Chapter 3

How access to language affects theory of mind in deaf children

Marek Meristo, Erland Hjelmquist, and Gary Morgan

The deaf community has undergone several changes in the past 20 years due to a growing awareness of sign language in the general public on the one hand (Morgan & Woll, 2010), and, on the other, a rapid rise in the use of neonatal screening for deafness and subsequent intervention for profoundly deaf infants based on cochlear implantation (Young & Tattersall, 2005). Every year around 840 children in the UK and 70 children in Sweden are born with moderate to profound deafness (rnid.org.uk; sdrf.se/sdr). Deafness has serious consequences for spoken language development, literacy, educational achievement, social-emotional development, and ultimately employment (Marschark, 2007). Over 90% of deaf children are born to hearing parents who have no prior experience of sign language or how to adapt their spoken language communication to make it more accessible for their deaf infant in the first few years (Mitchell & Karchmer, 2004).

School provision for deaf children in the UK is varied and depends on local authorities rather than a national standard. Deaf children can be educated with other deaf children in a unit or specialist deaf school, or in a mainstream hearing school with different levels of support. The language addressed to deaf children is therefore mixed, and can comprise the bilingual use of British Sign Language (BSL) and English, the use of signs alongside spoken English sentences (Sign Supported English, SSE), or the use of spoken English only. Education in the special schools for the hearing impaired in Sweden is coordinated by the National Agency for Special Schools for the Deaf and Hard of Hearing. 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. Usually this means that severely deaf children are in classes that use sign language as the first language and children with mildly impaired hearing are placed in classes where spoken Swedish is the first language of instruction. The schools also provide instruction in sign language for hearing siblings and hearing children whose parents are deaf. A sign language training programme for parents is available through a special curriculum established by the Swedish National Agency for Education. This programme is designed to provide parents with functional sign language skills so that they can interact with their children, thereby supporting their child's development.

The development of theory of mind abilities in deaf children

The inclusion of children with atypical development was introduced very early in theory of mind (ToM) research. Many children with autism were shown to have problems with taking another person's mentalistic perspective (Baron-Cohen et al., 1985; Chapter 8). At the same time, children with Down syndrome succeeded on the same tasks, suggesting that children with autism experience specific problems when it comes to mentalizing that are not simply caused by a general cognitive delay. As autism has a neurodevelopmental background, these findings pointed to a neurological basis for impairment in ToM development, and this conclusion has recently been supported by research on adults with Asperger syndrome. This group seemed to have difficulties spontaneously forming expectations based on other people's mental states when the task was given nonverbally as animations on an eye-tracking device although they had no difficulty answering correctly in elicited-response verbal mentalizing tasks, for example the Sally-Anne task (Senju et al., 2009).

Difficulties in ToM understanding among other atypically developing children, that is, deaf children of hearing parents (Peterson & Siegal, 1995), children with visual impairments (Hobson, 2004), and children with cerebral palsy (Dahlgren et al., 2003), who perform at a level similar to children with autism, suggest that neurobiological makeup is not the single reason behind ToM delays. Children who are born deaf do not have a cognitive impairment that leads them to be averse to social interaction but they are in some important ways cut off or disadvantaged in participating in everyday communicative situations. The case of environmental and cognitive influences on ToM development in atypical children is of great theoretical interest since they offer an opportunity to disentangle some of the language variables thought to be of importance in this respect.

It is by now a well-established finding that non-native late-signing deaf children, that is, 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

verbal false-belief tasks (e.g. the Sally-Anne task) than their hearing age mates (e.g. Corina & Singleton, 2009; Morgan & Kegl, 2006; Peterson & Siegal, 1995; Russell et al., 1998; Schick et al., 2007) and deaf peers from deaf families (Woolfe et al., 2002). For example, Russell et al. (1998) found that 40% of a group of deaf late signers between the ages of 13 to 16 years failed the standard unexpected location false-belief task compared with 15% of hearing 3–5-year-old children. In contrast, however, native signing deaf children, that is, deaf children who have deaf parents and have sign language as their first language, do not lag behind the typically developing hearing children in their ToM performance. This pattern seems to be specific to the verbal representation of other minds rather than to problems with understanding the concept of representation in general as a majority of these children passed a photographic representation task (Peterson & Siegal, 1998). The difference between native signing and late-signing deaf children in verbal mentalizing skills remains significant when the ToM task has been made easier to understand by using minimal verbal instructions such as in the 'thought pictures' measures (Woolfe et al., 2002). Here children are given pictures, for example, of a boy fishing who either has a true or false belief about whether he has actually caught a fish. The task in the false-belief condition is for the child to identify that, though the boy thinks he has caught a fish, in reality he has caught a boot and thus has a false belief.

Currently there are mixed results and too few studies on children with cochlear implants to draw firm conclusions but where the intervention occurs early, one study found that children do not seem to show delays in ToM performance (Remmel & Peters, 2009) contrary to previous results from children implanted at a later age (Peterson, 2004). Interestingly enough, it was not age at implantation that was most important in ToM performance but time since implantation, pointing again to the significance of participation and access to communicative situations.

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 language combinations in education, the delayed development of verbal ToM reasoning among deaf children of hearing parents is a consistent finding across various studies. In the majority of 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 represented on the hands in a word-by-word format according to English syntax), supplemented by lip-reading, finger spelling and signs from BSL/Auslan (Peterson, 2004; Peterson & Siegal, 1995; 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 a signed language, for example BSL (Woolfe et al., 2002), are educated primarily in sign language (Meristo et al., 2007) or taught according to the oralist approach (de Villiers & de Villiers, 2000). Children in oralist schools are required to follow instruction through lip-reading as communication in a sign language is not available or is avoided. The aim of oralism is mainly to facilitate the integration of deaf children with the hearing community and to prepare students to enter the hearing society without the need for sign language interpretation. Studies with profoundly and prelingually deaf children from hearing homes who are instructed in an oralist language mode have shown that these children are delayed in developing verbal ToM reasoning skills comparable with the skills of late-signing deaf children attending bilingual schools (Courtin, 2000; de Villiers & de Villiers, 2000; Peterson, 2004). While less common, deaf children from *deaf* homes who have gained early proficiency in a sign language have in many parts of the world nevertheless no choice but to attend classes in an oralist environment. In previous studies of ToM reasoning, native-signing deaf children typically attend bilingual schools.

Sign language in different social contexts

A key issue from the perspective outlined above is whether lack of access to a sign language as a medium for instruction once deaf children get to school influences performance on ToM tasks. We tested this by comparing the performance on ToM measures of deaf children who differ in their language environment at school but share similar home language environments (Meristo et al., 2007). In a first study, we gave the low-verbally loaded 'thought pictures' task to 97 deaf Italian children aged 4–12 years of whom 56 were from deaf families and had LIS (Italian Sign Language) as their native language, and 41 had acquired LIS as late signers following contact with signers outside their hearing families. Of the 56 native signers, 20 children attended oralist schools and 36 children attended bimodal/bilingual schools. For the 41 late signers, comparative figures were 23 and 18, respectively. In the bimodal/bilingual Italian schools, teachers use sign-supported Italian, which relies on spoken Italian words simultaneously accompanied by the corresponding LIS signs, or there is an LIS interpreter who simultaneously translates the teacher's messages into LIS. We found that 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.

In a second study, we gave deaf and hearing children from Estonia and Sweden a wide variety of verbal ToM measures including the standard 'Sally-Anne'

false-belief task, several emotion-reasoning tasks, and advanced ToM tasks of 'Strange stories' by Happé (1994) and 'Faux pas' from Baron-Cohen et al. (1999). The participants were 61 deaf children from Estonia and Sweden, ranging in age from 7 to 16 years, of whom 24 were native signers and 37 were late signers. 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. In both Estonia and Sweden, there is substantial expertise in deaf education, which in comparison with that in Italy, focuses on bilingual instruction without the use of sign-supported methods. In this environment, ToM performance should be enhanced, because there is greater direct access to a sign language than is the case in an oralist instructional environment. Overall, as expected, the bilingual native signers performed at the same level as the hearing comparison children, and performed significantly better than all the other deaf groups, that is, the bilingual Estonian late signers, the bilingual Swedish late signers and the oralist instructed native signers. All children in Study 2 passed a non-mental representation task and performed at ceiling in several executive functioning tasks (see below), indicating that variations in performance on the ToM reasoning measures cannot easily be attributed to variations in understanding representation generally or having difficulties with other cognitive task demands.

Deaf children's communicative experiences in the classroom seem to affect their development of mentalizing as native-signing deaf children attending bilingual programmes tend to outperform native signers attending oralist programmes that emphasized only speech. This research showed that deaf children—whether from hearing or deaf families—profit from bilingual instruction in expressing knowledge of how others' beliefs, feelings and intentions can influence their thinking and behaviour. These findings have important implications for the instruction of deaf children in terms of the benefits of continuing exposure to a sign language for their social awareness, even if they are proficient in lip-reading. There seems to be great flexibility and large possibilities for development and change, which extend beyond early childhood years, when it comes to mentalizing. Our results are also indicative of the resilience of the mentalizing skill, despite degraded linguistic input.

Emerging languages and theory of mind

Irrespective of language experience, the participants in the studies discussed above have ToM 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 a much longer period, as indicated by findings in

a Nicaraguan deaf community (Morgan & Kegl, 2006), a case of true language creation. The situation in Nicaragua is that successive generations of deaf people are learning a language that is still evolving (Senghas et al., 2004). Such a case should be of particular relevance to the question of the role of language input for development of ToM. The emergence of sign language in a Nicaraguan community of deaf children and adults over the past 30 years has made it possible to investigate language experience of different generations of speakers and ToM, but also spatial language and its relation to spatial cognition (Pyers & Senghas, 2009; Pyers et al., 2010). The sign language in Nicaragua was created by persons lacking language models. However, the younger members of the language community will be exposed to a model, signed by the pioneers, and so on, as time passes and new members and generations are added to the language community.

The Morgan and Kegl (2006) study compared two groups of deaf children on two measures: first, the thought-pictures ToM task and, second, an elicited mental state narrative task. The first group were deaf children of hearing non-signing parents who grew up in relative isolation from other deaf children but in otherwise very nurturing environments and first learned sign language in a special bilingual school for deaf children from around 10 years onwards. At the time of testing, the children had been signing for around 5–6 years. The second group consisted of deaf children from similar non-signing hearing parents in nurturing home environments who had entered the same signing environment as the first group but when they were younger (between 5 and 10 years). At the time of testing, they had also been signing for around 5 to 6 years. The two groups differed therefore not on how long they had been immersed in a signing environment but the age at which they had entered the school. The younger children outperformed the older group on the false-belief task based on 'thought pictures' with some of the older children failing this task even in their teens. Importantly the testers in this study were all fluent signers with good knowledge of how to assess deaf children with atypical language learning experiences. Furthermore the test had been previously used successfully with large groups of deaf children (Woolfe et al., 2002). Thus the possibility that poor performance was due to a non-deaf friendly task, children not understanding the point of the test or having to understand the instructions and test information through sign language interpreters could all be ruled out. It appeared that the older deaf children, despite language skills similar to those of the younger children, had real difficulties in false-belief reasoning. However, the differences in performance of the two groups were far less marked on the second ToM task involving elicitation of a narrative based on a wordless cartoon animation. The narratives allowed children to describe a series of mental

states and ensuing desires, confusions, and beliefs from another person's perspective but where they were in control of how they described mental states and behaviours. The narratives revealed that, rather than lacking ToM abilities, the children exposed to language very late in development could appreciate other people's mental states when embedded in a familiar context. However, this reasoning was fragile and, in cases where it had to be used in standard assessments, just not powerful enough.

This was the first study to propose that deaf children with late language acquisition can go on to develop ToM abilities but that such atypical experience results in a less optimal system compared with the case in typical development. The metaphor which Morgan and Kegl (2006) used to describe atypical ToM was like the language abilities of fluent but non-native speakers of a language. Fluent non-native speakers can use language in everyday interaction with very few difficulties but in certain tasks their less automatic more explicit linguistic skills can be found wanting.

In another study, which capitalized on the same natural experimental situation as in Morgan and Kegl (2006), Pyers and Senghas (2009) used a combined cross-sectional and longitudinal design to study 18 deaf persons having different experiences of learning emerging Nicaraguan sign language. The older cohort, as 'pioneers' of creating and learning the sign language, were almost 27 years of age at the first testing occasion and the younger cohort, having been introduced to the already existing sign language, was 17.5 years old. The differences in the spontaneous use of mental state verbs and performance on false-belief tasks were striking, showing higher results for the younger group, having had the more advanced language input but for a shorter time than the older group. These differences, however, disappeared when the testing was repeated two years later. To explain these fading differences, the crucial observation concerned the further development of language competence in terms of use of mental state terms in the older cohort. In the older cohort, more advanced language competence always preceded or co-occurred with success on false-belief tasks.

Nicaraguan deaf signers were further investigated specifically concerning spatial abilities and spatial language (Pyers et al., 2010). Such a study could show whether language experience is crucial for other cognitive domains beside ToM in a unique population of signers. The logic of the design of the study was the same as of the one discussed above. By using two cohorts of signers, one developing the very first version of sign language and one learning a more advanced one, it was possible to study the effects of language separated from social experience. The first cohort was about 30 years of age and the second cohort about 20 years of age at the time of testing. The first cohort had thus a

massively longer experience both of social interaction and of sign language in particular. However, the sign language was less developed for the first cohort. If a more advanced language was necessary for spatial cognition, relatively speaking, it would mean that the second cohort should perform higher on tests of spatial cognition.

The expectations were fulfilled. In experiments arranged to test spatial orientation, the second cohort was significantly better at correctly judging spatial relations than the 10 years older first cohort. The results on the spatial orientation test were compared with characteristics of the sign language of the participants, elicited in a spatial description task ('describe the location so that another person could find it'). The second cohort used a more efficient language in their descriptions, a left-right strategy in one task and a consistent placement of an object in space in the other task (interestingly enough, results on the two tasks did not correlate, suggesting independent language functions). Generally speaking, the participants in cohort 2 used a more advanced language than the participants from cohort 1 (Senghas et al., 2004). Evidently an efficient language for spatial descriptions is an aspect of the quality of cohort 2 language.

For both studies, all participants had been exposed to sign language at least since the age of 6 years. It would have been interesting to know how the variation in age at first exposure relates to false-belief performance since a strong relationship should be expected as previously shown by Morgan and Kegl (2006). The groups were small, however, and present problems in terms of low statistical power. It is interesting though, that in a group of people where some were not introduced to language until the age of 6 years, we see good performance on a false-belief task, given that language is relatively advanced, that is, for cohort 2.

Pyers and Senghas (2009) provide direct evidence for the role of language in false-belief tasks, whereas Pyers et al. (2010) give support for the importance of language input for another specific knowledge domain within the same population. In both cases, the individual profits from everyday interaction in an advanced language community.

Longitudinal studies of deaf children

The issue of quality of language input is of course central to the studies of deaf children of hearing parents with consistently low results on false-belief tasks. Even children where the hearing parents start using sign language when their child is 2 years of age show striking, and persistent, low levels of false-belief results compared with hearing children. In the first longitudinal study of deaf children of hearing parents, 10 deaf children were followed for a two-year period (Falkman et al., 2007). The children were tested at six-month intervals,

giving four observation occasions during the two years. Four tests of mentalizing skills were presented with two based on perceptual information. In one task, the child was shown a picture of a cat, which was then covered by a sheet of paper, with only a small hole showing a spot of the cat's fur. The child was then asked whether a person could understand that a cat is under the piece of paper, not having seen the picture before. In the other perceptual task, the child and the experimenter sat opposite each other at a table. A picture of a pig was then placed on the table, with the pig standing on its feet (or lying on its back) from the perspective of either the child or the experimenter. The child was asked to say how they saw the picture and how the experimenter saw the pig (as standing up or lying down), when viewing the picture from either side of the table. The two other tasks were an unexpected content task and a change-of-location task. A non-mental task was also included (a false photo task). The comparison group of hearing children was tested at the same occasions as the group of deaf children.

After two years the pattern of development was very clear. Over this time, there was no increase in scores on theory-of-mind tasks. The hearing children not only performed at ceiling already at the first testing but did so consistently during the whole investigation period. The deaf children presented a completely different picture. Only two of the 10 deaf children performed at maximum level at the first testing occasion and did so consistently during the two years. For the remaining eight children, one showed a developmental trajectory, starting by performing at 50% at the first testing condition, but after that reliably performing at 100%. The other seven children remained unreliable performers after two years. This is very convincing evidence for deaf children of hearing parents delay in expressing ToM skills.

Of particular relevance is that this study was carried out in Sweden where, as mentioned previously, the official policy is very favourable in promoting the use of sign language. In 1981, Swedish Sign Language (SSL) was given the status of an official language. The ambition is to offer children and parents as much sign language experience as early as possible, after the diagnosis of deafness. Parents are offered a 240-hour training programme, a curriculum-based course, validated by the Swedish National Agency for Education. The course covers functional sign language skills enabling parents to interact with their deaf children. Often parents add other courses to the curriculum-based course, in all giving the hearing parents a relatively good grounding for sharing a language with their deaf children.

In the study by Falkman et al. (2007), parents' sign language skills were rated by an experienced teacher of the deaf, based on records and reports from staff familiar with the parents. Bearing in mind the small sample size, there were no relationships between sign language skills of the parents and children's ToM performance. Although the hearing parents should have increased their

sign language skills over the years, this was evidently not enough to promote the expression of ToM reasoning among their children.

Thus offering an ambitious and curriculum-based sign language course to parents is not enough to enable the deaf children to display typical ToM skills. The delay persists over a number of years, despite the fact that the children are exposed to sign language, at preschool, school, and at home. The way the study described above was designed and the testing sessions were arranged, it is unlikely that methodological flaws could explain the lack of a positive development. Instead, the continuous sign language input from teachers, some deaf, some hearing, and peers at school had limited impact. The same seems to be the case with the ambitious sign language curriculum for hearing parents. This is a very different picture compared with the developmental trajectory in the Nicaraguan sign language community, where a very clear positive change in sign language competence occurred during a two-year period (Pyers & Senghas, 2009) and in Meristo et al.'s (2007) study, which showed that sign language at school is of importance, in particular, for native signers. More recently, Peterson (2009) reported another longitudinal study of late-signing children. The results are somewhat more positive compared with Falkman et al. (2007). A considerably delayed, but still uniform increase was observed over a longer time span than in Falkman et al. for all eight children in the study (except a drop at the fourth testing occasion for one child).

Deaf children of hearing parents thus offer an intriguing insight into the effects of environmental and cognitive factors on ToM development. In the next section, we begin by considering some factors currently thought to be influential in ToM development—executive functions and mirror neurons—and look at these as candidates for explaining delayed ToM in deaf children.

The impact of executive functions

To delineate the preconditions of ToM development, a role for general cognitive skills has been proposed. Leslie (1994) suggested a theory of mind mechanism (ToMM) supplemented by inhibitory control, a selection processor, for explaining the observed changes in children's performance in ToM tasks. More generally, before the age of 4 years, children in their actions are guided by the perceptually available facts rather than the implications of the facts. In the Sally-Anne task, the child, on seeing that the marble is in the basket, also tends to say that Sally will look for her marble in the basket, despite the fact that Sally cannot know since she did not see the transfer of the marble from the box to the basket. The child cannot resist the tendency to react to the obvious facts currently available to the perceptual system. Inhibitory skills, or more

generally executive functions, could be expected to change the pattern of response. For this reason, executive functions have been targeted as critical components of the developmental trajectory of ToM.

However, despite the face validity of this account, it has not been possible to find convincing relationships between the low ToM performance and executive functions among deaf children that differentiate them from comparable hearing children performing at a high ToM level (Falkman & Hjelmquist, 2006; Meristo & Hjelmquist, 2009; Woolfe et al., 2002). Both groups are comparable on measures of executive functions, and there is a within-group correlation between executive functions and ToM in the deaf groups (Meristo & Hjelmquist, 2009), but evidently excellent executive functions are not sufficient for the typical ToM trajectory to emerge.

Neurological systems and mind-focused interaction

Since the earliest ToM studies (Baron-Cohen et al., 1985; Premack & Woodruff, 1978), the biological/neurological dimension of ToM has been a recurrent issue. A recent focus is on the role of mirror neurons. Though single mirror neurons have only been observed and recorded among macaque monkeys, it is believed that humans also have mirror neuron systems. Empirical data from imaging studies (positron emission tomography-PET) and studies using transcranial magnetic stimulation and motor evoked potentials have been interpreted to this effect (Gallese & Goldman, 1998; Gallese et al., 2004). It was suggested in Gallese et al. (2004) that 'the basis of social cognition' rests on a highly automatic process involving perceptual and motor systems.

One hypothesis is that the mirror neuron system of deaf children has not been developed, or triggered to start to develop due to a low level of relevant language experience, supposing that relevant experience would entail reciprocal coordinated actions. However, there are good arguments against such an interpretation. Hauser and Wood (2010) reviewed animal research reaching the conclusion that a mirror neuron system is not necessary for an observer to comprehend goal directed actions never experienced before and not even within the possible repertoire of motor skills of the observer. Altogether, there is little reason to consider a malfunctioning or delayed triggering of a mirror neuron system as a candidate explanation of delayed ToM development among non-native deaf signing children.

The crucial missing piece: sharing language about mental states

Deaf children from hearing homes, educated in either spoken or signed language,

and hearing age-mates. One reasonable interpretation of these findings could be that participation in everyday conversations with family members and friends in some way or another facilitates the understanding of others as mental agents. Yet another more precise hypothesis has been formulated in relation to mothers' use of mental state talk with their young infants and the later development of mentalizing of the children (Chapter 2; Meins et al., 2002). Meins and colleagues (2003) found that it is specifically mental state comments that match with the child's concurrent state of mind ('mind-minded' talk), rather than the usage of mental state comments in general that relates to the children's later ToM performance.

In the case of deaf children, parents' use of appropriate mental state comments may be more difficult to accomplish when the children have severe language delays and the caregivers find communication with their deaf children effortful (Moeller & Schick, 2006). Hearing parents seem to spend less time in coordinated joint attention with their deaf children than with their hearing children (Harris & Chasin, 2005). The parents also tend to interrupt the child's attention by initiating new unrelated activities (Meadow-Orlans & Spencer, 1996). Hearing adults, when faced with communicational problems with deaf children, become more controlling and negative and engage in less flexible and creative discussions (Wood, 1991) as do most parents of 'handicapped' children (i.e. children with specific language impairment, autism spectrum disorders, Down syndrome, etc.). 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 provide better conditions for fluent conversations and thus promote the understanding of others' mental states (Meristo et al., 2007). A key issue from this perspective is whether this mismatching in early interaction with caregivers is reflected in later differences in mentalizing abilities.

The conclusions drawn from studies of how hearing children's ToM development is fostered by interaction with caregivers highlight how non-native signing deaf children's early experiences of communicative interaction are very different. This line of research suggests that emergence of a ToM is dependent on very active and specific patterns of reciprocal action. The tool for regulating such action is language, spoken or signed, and the crucial experience of the child is interaction, focusing on inner as well as outer phenomena, and getting linguistic input from an adult at the moment when the child's mental state is easy to notice and define (Meins et al., 2002, 2003; Siegal & Varley, 2002). The hard evidence for this kind of mechanism is based on results from hearing children, and is

of mind-related verbal comment. The first type refers to comments on the child's mental state, the second to comments on the child's mental processes, the third to the child's level of emotional engagement, the fourth one to comments on the child's attempt to manipulate other people's beliefs, and the fifth and final one to the parent's interpreting for the child (Meins et al. 2002, 2003). For example: type 1—'You know what that is, a palm tree'; type 2—'Now you are thinking'; type 3—'That was funny'; type 4—'You are trying to fool me'. The fifth type refers to the parent's interpretation of the child by putting words into the child's mouth and thus creating a dialogue where the parent is responsible for all the verbal contributions, alternating between infant and parent roles. Parents' talk represented by these categories at 6 months of age was highly related to the children's theory of mind performance three and a half years later. Furthermore, it was possible to disentangle mind-minded talk from maternal sensitivity, and showing that the character of talk was more important than maternal sensitivity. In this perspective, ToM is dependent on learning and specific interactive experiences framed in a conversational context where adults comment verbally on infants' inferred mental states.

The results from non-native signing deaf children, showing a delay in performance on ToM tasks, are completely in line with these observations, but remain to be firmly anchored in empirical data. However, it seems highly likely that a hearing parent with a deaf 6–12-month-old infant is in a very demanding situation when interacting with his or her child when it comes to commenting on mental states. Parents' sign language is at the best rudimentary and generally they are beginners when it comes to interacting in a new mode compared with spoken language. It is also possible that professionals connected with the family (in the UK, teachers of the deaf or speech and language therapists using audio-verbal therapies) have actually advised parents to avoid 'visual' cues when interacting with their children: signs, gestures, facial expressions, etc. As the child gets older and spoken or signed language continue to be delayed, there is a marked increase in the caregiver's difficulties in communicating and expressing mental state explanations for their own or their child's actions. The types of language that predict typical and natural individual variation in ToM development in typically developing hearing children now take on a more crucial significance for ToM development in the interaction between deaf children and their hearing parents. Any reduced experience of conversation may have dire consequences for these children's development of mentalizing skills.

Slaughter and Peterson (Chapter 2) suggest that the evidence for very early ToM capacities, already during the child's first year of life (Onishi & Baillargeon, 2005; Surian et al., 2007), reveals automatic and prelinguistic capacities (Apperly & Butterfill, 2009). We would suggest that there are excellent

opportunities for further investigation of the nature of very early theory of mind skills, and to establish in what way it is automatic and prelinguistic or not. Deaf children will play a key role in this research. Findings by Meins et al. (2002, 2003) have indicated that linguistic interaction at 6 months of age is positive for the development of verbally explicit ToM several years later. Whether this relationship can be traced to any of the mechanisms suggested by Apperly and Butterfill (2009) or by some other function, and what role linguistic communication more specifically has is still an open question.

As is clear from the discussion of research on deaf children, all studies have been done on children beyond, or far beyond, the prelinguistic chronological age. Future studies of native and late-signing deaf children below the age of 2 years, and preferably below 1 year of age, will be crucial for understanding the role of language, interactive communication, and the nature of very early mentalizing mechanisms. Our hypothesis is that late-signing deaf children will show less mentalizing skills from the first year of life onwards, reflecting that these skills are not entirely based on automatic mechanisms. However if these children do instead possess early implicit ToM abilities, despite far from optimal early language experiences, we have solid evidence that 'precursors' of verbal theory of mind actually are independent of later, full-fledged skills as children may pass implicit tasks but fail explicit ones.

Whatever the outcome, studying deaf children's early ToM skills in the first two years of development can provide a substantial theoretical contribution and the practical consequences for informing professionals working with deaf children could be considerable. If the precursors of ToM among deaf children are the same in native and non-native signers, the role of early sign language in terms of parental skills is specific to fostering fully blown verbal ToM reasoning abilities (those tested in a Sally-Anne task). If the result of such future work is that even at the start of life deaf children begin with atypical ToM development due to difficulties with adult–child interaction, then parenting skills are crucial. The implication is that more resources should be allocated to providing parents opportunities for learning sign language and more importantly, skills in communicating in mind-minded ways with their deaf children as early as possible.

Conclusions

We have outlined several potential contributors to ToM development in deaf and typically developing children. Results from a large number of studies focusing on specific ages and children from different cultures and language communities form a coherent picture consistently showing that late-signing deaf children have a delayed development of ToM reasoning skills. It appears

from research on native signing and late-signing deaf children that early access to language in situations where language is a means for, and an integral part of communication has a major effect on typical development of mentalizing skills. The very few longitudinal studies as well as studies of the emerging Nicaraguan sign language underscore these findings by showing a much delayed pattern of development of school-aged deaf children and even adults, from different countries and language environments. Taken together the reviewed research leads us to suggest that the major factor in explaining late-signing deaf children's delayed ToM development is the very reduced early experience of conversation and its role as a vehicle for mind-coordination.

So far, however, studies with deaf children have not included preverbal infants or toddlers and therefore the provisional interpretation of the previous research has to include findings from studies with hearing infants. Among other things, verbally framed joint attention on the mental world of the child during the child's first year has been shown to have a positive predictive effect on ToM understanding among hearing children several years later (Chapter 2; Meins et al., 2002; Ruffman et al., 2002). For hearing parents of deaf children this kind of subtle interaction is unfortunately very difficult to achieve when there is no easy access to a shared language. A few studies of older deaf preschool children document differences in interaction patterns and content of early conversations between parents with hearing and deaf children (e.g. Moeller & Schick, 2006). It would be expected that the interactive pattern between a deaf infant and its hearing parent is less characterized by mutual attention, specifically of the 'mind-minded' kind, compared with hearing parents of hearing infants and deaf parents of deaf infants, though this has yet to be confirmed.

Another direction for research with deaf infants and toddlers would be to map their nonverbal spontaneous ToM reasoning abilities. If our hypothesis is correct, we should find that deaf infants of hearing parents do not display a pattern of visual attention based on belief attribution to the same extent as typically developing hearing infants (Onishi & Baillargeon, 2005; Southgate et al., 2007; Surian et al., 2007). There is also a need to include deaf infants and toddlers of deaf parents who would be expected to show a development very similar to their hearing age-mates. Future research should attempt to refine the testing methodologies, including controlling for the different experiences deaf children may have with assessments (e.g. Marschark et al., 2000; Morgan & Kegl, 2006). Ideally these studies should be designed longitudinally to facilitate causal analyses—which is not only the ultimate aim from a theoretical point of view, but is also crucial for decisions concerning advice to parents and choice of instructional methods.

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