Theory of mind in children with severe speech and physical impairments

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ABSTRACT

The development of a person’s ability to understand other’s thoughts and feelings, so-called “theory of mind” (ToM), is subject to study. Children with communicative disabilities have exhibited problems in this respect, highlighting the role of language in the development of ToM. In this study, ToM was studied in children with cerebral palsy and severe speech impairments. Two tasks, differently dependent on verbal abilities, were used. The results were compared to those of a mental age matched group. The groups differed significantly on the verbally dependent task while difference in performance did not reach significance on the less verbally dependent one. The results are discussed in terms of a delayed development of ToM in children with severe speech and physical impairments, dependent on verbal abilities.

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1. Introduction

Theory of mind, i.e. an understanding that other people (and oneself) have thoughts, desires and beliefs and that these mental states govern behaviour, is a fundamental ability to fully understand human behaviour and to take part in daily life. It is essential to understand that people engaged in the same situation as one self can have different mental states in spite of the same experience. In general, this ability develops by the age of four (Perner, Leekam, & Wimmer, 1987; Surian & Leslie, 1999) and subsequently at the age of 6–7 an understanding of someone else's thinking about a third person's thinking develops. However the development of theory of mind begins early in the child’s life with precursor skills that includes joint attention, use of mental states and pretend play (Miller, 2006).

Many researchers have claimed that language plays a special role in the development of theory of mind. One suggestion is that language influences the development of theory of mind (ToM) through the children’s exposure to talk about mental states. This suggestion is based on the findings that mothers’ and families’ talk about mental states predicts children’s later theory of mind performance (Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Ruffman, Slade, & Crowe, 2002), that siblings promote the children’s development of theory of mind (e.g. Jenkins & Astington, 1996; Peterson, 2000) and that late-signing deaf children performed worse on theory of mind tasks in comparison to native signers (e.g. Meristo et al., 2007; Woolfe, Want, & Siegal, 2002). The latter finding could be explained by the late signers not having as many opportunities as native signers or hearing children to learn about mental states through conversation.

Another suggestion is that general language abilities promote the development of theory of mind (de Villiers & de Villiers, 2000). Astington and Jenkins (1999), e.g. found that scores of expressive language ability and receptive scores for syntax predicted later performance on theory of mind tasks. Farrar and Maag (2002) also found that vocabulary and MLU predicted performance on theory of mind tasks.
A combination of linguistic abilities and social competence, i.e. socio-linguistic intelligence, is suggested to be important (Shatz, 1994) for developing an understanding of the mind both of oneself and others. There are two assumptions behind this explanation. First, young children compare themselves to others as they develop a sense of self. Second, as language develops they start to participate in conversations giving verbal expressions to internal states, in line with Siegal, Varley, and Want (2001).

Another account of how children develop a theory of mind assigns a special role to pretend play. There are studies showing that children who engaged more in pretend play performed better on theory of mind tasks than those who did not (Lillard, 1994). Leslie (1987) suggested that the same cognitive structures are used in understanding other minds as in pretend play. Others claim that similar mental representation abilities are engaged in pretend play and false belief, despite the fact that pretend play and false belief develop at different ages (pretend play, in the second year; false belief, in the fourth or fifth year; Ferguson & Gopnik, 1988; Perner, 1988; Wimmer, Hogrefe, & Sodian, 1988).

There are also suggestions of a link between the capacity to hold in mind and development of theory of mind. Gordon and Olson (1998) claim that “the concept of false belief itself is acquired when the child has the computational resources to represent, that is hold in mind, a previously created representation even when a new representation is created by a new perceptual situation” (1998, p. 81), a view comparable with the earlier findings of Baddeley (1986). There are studies suggesting that working memory predicts theory of mind competence (Buitelaar, van der Wees, Swaab-Barneveld, & van der Gaag, 1999).

During the last years studies have been published, proposing a close link between executive functions and theory of mind. There are both theoretical and empirical reasons for this proposal. One reason is the hypothetical association between an inability to engage in goal-directed activity and pretend play in children with autism (Hughes, 1998a). Another claim is that ToM tasks pose significant demands on executive functioning (Hughes, 1998a). Carlson and Moses (2001) suggest that their findings of statistically significant correlations between a number of inhibitory control measures and theory of mind tasks imply that executive functioning is centrally involved in ToM development. This suggestion is also in line with other findings (e.g. Hughes, 1998a, 1998b; Hughes, Dunn, & White, 1998; Perner & Lang, 1999).

Due to the proposed importance of the role of language development, pretend play and working memory in the development of theory of mind, children with cerebral palsy and severe speech impairments are of special interest to the field. The diagnosis cerebral palsy is a non-specific diagnosis, based on clinical signs, all depending on a non-progressive damage of the immature brain, before, during or shortly after birth, with motor disabilities. As a consequence (Hagberg & Hagberg, 1993) the children have a severely restricted capacity for independent pretend play. In addition, the children are often limited in their productive speech which limits their contribution to discourse in conversational situations (Hjelmquist & Dahlgren Sandberg, 1996). In her studies of literacy abilities in children with SSPI Dahlgren Sandberg (2001) also found specific problems with working memory. Taken together, these observations indicate possible problems in the development of theory of mind in these children.

During the last decade a few studies have been made on children with SSPI and ToM ability. The common finding is that the children performed worse than children matched for mental age and/or IQ on theory of mind tasks (Dahlgren, Dahlgren Sandberg, & Hjelmquist, 2003; Falkman, Dahlgren Sandberg, & Hjelmquist, 2005). Dahlgren et al. (2003) suggested that the poor performance on the theory of mind task could partly be explained by linguistic and communicative skills. They also questioned the ecological validity of commonly used ToM tasks and argued that performance on false belief tasks might not predict theory of mind performance in real life. In a longitudinal study of six children with SSPI (Falkman et al., 2005) the authors found that the children followed a normal pattern of theory of mind development but with a severe delay compared to children without disability.

However, the role of language abilities in the development of theory of mind abilities in children with SSPI is still unclear. The conclusions from earlier studies have partly been based on the performance on the classical false belief task, Sally and Ann (Baron-Cohen, Leslie, & Frith, 1985) which requires certain verbal skills. The aim of this study was to investigate language abilities and short-term memory in relation to performance on the classical false belief task Sally and Ann and on the “thought picture” measure of theory of mind that minimizes verbal requirements.

2. Method

2.1. Participants

Fourteen children with SSPI participated in this study. The mean chronological age was 9:0, ranging from 5:2 to 12:8: 4 boys (mean age 9:1) and 10 girls (mean age 8:11). Their mean nonverbal mental age was 6:1 years, and their mean linguistic age was 7:7 years. All of the children had cerebral palsy with severe speech and physical impairments. To be included in the study the children had been judged by a speech and language therapist to be unintelligible by people outside the family. Six of them had no speech and the other eight were impossible to understand. Twelve of the children used Bliss as their primary mode of communication and some of them used other graphic media, like pictures or the alphabet. In addition six of the children tried to vocalize. According to medical information, they all had normal or corrected vision and normal hearing. Only one of the children was able to move independently and one boy could walk short distances with support. The children were contacted through local habilitation centres and special schools in the middle and south of Sweden.

A comparison group of 14 typically developing children, nine girls and five boys, with natural speech and without disabilities was used, matched for mental and linguistic age. According to parents and teachers, all of the children had normal vision and hearing and there were no indications of deviant language development. The mean chronological age in the
comparison group was 5;8 years, mean mental age 6;1 and mean linguistic age 7;5. They were selected from among children in schools and preschools in the neighbouring area of Göteborg. Informed consent was obtained from all parents. Group characteristics are presented in Table 1.

2.2. Materials

Eight tests were used in this study, a nonverbal test of intellectual ability, two tests of theory of mind, two tests of memory ability and three measures of language ability.

2.2.1. Intellectual ability

To assess mental age the Raven’s matrices (Raven, Raven, & Court, 1998) were used. This measure of nonverbal intelligence has frequently been used with non-speaking populations and has been judged to be reasonably valid and reliable in these circumstances. The British norms were used since there is no Swedish standardization.

2.2.2. ToM tests

2.2.2.1. Eva and Anna. Eva and Anna is a Swedish version of the Sally–Anne test (Baron-Cohen et al., 1985) and the procedure was that of Baron-Cohen et al. (1985). The scoring was 1 point for passing one trial.

2.2.2.2. Thought pictures. The false belief conditions of the “thought picture” test (Woolfe et al., 2002) was used. This task was constructed in an attempt to minimize the influence of language abilities in demonstrating theory of mind ability. The child looked at four pictures, one at a time. In each picture the critical object was hidden from the main character by a flap. The experimenter held the hand over the main character while the child was asked to lift the flap and look at what it revealed. The child was then presented a new picture where the main character was pictured with a thought bubble. In the bubble there were four pictures, one that showed what the flap actually hid, one that the main character was expected to think was behind the flap and two distracters. The child was asked what the main character would think was behind the flap and then what actually was there. There were four different false belief scenes and each child was presented two of these, randomly selected among the four. Maximum 2 points could be given. The order of presentation of the pictures was random.

2.2.3. Memory tasks

2.2.3.1. Corsi blocks. The children’s visuo-spatial working memory was tested by means of the Corsi blocks (Milner, 1971). A version of the original task was prepared, adapted to the children’s fine motor difficulties: a white plate 25 cm × 21 cm of size with nine blue quadrates (3 cm × 3 cm) spaced randomly on a white board. The quadrates illustrated the nine blocks in the original version. The digits 1–9 were printed beside the cubes, and were visible only to the experimenter. The experimenter pointed at the quadrates in random order, commencing with two and adding one for each sequence the child managed. Each sequence was repeated twice and the longest sequence repeated back, by pointing, to the experimenter was defined as the child’s memory score. Both a forward and a backward condition were presented.

2.2.3.2. Digit span. The Digit span subtest from the Wechsler Intelligence Scale for children-III (Wechsler, 1999) was adapted for use with the children with CCN. The figures used were printed on a chart and the experimenter pointed at them one at a time at a pace of approximately one figure per second. The child’s task was to point at the figures in the same order. The longest sequence repeated back was the child’s memory score. Also here both a forward and a backward conditions were used.

In both memory tasks the children in the comparison group answered by pointing.

2.2.4. Measures of language ability

2.2.4.1. PPVT. A Swedish version of Peabody Picture Vocabulary Test (Dunn & Dunn, 1997) was used to get a measure of vocabulary in Swedish. The American norms were used since there is no Swedish standardization of the PPVT. The resulting scores were used to derive linguistic age from the norm tables.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Chronological age Mean (range)</th>
<th>Mental age Mean (range)</th>
<th>IQ Mean (range)</th>
<th>Linguistic age Mean (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSPI group (n = 14)</td>
<td>9;0 (5.2–12.7)</td>
<td>6;1 (4;0–9;5)</td>
<td>72 (36–169)</td>
<td>7;6 (5;0–12;9)</td>
</tr>
<tr>
<td>Comparison group (n = 14)</td>
<td>5;7 (4;3–7;6)</td>
<td>6;1 (3;0–9;0)</td>
<td>106 (57–136)</td>
<td>7;4 (4;8–11;3)</td>
</tr>
<tr>
<td>p-Values</td>
<td>.000</td>
<td>1.000</td>
<td>.004</td>
<td>.848</td>
</tr>
</tbody>
</table>

2.2.4.2. TROG. The Swedish version of TROG (Bishop, 1998; Holmberg & Lundálv, 2002) was used to assess reception of grammar. Since the Swedish norms were under revision percentage correct of total number items performed was used.

2.2.4.3. Syntactic ability. An adaptation of a test of identification of syntactic correctness constructed by Nauclér and Magnusson (1994) was also used. It consisted of nine phrases; four with correct syntax and five with syntax intended to approximate a 2-year-old child’s way of speaking. The phrases were presented as comments made by a mother or her child. The child’s task was to indicate by pointing at a photograph representing a mother and a little girl in a conversational situation, which one made the comment. Percentage correct of number tried was computed.

The measures of reception of grammar and of syntactic ability were considered interesting since earlier research has claimed grammar and syntactic ability to be indicative of theory of mind ability.

2.3. Procedure

The data collection was part of a larger study on literacy and language abilities. All children were tested individually, in their homes or in a secluded room in their preschools or schools, according to their parents’ preferences. The number of testings varied from three to five depending on the child’s endurance and lasted approximately 45–60 min per test occasion. The children were tested by the second and third authors. To reach the best understanding of the child, the child’s personal assistant or in some cases one of the parents was present during the testing. The children with SSPI were allowed to use their optimal response mode and in the cases were the children gave their responses by pointing also the typically developing children used the same response mode. Each task was preceded by practice trials.

2.4. Data analyses

SPSS 15.0 was used for analyses of data. To analyse frequencies the Fisher exact test and $\chi^2$ were used. Group differences were also assessed by means of ANOVA. A composite score of theory of mind was computed defined as the sum of the theory of mind tasks. The relationship among the indicators of theory of mind ability on the one hand and mental age, language ability and memory indicators on the other was computed by means of the Pearson’s correlation coefficient.

3. Results

The children with cerebral palsy performed statistically significantly worse on the traditional false belief task Sally and Anne (Fisher’s exact test, $p = .020$). However, neither in the “thought picture” task ($\chi^2 = 2.600, df = 2, p = .273$) (Table 2) nor when using the composite score the difference in performance between groups was statistically significant different ($\chi^2 = 4.961, df = 3, p = .175$) (Table 3).

Seven out of 14 of the children with SSPI failed the thought picture task, though, while only three in the comparison group did. No child in the comparison group failed the Sally and Anne task but five in the SSPI group did.

The only difference between groups where the performance was statistically significantly different was grammatical competence measured by TROG where the comparison group had a higher result than the children with SSPI ($F(1, 26) = 5.771, p = .024$). The linguistic age, measured by PPVT, and syntactic knowledge was almost the same in the two groups ($F(1, 26) = .037, p = .848$ and $F(1, 26) = .258, p = .616$, respectively) (Table 4).

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Results on theory of mind tasks; “Sally and Anne” and thought pictures. Frequency passers and failers in the SSPI and comparison groups.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sally and Anne Pass Fail</td>
</tr>
<tr>
<td>SSPI group</td>
<td>9 5</td>
</tr>
<tr>
<td>Comparison group</td>
<td>14 0</td>
</tr>
<tr>
<td>p-Values</td>
<td>.020</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Results on theory of mind tasks; composite score. Frequency, passers and failers in the SSPI and comparison groups.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory of mind, composite score</td>
<td>SSPI group</td>
</tr>
<tr>
<td>3</td>
<td>4 3</td>
</tr>
<tr>
<td>2</td>
<td>3 3</td>
</tr>
<tr>
<td>1</td>
<td>3 3</td>
</tr>
<tr>
<td>0</td>
<td>4 0</td>
</tr>
<tr>
<td>p-Value</td>
<td>.175</td>
</tr>
</tbody>
</table>
The only significant difference in memory performance was found in Corsi block, forwards, where the children with SSPI performed worse ($F(1, 22) = 5.896, p = .024$) (Table 5). In Digit span the children with SSPI performed equally well as the children in the comparison group (Digit span total $F(1, 24) = .006, p = .941$; Digit span forwards, $F(1, 24) = .168, p = .685$; Digit span backwards, $F(1, 24) = .133, p = .718$). In the other Corsi block tasks the children with SSPI performed somewhat worse than the comparison group but not significantly so (Corsi block total, $F(1, 22) = 3.859, p = .062$; Corsi block backwards, $F(1, 22) = 2.010, p = .170$).

The interrelationships between the performance on Sally and Anne, thought pictures and the composite score on the one hand and chronological and mental age, IQ and the measures of linguistic abilities and memory on the other were studied by means of the Pearson’s correlation coefficient within each of the two groups (Table 6). In the group of children with SSPI the performance on the Sally and Anne task correlated positively with results on the TROG and with measures on memory, i.e. the total performance on digit span and all measures on Corsi block. The performance on thought pictures correlated positively with mental age, IQ and linguistic age. The composite score of theory of mind correlated positively with mental age, IQ, linguistic age and the measure of syntactic knowledge.

Since all children in the comparison group passed the Sally and Anne task no correlations could be computed. However, the performance on thought picture and the total performance correlated positively with chronological and mental age and with percentage correct on the TROG.

### Table 4
Verbal scores. Children with SSPI and comparison group.

<table>
<thead>
<tr>
<th></th>
<th>TROG, percentage correct</th>
<th>PPVT, linguistic age</th>
<th>Syntactic knowledge percentage correct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>SSPI group</td>
<td>88.12 (6.95)</td>
<td>7.6 (2.6)</td>
<td>70.6 (23.3)</td>
</tr>
<tr>
<td>Comparison group</td>
<td>86.88 (6.00)</td>
<td>7.4 (2.2)</td>
<td>74.6 (17.7)</td>
</tr>
<tr>
<td>p-Value</td>
<td>.618</td>
<td>.843</td>
<td>.616</td>
</tr>
</tbody>
</table>

### Table 5
Memory scores. Children with SSPI and comparison group.

<table>
<thead>
<tr>
<th></th>
<th>DS, total Mean (SD)</th>
<th>DS, forwards Mean (SD)</th>
<th>DS, backwards Mean (SD)</th>
<th>Corsi blocks, total Mean (SD)</th>
<th>Corsi blocks, forwards Mean (SD)</th>
<th>Corsi blocks, backwards Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSPI group</td>
<td>6.1 (2.6)</td>
<td>4.0 (1.7)</td>
<td>2.1 (1.4)</td>
<td>5.3 (2.1)</td>
<td>3.2 (0.9)</td>
<td>2.1 (1.4)</td>
</tr>
<tr>
<td>Comparison group</td>
<td>6.1 (1.4)</td>
<td>4.2 (1.0)</td>
<td>1.9 (0.6)</td>
<td>7.0 (2.1)</td>
<td>4.1 (0.8)</td>
<td>2.9 (1.4)</td>
</tr>
<tr>
<td>p-Value</td>
<td>.941</td>
<td>.685</td>
<td>.718</td>
<td>.062</td>
<td>.024</td>
<td>.170</td>
</tr>
</tbody>
</table>
group who have difficulties to develop theory of mind. The nature of this incompletely developed theory of mind is still unclear. However, a late developed theory of mind also means that the overall development, including language, social cognition and social development, could be negatively affected.

A Pearson’s correlation was computed in order to find out if IQ, mental age, language and memory could be a part of the explanation to the children’s shortcomings in theory of mind performance. In the SSPI group mental age and IQ were positively correlated to the thought pictures task and the composite score. If mental age and IQ could explain why one group of children with SSPI constantly fail to solve theory of mind tasks you would expect a lower IQ and mental age in the four children with SSPI who failed to pass any of the theory of mind tasks, since there were children with SSPI who passed some or all of the tasks. However, the results are not clear cut. Two children in the “passer” group had a lower IQ than one of the four children in the “failer” group. Only three of the children in the “passer” group had a higher mental age than all four children in the “failer” group. The results are not clear cut. Two children in the “passer” group had a lower IQ than one of the four children in the “failer” group. Only three of the children in the “passer” group had a higher mental age than all four children in the “failer” group. These results imply that mental age and IQ cannot alone explain the children’s performance.

Measures of language competence correlated with the performance on all theory of mind tasks implying that language plays an important role in the theory of mind development. This is in line with Tager-Flusberg’s reasoning (2000).

A question that needs to be answered is if these children have been exposed to conversations about mental states to the same degree as children in the spoken community. It has been argued that exposure to talk about mental states influences the development of theory of mind (e.g. Dunn et al., 1991; Jenkins & Astington, 1996; Peterson, 2000; Ruffman et al., 2002). In the deaf community it has been found that late-signing deaf children performed worse on theory of mind tasks in comparison to native signers. The authors (Meristo et al., 2007) explained this finding saying that late signers do not have as many opportunities as native signers or hearing children to learn about mental states through conversation. This could also be true for children with SSPI. In the present study the children with SSPI all used some AAC mode for communication. The comparison to native signers. The authors (Meristo et al., 2007) explained this finding saying that late signers do not have as many opportunities as native signers or hearing children to learn about mental states through conversation. This could also be true for children with SSPI. In the present study the children with SSPI all used some AAC mode for communication.

Working memory (Buitelaar et al., 1999) or the ability to hold in mind (Gordon & Olson, 1998) has been suggested to play an important role in the development of theory of mind. Dahlgren Sandberg (2001) proposed that children with cerebral palsy had a deficit in working memory and that this deficit could be a key factor in the children’s short comings in theory of mind tasks (Dahlgren et al., 2003). In the present study a relation between working memory, especially measured by Corsi blocks, and the performance on the Sally and Anne task was found. This relation, however, could not entirely explain why the four children with SSPI failed to pass any of the theory of mind tasks, since there were children with SSPI who passed some

| Table 6 | Correlation between performance on the theory of mind tasks and chronological age, mental age, IQ, verbal scores and memory scores. |
|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| \( p \) | SSPI group | Comparison group | \( p \) | SSPI group | Comparison group | \( p \) |
| Chronological age | –.192 | .038 | .374 | –.039 | .241 | .068 |
| Mental age | .303 | .162 | .176 | .367 | .011 | .001 |
| IQ | .201 | .127 | .042 | .167 | .067 | .001 |
| TROG, percentage correct | .189 | .067 | .032 | .188 | .067 | .032 |
| PPVT, linguistic age | .201 | .127 | .042 | .167 | .067 | .001 |
| DS, total | .176 | .075 | .036 | .137 | .045 | .001 |
| Corsi blocks, total | .144 | .094 | .024 | .109 | .047 | .001 |
| Corsi blocks, forwards | .121 | .071 | .017 | .108 | .046 | .001 |
| Corsi blocks, backwards | .146 | .098 | .024 | .109 | .047 | .001 |

It is also still unclear if the severe restriction on interactive abilities and mobility of the participating children with SSPI could interfere with the development of theory of mind. The development of theory of mind must be understood in the context of interaction, including language use and the time pressure in human interaction (Leslie, 1994). These children have extremely limited possibilities to interact independently with others, and also to engage in pretend play.
all theory of mind tasks and still performed at the same level on all of the memory measures as the children who failed to solve the theory of mind tasks.

In summary, there are children with cerebral palsy who fail to solve theory of mind tasks irrespectively of the verbal loading of the tasks. It seems as if expressive language ability and deficits in working memory could partly explain the children’s performance. However, to fully understand why some children with SSPI fail to solve the task we need to know more of these children’s possibilities to take part in conversations of mental states, their experiences of mental states in other peoples’ conversations and their possibility to take part in pretend play. We also have to study if the low results on theory of mind tasks reflect a lack of theory of mind, a slow but normal development of theory of mind, a lack of proper skills for application of a theory of mind or if it is a consequence of the experimental design. Even if we do not really know the whole picture it is important to have the development of theory of mind in mind in the children’s early development. As the development of theory of mind and language are closely connected it means that deficits in or an immature theory of mind could limit a child’s language and communicative development and vice versa. By taking advantage of the growing literature on intervention for abilities related to theory of mind as suggested by Miller (2006), clinicians, such as speech and language pathologists, can help the child in this development.

Acknowledgment

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