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Inferential ability in children with cerebral palsy, spina bifida and pragmatic language impairment

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1. Introduction

The ability to make inferences is intrinsically linked to comprehension, linguistically related as well as more cognitively and emotionally related. Inference generation, requiring adaptation to the linguistic and physical context and to various contextual demands, provides a useful means to examine pragmatic ability.

Inference generation facilitates coherence (Perkins, 2007), and thus supports comprehension (Norbury & Bishop, 2002). The ability to make inferences is essential for effective communication, since language often is undetermined and requires to be embellished in order to be understood (Leinonen, Ryder, Ellis & Hammond, 2003), and since most communicative expressions have meaning beyond the linguistically stated (Leinonen & Letts, 1997). Ryder and Leinonen (2003) and Leinonen et al. (2003) aptly argue that the linguistic expression is only a starting point for interpretation. To make an inference, we need to bring together information from the linguistic expression, the context and previous knowledge and experience to work out the possible intended meaning (Leinonen & Letts, 1997; Letts & Leinonen, 2001). It is commonly maintained that pragmatic comprehension, and thus the ability to make inferences, is also embedded in cognition. Long- and short-term memory, theory of mind, reasoning skills, lexical and syntactic knowledge, integration and thinking are central to the comprehension process (Leinonen et al., 2003; Perkins, 2007).

Difficulties with inference generation can be observed from two interrelated viewpoints according to Perkins (2007); the intrapersonal domain and the interpersonal domain. In the intrapersonal domain, the main issue is to integrate different sources of information within a coherent framework, and to adjust prior assumptions to new information. In the interpersonal domain, on the other hand, inference plays a crucial role in determining what the interlocutor actually means by integrating input such as speech, writing, gesture, and facial expression. In addition, it is necessary to consider the interlocutor's knowledge, intentions and beliefs, this being done through cognitive skills such as memory, knowledge and theory of mind (ToM).

An often used task to determine when children first acquire a ToM is false belief, i.e. the ability to understand that beliefs can also be false. ToM, where language and cognition is considered to interact with each other (Miller, 2004), is commonly seen as a critical cognitive capacity involved in pragmatic understanding (Perkins, 2007). By ToM is meant "the ability to predict and explain people's behaviour with reference to mental states" (Slaughter & Repacholi, 2003, p. 1). Difficulties with ToM ability have been reported for children with various impairments as e.g. autism (e.g. Baron-Cohen, Leslie & Frith, 1985), deafness (Woolfe, Want & Siegal, 2002), severe speech and physical impairment (Falkman, Dahlgren Sandberg & Hjelmquist, 2005), communication disabilities (Dahlgren, Dahlgren Sandberg & Hjelmquist, 2003), specific language impairment (SLI; Gillott, Furniss & Walter, 2004) and pragmatic language impairment (PLI; Botting & Conti-Ramsden, 1999). In the extensive research concerning ToM during the past decades, underlying factors such as problems with executive functioning (Hughes, 1998), linguistic ability (Miller, 2004), weak central coherence and lack of conversational experience (Woolfe et al., 2002; Frith, 2003; Falkman et al., 2005) have been proposed as contributing reasons for insufficient ToM ability. In a study of children with severe speech and physical impairment by Falkman et al. (2005), the delayed false belief skills of the children lead the authors to suggest that these were caused by impoverished communicative experiences on behalf of the children. The possible implication of language impairment in the development of ToM deficits has been discussed by e.g. Miller (2004). Miller found evidence for that children with SLI, mean age 4;1, performed at an age appropriate level when the false belief task was less demanding linguistically. Although there has been a tendency to attribute difficulties with ToM to the intrapersonal domain, several researchers have suggested that children's understanding of their partners´ inner states is

crucially related to contextual factors such as the emotional context of the interaction. Possibly, ToM is important for the ability to draw inferences regarding social situations and the pragmatics of interaction (Lewis & Carpendale, 2002).

In a much cited study by Bishop and Adams (1992) where 8 to 12-year-old children with SLI and children with PLI were compared, a general impairment of story comprehension was found. No significant differences between the groups regarding the ability to answer inferential and literal questions occurred, although there was a tendency for the PLI-group to perform more poorly than the SLI-children with inferential questions. Moreover, the PLI-group was more prone to give answers suggesting they had not understood the question. Similar problems with inference ability in children with language impairment have later been found in numerous studies (Dodwell & Bavin, 2007; Ford & Milosky, 2008) as well as for children with PLI (Leinonen & Letts, 1997; Letts & Leinonen, 2001; Norbury & Bishop, 2002; Botting & Adams, 2005), even though it must be emphasized that these problems often were manifested as trends rather than being significant. In the study by Letts and Leinonen (2001) it is noticeable that literal questions did not constitute a problem for children with language impairment, mean age 8;1 years. Pragmatic impairment itself does not always result in story comprehension deficits, two-thirds of the children in the PLI group in the Bishop and Adam study (1992) scored within normal limits. Some children with PLI did not have undue difficulty with inferential questions. It has been suggested that children with PLI do not have a deficit in inferencing *per se*, and that these children might be able to make inferences in the context of structured situations, while their difficulties surface in conversation (Botting & Adams, 2005). Another possibility is that children with PLI can make inferences, although not always appropriate (Norbury & Bishop, 2002).

In the study by Bishop and Adams (1992) several possible underlying causes to problems with story comprehension, and more specifically inferential comprehension, were mentioned; expressive language problems, difficulty in understanding questions in the absence of a concrete visual context and difficulties in remembering the story. Some additional possible causes, such as low general ability and weak structural language skills, were put forward in a later study by Norbury and Bishop (2002). In this study the authors found that 9-year-old children with SLI performed poorly on both inferential and literal comprehension questions based on stories generated from a series of pictures. The authors suggest that inferencing deficits may arise for quite different reasons in different groups of children, e.g. as part of a broader comprehension problem in some children and as a result of a more selective deficit in central coherence in others. Another often suggested possible underlying cause for problems in story comprehension is the linguistic form of the question. For example is “why” questions customarily thought to be the most difficult question form, and open-ended questions to be more difficult than yes/no questions (Leinonen & Letts, 1997). “Why” and “how” questions involve the ability to predict future developments and an awareness of cause and effect, and appear later than “what´s that” questions (Leinonen & Letts, 1997). Ryder and Leinonen (2003) conclude that it is important to consider the contextual demands of the question when trying to understand how children answer questions. The complexity of a question is rather explained in terms of the cognitive demands it makes than in its linguistic complexity. Integrating information could also be problematic for children with SLI, resulting in low inferencing scores (Dodwell & Bavin, 2007).

In a study with a somewhat different approach, it was demonstrated that knowledge availability is not sufficient to ensure adequate inference generation in children with typical development (Barnes, Dennis & Haefele-Kalvaitis, 1996). In spite of the fact that the children in this study were taught the same knowledge base about an imaginary planet, their inference ability varied. Barnes et al. (1996) made the conclusion that equally available knowledge is not equally accessible, and that it is accessibility rather than availability that is crucial for

inferencing. In addition, it was also shown that knowledge based differences were not significant determinants of inferencing in a study by Barnes, Faulkner and Dennis (2001).

Problems in the ability to make inferences among children with SB and hydrocephalus are well documented (Dennis & Barnes, 1993; Barnes et al., 2001). Dennis and Barnes (1993) found that 6-15 years old children with SBH performed worse than typically developing children when asked to make coherent inferences in order to link two connected events. These children had difficulties with drawing inferences to elaborate the content of a story as well. Barnes et al. (2001) found that inferencing difficulties were associated with poor access to knowledge-based information in children with hydrocephalus, whereas it was associated with problems in integrating text and knowledge-base in neurologically intact children with poor comprehension skills.

As is apparent from the text above, different approaches and different forms of analyses of atypical responses have been used to examine the ability to make inferences in children. In the study by Bishop and Adams (1992), which constitutes a starting point for this study, questions were divided into a literal and an inferential group. A qualitative analysis of atypical inferential responses revealed that one reason for giving an atypical response was that the child had not understood the question. In a later study by Norbury and Bishop (2002), the inferential questions were further subdivided into questions about *text-related inferences* and *gap-filling inferences*. It was found that the children most often were able to make inferences, but that the inferences could be *wrong* or *odd*, or that the *scope* of the questions could be misunderstood. Loukusa, Leinonen, Jussila, Mattila, Ryder, Ebeling & Moilanen (2007) subdivided the inference questions into *enrichment* questions, questions concerning *recovery of implicature*, *routine* questions and *feeling* questions. The atypical responses were categorized into eight error types: *incorrect focus, world knowledge, given information, don´t know, totally irrelevant, tautology, no reponse* and *other*.

In a recent study by Holck, Nettelbladt and Dahlgren Sandberg (2009), two groups of children with early-onset physical impairments, namely children with cerebral palsy (CP) and children with spina bifida with hydrocephalus (SBH), were compared to a third group without established brain damage but with primary pragmatic problems. CP and SBH are both reported to be associated with problems related to communication and pragmatic ability, and thus it was considered to be of interest to compare the three groups. It was found that all three groups experienced some difficulties with language comprehension in the forms of receptive grammar, inferential comprehension and literal comprehension compared to a group of typically developing (TD) children and/or to the norms of tests. In this study all three groups of children demonstrated problems with inferential and literal story comprehension to some extent. The aim of the current research was to further examine how the three groups cope with inferential and literal story comprehension. More specifically, we aim to explore the children's problems with understanding inferential and literal content, and the relationship between the two abilities, by analysing non-target responses in order to investigate possible group differences and underlying causes. A further intention was to develop an analytic framework applicable for both inferential and literal responses and possible to use in a clinical context. We also compared the results with the results of a group of typically developing children.

Based on previous research findings it could be expected that the children with PLI and SBH would perform more poorly than the CP group on inferencing comprehension questions, that inferential comprehension would tend to be more difficult than literal comprehension for all groups, and that story comprehension would be related to other measures of language comprehension.

2. Methods

2.1. Participants

A total of 40 children ranging from 5;2 to 10;9 years of age participated in the study: 10 children with cerebral palsy (7 boys, 3 girls), 10 children with spina bifida and hydrocephalus (6 boys, 4 girls), 10 children with language impairment and pragmatic problems (6 boys, 4 girls) and 10 typically developing children (7 boys, 3 girls). The group of TD children was matched for age and gender with the other three groups (Table I). There were no significant differences between the four groups neither in chronological age; χ^2 (3, n=40) =3.42, p=.331, nor in mental age; χ^2 (3, n=40) =7.64, p=.054). Although, the subsequent pair wise Mann-Whitney test revealed a significant difference in mental age between the PLI group (M=9;4) and the SBH group (M=6;9) (z=-2.52, p=.012).

Table 1. Distribution of chronological age (CA) and mental age (MA) across the groups

	M		*SD*		*Range*	
	CA	MA	CA	MA	CA	MA
CP	7;11	7;4	1.58	1.73	6;0-10;6	4;6-9;6
SB	7;2	6;9	1.97	1.71	5;2-10;9	4;0-9;6
PLI	8;2	9;4	1.91	2.14	5;3-10;2	6:0-11;6
TD	7;2	8;0	1.44	1.71	5;4-9;1	4;6-10;0
p	.331	.054				

Criteria for inclusion for all children were intelligible speech and IQ >70. The TD children had IQs within the normal range and no documented history of developmental delay. The criterion for inclusion of the children with cerebral palsy was a diagnosis of spastic diplegia. Two of the children had additional language impairment, mainly affecting phonological ability but also grammar to a lesser degree. The criterion for inclusion of the children with spina bifida was hydrocephalus. Two of the children in this group had additional language impairment, also mainly affecting phonological ability and grammar to a lesser degree. Criteria for the children with PLI were pragmatic problems as defined by the Children´s Communication Checklist (CCC; Bishop 1998, Swedish translation), in combination with an informal assessment by a teacher and/or a speech-language therapist. The children with CP and SBH were recruited from a wide geographical area, and the children with PLI were recruited from preschools and schools with special language units for children with language impairment in two regions in Southern Sweden. The study had ethical approval from the Ethics Committee of the Medical Faculty of Lund University. Written and informed oral consent was obtained from all parents.

2.2 Materials

2.2.1. Assessment of background variables

Children´s Communication Checklist (CCC). The Swedish version of CCC is a 79-item checklist assessing children's communication behaviours across 11 subscales, five of them constituting the pragmatic composite, i.e. the part of the CCC where the pragmatic ability is estimated. Parents and teachers were asked to complete CCCs separately. The Swedish CCC has Swedish norms, resulting in a Swedish cut-off at 140 (compared to the original at 132). The primary aim with the CCC was to assess the pragmatic ability of the child.

Language comprehension. The receptive language skills were assessed with the Test for Reception of Grammar (TROG; Bishop 1982, Swedish translation) and the Peabody Picture Vocabulary Test - revised (PPVT; Dunn and Dunn, 1981, Swedish translation).
Theory of mind. The false belief conditions of the "Thought picture" test (Woolfe et al., 2002) was used. This test is considered to minimize verbal task-performance requirements, which is an advantage since there is evidence for an association between language impairment and ToM (Gillott, Furniss & Walter, 2004). The child looked at two pictures, one at a time. In each picture the critical object was hidden from the main character by a flap. The investigator held a hand over the main character while the child was asked to lift the flap and look what was revealed. The child was then presented with 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 subsequently what actually was there. A correct response on both questions gave 1 point and maximal 2 points could be given. The order of the pictures was random.
Intellectual ability. To establish the children's IQ and mental age Raven's progressive matrices, coloured version (Raven, Court & Raven, 1986) was used. This is a non-verbal test, frequently used in studies of children with speech- and language impairment.

2.2.2. Inferential and literal assessment

Inferential and literal comprehension was assessed with a material from Bishop and Adams (1992; translated and adapted to Swedish by the authors). The children were presented with two short stories (Story A, "Ice skating", and Story B, "Rubbish pile"), and were subsequently asked 14 questions after each story (in total 28 questions). 14 questions concerned the literal contents of the two stories, the answer explicitly stated in the story. 14 questions required inferential processing and could be answered only by drawing an inference about something that had not been explicitly stated, i.e. implicit information in the story. The stories were presented without accompanying pictures.

2.3. Procedure

The first author collected the data for the children with CP and SBH, and the data for the children with PLI were collected by the children's speech-language therapists (in all two speech-language therapists). The data for the TD children were collected by one of the speech-language therapists and the first author. The tests were administered to the participants individually, in the children's preschools, schools or homes.

The administration of the CCC, TROG and PPVT followed the usual procedures. However, a more thorough description is given concerning the administration of the story task. The two stories were given in the same order, with "Story A" presented first followed by "Story B". The two stories were not given in a counterbalanced order since prior use had revealed that "Story B" was more challenging, thus causing more resistance from the children, compared to "Story A". Directly after each story was read, the child was asked 14 questions orally by the investigator. Seven factual questions for each story concerned explicitly stated story content, and seven questions required an inference to be made on the basis of information that was not directly stated in the story. Children who responded "don't know" were encouraged to have a guess. The responses were transcribed orthographically.

The assessment materials were presented in a counterbalanced order. One young child from the SBH group refused to participate.

2.4. Data analyses

Inspired by Bishop and Adams (1992), who found that some responses did not qualify as either correct or incorrect, we adopted a 3-point scoring system. The scores were assigned as follows: 2 points – fully correct and adequate, 1 point – partially correct, and 0 point - no response or incorrect.

A descriptive analysis of atypical responses was carried out. It was found that similar responses tended to occur frequently, and these formed the basis for groupings into five response categories. Four out of five categories were applicable for both inferential and literal questions: (1) *External associations,* the response was characterized by aspects not related to the text, as e.g. general or personal world knowledge or free associations; (2) *Text-related*, the response was related to aspects that can be found in the text, however not correctly; (3) *Lexical associations*, the response was semantically related to the target response and (4) *Don't know*. For the inferential questions a category was added, (5) *No obvious inference*, the response indicated that an inference had not been made. Examples from the different categories are found in Appendix. Since "why" questions and "think/believe" questions are often considered to be especially problematic for children with comprehension difficulties, we examined this separately in addition.

2.5. Statistical analysis

The SPSS (version 16.0) was used. Since the groups differed significantly on mental age, an ANCOVA with mental age as covariate was performed to assess group differences on the dependent variables. To explore specific group differences pair wise a Bonferroni test was performed. To assess within-group differences the Wilcoxon signed rank test was used. The association between variables was evaluated with a partial correlation, controlling for mental age. The level of significance was set at .05.

2.6. Reliability

Interrater reliability assessments were conducted in two steps. Firstly, reliability was calculated on the assignment of points in the scoring procedure. Reliability between two raters (the first and third author) on a sample of 560 responses to inferential questions was 86 %, and on a sample of 560 responses to literal questions 90 %. Secondly, reliability was calculated on the assignment of atypical responses into the four subcategories. Here, reliability between the same two raters was 95 % on the atypical responses to the inferential questions, and 94 % on the atypical responses to the literal questions.

3. Results

3.1. Between groups

Table 2 shows data for the CCC, grammar recall, lexical comprehension, false belief and for literal and inferential comprehension, typical and atypical responses. There was a significant difference between groups on the CCC, $F(3, 34) = 23.37$, $p = < .001$. As expected, pair wise comparisons revealed that the PLI group ($M = 133.2$) performed worse than the TD children ($M = 156.7$), $p = < .001$. The PLI group also performed worse than the CP group, $M = 133.2$ and 148.6 resp. ($p = < .001$), and the SBH group, $M = 145.9$ ($p = < .001$). There were no statistically significant differences on false belief and TROG, and only a main effect of group on PPVT, $F(3, 35) = 3.1$, $p = .039$.

Table 2. Differences among the groups (with mental age as a covariate). Mean number correct.

	CP		SB		PLI		TD		
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*p*
CCC (max 162)	148.6	4.4	145.9	7.6	133.2	7.1	156.7	5.8	.000
TROG (max 80)	67.8	7.2	67.0	9.0	69.2	5.5	71.6	7.5	.286
PPVT (max 192)	94.9	17.2	100.3	31.6	111.2	31.8	131.3	36.8	.039
False belief (max 2)	.60	.70	.50	.53	.90	.74	1.30	.68	.088
Lit compr (max 28)	18.6	3.6	15.6	7.5	18.0	5.1	22.9	3.7	.009
Inf compr (max 28)	22.3	3.6	16.1	8.6	16.3	7.1	22.9	3.0	.001
Inferential typical resp.	10.6	1.8	7.2	4.2	7.2	3.6	10.1	2.0	.004
Inferential ext. assoc.	0.8	0.9	1.4	1.1	2.6	1.2	1.2	1.2	.015
Inf text related	1.8	1.5	1.2	1.2	1.6	1.9	1.7	1.3	.848
Inf lexical association	0.1	0.3	0.0	0.0	0.1	.3	0.0	0.0	.612
No obvious inference	0.1	0.3	0.4	0.7	0.7	1.1	0.0	0.0	.012
Inferential don´t know	0.5	0.5	2.0	2.9	1.2	1.4	1.3	1.3	.334
Literal typical resp.	8.8	2.1	7.2	3.7	8.4	2.5	11.0	2.1	.008
Literal external assoc.	2.1	1.2	1.6	1.5	1.6	1.5	1.4	1.1	.718
Literal text related	1.6	1.2	1.9	1.7	1.9	1.1	1.0	0.7	.319
Literal lexical assoc.	0.6	0.7	0.5	0.7	0.4	0.5	0.5	0.7	.842
Literal don´t know	0.7	0.9	1.4	1.3	1.6	2.0	0.1	0.3	.014
"Why" questions	9.9	2.2	7.6	4.2	7.0	4.1	11.1	0.9	.001
"Think/believe" questions	6.9	1.2	4.7	2.3	5.5	1.5	6.5	2.1	.017

3.2. Inferential comprehension

The significant differences all involved the PLI group (Table 2). Significant group differences were revealed, $F(3, 35) = 6.61$, $p = .001$. Both the TD group, $M = 22.9$ and the CP group, $M = 22.3$, performed significantly better than the PLI group, $M = 16.3$ on inference comprehension ($p = .005$ resp. $p = .004$). The same relation applied concerning the total of typical responses, where significant group differences also occurred, $F(3, 35) = .5.21$, p = .004. Both the TD group, $M = 10.1$, and the CP group, $M = 10.6$, had significantly more typical responses than the PLI group, $M = 7.2$ ($p = .038$ resp. $p = .008$; Figure 1). The results for the response categories revealed some further significant differences; there was a significant difference between groups on *external associations,* $F(3, 35) = 4.01$, $p = .015$, where the PLI group had more *external associations* than the CP group, $M = 2.6$ and 0.8. resp. ($p = .013$). In addition a significant main effect of group occurred on *no obvious inferences,* $F(3, 35) =4.21$, $p = .012$, where the pair wise comparisons revealed that the PLI group had more *no obvious inferences* than both the CP group, $M = 0.70$ and 0.10. resp. ($p = .0.26$) and the TD group, $M = 0.0$ ($p = .018$; see Figure 2 for the distribution of atypical inferential responses in the groups). The examination of "why" and "think/believe" questions showed a significant main effect of group, $F(3, 35) = 6.93$, $p = .001$ and $F(3, 35) = 3.87$, $p = .017$. resp. The PLI group, $M = 7.0$, performed significantly worse than the TD group, $M = 11.1$, and the CP group, $M = 9.9$, ($p = .001$ and $p = .006$ resp.) on the "why" questions, and significantly worse on the "think/believe" questions than the CP group, $M = 5.5$ and 6.9 resp. ($p = .047$).

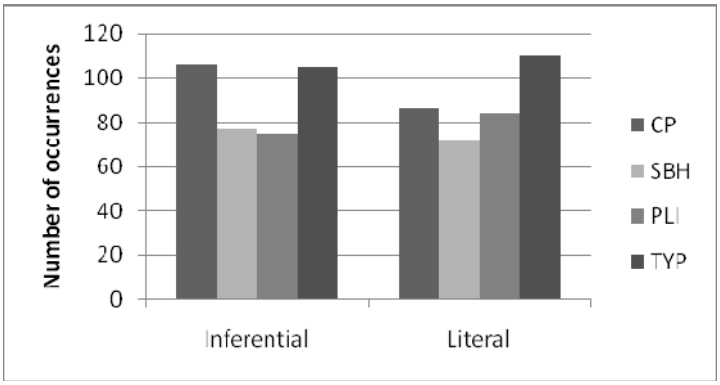

Figure 1. Distribution of typical inferential and literal responses in the four groups.

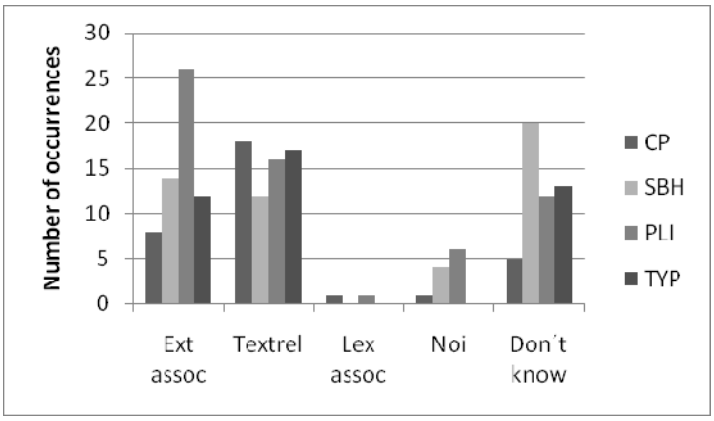

Figure 2. Categories of atypical inference responses in the four groups.

3.3 Literal comprehension

With literal questions the significant differences all involved the PLI group and the TD groups. On the literal questions, number correct, the significant group difference was $F(3, 35) = 4.54$, $p = .009$, and the TD group, $M = 22.9$, performed significantly better than the PLI group, $M = 18.0$ ($p = .004$). There was also a significant group difference on typical responses, $F(3, 35) = 4.67$, $p = .008$, where the TD group also had significantly more typical responses than the PLI group, $M = 11.0$ and 8.4 resp. ($p = .009$). In addition, a main effect of group was revealed on *don´t know* responses, $F(3, 35) = 4.08$, $p = .014$. The PLI group had significantly more *don't know* responses than the TD group, 1.60 and 0.10 resp. ($p = .013$). See Figure 3 for the distribution of atypical literal responses in the groups.

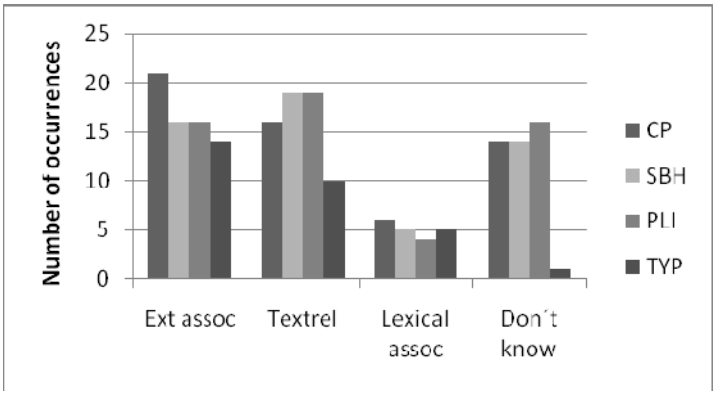

Figure 3. Categories of atypical literal responses in the four groups.

3.4. Within groups

The only statistically significant difference within groups concerned the CP group performing significantly better on inferential questions than on literal questions, M = 22.3 and 18.6 resp. (z = -2.68, p = .007).

3.5. Correlations

The correlation analysis did not reveal any clear cut differences between the groups, but some interesting patterns could be traced. The correlations are presented in Table 3. No correlations occurred in the TD group.

Table 3. Partial correlations (with mental age as a covariate).

	Literal compr.	CCC	TROG	PPVT	Why	Think/ believe
CP						
Inferential comprehension	.854***		.762*			
Literal comprehension		.889***		.749*		
SBH						
Inferential comprehension	.669*		.853***		.916***	
Literal comprehension					.786*	.736*
PLI						
Inferential comprehension				.687*	.947***	.834**
Literal comprehension				.863***		.812**

n = 10, *p = <0.05 two-tailed; **p = <0.01 two-tailed; ***p = <0.005 two-tailed

4. Discussion

Lewis and Carpendale (2002) suggested that ToM is important for the ability to draw inferences regarding social situations and the pragmatics of interaction. In the present study, though, it can be concluded that ToM, measured as false belief, had no bearings on inferential or literal comprehension. Previous research on e.g. children with severe physical impairment (Falkman et al., 2005) and communication disabilities (Dahlgren et al., 2003) has established that these children experience problems with ToM. A difference between the children in the mentioned studies and the children with physical impairment in this study is the severity of the communicative problems and the physical impairment. In the earlier studies all children were anarthric or severely dysarthric and used Augmentative and Alternative Communication (AAC) for communication. Probably, the groups of children in this study did not differ enough in conversational understanding, all of them having spoken language as their primary communication mode and being able to initiate and participate in conversations. Furthermore, the ecological validity of commonly used ToM tasks, such as false belief, has been questioned by Dahlgren et al. (2003). The authors also proposed that performance on false belief tasks do not predict ToM performance in real life.

Certain similarities between our findings and those reported by Bishop and Adams (1992) were found. Like Bishop and Adams (1992) we found general impairment on a story comprehension task, and that the ability to answer inferential questions was not significantly worse than ability to answer literal questions. Somewhat unexpected, a good 50 % of the children in the present study even found it easier to answer inferential questions than literal questions. In fact, the CP group and the SBH group both performed better on inferential questions, although the difference only reached significance in the CP group, where the mean result of the inferential questions exceeded the mean result of the literal questions by almost four points. It was only in the PLI group that the problems with inferential questions were more pronounced than with literal questions, since the TD group performed similarly on both types. In the study by Bishop and Adams (1992), where they investigated children with SLI and a subgroup of children with PLI, the children with PLI were not found to perform significantly worse on inferential questions than the SLI group. A contributing reason for this could be that compared to the PLI children in our study, the children in the Bishop and Adams study were selected from a larger sample of children with SLI, thus having pronounced language impairment. This may generate a different pattern of difficulties compared to our sample of children with PLI. Bishop and Adams (1992) discussed why inferential comprehension was not significantly more difficult than literal comprehension. They suggested that if a child is not able to impose a structure on a story, this will have an impact on understanding and remembering both explicitly mentioned and inferred aspects of the story. Another suggestion is put forward by Botting and Adams (2005). They propose that it is not a problem with inferencing *per se,* and that inferencing is not problematic in structured situations but emerge when the child has to make inferences in a less structured situation such as a conversation. This account would help to explain why it sometimes is hard to pin down pragmatic problems in clinical assessments. It must also be taken into consideration that, as Norbury and Bishop (2002) point out, children could guess some correct answers to inference questions by using general knowledge.

An expected outcome was that the children with PLI and SBH would perform more poorly than the CP group on inferential questions. This was only confirmed for the PLI group, where there was a significant difference. Thus, in this study we could not replicate the findings by Dennis and Barnes (1993), who found that children with SBM had difficulties with drawing inferences. Possibly different methods to measure inferential comprehension and different sample sizes influence the results. On the literal questions the PLI group performed significantly worse than the TD group.

The hypothesis that story comprehension should be related to other measures of language comprehension was only partly confirmed. TROG and inferential comprehension were only related in the CP- and the SBH groups, thus indicating that language comprehension is an ability of importance for inferencing in these groups. In the study by Norbury and Bishop (2002) language comprehension was not found to correlate with inference comprehension in the PLI group, a result also found by Leinonen et al. 2003. PPVT was related to both inferential and literal comprehension in the PLI group, indicating a relation between vocabulary and story comprehension. In addition, PPVT was related to literal comprehension in the CP group. When regard was taken to the specific "why" and "think/believe" questions, associations were found in the SBH- and PLI groups. In both these groups, inferential comprehension was strongly associated with "why" questions and more moderately associated with "think/believe" questions in the PLI group. Thus, the emerging picture of associations between two types of comprehension, story comprehension and language comprehension is not very straightforward. Yet, a pattern of associations could be discerned where inferential comprehension tended to be related to language comprehension in the CP group and to the ability to predict future developments and cause/effect relations in the SBH- and PLI groups. The suggestion made by Ryder and Leinonen (2003) that the complexity of a question rather is explained in terms of the cognitive demands than in terms of its linguistic complexity, could help to explain this finding. In contrast to the CP- and the SBH group, inferential comprehension was not related to literal comprehension in the PLI group, thus suggesting that inferential comprehension in this group can be relatively independent of literal comprehension and more constitutes an entity of its own. Interestingly, the only correlation regarding CCC was in the CP group, where CCC was associated with literal comprehension but not with inferential comprehension.

When carrying out an assessment of language comprehension, there are reasons to believe that customary language comprehension tests such as TROG and a story comprehension task tap different aspects of language comprehension. TROG measures language comprehension on a sentence level, whereas story comprehension demands comprehension on text level. Possibly sentence level comprehension as measured by TROG is less demanding, providing the child with a concrete visual context with a restricted number of possible interpretations (Bishop & Adams, 1992). A clinical implication is that more than one instrument should be used in order to pin down in what area a child experiences most comprehension difficulties. This is vital for planning a relevant intervention.

In accordance with the findings of Norbury and Bishop (2002) the children in our study most often could make inferences, although not always the appropriate ones. This was shown in the analysis of atypical responses specifically developed for this study. For inferential questions the analysis showed that the PLI group had significantly more *external associations* and more *no obvious inferences* than the CP group. This means that the PLI group relied more on external factors, such as general world knowledge and free associations, than on text-related factors when delivering an atypical response compared to the CP group. If, as was suggested earlier, the PLI group has difficulties with predicting future developments and cause/effect relations, an easy way out when confronted with a question one do not know the answer to could be to turn to familiar experiences in order to achieve some coherence, and sometimes more or less to have a guess. At least, a guess is a notch better than not doing any inference at all. The CP group, on the other hand, tended to give text-related atypical responses, which is interesting since an association occurred between inference comprehension and TROG in this group. According to Harley (2001), comprehenders with less prior knowledge rely more on the surface detail in the text to answer questions.

Our categorization of atypical responses suggests that the categories differ qualitatively: *text-related responses* are closer to the typical responses than are *external associations*.

Lexical associations could be regarded as an intermediate case. The occurrences of this category are rare and thus difficult to discuss further, although they are interesting as a phenomenon. Most often they concern nouns, and only occasionally verbs, adjectives and prepositions. In the case of an inferential *external association,* the child makes an inference although not an adequate one, which can be considered to be closer to the target than making a *no obvious inference.* A *don´t know* response, on the other hand, can reflect a genuine lack of understanding but also an awareness of one's own limitations. When the atypical responses were compared between inference- and literal comprehension, an interesting pattern occurred in the TD group. Their proportion of *don't know* responses was considerable larger than in the other groups on the atypical inference responses. This could be interpreted as that the TD children rather gave a *don't know* answer than having a guess, thus demonstrating an awareness of their shortcomings. It is also noteworthy that the TD children had no occurrences of *no obvious inference,* and that the occurrences of this category were rare across groups.

To sum up, we find the analysis of atypical inferential and literal responses to be a useful tool, possible to employ in a clinical setting. It contains a limited amount of categories which are clearly defined as shown by the high interrater reliability. In addition, it has clinical implications. For example, a child having many *text-related* atypical responses demands a different form of intervention than does a child who has a lot of *external associations*.

Methodological considerations

This study suffered from a limited sample size, which calls for caution in interpreting the results. When analysing the responses Story A ("Ice skating", 74 words) appeared to be easier for the children to comprehend than Story B ("Rubbish pile", 103 words), perhaps because the knowledge base of the two were differently well known to the children. As Harley (2001) points out, prior knowledge has a large effect on the ability to understand language, and the more we know about a topic the better we can comprehend new material. Possibly the content of story B was more unfamiliar to the children than the content of story A. Further, it has to be considered that an unexpected answer, possibly deemed "wrong" by adults, may be the product of a perfectly logical sequence of thoughts from the child's perspective (Letts & Leinonen, 2001).

5. Summary and conclusions

In summary, this study showed that the children with PLI experienced problems with inferential ability, performing significantly worse on inferential questions than the CP group and the TD group. This was not the case with the SBH group, and the CP group even achieved better with inference questions than with literal questions. The analysis of atypical inferential responses revealed that the PLI group relied more on *external associations* than the CP group when making an atypical response, whereas the CP group used more *text-related* responses. The analysis of relationships demonstrated that inferential comprehension was related to language comprehension in the CP group, but more to the ability to predict future developments and cause/effect relations in the SBH- and PLI groups. The results of this study suggest that language comprehension both on sentence- and text level must be taken into account when performing an assessment, since they appear to measure different aspects of language comprehension. In order to carry out an adequate intervention, it is also vital to determine what kind of atypical responses a child gives. The analysis of atypical responses especially developed for this study was found to have the potential to be a valuable tool for this purpose. Finally it can be concluded that ToM, measured as false belief, had no bearings on inferential or literal comprehension in this sample.

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Appendix: Examples from categories of atypical responses

Inferential external associations:
Question: How did the man know that something was wrong?
Response: You shouldn´t fall, you should skate
Response: He went to the hospital

Inferential text-related response:
Question: How did the man know that something was wrong?
Response: The radiator* wasn´t warm.

No obvious inferences:
Question: How do you think Andrew felt when he got back?
Response: He lied in a blanket.
Question: How do you think the other children felt when they saw Mike racing on the go-cart?
Response: Then the children are supporting him.

Literal external associations:
Question: Who rescued Andrew?
Response: Daddy.
Response: A police.

Literal text-related response:
Question: Who rescued Andrew?
Response: He who fell into the water.

Lexical associations:
Chocolate → coffee, water
Hat → helmet
Warm → cold
Go → cycle

*In the Swedish translation “fire” is substituted with “radiator”

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