjects and even changing the choice during the course of schooling (SPM, 2007). The goal is for students to become functionally bilingual, meaning that they should be able to use both languages to communicate, to seek new knowledge and to influence their own lives. In order to reach this goal SPM tailors instruction to meet individual needs in signing, speaking, reading and writing. Usually classes with sign language as the first language and classes for children with impaired hearing where spoken Swedish is the first language are both offered. Every school aims to be flexible in its working methods so that each child is treated according to his or her own needs. The schools also provide instruction in sign language for siblings who have unimpaired hearing and children whose parents are deaf. In this way, in addition to learning sign language, the children also have the opportunity to experience a deaf environment and to gain insight into the situation of their deaf siblings. A sign language training programme for parents is available through a special curriculum established by the Swedish National Agency for Education. This program is designed to provide parents with functional sign language skills so that they can interact with their children, thereby supporting their child's development (TUFF, 2007).

Unlike the other Nordic and Baltic countries, the Estonian government officially accepted Estonian Sign Language as late as in March 2007. Accordingly, deaf education has until recently followed the oralist tradition by using spoken language and lipreading. Today, however, Estonian deaf children can choose between deaf schools following different educational philosophies. At schools following the oralist method children are taught mostly by hearing teachers to use their remaining hearing to talk and lip-read with sign language being avoided as much as possible. The schools aim to prepare their students to manage independently in a hearing

society without any need of sign language interpreters. Fifty four percent of the children studying according to the oralist approach today have a hearing loss of more than 96 dB, an additional 18 percent have a severe hearing loss (76 – 95 dB in their better ear). In 1994 a school with a bilingual approach was established. Estonian Sign Language is used at this school for classroom instructions and Estonian is taught as a second language for reading and writing. The students are educated by teachers, most of whom are deaf themselves, in sign language up to the fifth grade. Spoken language appears thereafter as a separate subject in the curriculum once a day.

Deaf children and mentalizing skills

Deaf children's development of mentalizing skills is of great theoretical interest since they offer an opportunity to disentangle some of the variables thought to be of importance in this respect. Difficulties in theory-of-mind understanding among deaf children quantitatively at a level similar to problems of autistic children would suggest that neurobiological makeup is not the single reason behind having problems in understanding other minds.

Despite the great popularity of theory-of-mind research among developmental psychologists, relatively little is known about how deaf children acquire insight into other minds. Several studies have shown that non-native late signing deaf children, i.e. deaf children who grow up with hearing parents, and thus do not have sign language as their first language, tend to perform at a lower level on false-belief tasks than their hearing age mates matched on mental age (Courtin, 2000; de Villiers & de Villiers, 2000; Peterson, 2004; Peterson & Siegal, 1999, 2000; Russell et al., 1998; Woolfe et al., 2002). In the study by Russell et al. forty per cent of a group of deaf late signers between the ages of 13 and 16 failed a modified standard unexpected location false-belief task compared to fifteen per cent of 3- to 5-year-old hearing children. In contrast, however, native signing deaf children, i.e. deaf children who have deaf parents, do not lag behind the typically developing hearing children in their theory-of-mind development. This pattern seems to be specific to the representation of other minds rather than to problems with understanding the concept of representation in general. In a study by Peterson and Siegal (1998) it was shown that while less than half of the 5- to 11-year-old deaf children from hearing homes displayed an accurate understanding of false-belief, a majority of these children passed the task of photographic representation, developed by Zaitchik (1990). A hearing comparison group of 4-year-old children performed equally well on both the false-belief and false-photograph task in this particular study. Another finding is that deaf children from hearing homes show difficulties with theory-of-mind understanding even if verbal task-requirements are minimized. Using the "thought pictures" task Woolfe et al. (2002) and Falkman and Hjelmquist (2007) have demonstrated that the difference between native signing and late signing deaf

children in mentalizing skills remains significant when the theory-of-mind task has been made more easily comprehensible by using minimal verbal instructions.

Interestingly, research demonstrates that profoundly and prelingually deaf children from hearing homes who are trained in an oral language mode are also delayed in developing insight into other minds (Courtin, 2000; de Villiers & de Villiers, 2000; Peterson, 2004). Peterson and Siegal (1999) have found, however, that oralist instructed deaf children performed comparably to native signing children. One reason for these conflicting results could be the different hearing status of children included in these studies. In Peterson and Siegal the children included in the oralist deaf group had a moderate to severe hearing loss whilst in Courtin, and de Villiers and de Villiers, only children with severe or profound hearing impairments were included. Thus, with the resulting differences in access to everyday conversation depending on the children's hearing level, these children could develop mentalizing skills at different ages.

Previous research on mentalizing skills among deaf children has been carried out in different countries, with different views on deaf education and children being exposed to different sign languages. It is striking that although deaf children are exposed to various forms of languages in education, the delayed development of mentalizing abilities among deaf children of hearing parents is a consistent finding across various studies. In the majority of deaf studies from the UK and Australia, children are recruited from schools which follow the philosophy of Total Communication where spoken language is usually combined with signed English (English is translated in a word-by-word way according to English syntax), supplemented by lipreading, finger spelling and British Sign Language/Auslan. (Peterson, 2004; Peterson & Siegal, 1999; Russell et al., 1998). In other studies deaf children are recruited from mainstream schools with sign language provision or special schools with bilingual communication using both spoken English and British Sign Language (Woolfe et al., 2002), are orally taught (de Villiers & de Villiers, 2000) or educated primarily in sign language (Falkman, 2005).

The importance of fluent communication with a caregiver for the development of mentalizing skills was demonstrated by Meins et al. (2002) in a sample of hearing children. The authors showed that mothers' talk and "mind-mindedness" with their hearing children at six months of age were predictive of mentalizing skills at 48 months of age. In dyads consisting of a hearing parent and a deaf child the parent's use of appropriate mental state comments, i.e. mind-mindedness, must be more difficult to accomplish. Among other things, Meadow-Orlans and Spencer (1996) have shown that these dyads spend less time in coordinated joint attention and mothers tend to interrupt the child's attention by initiating new unrelated activities. Wood (1991) has argued that hearing adults, when faced with communicational problems with deaf children, become more controlling and negative. Deaf children thus become over-controlled and there is less space for flexible and creative discussions. This pattern of interaction is strikingly parallel to the interaction

between children with cerebral palsy and their parents (Hjelmquist & Dahlgren Sandberg, 1996). Children with severe cerebral palsy also show delays in false-belief development (Dahlgren, Dahlgren Sandberg, & Hjelmquist, 2003; Falkman et al., 2005). A key issue from this perspective is whether this mismatching in early interaction with caregivers is reflected in later differences in mentalizing abilities.

Taken together, previous deaf studies consistently suggest that deaf children from hearing families, educated in either spoken or signed language, are delayed in developing mentalizing skills compared to their native-signing and hearing age mates. The results of these studies point to the importance of participation in everyday conversations with family members and friends that in some way or another facilitate the understanding of others as mental agents (Woolfe et al., 2002).

Summary of empirical studies

General and specific aims

The general aim of the empirical studies was to explore the relationship between mentalizing on the one hand and different language experiences and cognitive characteristics on the other hand. The aim of study I was to determine whether access to sign language as the medium of instruction influences theory-of-mind reasoning among deaf children. In study II the effects of working memory skills on the relation between language of instruction and understanding false-belief was examined. Study III aimed at testing if differences in theory-of-mind skills between different groups of deaf children, as reported previously, were mirrored in corresponding differences in executive functions. Study IV was designed to examine the relation between hearing children's theory-of-mind and their caregivers' insight into the children's social reasoning.

Study I

The aim of study I was to examine if the language of instruction in school affects theory-of-mind reasoning among deaf children. Previous studies concerning theory-of-mind abilities among deaf children have shown that deaf children from hearing homes lag several years behind hearing children in performance on false-belief tasks (Falkman, Roos, & Hjelmquist, 2007; Peterson & Siegal, 1999; Russell et al., 1998; Woolfe et al., 2002). Deaf children from homes with at least one deaf parent or older sibling using sign language, however, perform at the same level as typically developing hearing children. In the present study we thus aimed to go beyond the distinction of deaf children as native – non-native signers by dividing these groups further with respect to the language used at their school, i.e. spoken or signed language. We also broadened the scope of theory-of-mind tasks included in previous deaf research by adding tasks designed to test understanding of affective perspective taking as well as more advanced false-belief tasks.

Study II

All mentalizing tasks typically impose some memory demands. To correctly answer questions about someone else's perspective, children have to follow and remember the whole storyline and keep track of their own and other's alternative representations. Additionally, in order to give a correct answer about another's false belief, a child has to suppress his or her own knowledge about the real state of affairs. The development of working memory has been shown to follow a different pattern among deaf children compared to their hearing age mates (Boutla, Supalla, Newport, & Bavelier, 2004; Emmorey & Wilson, 2004; Wilson, Bettger, Niculae, & Klima, 1997). Native signing deaf people typically have a shorter forward recall span than hearing people. Wilson et al. have also shown that deaf native signing children do not differ to the same extent as hearing children on verbal recall of digits forward and backward. A standard finding is that hearing children are worse at recalling digits backward than forward. The aim of study II was to ensure that differences between the deaf groups on mentalizing tasks do not depend on underlying problems with working memory.

Study III

The aim of study III was to examine if there are differences in executive functions between the four groups of deaf children, i.e. bilingual native signers, oralist native signers, bilingual late signers and oralist late signers, which might account for the differences in their theory-of-mind reasoning. Previous research has shown that executive functions and theory-of-mind performance are related in typically developing hearing pre-school children (Carlson & Moses, 2001; Hala et al., 2003; Hughes, 1998; Sabbagh et al., 2006). For deaf children, on the other hand, Woolfe et al. (2002) found no significant differences between native and late signers on executive functioning tasks. In this particular study native and late signers performed equally well on the Wisconsin card sorting task while late signers were significantly worse on the false-belief tasks. Thus, the advantage of native signers in ToM tasks could not be explained by differences in executive functioning.

Study IV

In this study hearing children only were included. One aspect of language and communication that has recently been given a lot of attention in the context of theory-of-mind development is a caregiver's tendency to treat the child as a mental agent. Among others, Meins et al. (2003) demonstrated that mothers' mental state comments in a play situation with their infants that matched with the child's concurrent state of mind, were related to the children's later ToM performance. They propose that mothers' appropriate mental comments draw attention to the existence of mental states, and later help to make sense of these inner experiences by combining them with external linguistic comments. The aim of study IV was to examine whether a caregiver's insight into his/her child's mind relates to the child's

socio-cognitive understanding even in middle childhood among hearing children. As older children expand their conversational environments to include people outside the mother-child dyad to a greater extent, fathers and teachers were also included in study IV.

Methods

Participants

An overview of the different groups in relation to the four empirical studies is given in Table 1.

Study I. Two experiments were included in this study. In experiment 1, the participants were 97 profoundly deaf Italian children, aged 4 to 12 years, of whom 41 were late signers ($M = 10$ years 1 month) and 56 were native signers ($M = 8$ years 7 months). Of the 41 late signers, 23 children attended oralist schools and 18 children attended bimodal/bilingual schools. For the 56 native signers, comparative figures were 20 and 36 respectively. 105 hearing children were recruited as controls from schools from north-eastern Italy. They were divided into four age groups: 3- to 4-year-olds, 5- to 6-year-olds, 7- to 8-year-olds, and 9- to 10-year-olds.

The participants in experiment 2 were 61 deaf children, ranging in age from 7 to 16 years of whom 24 were native signers from deaf families where sign language was used in the home ($M = 12$ years 3 months) and 37 were late signers from hearing families ($M = 12$ years 3 months). The native signers all attended schools in Estonia: 11 attended a bilingual school and 13 attended an oralist school. Of the 37 late signers, 16 attended a bilingual school in Estonia and 21 attended a bilingual school in Sweden. All children were prelingually deaf and none of them had any additional disabilities such as cerebral palsy, autism, mental retardation or visual impairment. In addition to the deaf children, 26 hearing children, aged 6 to 15 years, were recruited from schools located in Estonia to act as controls.

Study II and III. Eighty Estonian children, ranging in age from 6 to 16 years participated in studies II and III. The deaf sample consisted of 54 prelingually and severely or profoundly deaf children without any additional disabilities. They were divided into four subgroups according to the mode used in daily conversations with other family members and the educational policy of their school. Of the 24 native signers, 11 attended a bilingual school and 13 attended an oralist school. The group of 30 late signing deaf children consisted of 16 children attending a bilingual school and 14 children from an oralist school. The comparison group consisted of 26 hearing children, aged 6 to 15 years, from Estonia.

Study IV. Thirty-nine typically developing hearing children (25 boys and 14 girls) between 7 years 0 months and 9 years 11 months ($M = 8$ years 7 months) from a primary school in western Sweden were included in this study. Thirty-two mothers, 30 fathers and 30 teachers filled in and returned the questionnaire.

Table 1. Groups of children participating in the empirical studies.

Group and language access	Study I Exp. 1*	Study I Exp. 2*	Study II	Study III	Study IV
Native signers					
Bilingual (Estonia) ($n=11$)		x	x	x	
Oralist (Estonia) ($n=13$)		x	x	x	
Bimodal/bilingual (Italy) ($n=36$)	x				
Oralist (Italy) ($n=20$)	x				
Late signers					
Bilingual (Estonia) ($n=16$)		x	x	x	
Bilingual (Sweden) ($n=21$)		x			
Oralist (Estonia) ($n=14$)			x	x	
Bimodal/bilingual (Italy) ($n=18$)	x				
Oralist (Italy) ($n=23$)	x				
Hearing children (Estonia) ($n=26$)		x	x	x	
Hearing children (Sweden) ($n=39$)					x
Hearing children (Italy) ($n=105$)	x				

Note. Exp. 1 = Italian sample, Exp. 2 = Estonian and Swedish sample

Procedure

As the researchers contributing to the studies in this thesis are not fluent in any of the three sign languages used, myself having practically no knowledge, all the testing procedure was carefully prepared with the help of deaf assistants and hearing interpreters. The exact formulation of the language used for the tasks and questions was developed in consultation with a hearing interpreter and a deaf assistant at the bilingual school in Estonia, and in consultation with a hearing interpreter and two deaf native speakers of Swedish Sign Language in Sweden. In this way, steps were taken to make sure that accurate sign language was used in the testing procedure, taking into account the restriction that no researcher was fluent in any of the three sign languages.

All the Italian deaf children were tested by a hearing professional sign language interpreter following the procedure used by Woolfe et al. (2002).

In Estonia and Sweden each child was tested individually in a quiet room at his or her school. An assistant who knew the children well carried out the testing. At the bilingual school in Estonia the assistant was deaf herself, so an interpreter simultaneously interpreted all communication between the child and the assistant from Estonian Sign Language to Estonian. This made it possible for the experiment leader to follow the procedure. Children from deaf families at the oralist school in Estonia were tested in sign language by a hearing assistant who had grown up with a deaf parent and was fluent in Estonian Sign Language. The oralist late signing deaf

children were tested in spoken Estonian. The Swedish deaf children were tested by an assistant who did not suffer from any hearing impairment herself, but as she had grown up with a deaf parent and worked daily with deaf children, she was bilingual and thus fluent in Swedish Sign Language.

To avoid possible ambiguities when analyzing answers after the testing, test sessions in Estonia and Sweden were video recorded with two cameras. Test sessions did not last longer than approximately 20 minutes in order to avoid fatigue effects. We also consulted a professor of English, who grew up in Sweden with an Estonian parent, concerning semantic fields of epistemic verbs such as *think* and *believe* in English, Swedish and Estonian.

Tasks

Studies I, II and III

Information regarding which tasks were included in each study is shown in Table 2.

Table 2. Tasks included in each study.

	Study I Exp. 1*	Study I Exp. 2*	Study II	Study III	Study IV
Theory-of-mind tasks					
Emotion recognition cartoons 1 & 2		x		x	
Belief-desire based emotions		x		x	
Unexpected contents		x	x	x	
Unexpected location		x	x	x	
Second-order false-belief		x		x	
“Strange stories”		x		x	x
“Faux pas”		x		x	
“Thought pictures”	x				
Working memory tasks					
Digit span			x		
Executive functioning tasks					
Go-no-go and Conflict tasks				x	
Wisconsin card sorting task				x	
Other measures					
Test of non-mental representation		x	x	x	
Raven’s matrices	x	x	x	x	
Italian Sign Language test	x				
Peabody picture vocabulary test					x
Maternal accuracy task					x

Note. Exp. 1 = Italian sample, Exp. 2 = Estonian and Swedish sample

Theory-of-mind tasks

Emotion Recognition Cartoon-1 (ERC-1). Following the procedure devised by Howlin, Baron-Cohen, and Hadwin (1999) to examine children's recognition of emotions caused by situations, desires or beliefs, this measure involved presenting children with cartoon stories and asking them to report on the emotions of the main character as depicted in the stories. Two belief-based emotion stories were presented, each using three pictures. In the first story (ERC-1), the first picture showed two parents in a travel agency buying a holiday trip to the mountains. The second picture depicted the story character with "thought bubbles" of both his desire and his belief respectively. These showed a boy who wants to go skiing in the mountains, but who thinks that his parents have bought a trip to a seaside resort. Here the child was asked two control questions to ensure that he or she had understood what the story figure's desire and belief were, "What does the boy want?" and "Where does the boy think they are going to travel?" Then the test question "How will the boy feel when he thinks that his parents have bought a trip to a seaside resort?" was asked. Since the story character does not know that they were actually going skiing and instead believes they are going to the seaside, he will consequently feel unhappy. The last picture showed the character happily encountering the outcome of the situation. The child was then asked the emotion control question, "How does the boy feel when he is skiing with his family?" To pass this task, the child had to respond correctly to both the test question and the control questions about the character's desire and belief, as well as the question about the character's emotion in the outcome situation.

Emotion Recognition Cartoon-2 (ERC-2). In the second story, the task was again to predict a story character's emotions taking into consideration both desire and belief. The child was told a story about a girl wanting to go to the cinema, not knowing it had sustained water damage and was therefore closed. The child was again asked to predict the character's emotion both before (happy) and after (unhappy) witnessing the last picture that depicted the outcome. In both ERC-1 and ERC-2, the story character's belief was false, while the character's desire was fulfilled in ERC-1, but unfulfilled in ERC-2.

Belief-Desire Based Emotion Reasoning Task. This task also concerned emotion recognition abilities and followed the procedure used by Harris et al. (1989). The child was first introduced to a toy rabbit described as liking Coca Cola and disliking milk. The child was then asked two control questions: "How does the rabbit feel when he is given a can of Coca Cola?" and "How does the rabbit feel when he is given some milk?" The child was then told the following: "The rabbit then went out for a walk and, while he was out, the cat replaced Coca Cola with milk in a Cola can. When the rabbit comes back from his walk, he is really thirsty. He can see the can on the table but he can't see what's inside the can." The main test question followed

concerning emotion-inference based on the story character's false-belief, "When the rabbit first comes back from his walk, how does he feel – happy or not happy?" Children who responded correctly to the test question were rated as successful only if they also passed the accompanying control questions, "How does the rabbit feel after he's had a drink – happy or not happy?" and "What's really in the can?"

Unexpected Content Task. Following the procedure of Perner et al. (1987), the children were shown a "Smarties" tube that actually contained buttons. They were then asked what they thought was inside the tube. After they had discovered the contents, and when the tube was closed again, the children were asked two belief questions, one about the belief of another child in a different room, "If we ask your friend, what will he/she think is in here?" and one about their own prior belief, "When I first asked you about the content of the sweets box, before we looked inside, what did you think was in here?"

Unexpected Change of Location Task. Following Hughes et al.'s (2000) modification of the classic Sally-Anne task (Baron-Cohen et al., 1985), this task consisted of a story accompanied by four pictures. The first picture showed a boy with a bag and an apple, and a girl with a box. In the second picture, the boy is depicted by putting the apple in his bag wanting to keep it safe. In the third picture, while the boy is outside playing, a girl takes the apple and puts it in her box instead. The fourth picture depicted the boy returning to pick up his apple. To pass this task, the child then had to answer correctly the test question "Where will the boy look for his apple?" as well as two control questions about the current location ("Where is the apple really?") and the original location of the apple ("Where was the apple first of all?").

Second-Order False-Belief Task. In order to assess the children's ability to attribute a mistaken belief about a belief to a story character, we used Hughes et al.'s (2000) "Chocolate" story based on the second-order task developed by Sullivan, Zaitchik, and Tager-Flusberg (1994). The story was about a granddad and his grandchildren and was again told with the help of pictures: "Granddad gives a chocolate bar to his grandchildren and asks them to put it away until Mum says they can have some. The children put the chocolate in the fridge and go out to play. Soon the boy feels thirsty and goes inside for a glass of water. He sees the chocolate in the fridge, wants to keep it for himself, and puts it in his bag. The girl is playing by the window and can therefore see what her brother is doing. The boy, however, is busy hiding the chocolate, so he does not notice the girl looking at him. Later, when the boy and girl are drinking tea, mum says that now they can have some of the chocolate." The children were then asked the test question, "Where does the boy think the girl will look for the chocolate?" In order to pass this task the child also had to respond correctly to a reality control question ("Where is the chocolate really?") as well as a memory control question ("Where was the chocolate first of all?") that were asked following the test question.

“Strange Story”. The children were read one of Happé’s (1994) “Strange Stories.” This involved an old woman walking home alone late at night. A man suddenly appears and comes towards her, wanting to ask what time it is. The old woman, seeing the man, starts to tremble and says, “Take my purse, just don’t hurt me please!” The children were then asked, “Was the man surprised to hear what the old lady said?” and “Why did she say that, when the man only wanted to ask what time it was?” Answers to the justification question were coded according to Happé’s procedure. One point was given for a clear indication of the woman’s false belief, e.g. referring to her belief that he was going to mug her, or her ignorance of his real intention. References to her trait (“She’s a nervous person”), or state (“She’s scared”), without remarking that her fear was unnecessary was given 0.5 point. Children were given a score of zero if they gave factually incorrect or irrelevant answers.

“Faux Pas”. As defined by Baron-Cohen, O’Riordan, Stone, Jones, and Plaisted (1999), a faux pas is “when a speaker says something without considering if it is something that the listener might not want to hear or know, and which typically has negative consequences that the speaker never intended.” For the faux pas situation included in our studies, an inadvertently insulting story character was described who made critical remarks about a birthday present he had received (a toy airplane) without remembering that he was speaking to the person who gave it to him. After consulting the deaf assistants and a sign language interpreter, the original test questions were modified to make the task more easily comprehensible in sign language. The original questions in Baron-Cohen et al. were “In the story did someone say something that they should not have said” and “What did they say that they should not have said?” In the present study, the deaf children were asked a faux pas detection question “In the story did someone say something that was improper?” If the child said yes, he or she was then asked, “What was it that was improper?” In order to pass the test the children also had to answer correctly the comprehension question (“What did X give Y for his birthday?”) and false-belief question (“Did X remember that Y had given him the toy airplane for his birthday?”).

“Thought pictures”. As in the procedure used by Wellman, Hollander, and Schult (1996) and Woolfe et al. (2002), two pictures were first shown to examine the children’s understanding of “thought bubbles”: one depicting a boy thinking about a dog (a boy with an attached thought bubble containing a dog) and the other depicting a boy with a real dog (a boy with a dog on a lead). The deaf children were asked in Italian Sign Language (LIS) (and the hearing in spoken Italian) to point to the picture showing a boy thinking about a dog. All the children who participated in Experiment 1 gave the correct answer. The children were then shown four ToM “thought pictures” (adapted from a procedure used by Custer, 1996): two pictures where the main character’s belief was false (FB), and the other two where the main character’s belief was true (TB). The four thought pictures were: 1) a boy fishing

thinks has caught a fish (TB = fish / FB = boot); 2) a girl thinks she sees a tall boy over a fence (TB = a tall boy / FB = a small boy standing on a box); 3) a man thinks he is reaching into a cupboard for a drink (TB = a drink / FB = a mouse); and 4) a man thinks he sees a fish in the sea (TB = a fish / FB = a mermaid). The content of the items in the FB and TB tasks was randomized across children. For each thought picture, children were asked a belief and a reality question. They were scored as having passed the task if they answered both questions correctly. Each child therefore received an FB score from 0 to 2 and a TB score from 0 to 2.

Working memory tasks

Digit Span subtest of the WISC (Wechsler, 1977) was used as a measure of verbal working memory. The children were told, in Estonian or Estonian Sign Language, to repeat sequences of numbers signed, or read out loud, by the experimenter, first in a forward recall condition and then in a backward recall condition. Two trials of each sequence length were given to each child. The score for each task was the length of the longest sequence with at least one completely correct response.

Executive functioning tasks

Go-no-go and *Conflict task*. Becker Visual Go-No-Go and Conflict tasks were used to measure inhibitory control skills (Becker et al., 1987). With the appearance of two different stimuli on the computer screen the child has to make a choice, either to respond, or not to respond. In the Go-no-go condition the child has to respond every time two squares are presented on the screen and not respond when one square appears. In the Conflict condition the child is asked to respond once when two squares are presented and twice when one square appears. The total score for each task was the number of right responses to both stimuli with the maximum score of 32 for each task.

Wisconsin Card Sorting Task (WCST). Attentional flexibility was assessed by using the Wisconsin Card Sorting Test (Korkman, 1997). In this task, four stimulus cards are first placed on the table in front of the child. Each card has a symbol of different colour and shape: a red triangle, a yellow circle, a blue star and a green cross. Next, the experimenter takes a random card out of a set of 27 additional cards and asks the child to sort it on the basis of the two dimensions, colour and shape. On each trial the experimenter lets the child know whether a particular match is right or wrong and records the child's response. After a child has had six right guesses in a row the experimenter changes the dimension of stimulus unbeknown to the child. Success on this task was rated as a total number of right guesses, with the maximum score of 27.

Other measures

Test of Non-Mental Representation. Following Zaitchik (1990), a test of non-mental representation was included in order to make sure that possible difficulties in

performance on false-belief tasks were due to problems specifically with mental representation and not representation in general. The assistant first took a photo of the child with a Polaroid camera and together they then watched the developing photograph. Next, the children were shown a toy rabbit holding a blue toothbrush. The assistant took a photograph of the rabbit. While the photograph was placed to develop face down, the assistant replaced the blue toothbrush with a white one. The children were then shown two photos taken beforehand, and were asked to point to the photo that matched the developing photograph. Control questions were then asked concerning the colour of the toothbrush that the rabbit had first held, and the colour of the toothbrush the rabbit was in reality holding now, i.e. two questions. All children passed the non-mental representation task.

Non-verbal mental age. All the children were given Raven's matrices as a test of nonverbal intelligence (Raven, Raven, & Court, 2000).

Italian Sign Language (LIS) measures. All Italian deaf children included were first given a test for proficiency in LIS based on the British Sign Language (BSL) Receptive Skills Test (Herman, Holmes, & Woll, 1999). Each of the 40 sentences in the original BSL test was translated into LIS and recorded on a DVD to be used as a test of proficiency in LIS. The translations used LIS constructions common to Italian signers despite regional variations. Before the test was administered, the children were given a vocabulary check involving signs for items (e.g. book, pencil, table, car). Just like the BSL test, the LIS test evaluated the understanding of grammatical features such as spatial verb morphology, number/distribution, size/shape specifiers, noun/verb distinctions, and handling of classifiers. Scores were given out of a maximum score of 40. Additionally, teacher ratings of children's abilities in LIS were available for all 97 children. As in Peterson and Siegal's (1999) study, teachers rated each child on scales of expressive language skill, comprehension, and vocabulary size. Ratings ranged from 1 (both "below average" and "inadequate for effective communication"), through 3 ("average"), up to 5 (both "highly competent" and "well above the average for signing children of the same age"). The overall score for each child was created by averaging ratings on all three scales. The mean score for the 97 children was 3.80 ($SD = .98$). The correlation between scores on the LIS test and the teacher ratings was .68, $p < .01$, providing evidence for validation of the LIS adaptation of the BSL test. We used LIS scores rather than teacher ratings as a language measure as LIS test scores provide a constant measure of language proficiency across schools. Children in the hearing control groups were tested by a native Italian speaker on an Italian version of the Test for the Reception of Grammar (TROG) (Bishop, 2003).

Study IV

Strange stories. The children were given eight of Happé's (1994) 24 strange stories designed to test theory-of-mind on different levels. The stories involved white lie, lie, double bluff, appearance/reality, persuasion, sarcasm, joke, and

misunderstanding. Each story was read out loud while a copy of the story was available in front of the child to minimize memory requirements. At the end of each story the child was asked two test questions; a comprehension question, “Was it true, what X said?”, and a justification question, “Why did X say that?” Answers to the justification question were coded according to Happé’s (1994) modified procedure (R. Booth, personal communication, March 5, 2004). Two points were given for a complete answer with a clear indication of the story character’s mental states. Justifications with references to outcome or correct physical states were given one point. Children were given a score of zero if they gave factually incorrect or irrelevant answers. Since 20 of the 39 children incorrectly answered the comprehension question of the double bluff story, that story was excluded from further analyses. Three children gave incorrect answer to the comprehension question of the misunderstanding story. Their answers to the justification question of the same story were replaced with the group mean of that particular story. The comprehension questions of all other stories included were answered correctly by all children. On the strange stories the possible ToM score ranged between 0 and 14 points.

Peabody picture vocabulary test (PPVT-III) (Dunn & Dunn, 1997). The Swedish version of the PPVT-III was used to assess the children’s receptive language ability. The experimenter presents a word together with four pictures and the child is then asked to choose which of the four pictures presented depicts the word.

Maternal accuracy task. All children, as well as both their parents and a teacher were asked to complete the maternal accuracy task (MAT) (Sharp, Fonagy, & Goodyer, 2006). This was used to determine how well the caregivers could predict the children’s thinking in social situations. The task has been designed following the paradigm of *maternal mind-mindedness*, which refers to a mother’s inclination to treat her child as a psychological being – an individual with a mind, rather than a mere creature with needs that must be satisfied, developed by Meins and colleagues (2003). Meins et al. have operationalized the maternal accuracy in reading a child’s psychological states by evaluating it against an independent coder. As in study IV we interviewed older children, we could ask the children to report on the psychological content of their minds themselves (Sharp et al., 2006). Thus, all children were first presented individually with fifteen stories containing distressing social scenarios. These included loneliness, ridicule, being singled out, under-achievement in sport, having an accident, a family member having an accident, social exclusion, academic under-achievement, physical size, moving to a new school, physical disability, social embarrassment, a parent working abroad, poverty and peer rejection. The stories were slightly modified to fit a Swedish context. As with the theory-of-mind task, the stories were read out loud while a copy was placed in front of the child for reference. After each story children were presented with three response options: (1) an unrealistic and positive alternative with strong self-reference; (2) a negative alternative with strong self-reference; and (3) a neutral/rational/adaptive option

devoid of a global, internal and stable self-attribution. The same stories were then presented to the child's mother, father and a teacher who knew the child well, in a form of a questionnaire that they were asked to fill in themselves. To assess the extent to which the caregivers were able to predict the attributions the children made, they were asked to guess which response option their child would choose for each scenario. The accuracy score thus equalled the number of stories on which the caregiver chose the same response as the child.

Main results

Study I

The main findings of study I revealed that there were differences on the theory-of-mind reasoning tasks between the different deaf groups as well as between the hearing and the deaf groups. In Experiment 1, the deaf children with bimodal/bilingual instruction outperformed those with oralist instruction on the ToM tasks, even after chronological age, nonverbal intelligence, and level of sign language were partialled out. There were no significant differences in ToM performance as shown by responses on false-belief tasks between the bimodal/bilingual instructed native signers and 3- to 4-year-olds as well as 5- to 6-year-olds. However, the hearing 5- to 6-year-olds significantly outperformed the oralist-instructed native signers as well as the late signers, regardless of whether they were exposed to oralist or bilingual instruction. The hearing 7- to 8-year-olds and 9- to 10-year-olds outperformed all of the deaf groups. When just the youngest bimodal/bilingual instructed native signers ($M = 82.5$ months) were considered, they were outperformed by the hearing 5- to 6-year-olds.

In Experiment 2, responses on the eight mentalizing tasks were scored on a 0 - 8 point scale. The results showed that the hearing children outperformed the bilingual Estonian late signers, the bilingual Swedish late signers, and the oralist Estonian native signers. The bilingual native signers performed at the same level as the hearing children, but they performed better than all the other deaf groups, i.e. the bilingual Estonian late signers, the bilingual Swedish late signers and the oralist native signers. There was no difference between the bilingual late signers in Estonia and Sweden. We carried out an analysis of covariance to determine whether the differences between groups in performance on the mentalizing tasks would remain once chronological and mental age were partialled out as covariates. These differences remained significant, and planned contrasts confirmed that the hearing children performed significantly better than all groups of deaf children, with the exception of bilingually instructed native signers.

Study II

In study II a child was considered to have an understanding of false-belief if he or she answered correctly both test questions of the unexpected contents task and the test question as well as the two control questions of the unexpected location task.

On the false-belief tasks no significant differences were found between the bilingual native signers and the hearing children. The hearing children, however, performed significantly better than the oralist native signers. The oralist-instructed native signers were also outperformed by the bilingually instructed native signers. There were no significant differences between the bilingual late signers, the oralist late signers and the hearing children.

On the digit span tasks the hearing children could recall significantly more digits forward than any of the deaf children. A significant group effect was also found on the digit span backward recall, the hearing children outperforming both the bilingual and the oralist late signers, but performing at the same level as both the bilingual and the oralist native signers. Comparisons between the bilingual and the oralist native signers showed that these groups performed at the same level, both on forward and backward digit recall. There were no differences found between the bilingual and the oralist late signers.

Study III

The hearing children performed better than the bilingual late signers, the oralist late signers and the oralist native signers on the theory-of-mind tasks. The bilingual native signers performed as well as the hearing children, but outperformed all the other deaf groups on the composite theory-of-mind score.

On the Go-no-go and the Conflict task there were no significant differences in mean scores between any of the groups. The hearing children were outperformed by every deaf group on the Wisconsin card sorting task, while there were no significant differences between the deaf groups. There were no significant correlations between the theory-of-mind composite score and the different executive functioning tasks after the effects of the chronological and mental age were partialled out. All children passed the non-mental representation task.

Study IV

The main finding of study IV was that there was a significant correlation between the mothers' accuracy scores on the maternal accuracy task and the children's theory-of-mind scores. This relation remained after chronological age and PPVT-III scores were held constant. Thus, those mothers who were more accurate in predicting their children's reasoning in distressing social situations had children who had higher ToM scores. Positive, but not significant, correlations were also found between children's ToM scores and their father's accuracy scores, as well as with their teachers' accuracy scores.

To examine if children's tendency to reason about others' thoughts in a neutral/rational, negative or positive/unrealistic manner was related to maternal accuracy, correlations between children's MAT answers and mothers' MAT accuracy scores were calculated. There was a significant positive correlation between children's neutral/rational answers and mothers' accuracy, and a negative correlation between children's positive/unrealistic answers and mothers' accuracy. Significant correlations were also found between the fathers' accuracy and children's neutral/rational and negative answers respectively. There was a close-to-significant correlation between children's neutral/rational answers and their teachers' accuracy. Thus, children who made neutral/rational interpretations about others' thoughts had parents who made more accurate predictions.

The analyses also revealed a significant positive correlation between the children's ToM scores and their neutral/rational answers on the MAT, and a significant negative correlation between the ToM scores and the positive/unrealistic answers. The negative answers were unrelated to the ToM scores. The patterns of significant relations remained after the effects of chronological age and PPVT-III scores were partialled out.

Discussion

A lot of research in developmental psychology has during the last 20 to 25 years revolved around the question of what it means to develop a theory-of-mind. Until recently, the main discussions have focused on the differences between 'simulation theory' and 'theory-theory'. In a landmark paper from 1993, Gopnik argued against the proponents of simulation theory, suggesting that the idea of privileged first-person knowledge of our own psychological states is just an illusion. The evidence suggests that when children cannot report the false beliefs of others, they are equally ignorant of their own previous false beliefs. The mental states of others, accordingly, cannot be discovered through first-person experience of the same states. Instead Gopnik (1993:10) concludes that "commonsense psychological beliefs are constructed as a way of explaining ourselves and others", the view that has come to be called 'theory-theory'.

Both these approaches, simulation theory and theory-theory, have however been criticized for being too individualistic as the understanding of minds is seen as an individual process of introspection or formed by an individual child-theorist (Carpendale & Lewis, 2004). Carpendale and Lewis instead propose a constructivist account, which combines the social and individualistic parts of development, and where the understanding of others as mental agents develops through social interaction. They argue that children are embedded in triadic interactions taking place between the child, another person and the world. An understanding about the world as well as about the other person is constructed through the regularities that the children experience in these interactions. Social knowledge is thus acquired in action and is practical, and not based on theories that are formed to explain the

behaviour of other people. The ability to reflect and report on the knowledge of mental states develops later. According to Carpendale and Lewis, thus, to engage in cooperative interaction and exposure to talk about mental states are the cornerstones of the development of social understanding.

The by now extensive research on early imitation is of great interest in this context. Already in the 1970's it was shown how toddlers and parents interact with imitative behaviour (Meltzoff & Moore, 1977). Later, the more complex behaviour of deferred imitation was shown among children around 12 months of age (Heimann & Meltzoff, 1996), and Meltzoff (2004) argued for imitation being part of the origins of theory-of-mind. Whatever the true nature of imitation, the behavioural data from imitation studies fit with the idea that early interaction is crucial for later development. Research on imitation and theory-of-mind respectively has largely been conducted as independent enterprises, but it is evident that core issues concerning the development of intentionality and an understanding of others as agents are common to the two different areas of research.

Nelson (2005) has described social cognitive development in terms of “entering into a community of minds”. According to Nelson, to acquire a theory-of-mind is to understand what it means to be a human being in a human community. This development extends through language and involves learning to participate in a shared belief system. The development of one particular group of children, i.e. deaf children, becomes interesting in this context since they do not have access to the “community of minds” in the same natural way as hearing children do. Our studies, as well as some previous research (e.g. Peterson & Siegal, 1999; Woolfe et al., 2002), confirm that deaf children from hearing homes lag several years behind hearing children in developing mentalizing skills and that it is an advantage for deaf children to have deaf parents when it comes to understanding other minds. Since in the Estonian and the Italian cases we could recruit a group of deaf children with deaf parents where the children did not use sign language at school, we found that the advantage of having deaf parents is not independent of other factors. Deaf native signing children from an oralist school performed worse than deaf native signing children from a bilingual school on the theory-of-mind tasks. Thus, these differences point to the important role of education given in a native language environment in order to maintain the expression of mind-reading skills through practice.

On the other hand, the Swedish system with very early diagnosis of deafness and sign language instruction immediately offered hearing parents, together with early sign language experience at preschool for deaf children, were not enough for the group of late signing children in the present thesis to be put on the same developmental track as deaf children of deaf parents. Something in the early coordination of minds and introduction to other minds seems to be different in the two communicative environments. In this sense, mentalizing is sensitive to specific kinds of early experiences. At the same time, mentalizing is resilient to even very

impoverished linguistic experiences. Morgan and Kegl (2006) showed that people in a Nicaraguan community of very late signers, after the age of ten, used mental state expressions in narratives, though they performed poorly at false belief tasks.

Working memory has been suggested to contribute to the performance on theory-of-mind tasks (Carlson & Moses, 2001; Carlson, Moses, & Breton, 2002; Davis & Pratt, 1995; Hala et al., 2003). To correctly answer questions about someone else's false-beliefs, the children have to follow and remember the whole storyline. There were no significant differences between the two groups of native signers or between the two groups of late signers in forward or backward digit recall in study II, suggesting that the differences found in theory-of-mind performance are not attributable to any systematic differences in working memory between the deaf groups.

Even though there were significant differences in theory-of-mind skills between the bilingual native signing deaf children on the one hand and the oralist native signers, the oralist late signers and the bilingual late signers on the other, there were no corresponding differences among the four deaf groups on the executive functioning skills in study III. These findings indicate that some deaf groups' lower performance on theory-of-mind tasks can not be understood as difficulties with executive functions.

As all deaf Estonian parents have been instructed orally at school themselves, and thus may be lacking a fully-fledged sign language, another signing community, i.e. school, could have a compensatory effect on the development of mentalizing skills for native signing deaf children attending a school where signing is used as primary mode of communication and instruction. Wood (1991) has argued that hearing adults, when faced with communicative problems with deaf children become more controlling and negative. Deaf children become over-controlled, and there is no space for flexible and creative discussions. Teachers in this situation also tend to focus more on speech accuracy and auditory awareness than on meaningful and contingent conversation (Singleton & Morgan, 2006). Having deaf teachers, who share a common language with the children, as is the case in the bilingual school, can accordingly provide better conditions for fluent conversations and thus promote the understanding of others' mental states.

The importance of fluent communication with a caregiver for a child's socio-cognitive development was demonstrated by Meins et al. (2002) who showed that mothers' tendency to comment appropriately on their children's mental states at six months of age was predictive of theory-of-mind performance at 48 months of age. This relation was independent of children's verbal ability, mother's education, and attachment security suggesting that it is specifically mother's "mind-mindedness" rather than the general quality of infant-mother interaction that is important in developing theory-of-mind. The results in study IV show that mothers' insight into the child's mental life is related to children's theory-of-mind reasoning even in middle childhood. These findings suggest that the development of mentalizing skills

is a gradual process, which requires constant access to talk about different mental states. There seems to be great flexibility and large possibilities for development and change, which extends long beyond early childhood years, when it comes to mentalizing.

The measure used in study IV focuses on caregivers' insight into their child's social reasoning, and not on the actual communication patterns. One possible interpretation of our findings could be that more insight into the thoughts and feelings of the other family members can be a result of more family talk about mental states. According to Fonagy and Target (1997), and Meins et al. (2002; 2003), mothers' mentalizing skills offer a "scaffolding" context where children learn to understand their own behaviour in terms of mental states. Thus, engaging with the child on a mental level provides an opportunity for the children to learn to reason about their own and others' thoughts and feelings. There were no significant correlations between children's theory-of-mind reasoning and teachers' or fathers' accurate predictions of the children's thoughts in study IV. As the results are correlational only, there are two obvious caveats to any interpretations in terms of causality or direction of influence. The children of the more 'mind-minded' mothers might be more responsive and invitive in terms of joint attention and cooperation in general. Closely related is the possibility of a genetic factor common to mothers and children correlating with high mentalizing levels. The evidence concerning the genetic background of ToM is equivocal, however. Hughes and Cutting (1999) could, in a twin study, identify a high genetic component explaining variation in ToM. However, in a later, larger, and more diverse sample of twins (Hughes et al., 2005) only a small fraction of variation in ToM performance could be explained by genetic variation. The two studies used different age groups, 42-month-olds 1999 and 60-month-olds 2005. Hughes et al. (2005) suggested, in line with other researchers, the possibility that the impact of genes and environment, respectively, varies with age, with environmental effects being more salient at later ages. Altogether the results are compatible with a considerable environmental impact on the development of mentalizing, with language playing a crucial part, acting as a tool for the co-ordination of minds.

In the case of deaf children, Meadow-Orlans and Spencer (1996) have identified two obstacles to the sensitive parenting of deaf children who grow up in hearing families: feeling inadequate in rearing a deaf child and the absence of communicative skills in a shared language. Among other things, hearing caregivers have been shown to spend less time in coordinated joint attention with their deaf children than with their hearing children, with the caregiver also tending to interrupt the child's attention by initiating new unrelated activities. Thus, appropriately identifying and commenting on the child's mental states in a "mind-minded" way seems far more difficult if the child and the caregiver have different hearing status.

Our results fit with the general notion of the decisive role of language and communication for mentalizing. The studies presented here, however, suffer from

one weakness, i.e. the lack of language tests, except in the case of the Italian participants. More specifically, there was no test of the mastery of complement clauses, by some researchers suggested as decisive for the understanding of false-belief (de Villiers, 2005; de Villiers & Pyers, 2002; Schick, de Villiers, de Villiers, & Hoffmeister, 2007). The reason for this is that there are simply no tests available for Estonian Sign Language or Swedish Sign Language. Lacking such tests, it still seems highly unlikely that the generally low mentalizing results could be ascribed to language obstacles. Control questions were used in a number of cases, and they were answered correctly. The test of non-mental representation was also easily past. Equally important, the recent results from children aged between 13 months to 2 years, indicating understanding of false-belief, cannot be explained as related to mastery of the complement clause, or any other linguistic construction (Onishi & Baillargeon, 2005; Southgate, Senju, & Csibra, 2007; Surian, Caldi, & Sperber, 2007). If these results from very young children can be further replicated, it shows that the emergence of false-belief is largely independent of language, whereas, according to the results in this thesis, and other research, its maintenance and further development is dependent on specific communicative experiences, where language plays an integral part. Language seems to be the best tool for the coordination of minds in a conversational context.

The results are also indicative of the resilience of the mentalizing skill, despite degraded linguistic input. As shown by the statistical measure of effect size (η^2), the significant result, though consistently in the direction of better results the more native language experiences a person has been offered, the effects are sometimes at medium level. Irrespective of language experience, the participants in the present studies have mentalizing and theory-of-mind skills to a fair degree. To find really severe delays, and perhaps deviances, specifically in respect of false-belief, the child's lack of language exposure must last for around 10 years, as indicated by recent findings in a Nicaraguan deaf community (Morgan & Kegl, 2006). Nevertheless, the results from the present studies contribute theoretically and practically. They strengthen the theoretical position that mentalizing and theory-of-mind is not an all-or-none mental faculty, but a skill varying considerably in relation to communicative and language exposure, and at least at certain developmental stages marginally dependent on genetic variation (Hughes et al., 2005). At the same time, the results have the pedagogical implication of early and consistent introduction of relevant communicative and language experiences in educational settings for children who, as in the case of deaf children, run the risk of having few such experiences.

In conclusion, the present work has provided evidence for the importance of everyday family conversations for the development of theory-of-mind reasoning. For deaf children the continuous access to fluent conversations in a shared language between the child and his or her immediate surrounding, both at home and at school, provides opportunities to talk about the beliefs of others and to formulate an understanding of how these can be false. For hearing children, who naturally

share a common language with their caregivers, the relation between mothers' insight into the child's mental life and children's theory-of-mind further emphasizes the role of family talk about mental states when it comes to theory-of-mind ability, even at the age of 8.

A natural next step will be to empirically test the hypothesis that the early interaction between hearing parents and their deaf children are characterized by less 'mind-mindedness' and that this is related to later lower mentalizing skills.

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Appendix

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