Do You See What I Mean? Shared Reference in Non-native, Early Signing Deaf Children

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A group of non-native, early signing deaf children between the ages of 7 and 11 years were tested on a referential communication task. A group of hearing children matched for sex and mental and chronological age were also included in the study. The aim was to study the deaf children’s ability to take another person’s perspective in a task that resembled a real-life communicative situation to a higher extent than the standard theory of mind (ToM) tasks. A further aim was to investigate the possible importance of a number of background variables such as mental and chronological age, working memory, and false-belief attribution. Results show that the hearing children outperformed the deaf children on the referential communication task and that results were highly correlated with both chronological and mental age, as well as with working memory. There was a positive, but not significant, correlation between false belief and success on the referential communication task. This is an indication that the two tasks tap different abilities and that false belief might be necessary, but not sufficient in order to be skilled in the art of referential communication. The possible role of working memory in the referential communication task is also discussed. The results support the hypothesis of the importance of early talk about mental states for the later development of ToM abilities.

Much of our everyday communication is referential—where a speaker attempts to identify for an addressee a particular referent in the world (Horton & Keysar, 1996). According to Krauss (1979, p. 51), referential communication constitutes “one of the simplest and most fundamental social uses of language.” For example, if there were five different sweaters on the shelf in a shop, each one a different color, it is enough to say “the red one” to identify the intended object, that is, I have unequivocally referred to a specific object. Often the referential situation is not that simple, however (if, e.g., instead there were two red sweaters on the shelf more information has to be added to identify the particular sweater intended), and it is therefore easy to construct tasks of differing complexity for testing the ability to use referential communication in children. Normally, referential communication skills develop during childhood (Hedelin & Hjelmquist, 1998), reach quite good standards at 6–7 years of age, and seem to be refined at about 9–10 years of age. Lloyd (1982) found that although the performance was not optimal concerning information given, 10-year-olds performed like grown-ups in formulating requests for clarification and in outcome, whereas 7-year-olds produced fewer messages than the older children did.

The Glucksberg and Krauss (1967) paradigm has been one of the most common methods for studying referential communication (Dahlgren, Dahlgren Sandberg, & Hjelmquist, 2006). This task, a game where one participant is asked to choose a card out of a set of cards and then verbally describe it in a way...
so that another participant is able to pick up the same card from an identical set of cards, has been used in a great number of studies showing that even 10-year-olds have problems with correctly evaluating the verbal messages in the task (Brownell, Trehub, & Gartner, 1988; Hedelin & Hjelmquist, 1998; Robinson & Robinson, 1977; Sonnenschein, 1986). In fact, 4- and 5-year-olds in Brownell et al. (1988) evaluated verbal messages on irrelevant grounds, the 6-year-olds on the basis of the success or failure of the behavior following the verbal message (not the quality of the message), and not until the children were 10 years old did they evaluate the verbal message on the basis of its quality.

To be able to use referential communication in an efficient manner, at least three factors play an important part. The first and second factors involve the child having to have developed basic communicative and linguistic skills as well as the necessary information-processing skills. The third factor of importance is the ability to take another person’s perspective, more specifically a so-called theory of mind.

The term theory of mind (ToM) refers to our ability to attribute thoughts, beliefs, and feelings to ourselves and to other people and to our understanding that actions are governed by these thoughts, beliefs, and feelings (Tager-Flusberg, Baron-Cohen, & Cohen, 1993). This ability is central to our social life. In order to understand that beliefs are only representations of the world, not exact copies, the child must be able to understand that beliefs can also be false, that is, they can also be misrepresentations of the world (Hala & Carpendale, 1997). The ability to attribute false belief has therefore become the most widely used test of whether a child has developed a ToM or not. The original so-called false-belief task is the “Maxi”-task developed by Wimmer and Perner (1983). In the Maxi-task the following short story is acted out for the child with the help of little dolls and dollhouse furniture. Mother returns from her shopping trip. She has bought some chocolate for Maxi. Maxi puts the chocolate away in Cupboard A. After Maxi has put the chocolate away, he goes out to play. Mother takes the chocolate out of the cupboard and uses some of it for a cake. She puts the chocolate back, not in Cupboard A, but in Cupboard B. She then goes out to buy some more eggs for the cake. Maxi comes back from the playground. He is hungry and wants some chocolate. After the story is completed, the child is asked where Maxi will look for his chocolate.

In contrast to the standard ToM task, the referential communication task invites the child to take his or her own initiatives. In the ToM task the experimenter asks the child for specific information; often the child only has to point to one of two locations or answer yes or no. In contrast, the referential communication task requires the child to understand on his or her own what information needs to be given in a certain situation and to leave out information that is not relevant. Thus, despite the range and specificity of the conversation being limited, for example, a card game will still have a higher degree of resemblance to a real-life communicative situation. In line with this, Woolfe, Want, and Siegal (2003) found a low relationship between ToM and a referential communication task, indicating that the two tasks tap different abilities. A crucial difference is also that the referential communication task does not explicitly invoke false-belief judgments but requires true and relevant information to be conveyed.

Previous studies on deaf children show that they in certain cases exhibit problems in all three areas considered to be of importance in the ability to use referential communication in an efficient manner, that is, linguistic skills, information-processing skills, and ToM.

Many are in agreement that a significant problem facing deaf children lies in the barrier it creates to the acquisition of functional communication skills. The interpersonal communication of deaf children born into hearing families is often clearly impaired. Previous research has also pointed to the importance of sign language for the development of communicative skills (e.g., Schick & Gale, 1995). Even in cases where children have acquired a high level of sign language, their hearing parents are not always able to sign well enough for a complex and sophisticated bidirectional communication system to develop (Vaccari & Marschark, 1997). Much of research, however, has concentrated on specific linguistic skills rather than on the combination of both linguistic and nonlinguistic skills that together create a necessary foundation for successful everyday communication (Mackay–Soroka, Trehub, & Thorpe, 1987).
When it comes to the necessary information-processing skills, working memory is of great interest since previous research has shown that native signer’s (deaf children born to deaf parents) performance on a task of verbal working memory (the digit span, Wechsler, 1977) deviates differently from hearing children’s in that the hearing children show greater differences for forward and backward recall. Deaf native signers have, in previous studies, also shown better results than hearing children on backward recall as well as on spatial working memory (Wilson, Bettger, Niculae, & Klima, 1997).

Even though the referential communication game could be viewed as a task where communication is about the physical, rather than the mental, world (Woolfe, Want, & Siegal, 2003), it is still, in a sense, a ToM task in that it requires the understanding of another person’s state of knowledge as the child needs to be able to determine if it is necessary to supply more information than what has already been given (Hedelin & Hjelmquist, 1998). A full-fledged referential communication skill also implies an understanding that the listener can be misinformed (an understanding that comes with a developed ToM), not only that the listener has too little information. Even though there is a rather intense debate going on regarding how ToM develops, most researchers are in agreement that at about the age of 4 years most typically developing children have acquired a so-called first-order ToM. A number of previous studies have demonstrated, however, that deaf children who are not native signers (i.e., are born into hearing families) show problems in the area of ToM (Peterson & Siegal, 1995, 1999; Woolfe, Want, & Siegal, 2003), in contrast to deaf children born in deaf families, who show the same developmental pattern as hearing children in hearing families. It is likely that this delayed development in the area of ToM would also affect their ability to perform referential communication messages. In fact Mackay-Soroka et al. (1987) has previously shown that deaf children are delayed on referential communication tasks and this finding was reported before the observation of delay of ToM tasks among deaf children was published.

Woolfe, Want, and Siegal (2002) suggested a “conversational” theory to explain the low performance on ToM tasks among non-native signers. The lack of a shared language enabling the typical interactive pattern between infant and parents, where parents use language to comment on the inner mental states of their babies, was supposed to be detrimental to the child’s development of ToM skills. Deaf children born in deaf families of course share a language with their parents in the same way hearing children in hearing families do and, therefore, show the same developmental patterns as do hearing children. This view is strongly supported by the findings of Meins et al. (2002, 2003). They showed that among hearing children that mothers’ mind-minded talk about babies’ putative mental states at 6 months predicted mentalizing skills 4 years later. We can be sure that deaf children born to hearing parents are not offered a native language interaction at 6 months by their parents. We should therefore expect a lower performance on a mentalizing task among these children, compared to hearing children.

In summary, the aim of the study was to examine the referential communication abilities of a group of young, non-native early signing, deaf children. As non-native signers have previously exhibited a delayed ToM development, we hypothesized that this group would also have more trouble completing the referential communication task compared to an age-matched group of typically developing hearing children.

A further aim of this study was to examine the possible role played by a number of additional background variables, that is, chronological age, mental age, working memory, and linguistic skill, in the ability to complete the referential communication task. A comparison between referential communication and a standard ToM task was also conducted.

Method

Participants

Ten severely or profoundly deaf children took part in this study. They were drawn from two special schools, one residential and one day school, where Swedish Sign Language (SSL) was the official language. In practice this meant that SSL was used by all personnel, not only for explicit teaching in the classroom but in all other situations as well. The children ranged in
from 7.4 to 11.3 years, with an average of 9.4 years. None of the participating deaf children had any additional disabilities that might affect their level of functioning (e.g., autism, mental retardation, visual impairment, or cerebral palsy). The mean age for receiving a diagnosis was 20 months. In light of the comparatively early diagnosis together with the fact that Swedish deaf children and their families are offered sign language education as soon as a diagnosis has been given, the present study could be viewed as a case where non-native signing children are offered what seems to be very good conditions for developing their language, given the lack of a signing deaf person in the home. If we were to find delays in this group, this would further support the view that early (i.e., before the child’s second birthday) conversational experience in a language shared with parents/caretakers is of great importance.

Four of the children had cochlear implants (CIs), but all of them, including one boy who had acquired spoken language to the degree where strangers could easily understand him, used SSL as their primary mode of communication. The inclusion of CI children was in practice necessary, though it introduces questions concerning the comparison with the other deaf children. In Sweden it is increasingly difficult to find deaf children without CI, today even more so than in 2001 when the groups participating in the present study were formed. Two of the CI children were given their implants at the age of 3 years, one at 5 years, and finally one boy at 8 years. More importantly, however, from a methodological point of view, Peterson (2004) shows that CI children who were implanted at a mean age of 2 years performed low on ToM tasks. Because there was no noticeable effect of CI in Peterson’s study, together with the fact that only one of the CI children actually made use of the CI in communicative situations, we considered it motivated to include a group of deaf children mixed in respect of CI use.

Two of the deaf children came from families where one or both parents had a hearing loss; however, both were non-native signers. One of them was adopted to Sweden from another northern European country at the age of 3 years, and at that time she had had no introduction to sign language at all. The other child has one parent with a hearing loss, but neither of her parents knew any sign language beforehand.

A comparison group of 10 typically developing hearing children individually matched for mental age and sex also took part in the study. Mental age was determined by Raven’s (1965) colored progressive matrices. No statistically significant differences were found in chronological or mental age between the two groups, $F(1, 18) = 0.010, p = .920$; $F(1, 18) = 0.054, p = .819$. Background data for both groups regarding chronological and mental age can be found in Table 1. The Raven test was chosen because it requires judgment of spatial relations with very low verbal loading and has been used in related research before (Woolfe, Want, & Siegal, 2002). Other tests of mental abilities have proven to be problematic for comparisons between deaf and hearing children.

Materials

All test instructions given in sign language were first translated from Swedish to SSL by an experienced translator and were also checked by two of the teachers who worked at the special school for the deaf where the testing took place. Both these teachers were themselves deaf native signers.

Referential communication task. The referential communication task used was based on the Glucksberg and Krauss (1967) paradigm. The child and the experimenter sat opposite each other at a table. Both had an identical set of 16 cards randomly laid out on the table in front of them. Between them they had a screen that was high enough to prevent them from seeing each other’s cards but not so high that it prevented them to freely communicate with each other in sign language. The cards depicted faces drawn in black on a white background. They differed on four different dimensions with two values on each dimension (boy/girl, happy/sad, nose/no nose, large head/small head, giving sixteen cards). These four dimensions were pointed out to the child, and the interpreter also signed all the signifying words to the child. The child was told that this was a game where one of the participants was to choose a card and then verbally describe it in a way so that the other participant was able to pick
up the same card. Before the actual test sessions a practice trial took place in order for the experimenter to make sure that the child had understood the task. After the practice trial, the child was asked to start.

The child chose a card and then began describing it. When the child stopped, the experimenter asked the so-called adequacy question, that is, the child was asked to judge if he or she had given enough information for the experimenter to be able to choose the correct card. The adequacy question was asked once. If the answer to the adequacy question was “yes,” the experimenter picked up the card she thought corresponded to the description. If the answer was “no,” the child was then allowed to add information if he or she wanted to. The procedure usually took only a few minutes and was repeated three times directly after one another.

ToM task. An adaptation of the original Maxi-task developed by Wimmer and Perner (1983) was used. In addition to the actual test question where the child is asked where Maxi will look for his chocolate, the following control questions were also asked: (a) “Where did Maxi put the chocolate?” (after Maxi has put the chocolate away in Cupboard A); (b) “Where is the chocolate now?” (after Mother has moved the chocolate to Cupboard B); and (c) “Where did Maxi first put the chocolate?” (after the test question has been asked). If the child failed the actual test question, he or she was also asked if Maxi could know that mother had moved the chocolate.

Memory tasks. Two memory tasks were used, one verbal and one visuospatial. The verbal memory task used was the digit span subtest of the Wechsler Intelligence Scale for Children (Wechsler, 1977). The children were asked to repeat numbers read out loud or signed by the experimenter. This was done both forward and backward. The visuospatial task was the so-called Corsi blocks task (Rapala & Brady, 1990). Blocks were placed on a sheet of paper. The experimenter then pointed at the blocks in a slow pace in a certain pattern, and the child was asked to repeat the pointing. The number of blocks started at four and continued up to nine blocks.

Sign language proficiency rating of the deaf children. In order to make sure that the children’s task performance on the referential communication, ToM, and memory tasks is not masked by limited language skills, a rating of each of the participating deaf children was conducted (there is at present no formal test of sign language proficiency available in Sweden). A highly experienced teacher of the deaf together with an experienced sign language interpreter used to working with children independently viewed video sequences of each child and rated their sign language level. Each of the children was also shown a video of a story told in SSL and was immediately afterward asked questions on the content of the story. In addition to this, interviews were conducted with all teachers as well as with the staff at the deaf unit of the county council. This resulted in each child receiving a rating of 1 (not yet reached the sign language level expected for that age group), 2 (age equivalent sign language level), or 3 (higher level of sign language than expected for that age group).

Procedure

Each child was tested individually in a quiet room made available at the child’s school. All testing of the deaf children was conducted by a female assistant fluent in SSL and also hearing so that she was able to communicate directly with both the children and the experimenter. She was familiar to the children and had also been given careful instructions how to carry out the different tasks. The experimenter was always present for the testing of the deaf children and the test sessions were video recorded with two cameras (one

Table 1 Background data for deaf and comparison groups regarding chronological and mental age

<table>
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<th>Deaf group (n = 10)</th>
<th>Comparison group (n = 10)</th>
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<tr>
<td></td>
<td>M (SD)</td>
<td>Range</td>
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<tr>
<td>Chronological age</td>
<td>9.44 (1.31)</td>
<td>7.42–11.25</td>
</tr>
<tr>
<td>Mental age</td>
<td>9.98 (1.54)</td>
<td>7.75–11.67</td>
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pointed at the child and one pointed at the assistant carrying out the testing). These recordings were later transcribed into Swedish and used for scoring. The experimenter conducted all testing on the referential communication task. The experimenter had enough sign language ability to manage this task, and the female assistant was also present in case any communication needed to be clarified (this was rarely the case, however). The experimenter carried out all testing of the hearing children.

Scoring

Referential communication task. The referential communication task was scored in accordance with a study by Dahlgren et al. (2006). The numbers of relevant, irrelevant, and redundant features noted before the adequacy question were counted. Relevant information was defined on four distinguishing dimensions. Irrelevant information was defined as mentioning other characteristics of the pictures, for example, “eyes” and “mouth” that did not distinguish the pictures, and redundant information that is correct but is a rephrasing of information already given, for example, “long hair” if “girl” had already been mentioned. Redundant features do not add to the information but could be taken as an indication that the child grasps the task and is trying to give a more exhaustive explanation. It could however also indicate that the child does not distinguish between crucial and not crucial features. As a strict measure of the real competence to solve the task, an efficiency measure was used. Total number of mentioned relevant features subtracted by total number of irrelevant features, divided by the maximum possible number of relevant features (i.e., perfect performance; only maximum relevant features mentioned and no irrelevant ones = 1). This measure was used as it taps the child’s ability to pick out the distinguishing features and to avoid irrelevant features, which is the essence of the task, and also what is the mark of efficient referential communication in a real-life setting.

ToM task. In order for the child to pass the task, all control questions had to be answered correctly. One point was given for correct false-belief responses, (i.e., “where will Maxi look for his chocolate?”). If the child answered all control questions correctly, but failed the test question, a score of zero was given. If a child failed any of the control questions he or she was excluded from the study.

Statistical Analysis

A two-factor mixed analysis of variance (ANOVA) repeated measures design was carried out to compare children’s performance across group and trial. The between-subject factor was group (deaf vs. hearing); the within-subject factor was trial (first, second, and third). The dependent variables were measures of different aspects of the referential communication task: efficiency, number of relevant features, number of irrelevant features, number of redundant features, total number of features given, and finally number of correct answers on the adequacy question. Variables controlled for were age (chronological and mental), memory (two subtests of verbal memory and one test of spatial memory), and ToM.

A one-way ANOVA was used for analyzing between-group effects in the memory tasks, and the Wilcoxon signed ranks test was used to analyze possible within-group differences on the test of verbal working memory. Pearson correlations were computed between data on chronological and mental age and verbal and spatial memory.

Results

The analysis showed that the hearing children provided more relevant information, \( F(1, 18) = 5.584, p = .03 \), were more efficient, \( F(1, 18) = 6.903, p = .017 \), and correctly answered the adequacy question more often, \( F(1, 18) = 8.733, p = .008 \), than the deaf children (Table 2). Covariates were included in two steps: first all six (i.e., chronological and mental age, forward and backward verbal recall memory, spatial memory and ToM), then only those, if any, that contributed significantly at \( p \) level .05 or less. The multivariate analysis should, however, be interpreted with some caution as the low number of participants in the present study does make the statistical analysis less powerful and decreases the possibility of finding true
differences/relationships. Adding the covariates did not alter the results for the three variables mentioned above.

There was no difference between deaf and hearing children, however, with regard to amount of irrelevant or redundant information, $F(1, 18) = 1.350, p = .188$, and $F(1, 18) = .086, p = .773$, respectively, or in total number of features, $F(1, 18) = 1.922, p = .183$, and these results were not influenced by the covariates.

A comparison of performance across trials without covariates showed an effect of training on only two of the six measures, namely, amount of relevant information given, $F(2, 36) = 6.71, p = .003$, and total amount of information given, $F(2, 36) = 6.96, p = .003$, but these effects disappeared when the covariates were included: relevant information, $F(2, 32) = 0.30, p = .745$, with covariates mental age and digit span forward, and total amount of information, $F(2, 34) = 0.28, p = .754$, with covariate mental age.

There was a significant interaction between trial and group for amount of relevant information given, $F(2, 36) = 4.16, p = .024$, but this effect disappeared when the covariates mental age and digit span forward were included, $F(2, 32) = 1.77, p = .186$.

All children in the hearing group passed the ToM task, but only four children in the deaf group did so. A Fisher’s exact test also showed the difference in performance on the ToM task between the two groups to be significant ($p = .011, \text{two tailed}$).

A one-way ANOVA showed a significant group difference on the digit span task forward recall, with the hearing children clearly outperforming the deaf children, $F(1, 18) = 27.563, p < .001$. There were no significant differences between the two groups on the digit span backward recall or the Corsi block task, $F(1, 18) = 1.991, p = .175; F(1, 18) = 0.066, p = .801$. A Wilcoxon signed ranks test revealed that there were significant within-group differences in both deaf and hearing children when comparing performance on the forward and backward recall of the digit span task (deaf: $z = 2.126, p < .05$; hearing: $z = 2.848, p < .01$).

Four of the children were rated as having sign language abilities more advanced than could be expected considering their age. One child was rated as age equivalent in his or her sign language ability, and three children were rated as having not yet reached the sign language ability expected for their age. One child was rated as age equivalent in productive sign language but above age equivalent on sign language reception. One child was rated the opposite way, that is, above age equivalent on language production and as age equivalent on language reception.

Correlations

Point-biserial correlations were computed for the deaf group (the hearing group performed at ceiling with no variation) between the false-belief task and the other covariates (chronological and mental age), as well as between verbal working memory measures (digit span forward and backward recall) and spatial working memory (Corsi block task). There were no significant correlations between false belief on the one hand and any of the remaining background variables on the other (chronological age: $r_{pb} = +.07, p = .86$; mental age:

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| Table 2 | Group differences and changes in performance across trials on the referential communication task (mean values), deaf and hearing groups, after controlling for covariates |
|---------|---------------------------------|-----------------|-----------------|
|         | Trial 1 | Trial 2 | Trial 3 |
| Deaf    |         |         |         |
| Relevant | 2.00    | 2.50    | 2.90    |
| Irrelevant | 0.30    | 0.60    | 0.60    |
| Redundant | 0.10    | 0.20    | 0.10    |
| Total    | 2.40    | 3.30    | 3.60    |
| Efficiency | 0.45    | 0.47    | 0.56    |
| Adequacy | 0.50    | 0.40    | 0.40    |
| Hearing  |         |         |         |
| Relevant | 3.4     | 3.6     | 3.5     |
| Irrelevant | 0.2     | 0.2     | 0.2     |
| Redundant | 0.1     | 0.1     | 0.1     |
| Total    | 3.7     | 3.9     | 3.8     |
| Efficiency | 0.68    | 0.85    | 0.85    |
| Adequacy | 0.90    | 0.90    | 0.90    |

*a* A significant group difference.  
*b* A significant interaction effect.  
*p < .05, **p < .01.*
age: $r_{pb} = +.21, p = .57$; digit span backward recall: $r_{pb} = -.19, p = .60$; Corsi blocks: $r_{pb} = +.41, p = .24$, all one tailed). Digit span forward recall showed no variation in the deaf group.

To further examine the importance of the hypothesized background variables, correlations were computed between chronological and mental age, verbal and spatial working memory, and false belief on the one hand and performance on the referential communication task on the other (Table 3). Because statistical analysis had revealed very little difference across trials, the results on the referential communication task used in the correlations were mean values (across all three trials). Chronological age was significantly correlated with total number of features (deaf: $r = .684, p = .029$; hearing: $r = .651, p = .042$), efficiency (deaf: $r = .648, p = .043$; hearing: $r = .508, p = .134$), relevant features (deaf: $r = .750, p = .012$; hearing: $r = .668, p = .028$), and adequacy question (deaf: $r = .655, p = .040$; hearing: $r = .679, p = .031$) in both groups. Mental age was even more strongly correlated with total number of features (deaf: $r = .754, p = .012$; hearing: $r = .662, p = .037$), efficiency (deaf: $r = .840, p = .002$; hearing: $r = .744, p = .014$), relevant features (deaf: $r = .936, p = .000$; hearing: $r = .827, p = .003$), and adequacy question (deaf: $r = .845, p = .002$; hearing: $r = .785, p = .007$) in both groups. There was also a significant correlation in the deaf group between verbal working memory, backward recall, and total number of features as well as adequacy question ($r = .836, p = .003$, and $r = .668, p = .035$, respectively). In the hearing group there was a strong correlation between spatial working memory on the one hand and total number of features, irrelevant features, and adequacy question ($r = .765, p = .010$; $r = .643, p = .045$; $r = .734, p = .016$, respectively). Information on correlations can be found in Table 3.

**Discussion**

The deaf children who participated in the present study had all reached an age of between 7 and 11 years, an age when they could be expected to have reached good standards in referential communication skills (Hedelin & Hjelmquist, 1998). Despite this the group of deaf children were less efficient in their referential communication than the hearing group, they also provided less relevant information and were less able to make an adequate judgment when asked if they had provided enough information for the listener to be able to pick the right card. Even though the deaf children continuously provided more total information across trials, the quality of the communication did not improve as the deaf children were less likely to use only the referentially distinguishing features.

According to Lindblom (1990), in order for interpersonal communication to be successful, the speaker has to have what is referred to as communicative empathy, that is, the ability to take the point of view of the interlocutor, otherwise communication might break

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**Table 3**  Correlations between performance on the referential communication task and the hypothesized background variables

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<thead>
<tr>
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<th>Deaf</th>
<th>Hearing</th>
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<tr>
<td></td>
<td>Relevant</td>
<td>Irrelevant</td>
</tr>
<tr>
<td>Chronological age</td>
<td>.750*</td>
<td>-.037</td>
</tr>
<tr>
<td>Mental age</td>
<td>.936**</td>
<td>-.305</td>
</tr>
<tr>
<td>Digit span forward</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Digit span backward</td>
<td>.481</td>
<td>.440</td>
</tr>
<tr>
<td>Corsi blocks</td>
<td>.197</td>
<td>.319</td>
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<tr>
<td>False belief</td>
<td>.100</td>
<td>-.260</td>
</tr>
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* $p < .05$; ** $p < .01$.

*No variation in the deaf group.

*No variation in the hearing group.
down. Essentially this would require the child to have developed a ToM. Indeed, the only child in the deaf group who performed perfectly on the efficiency measure of referential communication (i.e., provided information on all four relevant features while mentioning none of the irrelevant) also passed the mentalizing task. The correlation in the deaf group between ToM, as measured by a standard false-belief task and efficiency on the referential communication task, was not significant, however, and this is in accordance with the lack of a relationship reported by Woolfe, Want, and Siegal (2003), though note that in their study the two tasks were presented 2 months apart. Nevertheless, the deaf children in our study performed significantly poorer than the hearing children on the mentalizing task. Our results strongly suggest that ToM is a necessary, but not sufficient, prerequisite for successful referential communication.

Of course the child must also have developed a certain level of language skills in order to be able to formulate a message in referential communication. All but two of the deaf children were judged as having receptive sign language skills that were age equivalent or above the expected level for their age, and all but three had productive sign language levels that were age equivalent or above average for their age group. The children who were rated as having sign language skills that were below that which could be expected for their age still had a language level that would be judged as enough to manage the referential communication task used in the present study, as shown by the children during the practice trial. Essentially, the referential communication task only required the vocabulary for describing the relevant features (boy/girl, happy/sad, nose/no nose, large head/small head), and this was definitely within the children’s repertoire. Equally important, all deaf children answered all control questions on the ToM tasks correctly. Answering these questions implied managing sign language within a story context, which, as described in the Method section, implies keeping track of a number of events in a narrative. It is not very likely that the deaf children because of sign language deficiencies would fail the false-belief question but pass the control questions. It is even less conceivable that linguistic factors could in any way contribute to the less than perfect performance of the hearing children on the referential communication task. This leads us to the conclusion that language level per se, whether spoken or signed, had a negligible effect on the observed group differences on the referential communication as well as ToM performance.

Answering the adequacy question correctly, that is, being able to judge if enough relevant information has been given in order for the experimenter to be sure to pick the right card, would again require the child to take the point of the interlocutor. There was no correlation, however, between answers given on the adequacy question and passing the false-belief task. Judging whether or not enough information has been given does, however, also make demands on the child’s working memory capacity.

The results also show that there is a significant positive correlation between working memory and high performance on the adequacy question for both groups. In the hearing group it is spatial working memory that correlates with adequacy, whereas in the deaf group it is verbal working memory backward report.

There was also a significant or close to significant positive correlation for both groups between age, both chronological and mental, and amount of relevant features given, correct answer to the adequacy, and degree of efficiency.

Earlier studies have also shown that deaf and hearing children differ on tasks of working memory. Wilson et al. (1997) found that there is a large discrepancy between forward and backward recall on tests of verbal working memory in hearing children, whereas deaf children’s results on forward and backward recall are much more similar. This pattern is true also in the present study. There is a significant within-group difference between forward and backward recall in both groups, but notably more significant in the hearing group ($p = .004$ in the hearing group vs. $p = .03$ in the deaf group). Wilson et al. also found that the deaf native signing children actually outperformed the hearing children on spatial working memory. In the present study, the deaf children were equal to, but not better than, the hearing children on spatial working memory ($p = .175$).

As we hypothesized, even though the comparison group outperformed the deaf group in most respects...
on the referential communication task, there was still some variation in the hearing group. This is in accordance with previous research (e.g., Hedelin & Hjelmquist, 1998; Lloyd, 1982; Sonnenschein, 1986) showing that referential communication skills are found in children at the age of approximately 6–7 years but continue to develop and are not fully fledged until several years later.

A problem in this research is of course the small sample size. It is, however, extremely difficult in a small country to obtain large samples. Looking at other studies of deaf children also shows samples along the same size as the present study (e.g., Peterson, 2004).

One possible threat to the validity of the results is the inclusion of children with CI. However, a closer look at the results shows that out of the four children in the deaf group who passed the false-belief task, two were CI implanted whereas two were not. Also, the only child in the deaf group who both passed the standard belief task and had a perfect score on the efficiency measure did not have a CI. The results of the children with CI are thus compatible with those reported in Peterson (2004).

To conclude, the deaf non-native signers are delayed in their ToM development and their referential communication development, but there is only a low relationship between the two. Lack of relevant early (i.e., before the child’s second birthday) conversational experiences could be part of the explanation for these results (even though in the case of referential communication, information-processing variables also seem to be of importance). This interpretation is strongly supported by the results of Meins et al. (2002, 2003), who have found the mothers talk about infants’ mental states at 6 months of age significantly predicted children’s mentalizing skills 4 years later. Because the deaf children in our study did not at all share a common language with their parents at the age of 6 months, we would expect delays in mentalizing skills several years later.

An obvious future research task is to record and analyze the very early communication between deaf children and their parents, whether deaf or hearing, the latter case requiring very early detection of the deafness and consequently posing a major methodological challenge.

References


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