CHAPTER SIX

RESULTS AND DISCUSSION OF RESULTS

"It is the mind, which creates the world about us, and even though we stand side by side in the same meadow, my eyes will never see what is beheld by yours, my heart will never stir to the emotions with which yours is touched" (George Gissing, p. 52, in Diehl, 2003, p. 253).

The results of the study will be presented in the following way in order to address the three research aims of the study:

- The communication, cognitive processing and theory of mind results will each be presented separately in order to determine whether group differences exist and whether the three groups obtained different profiles in each of these areas.
- Correlation coefficients between various aspects of communication, cognitive processing and theory of mind will be presented, in order to determine whether a relationship between these three areas exists.
- Discriminant function analyses will then be presented to help determine which measures from the assessment battery best differentiate between the three groups.

Throughout the chapter, summaries will be presented in boxes in order to highlight the main findings.

6.1 COMMUNICATION ASSESSMENT RESULTS

The results of the communication assessment will be presented under the headings of receptive language, expressive semantics, expressive grammar, narrative ability and pragmatics. At the end of this section the communication profiles obtained for the HFPDD and SLI groups will be presented.

6.1.1 <u>Receptive language</u>

6.1.1.1 Overview of results

Results of the receptive language measures are presented in table 6.1. This includes the means and standard deviations (SDs) for the different receptive language measures; analysis of variance results for the BPVS (standardized score - SS), Basic Concepts (raw score - RS) and Grammatic Understanding (standard score - SS) measures (indicating whether groups were significantly different on these measures); the Kruskal-Wallis Test for the understanding conversation measure (indicating whether groups were significantly different test results (indicating which groups scored significantly different) on these measures). Different letters (with letters being presented under the mean values) indicate significant differences between groups on the Bonferroni t test. Two groups having the same letter indicates that there is no significant difference between these two groups on that measure but two groups having a different letter indicates that there is a significant difference between these two groups on that measure. Additional descriptive statistics values and additional values for the analysis of variance, Kruskal-Wallis Test and Bonferroni t test are presented in appendix C1.

Measure	HFPDD		SLI group		NDD group		ANOVA	Kruskal-
	group							Wallis
	Mean	SD	Mean	SD	Mean	SD	F value	Chi-
								square
BPVS (SS)	94.5	13.6	101.4	7.5	113.6	8.2	23.46 ***	
	a		a		b			
Basic Concepts	15.5	2.9	17.4	0.9	18.0	0.0	13.87 ***	
(RS)	a		b		b			
Grammatic	9	2.4	11.1	2.1	13.2	2.0	24.29 ***	
Understanding	a		b		c			
(SS)								
Understanding	4.5	1.7	9.3	1.1	10	0.0		62.6 ***
conversation	a		b		b			
(Rating)								

Table 6.1: Summary of receptive language results

*p<.05; **p<.01; ***p<.001

In table 6.1 descriptive statistics for the BPVS standardized score (SS), Basic Concepts raw score (RS), Grammatic Understanding standard score (SS) and understanding conversation

rated score (pragmatic comprehension) are presented. For all the above measures the standard deviation was largest for the HFPDD group, indicating that this group contains the greatest variability. When looking at the means obtained, receptive language was weaker in the SLI group than the NDD group, but it was weakest in the HFPDD group. The differences between the three groups on all the measures of receptive language were statistically significant, as shown by the analysis of variance and Kruskal-Wallis results.

The results from the Bonferroni t test indicated that the HFPDD group scored significantly more poorly than the SLI group on the measures of Basic Concepts, Grammatic Understanding and understanding conversation. The SLI group scored significantly more poorly than the NDD group on the BPVS and Grammatic Understanding measures. The HFPDD and SLI groups did not score significantly differently on the BPVS. The HFPDD group scored significantly more poorly than the NDD group did not score significantly differently from the NDD group on the Basic Concepts and understanding conversation measures. These results indicate that receptive language was weaker in the SLI group than the NDD group, but that it was weakest in the HFPDD group.

Standard scores for individual participants for the Basic Concepts sub-test could not be derived as some of the subjects were older than the norms provided in the test manual. In order to obtain an idea of how the three groups performed in relation to the norms provided on this test, the mean raw scores for each group were converted to a standard score and percentile rank based on the mean age of that group (6.2 years for all three groups). The standard scores and percentile ranks obtained are presented in table 6.2.

Table 6.2: Standard scores and percentile ranks obtained for the mean raw scores on the Basic Concepts sub-test

	HFPDD group	SLI group	NDD group
Standard score	5	8	12
Percentile rank	5	25	75

For the SLI group, the mean standardized score for the BPVS (101.4) and the mean standard score for the Grammatic Understanding sub-test (11.1) still fell into the average range, when assessing these results according to the test manuals of these measures. Furthermore, when the mean raw scores for the Basic Concepts sub-test were converted into a standard score (8)

and percentile rank (25), the SLI group's performance still fell in the average range, although in the low average range.

For the HFPDD group, the mean standardized score of the BPVS (94.5) and mean standard score for the Grammatical Understanding sub-test (9) still fell into the average range, when looking at these results according to the test manuals of these measures. The standard (5) and percentile rank (5) scores obtained from converting the mean raw scores for the Basic Concepts sub-test, however, indicate marked difficulty on this measure for the HFPDD group (with below average ability being indicated by scores falling below the 16th percentile). Furthermore, the HFPDD group appeared to experience marked difficulty on the understanding conversation measure of the pragmatic rating. This was obtained from the rating of two items: comprehension of literal meaning (out of a score of 5) and use of context in comprehension (out of a score of 5), where a total score of 10 could be obtained for understanding conversation. A mean score of 4.5 obtained over two items (which was obtained for the HFPDD group) would suggest marked difficulty in this area, suggesting much inappropriate performance in this area according to the pragmatic rating scale. Results, therefore, indicate particularly marked difficulty in the areas of understanding more abstract concepts and understanding conversation for the HFPDD group. Results for the receptive language measures are schematically summarised in tables 6.3, 6.4 and 6.5.

	BPVS	Basic Concepts	Grammatic	Understanding
			Understanding	conversation
Strongest	NDD	NDD	NDD	NDD
to	SLI	SLI	SLI	SLI
weakest	PDD	PDD	PDD	PDD

Table 6.3: Order of performance of groups on receptive language measures

Table 6.4: Profile of HFPDI) group's recept	ive language results
-----------------------------	------------------	----------------------

	BPVS	Basic Concepts	Grammatic Understanding	Understanding conversation
Functional	*		*	
Concern				
Significant concern		*		*

	BPVS	Basic	Grammatic	Understanding
		Concepts	Understanding	conversation
Functional	*	*	*	*
Concern				
Significant concern				

Table 6.5: Profile of SLI group's receptive language results

In contrast to the HFPDD group, the SLI group (as a group) appears to have performed in the functional range for all four of these areas, even though it performed significantly weaker than the NDD group on the BPVS and Grammatic Understanding measures. There were, however, individuals within the SLI group who experienced difficulty on the receptive language measures. What was interesting, when looking at the individual results of the children with SLI, was that at a conversational level, these subjects appeared to compensate for their receptive language difficulty (possibly by relying on non-verbal information) and did not appear to experience as much difficulty as many of the subjects in the HFPDD group. The HFPDD group experienced particular difficulty in the areas of Basic Concepts and understanding conversation.

6.1.1.2 Discussion of results in relation to previous studies

Results support previous findings that comprehension in PDD is weaker than in children with developmental language disorder (Sherman et al., 1983, as cited in Beisler et al., 1987). Results also support the findings that children with HFPDD do not necessarily perform poorly on formal language tests (Beisler et al., 1987; Eskes et al., 1990), with the HFPDD group performing in the functional range on the BPVS and Grammatic Understanding measures. Furthermore, the results support the findings that it is more often in context and at a conversational or discourse level that children with PDD's receptive language difficulties become evident (Sharp, 1992; Tager-Flusberg et al., 2005). The results did indicate a difference between the understanding of abstract versus more concrete vocabulary, with the HFPDD group experiencing difficulty on the Basic Concepts sub-test. This was not supported by Hobson and Lee's (1989) study that found that autistic adolescents did not score more poorly on highly abstract versus more concrete items on the BPVS. The current finding of more difficulty on abstract vocabulary items may be related to the sample being a much younger one and the populations being studied being slightly different (autistic in Hobson and Lee's (1989) study and HFPDD in this study). Previous studies have generally not provided an overall profile of receptive language difficulties. The results of the current study highlight particular receptive language difficulties, i.e. difficulty with more abstract language and difficulty understanding discourse/language in context in HFPDD, with performance on the receptive language measures tapping the more structured aspects of language falling in the functional range, although the children with HFPDD still performed significantly more poorly on these than the children with NDD did.

6.1.1.3 <u>Summary of receptive language results</u>

While both the HFPDD and SLI groups experienced more difficulty in the area of receptive language than the NDD group, the HFPDD group also experienced significantly more difficulty than the SLI group. The HFPDD group and SLI group did not score significantly differently on the measure of receptive vocabulary (the BPVS), although they did score significantly more poorly than the NDD group. The HFPDD and SLI groups scored significantly more poorly than the NDD group on the Grammatic Understanding measure, with the HFPDD group also scoring significantly more poorly than the SLI group on this measure. However, when analysing the HFPDD and SLI groups' mean scores on these measures, in relation to the norms in the test manuals on these measures, they still performed in the functional range. The HFPDD group, however, experienced significant difficulty on the Basic Concepts and understanding conversation measures, with the SLI group on the SLI group on the set manuals on these measures.

6.1.2 <u>Expressive semantics</u>

6.1.2.1 Overview of results

Results of the expressive semantic language measures are presented in table 6.6. This includes the means and standard deviations (SDs), analysis of variance results (indicating whether groups were significantly different on these measures), and Bonferroni t test results (indicating which groups scored significantly differently on these measures) for the Word Finding Vocabulary Test age score (in months), the pronoun alternation task raw score (RS), the Oral Vocabulary standard score (SS) and the modified TOPS raw score (RS). Different letters (with letters being presented under the mean values) indicate significant differences

between groups on the Bonferroni t test. Additional values for the descriptive statistics, analysis of variance and Bonferroni t tests are presented in appendix C2.¹

Measure	HFPDD group		SLI group		NDD group		ANOVA
	Mean	SD	Mean	SD	Mean	SD	F value
Word Finding	60.6	15.5	62.0	9.5	83.4	13.7	24.64***
Vocabulary Test	a		a		b		
(age score in months)							
Pronoun alternation	9.7	5.8	15.5	3.3	16.6	1.1	23.3***
(RS, n=17)	a		b		b		
Oral Vocabulary (SS)	6.7	2.8	9.2	1.8	12.1	1.1	47.2***
	a		b		c		
Modified TOPS (RS,	9.3	8.6	38.5	11.9	56.2	7.9	157.6***
n=100)	a		b		c		

Table 6.6: Summary of expressive semantic results

*p<.05; **p<.01; ***p<.001

In an examination of the mean scores obtained, the HFPDD group scored more poorly than both the SLI group and NDD group on all these measures. The HFPDD group obtained larger standard deviations for all the expressive semantic measures except the modified TOPS, possibly suggesting the greater variability on these measures for the HFPDD group. The standard deviation obtained for the modified TOPS was, however, smaller than that obtained for the SLI group and not very different to that obtained for the NDD group. Results would appear to suggest that as a group the HFPDD group scored consistently more poorly on the modified TOPS. Looking at the mean scores obtained for the HFPDD group in relation to the SLI and NDD groups and across tests tapping greater depths of meaning, it would appear that the HFPDD group's performance became poorer as greater depths of semantic meaning were tapped.

Analysis of variance results indicated significant differences for all expressive semantic measures across the three groups. The results of the Bonferroni t tests indicated that, when compared to the SLI group, the HFPDD group did not score significantly more poorly on the Word Finding Vocabulary Test but did on the pronoun alternation task, Oral Vocabulary subtest and modified TOPS measure. When compared to the NDD group, the SLI group scored

¹ It must be noted that for one of the subjects with SLI, responses for 19 of the 50 items on the modified TOPS were not recorded due to audiotape failure. For this subject an overall score for the modified TOPS was calculated by working out the number of items (i.e. percentage) that this child would have been expected to get correct on the missing items, based on the number of items that he scored correctly on (i.e. percentage) on the rest of this measure and then adding these two scores together.

significantly more poorly on all these measures except the pronoun alternation task. When compared to the NDD group the HFPDD group scored significantly more poorly on all the expressive semantic measures.

The HFPDD group scored similarly to the SLI group on the measure of expressive vocabulary (Word Finding Vocabulary Test), with the NDD group doing much better. The mean age of all three groups was 74 months, indicating that while the HFPDD group (who obtained a mean age score of 60.6 months on this measure) and the SLI group (who obtained a mean age score of 62.0 months on this measure) did not score significantly differently on the expressive vocabulary measure, they did both score poorly.

The HFPDD group scored markedly more poorly than the SLI group on the measure of descriptive semantics (Oral Vocabulary sub-test). The SLI group in turn scored markedly more poorly than the NDD group on this measure. On this measure a standard score of 6 to 7 suggests below average ability (according to Newcomer and Hammill, 1997), indicating below average ability in this area for the HFPDD group. A standard score of 8 to 12 indicates average ability (according to Newcomer and Hammill, 1997), suggesting average ability for the SLI group, although they do appear to score in the low average range, while the NDD group appear to score in the high average range.

The norms from the TOPS were unable to be strictly applied due to the modifications that were made in the administration of this measure. However, a qualitative evaluation of these norms and comparison of the mean group scores in relation to these, would appear to suggest performance for the HFPDD group in the extremely below average range, performance for the SLI group in the low average to below average range and performance for the NDD group in the high average range.

When compared to the SLI group, on the expressive semantic measures, the HFPDD group scored the weakest on the pronoun alternation measure and modified TOPS (which taps explaining, interpreting and inferring), although they also scored markedly more poorly on the Oral Vocabulary measure. On the modified TOPS the SLI group in turn scored markedly more poorly than the NDD group. According to Norris and Hoffman's (1993) framework, the pronoun alternation task and Oral Vocabulary sub-test would appear to tap greater depths of meaning than the Word Finding Vocabulary Test (expressive vocabulary measure), while the

modified TOPS would tap the greatest depths of meaning than any of these other measures. The pronoun alternation task would appear to have an interpretation component, based on the perspective taken and may, therefore, possibly tap even greater depths of meaning than the Oral Vocabulary sub-test, which assesses description rather than interpretation. Results suggest that as the expressive semantics battery tapped greater depths of meaning, so the HFPDD group scored more poorly and became more differentiated from the SLI group. Poorer performance as the expression of greater depths of meaning is tapped, would appear to suggest greater difficulty as one goes deeper into the semantic system, confirming significant difficulty with the semantics of language in the HFPDD group. Furthermore, both the pronoun alternation task and modified TOPS measures appear to rely on the dual processing of visual and verbal information. On the pronoun alternation task correct use of the verbal stimulus (in this case the pronoun) depends on the visual perspective being taken. On the modified TOPS the child has to integrate visual and verbal information. A qualitative analysis of the results of the modified TOPS indicated that the HFPDD subjects often focused on inappropriate information when attempting to explain, interpret and infer the information that was presented, to the detriment of seeing the overall gist of the situation. In contrast the SLI subjects appeared rather to experience difficulty putting their thoughts into words, with their answers (even when not correct) appearing to be more related to the correct answer and being more on track, than participants from the HFPDD group. A summary of the results for the expressive semantics assessment is schematically presented in tables 6.7, 6.8 and 6.9.

	Word Finding		Pronoun	Oral	Modified TOPS
	Vocabulary Test		Alternation	Vocabulary	
Strongest	NDD		NDD	NDD	NDD
to	SLI P	DD	SLI	SLI	SLI
weakest			PDD	PDD	PDD

Table 6.7: Order of performance of groups on expressive semantic measures

Table 6.8: Profile of HFPDD group's expressive semantic results

	Word Finding	Pronoun	Oral	Modified TOPS
	Vocabulary	alternation	Vocabulary	
	Test			
Functional				
Concern	*		*	
Significant concern		*		*

	Word Finding	Pronoun	Oral	Modified TOPS
	Vocabulary	alteration	Vocabulary	
	Test			
Functional		*	*	
Concern	*			*
Significant concern				

Table 6.9: Profile of SLI group's expressive semantic results

6.1.2.2 Discussion of results in relation to previous studies

The results of the Word Finding Vocabulary Test suggest that children with HFPDD may have different expressive vocabularies compared to typically developing children. This could possibly be due to the previously reported 'patchy' vocabulary acquisition in this group (Schoenbrodt et al., 1995). It may be possible that their vocabulary acquisition is affected by them focusing on different classes of words from typically developing children. Another reason for the difficulty in expressive vocabulary would relate to reports of children with SPD having word retrieval difficulties (Smedley, 1989) and children with autism experiencing difficulty using meaning to retrieve words from memory (Lord & Paul, 1997; Tager-Flusberg, 1991).

The children with HFPDD experienced markedly more difficulty on the pronoun alternation task than both the children with SLI and the children with NDD. This difficulty with first versus second person pronouns is supported in the literature (Jordan, 1989; Lee et al., 1994; Oshima-Takane & Benaroya, 1989). While pronoun reversal has been reported to occur in some children with language disorder (Fariberg, 1977, as cited by Tager-Flusberg, 2005), the results of the current study would suggest that this difficulty is far milder in children with language disorder. What is interesting is that in their conversational language, only a few of the children with HFPDD still made pronoun reversals. However, when taxed during the pronoun alternation task, many of the children in the HFPDD group made pronoun reversals. The greater difficulty that the HFPDD group had with pronoun reversals even in relation to the SLI group would support the observation that their difficulty with pronouns is out of keeping with other aspects of their language development, such as their general grammatical development (Lee et al., 1994).

Poor performance on the Oral Vocabulary measure in the HFPDD group supports the finding that these children experience difficulty with the semantic function of describing. A study by

Dennis et al. (2001) did not find that a group of high functioning children with autism experienced difficulty with describing, while a study by Ziatas et al. (2003, as cited by Tager-Flusberg, 2005) did find difficulty with describing in older higher functioning children with autism. In the current study, while the SLI group scored significantly more poorly than the NDD group on describing, the HFPDD group scored even more poorly, suggesting that this may be an area of particular difficulty for this group.

The very marked difficulty that the children with HFPDD experienced on the modified TOPS would support the finding of difficulty with higher level semantics reported in the literature, including difficulty with explaining (Silliman et al., 2003; Zaitas et al., 2003, as cited by Tager-Flusberg, 2005), interpreting (Grant et al., 2004; Kerbel & Grunwell, 1998) and inferencing (Dennis et al., 2001; Frazier Norbury & Bishop, 2002; Grant et al., 2004; Happe, 1994; Joliffe & Baron-Cohen, 1999; Smedley, 1989). This difficulty with higher level semantics, therefore, appears to be a fairly robust finding. The current study provides support for an increase in semantic difficulties in HFPDD as tasks tap greater depths of meaning. A systematic assessment of semantics such as this, where greater depths of meaning are systematically tapped, does not appear to have previously been carried out.

6.1.2.3 <u>Summary of results of expressive semantics assessment</u>

The HFPDD group experienced significant difficulty with all the measures of expressive semantics, appearing to experience the greatest difficulty on the pronoun alternation and modified TOPS measures. The SLI group experienced marked difficulty on the Word Finding Vocabulary Test and modified TOPS measures. While the HFPDD group scored similarly to the SLI group on the Word Finding Vocabulary Test, it performed markedly more poorly on the modified TOPS. It also scored more poorly than the SLI group on the HFPDD group scored significant task and Oral Vocabulary measures. Results appear to suggest that the HFPDD group's performance worsened as greater depths of semantic meaning were tapped.

6.1.3 Expressive grammar

6.1.3.1 Overview of results

Results of the expressive grammar language measures are presented in table 6.10. This includes the means and standard deviations (SDs), analysis of variance results (indicating whether groups were significantly different on these measures) and Bonferroni t test results (indicating which groups scored significantly differently on these measures) for the measures of minor utterances, major utterances, phrasal utterances, T-units, dependent clauses, total clauses, mean length of utterance (MLU) and different complex clauses used. Different letters (with letters being presented under the mean values) indicate significant differences between groups on the Bonferroni t tests. Additional values for the descriptive statistics, the analysis of variance and Bonferroni t tests for the expressive grammar measures are presented in appendix C3.²

Measure	HFPDD g	group	SLI grou	р	NDD gro	oup	ANOVA
	Mean	SD	Mean	SD	Mean	SD	F value
Minor	44.69	17.52	47.31	22.63	39.44	20.94	0.97
	a		а		a		
Major	13.54	6.70	15.58	7.83	7.20	3.38	12.23***
	a		а		b		
Phrasal	25.15	11.04	29.92	8.03	21.52	7.08	5.72**
	a,b		a		b		
T-units	120.38	55.52	108.96	36.44	135.36	29.26	2.52
	a		а		а		
Dependent	15.23	12.31	11.96	7.28	29.92	12.25	19.68***
clauses	a		а		b		
Total clauses	135.62	65.81	120.92	41.95	165.28	37.90	5,14**
	a,b		а		b		
MLU	5.85	1.01	5.75	0.61	7.28	0.58	32.15***
	a		а		b		
Different	3.65	1.90	3.96	1.68	5.92	1.26	14.26***
complex clauses	a		a		b		

Table 6.10: Summary of expressive grammar results

*p<.05; **p<.01; ***p<.001

² It must be noted that data was missing for one of the NDD subjects for the conversational sample that the expressive grammatical measures were based on. Results for expressive grammar for the NDD group were, therefore, calculated on 25 rather than 26 subjects.

An analysis of the mean scores indicates that the HFPDD and SLI groups used more minor, major and phrasal utterances and fewer T-units, dependent clauses, total clauses and different complex clauses than the NDD group. They also used a smaller MLU than the NDD group. For the measures, minor, major and phrasal utterances, T-units dependent clauses, total clauses and MLU, the HFPDD group's mean score fell between the mean scores of the NDD and SLI groups, suggesting that the SLI group is more impaired in expressive grammar than the HFPDD group. Interestingly, the only measure where the HFPDD group's mean score did not fall between the SLI and NDD groups' mean scores was the measure of number of different complex clauses. Here the HFPDD group did slightly more poorly than the SLI group. This may be due to this measure tapping more into the conceptual and generativity aspects of expressive grammar.

The analysis of variance results indicated significant differences between the three groups on the measures of major and phrasal utterances, dependent clauses, total clauses, MLU and different complex clauses used. The three groups did not differ significantly on number of minor utterances (e.g. "yes", "no", "umm") used or number of T-units, with a T-unit being roughly equivalent to a sentence. This would suggest that the three groups used a similar number of sentences in the language samples taken but that the grammatical complexity of their sentences differed. While the three groups did not differ statistically on number of Tunits used, the SLI group still used less T-units than the other two groups. The HFPDD group had the largest standard deviation for number of T-units, possibly suggesting greater variability in the area of expressive grammar in this group than in the other two groups. Use of far less T-units by some children in the HFPDD group may indicate generativity difficulties in these children (i.e. they experienced difficulty generating sentences or responses in the interaction).

The HFPDD and SLI group scored significantly differently to the NDD group on number of major utterances, number of dependent clauses, MLU and different complex clauses used. The HFPDD and SLI groups were found to use more major utterances than the NDD group, possibly as they used these instead of more complex clausal utterances. The HFPDD and SLI groups used fewer dependent clauses, a shorter MLU and fewer different complex clauses than the NDD group, indicating the use of less complex grammar than the NDD group.

The SLI group did, however, score significantly more poorly than the HFPDD group on certain measures, these being the number of phrasal structures used and the total number of clauses used. The SLI group used significantly more phrasal structures than the HFPDD group and NDD group, who did not differ significantly on this measure. The SLI group possibly used more phrasal structures as they employed these instead of using more complex clausal utterances. The SLI group used significantly less total number of clauses than both the HFPDD group and the NDD group, who did not differ significantly on this measure. These results would appear to suggest that while children with HFPDD may experience a grammatical language difficulty, this does differ and is less severe than in children with SLI. Results of the expressive grammar analysis are schematically summarised in table 6.11.

	Minor	Major	Phras.	Т-	Depend.	Total	MLU		Diff.
				units	Clauses	claus.			compl.
									claus.
Most/	SLI	SLI	SLI	NDD	NDD	NDD	NDD		NDD
greatest	PDD	PDD	PDD	PDD	PDD	PDD	PDD SI	LI	SLI
to	NDD	NDD	NDD	SLI	SLI	SLI	_		PDD
least/									
fewest									

Table 6.11: Order of performance of groups on expressive grammar measures

In contrast to the receptive language and expressive semantic measures, on the grammatical analysis the SLI group now generally appeared to be the weakest group. Even in relation to the HFPDD group, the SLI group used markedly fewer total clauses and more phrases.

The results of the grammatical analysis bring into question the suggestion that children with HFPDD do not have grammatical language difficulties. Results suggest that their language is not as complex as their peers without developmental difficulties and that particular difficulty is evident at stage V of the LARSP, with there being a reduced amount and range of complex grammar. In particular, in comparison to the NDD group, the HFPDD group used more major utterances, fewer dependent clauses, a shorter MLU and a smaller range of different complex clauses. The same observations as these were made for the SLI group. In addition, the SLI group used more phrasal utterances when compared to the NDD group and fewer total number of clauses. While the SLI group's grammatical language difficulties appeared more marked than those of the HFPDD group. Of particular note is that the HFPDD group used

fewer different complex clauses than even the SLI group, possible suggesting difficulty with grammatical creativity or generativity in their language use.

It was decided to look at the frequency of the number of different complex clauses used by the three groups, as it was felt that this may provide information on whether the HFPDD group's difficulties were more of a conceptual nature. The number of different dependent clauses (i.e. stage V utterances) that were employed by each participant who used dependent clauses was calculated. These results are presented in figure 6.1. Figure 6.1 shows the percentage of participants from each group who used a different number of different complex clauses, ranging from no complex clauses to eight different complex clauses.



Figure 6.1: Frequency of number of different complex clauses used

More HFPDD participants, who used complex clauses, employed only one or two different types of complex clauses than either of the other groups. More SLI subjects used three or five different types of complex clauses than either of the other two groups. More NDD subjects used six, seven or eight different types of complex clauses than either of the other two groups.

Results indicate that, when compared to both the NDD and SLI groups, the HFPDD group showed less variety in the number of different stage V level LARSP structures that they used. The NDD group used the most different types of complex clauses. These results would appear to suggest a possible different underlying difficulty to the SLI and HFPDD groups' grammatical difficulties. In comparison to the NDD and SLI group, the HFPDD group appear to have a generativity problem, appearing to have difficulty using complex grammar in a variety of different ways. While they on average used slightly more dependent clauses than the SLI group, the results in figure 6.1 indicate that they did not use these in as varied a way as the other two groups and that they tended to use the same complex clause structures over and over.

The presence of the different types of complex clause structures that were used in the different groups was calculated. The number of children from each group who used a particular structure was recorded (even if this structure was only used once). The percentage of participants from each group, who used each type of complex clause structure, is shown in figure 6.2



Categories of Complex Grammatical Structures

Figure 6.2: Percentage of participants from each group who used each type of complex clause structure

Apart from the coord 1+ category, markedly more participants from the NDD group used all the other categories than participants from the HFPDD and SLI groups. Fewer HFPDD participants than SLI participants used the subord A structure. However, more HFPDD participants used the subord A1+ structure than SLI participants, suggesting that a marked difference between the HFPDD and SLI groups on use of the overall subord A category does not appear to exist. Fewer HFPDD participants used the postmod 1 structure than SLI participants. However, more HFPDD participants used the postmod 1+ structure than SLI participants, suggesting that a marked difference between the HFPDD and SLI groups for the use of the overall postmod clause category does not exist. The same number of HFPDD and SLI participants used the coord 1 category. Slightly fewer HFPDD participants used the subord C category than SLI participants.

The number of subjects who used sub O structures is of particular interest as this reflects the syntax of complementation, which de Villiers and de Villiers (2000) suggested needs to be understood before the theory of mind concept of belief can be understood. All the NDD subjects used the sub O structure, 84.6% of the SLI subjects used this structure, while 76.9% of the HFPDD subjects employed this structure. The observation that fewer HFPDD subjects than SLI subjects used the subord O structure, is interesting, as it may partly account for their greater difficulty on the theory of mind tasks. Furthermore, the observation that fewer SLI subjects then NDD subjects used the subord O structure could partly account for why the SLI subjects experienced more difficulty than the NDD subjects on the theory of mind tasks. The difference between the number of subjects who used the subord O structure across the three groups was, however, not large. Studies have shown that it is understanding and not use of this structure that is important (de Villiers & de Villiers, 2000). It is possible that some of the subjects may have used the subord O structure without fully understanding it. This is particularly possible in the HFPDD group, where the rote learning of language reflected in a gestalt language learning style has been reported (Prizant, 1983; Schoenbrodt et al., 1995). No participants from the HFPDD group were noted to use the sub S structure at all. Sub S structures, for example "What she did made me cross" and "What I said was important" appear to reflect talking about a person's thoughts and feelings of past events. Furthermore, these structures appear to reflect talking about events that are no longer present, which may have resulted in them being more difficult for the HFPDD group, as they are more conceptual structures.

These results suggest that children with HFPDD do have grammatical language difficulties. These appear to have a different pattern from that seen in SLI. Results suggest that the difficulty with complex grammar in HFPDD may possibly be due to conceptual language difficulties and generativity problems.

6.1.3.2 Discussion of results in relation to previous studies

These results do not support previous studies that have indicated that PDD does not involve an impairment in grammatical ability (Tager-Flusberg et al., 1990). The results would, however, support studies that demonstrated grammatical language difficulties in children with HFPDD (Frazier Norbury & Bishop, 2003) and autism (Jarrold et al., 1997). Similar to Frazier Norbury and Bishop's (2003) study the HFPDD group in the current study used less complex sentences than typically developing children and appeared to experience particular difficulty with complex grammar at stage V of the LARSP. This greater difficulty at stage V of the LARSP has previously been proposed by Smedley (1989) to occur in children with SPD. Similar to Tager-Flusberg et al.'s (1990) study, where a narrower range of grammatical structures in children with autism when compared to Down syndrome was found, in the current study a narrower range of grammatical structures appeared evident in children with HFPDD when compared to children with SLI. It was not within the scope of this study to do grammatical analyses according to diagnosis (for example, comparing the expressive grammar of the children given a diagnosis of Asperger's syndrome versus HFA versus SPD). Furthermore, it was uncertain how accurate the exact diagnosis (within the high functioning range of the PDD spectrum) that was given to the children was, as a particular diagnostic measure was not followed for inclusion in this study. Inclusion was rather based on diagnoses given by professionals with whom the children had been in contact. This, however, would appear to be a useful area to investigate in future studies, as the literature has suggested that individuals with HFPDD's syntactical abilities may differ according to their specific diagnosis (Ghaziuddin et al., 2000; Tager-Flusberg et al., 2005). Something that does not appear to have been previously investigated in the literature is how children with HFPDD's syntactic abilities differ from children with SLI's syntactic abilities. The current study does appear to suggest some important differences. Both the SLI and HFPDD group presented with grammatical difficulties. While the SLI group appeared to have poorer expressive grammar than the HFPDD group, a more qualitative analysis of the data indicated that the HFPDD group used a smaller variety of complex clauses than even the SLI group.

This would appear to suggest a generativity difficulty, possibly suggesting a different underlying basis to the HFPDD and SLI groups' expressive grammatical difficulties. More in-depth research of children with HFPDD and SLI's expressive grammar in the future may provide further interesting insights into these differences.

6.1.3.3 <u>Summary of expressive grammar results</u>

Both the HFPDD and SLI groups presented with expressive grammatical difficulties. While the SLI group's grammatical difficulties appeared more marked than those of the HFPDD group, qualitative analysis of the results indicated that the HFPDD group appeared to have less variety than even the SLI group in the different types of complex clauses that they used. This may possibly point to a conceptual basis to their grammatical difficulties and/or generativity difficulties.

6.1.4 <u>Narrative ability</u>

6.1.4.1 Overview of results

Results of the narrative analysis are presented in figure 6.3. Here the total coherence scores, clarity scores and total narrative score (coherence and clarity scores combined) are presented. The means, Kruskal-Wallis test results (indicating whether groups were significantly different on these measures) and Bonferroni t test results (indicating which groups scored significantly differently on these measures) are included. Stars indicate significant differences between groups on the Kruskal-Wallis test. Different letters indicate significant differences between groups on the Bonferroni t test. The Bonferroni t test was only run on the total coherence and total narrative scores. It was unable to be run on the clarity scores due to the clarity score consisting of only one item. Additional descriptive statistic values and additional values for the Kruskal-Wallis test and Bonferroni t test are presented in appendix C4.



Total narrative score (combination of coherence and clarity scores) *** *** p<.001

Figure 6.3: Division of total narrative score

The mean score obtained by the HFPDD group (1.5) and SLI group (1.8) for the clarity rating were similar in contrast to the NDD group, who obtained a mean score of 4.0. This would appear to indicate that both these groups experience similar levels of difficulty in the area of clarity. The mean score obtained by the HFPDD group for the coherence rating (7.0) was, however, markedly poorer than that obtained by the SLI group (18.6), who also did more poorly than the NDD group (who obtained a mean score of 22.7). This would appear to suggest that narrative coherence is a particular area of difficulty for the HFPDD group, with this group experiencing even more difficulty with narrative coherence than the SLI group.

Results from the Kruskal-Wallis test indicate that for the overall coherence score, the clarity score and for the overall narrative score the three groups were statistically different. The Bonferroni t test results indicate that the HFPDD group scored significantly more poorly than the SLI group on the overall coherence and the total narrative measures. The SLI group in

turn scored significantly more poorly than the NDD group on both the overall coherence and total narrative measures.

Kruskal-Wallis tests were carried out on the different items of the narrative analysis, in order to determine whether significant differences existed between groups on these items. Results are presented in table 6.12.

	Chi-Square	df	р
Temporal organisation	56.9	2	<.0001 ***
Relevance	57.8	2	<.0001 ***
Development of character(s)	56.8	2	<.0001 ***
Supporting description	54.6	2	<.0001 ***
Ending	50.0	2	<.0001 ***
Clarity	47.0	2	<.0001 ***

Table 6.12:	Kruskal-Wallis	test results or	n different items	of narrative anal	ysis

The results from the Kruskal-Wallis test indicated that the performance on all the above items was statistically significantly different across the three groups.

Frequency distributions of the different parameters of the narrative analysis were conducted, as Bonferroni t tests could not be carried out on single items. These included frequency distributions for: temporal organisation, relevance, developing character(s), supporting description, ending and clarity. These are presented in figures 6.4, 6.5, 6.6, 6.7, 6.8 and 6.9.



Figure 6.4: Frequency distribution - Temporal organisation



Figure 6.5: Frequency distribution - Relevance



Figure 6.6: Frequency distribution – Development of character(s)



Figure 6.7: Frequency distribution - Supporting description



Figure 6.8: Frequency distribution – Ending



Figure 6.9: Frequency distribution – Clarity

These figures reflect the number of participants from each group (frequency) receiving a particular rating (i.e. 1, 2, 3, 4 or 5) on each item that was rated. For all these items, more HFPDD participants obtained a rating of 1 than any of the other ratings and then a rating of 2. Ratings of 3 were obtained for all the items rated. Ratings of 4 were only obtained for a few HFPDD participants for the items relevance and ending. Ratings of 4 were not obtained for any of the other items. No HFPDD participant ever obtained a rating of 5.

In contrast, in the SLI group more participants obtained a rating of 4 than any other rating for the items: temporal organisation, relevance, development of character(s) and ending. For supporting description more SLI participants obtained a rating of 3 than any other rating. For clarity more SLI participants obtained a rating of 2 than any other rating, followed by a rating of 1. For all the items except ending more subjects with NDD obtained a rating of 5 than any other score. For the variable ending more NDD subjects obtained a rating of 4 than any other rating.

These results suggest that the SLI participants experienced more difficulty with the clarity (structural aspects) of relating a story than the coherence (integration aspects). The HFPDD group in contrast experienced markedly more difficulty with coherence than the SLI group did. Their performance on the clarity item was, however, also worse than the SLI group, although not markedly so. Coherence would appear to be part of the meaning system and would appear to rely on much integration of information. Clarity would, however, appear to be more related to grammatical aspects and would not appear to lie as centrally in the language processing model. The results of the narrative analysis are schematically summarised in tables 6.13, 6.14 and 6.15.

Table 6.13: Order of performance of groups on narrative measur
--

	Coherence	Clarity	Total narrative
Strongest	NDD	NDD	NDD
to	SLI	SLI	SLI
weakest	PDD	PDD	PDD

Table 6.14: Profile of HFPDD group's narrative results

	Coherence	Clarity
Functional		
Concern		
Significant concern	*	*

Table 6.15: Profile of SLI group's narrative results

	Coherence	Clarity
Functional		
Concern	*	
Significant concern		*

6.1.4.2 Discussion of results in relation to previous studies

The results obtained support previous studies' findings that narrative ability is affected in PDD (Baltaxe & Simmons, 1977; Baron-Cohen et al., 1986; Losh & Capps, 2003; Tager-Flusberg, 1995). They, however, do not support the suggestion that the difficulty PDD children experience with narrative tasks is not necessarily specific to PDD and is secondary to their mental age (Capps et al., 2000, as cited by Losh & Capps, 2003) and language abilities (Loveland et al., 1990; Tager-Flusberg & Sullivan, 1995). In contrast to these studies, the results suggest that children with HFPDD may have a specific difficulty with narrative coherence. The current study's findings, unlike the study by Frazier Norbury and Bishop (2003), did find significant differences between the HFPDD group and the SLI group on narrative ability. The differences in these two studies' results would appear to be due to the different assessment tools used, as the current study focused particularly on coherence, while Frazier Norbury and Bishop's (2003) study focused on global structure, local linguistic structure and evaluation.

The results of the current study would appear to suggest that poor narrative coherence is strongly associated with pragmatic ability and the diagnosis of PDD. The group with HFPDD were noted to experience significantly more difficulty with coherence than the SLI group. While the SLI group also experienced difficulty with coherence their difficulty was not as marked as that of the HFPDD group. Both the HFPDD group and SLI group experienced difficulty. However, in relation to their performance on the coherence aspects, the SLI group appeared to experience particular difficulty with clarity. These results would appear to suggest that the SLI group's narrative difficulties have a more conceptual language basis. These results would, therefore, suggest that differences do exist between children with HFPDD and SLI on certain narrative measures. These results appear to stress the importance of focusing specifically on narrative coherence when assessing children with HFPDD's narrative ability.

Both the HFPDD and SLI groups experienced difficulty with narrative coherence and clarity. However, the HFPDD group experienced significantly more difficulty with narrative coherence. This would appear to suggest a specific difficulty with narrative coherence in HFPDD. In relation to their performance on the coherence aspects, the SLI group appeared to experience particular difficulty with the clarity measure. Results would appear to suggest that the HFPDD group's narrative difficulties have a more conceptual language basis, while the SLI group's narrative difficulties have a more structural language basis.

6.1.5 <u>Expressive pragmatics</u>

6.1.5.1 Overview of results

Results of the expressive pragmatic analysis are presented in figure 6.10. Here the results for verbal, paralinguistic and non-verbal pragmatic aspects, as well as total expressive pragmatics are presented. The means, Kruskal-Wallis test (indicating whether groups were significantly different on these measures) and Bonferroni t test results (indicating which groups scored significantly differently on these measures) are included. Stars indicate significant differences between groups on the Kruskal-Wallis test. Different letters indicate significant differences between groups on the Bonferroni t test. Further descriptive statistic values and additional values for the Kruskal-Wallis test and the Bonferroni t test are presented in appendix C5.³

³ It must be noted that videotaped data for the conversational sample was missing for one of the NDD subjects. This child was, however, felt to have good pragmatic skills. This child's pragmatic skills were rated on her general interaction with the researcher during other assessment measures that were video taped.



*** p<.001

Figure 6.10: Results of expressive pragmatic rating ***

An analysis of the mean scores for the verbal, paralinguistic and non-verbal aspects indicate that the HFPDD group experienced markedly more difficulty than both the SLI and NDD groups on all these aspects. Results from the Kruskal-Wallis test indicated that the three groups scored significantly differently on the verbal, paralinguistic and non-verbal aspects of pragmatics, as well as on overall expressive pragmatics. The results of the Bonferroni t test indicated that the HFPDD group scored significantly more poorly than both the SLI and NDD group on the verbal, paralinguistic and non-verbal measures. The SLI group scored significantly more poorly than the NDD group on the verbal and paralinguistic aspects, but not on the non-verbal aspect.

Table 6.16 provides the means and standard deviations for the various components of the pragmatic analysis. In order to make interpretation easier, items from the pragmatic analysis were combined together in the following ways:

- Speech acts This still consisted of one item.
- Topic skills This consisted of a combination of the three topic skills items.

- Turn taking This consisted of a combination of the four turn taking items.
- Lexical selection This consisted of a combination of the two lexical selection items.
- Stylistic variations This consisted of the communicative sensitivity item.
- Prosody and voice This consisted of a combination of the prosody and voice items.
- Speech rate and fluency This consisted of a combination of the speech rate and fluency items.
- Intelligibility This consisted of the intelligibility item.
- Body posture and gesture This consisted of a combination of the body posture and gesture items.
- Eye contact and facial expression This consisted of a combination of the eye contact and facial expression items.

Aspects	Components of	HFPDD	group	SLI grou	ıp	NDD gr	oup
	aspects	Mean	SD	Mean	SD	Mean	SD
Verbal	Speech acts (n=5)	2.04	1.00	4.89	0.33	4.96	0.20
aspects	Topic skills	4.15	1.52	14.0	1.27	14.92	0.27
	(n=15)						
	Turn taking	6.08	2.38	17.85	1.69	19.77	0.71
	(n=20)						
	Lexical selection	5.15	1.87	6.08	1.52	9.77	0.59
	(n=10)						
	Stylistic	1.23	0.43	4.54	0.65	5.00	0.00
	variations (n=5)						
Paralinguistic	Prosody and	4.65	2.45	9.54	1.48	9.85	0.46
aspects	voice (n=10)						
	Speech rate and	6.50	2.01	8.62	1.58	9.89	0.33
	fluency $(n=10)$						
	Intelligibility	3.65	1.23	3.81	1.17	5.00	0.00
	(n=5)						
Non-verbal	Body posture and	3.81	2.00	8.96	1.76	9.92	0.39
aspects	gesture (n=10)						
	Eye contact and	4.08	2.17	9.19	1.13	9.85	0.37
	facial expression						
	(n=10)						

Table 6.16: Means and standard deviations for the various components of the pragmatic analysis

An analysis of these results indicated that the HFPDD subjects experienced marked difficulty with all the verbal aspects of pragmatics, including speech acts, topic skills, turn taking, lexical selection and stylistic variations. Their difficulty appeared greater than even the SLI group. In relation to the NDD group, the SLI group's main difficulty in the area of verbal aspects appeared to be with lexical selection. In the area of intelligibility and prosodics, the HFPDD group also appeared to experience marked difficulty, particularly with prosody and voice. While the SLI group experienced some difficulty with the paralinguistic aspects, their main difficulty was with intelligibility. The HFPDD group also experienced difficulty with intelligibility, but appeared to experience slightly less difficulty in this area than the SLI group. The HFPDD group, in relation to both the SLI and NDD groups, experienced marked difficulty both with body posture and gesture, and eye contact and facial expression. The SLI group did not appear to differ markedly from the NDD group in the area of non-verbal aspects. A summary of the results of the expressive pragmatics assessment is presented schematically in tables 6.17, 6.18 and 6.19.

Table 6.17: Order of performance of groups on expressive pragmatic measures

	Verbal	Paralinguistic	Non-verbal
Strongest	NDD	NDD	NDD
to	SLI	SLI	SLI
weakest	PDD	PDD	PDD

Table 6.18: Profile of HFPDD group's expressive pragmatic results

	Verbal	Paralinguistic	Non-verbal
Functional			
Concern			
Significant concern	*	*	*

Table 6.19: Profile of SLI group's expressive pragmatic results

	Verbal	Paralinguistic	Non-verbal
Functional			*
Concern	*	*	
Significant concern			

6.1.5.2 Discussion of results in relation to previous studies

The results support the presence of significant pragmatic difficulties in PDD. A marked deficit in the area of pragmatics in PDD has been noted in the literature (Tager-Flusberg et al., 2005). Results support previous findings indicating marked difficulty with the verbal aspects of pragmatics in PDD, including difficulty with speech acts (Adams & Bishop, 1989; Bishop et al., 1994; Dennis et al., 2001; Lord & Paul, 1987, 1997; Schoenbrodt et al., 1995), topic skills (Bernard-Opitz, 1982; Eales, 1993; Lord & Paul, 1997; Loveland & Tunali, 1991;

McCaleb & Prizant, 1985; Tager-Flusberg et al., 2005), turn taking (Adams & Bishop, 1989; Baltaxe & D'Angiola, 1996; Bishop & Adams, 1989; Ferrier et al., 1991; Leinonen & Letts, 1997; Lord & Paul, 1997; Tager-Flusberg & Anderson, 1991; Tager-Flusberg et al., 2005; Volden, 2004), lexical selection (Baltaxe & D'Angiola, 1992; Fine et al., 1994; Rumsey, 1992; Tager-Flusberg & Sullivan, 1995) and stylistic variations (Dobbinson et al., 1998; Ghaziuddin & Gerstein, 1996; Hewitt, 1998b; Lord & Paul, 1997).

Results also support previous findings indicating marked difficulty with the paralinguistic aspects of language in PDD. Most of the literature in this area has reported difficulties with prosody (Fine et al., 1991; Gerken & McGregor, 1998; Lord & Paul, 1997; Schoenbrodt et al., 1995; Tager-Flusberg et al., 2005; Thurber & Tager-Flusberg, 1993) and voice (Tager-Flusberg et al., 2005), with no literature found that reported on speech rate or fluency. The results of the current study would suggest some difficulties in the area of speech rate and fluency, although these would not appear to be as marked as difficulties with prosody and voice. In terms of intelligibility, articulation in PDD has generally been reported to be normal or even precocious, although articulation difficulties do occur in some children with PDD (Tager-Flusberg et al., 2005). The poor intelligibility rating found in the current study for the HFPDD group, therefore, came as a surprise. A qualitative analysis of the results suggested that intelligibility in the HFPDD group was affected by aspects such as loudness levels and looking down when talking, etc. and not just articulation. Underlying reasons for poor intelligibility in PDD would appear to require further investigation in future studies.

Results also support previous findings indicating marked difficulty with the non-verbal aspects of language in PDD - with difficulty with gestural communication (Charman et al., 1997; Kasari et al., 1990; Schoenbrodt et al., 1995; Stone & Caro-Martinez, 1990), facial expression (Braverman, 1989) and eye contact (Braverman, 1989). The good performance of the SLI group on the non-verbal aspects of pragmatics is supported by the work of Bishop (2000). Bishop (2000) suggests that non-verbal communication skills provide a good clue to whether pragmatic difficulties are secondary to a structural language impairment or whether they are due to a primary pragmatic difficulty. Difficulty with non-verbal aspects (as seen in the HFPDD group) would suggest the presence of a primary pragmatic difficulty, while relatively intact non-verbal pragmatic skills would be suggestive of a language impairment in the absence of a primary pragmatic impairment. This would appear to apply to the SLI group.

Results suggest significant difficulties in the areas of verbal, paralinguistic and non-verbal aspects of expressive pragmatics for the HFPDD group. The HFPDD group appeared to experience marked difficulty with all the different aspects within the verbal, paralinguistic and non-verbal categories. While the SLI group also experienced difficulties with the verbal and paralinguistic aspects of pragmatics, these were not as marked as the HFPDD group's difficulties, with the HFPDD group experiencing significantly more difficulty than the SLI group on these measures. In the area of verbal aspects, the SLI group's main difficulty appeared to be with lexical selection. In the area of paralinguistics the SLI group's main difficulty appeared to be with prosody and voice. In contrast to the HFPDD group, the SLI group did not differ significantly from the NDD group in the area of non-verbal aspects. The results would appear to suggest that the SLI group's pragmatic difficulties are secondary to structural language and speech difficulties, while the HFPDD group's pragmatic difficulties are more primary and central in nature.

6.1.6 <u>Summary of communication results</u>

The results of the communication battery are summarised in figure 6.11, which provides a schematic overview of the different profiles obtained for the HFPDD and SLI groups. The results of the communication battery clearly differentiate the HFPDD and SLI groups, with different profiles being obtained for each of these groups on the communication measures.



Figure 6.11: Communication profiles obtained for the HFPDD and SLI groups

The HFPDD group's performance on the BPVS was functional. Their participants' performance on the Grammatic Understanding (GU) sub-test appeared to be borderline between an area of concern and a functional area. Their performance on the measures of the Word Finding Vocabulary Test (WFVT), the Oral Vocabulary sub-test (OV) and the expressive grammar (G) measures appeared to be of concern. However, their performance on the measures of Basic Concepts (BC), understanding conversation (UC), pronoun alternation (PA), the modified TOPS (MT), narrative coherence (COH), narrative clarity (CL) and on the verbal (V), paralinguistic (P) and non-verbal (NV) aspects of the pragmatic measure was of significant concern.

In contrast, the SLI group's performance on the BPVS, Basic Concepts (BC), Grammatic Understanding (GU), understanding conversation (UC), pronoun alternation (PA) and non-verbal pragmatic (NV) measures was functional. Their performance on the Oral Vocabulary (OV) measure appeared to be borderline between an area of concern and a functional area. Their performance on the Word Finding Vocabulary Test (WFVT), modified TOPS (MT), narrative coherence measure (COH), measure of verbal pragmatics (V) and measure of paralinguistic pragmatics appeared to be of concern. Moreover, their performance on the

measures of expressive grammar (G) and narrative clarity (CL) appeared to be of significant concern.

All the areas that the HFPDD group experienced as a significant concern, i.e. on the Basic Concepts (BC), understanding conversation (UC), pronoun alternation (PA), modified TOPS (MT) and narrative and pragmatic measures, appear to rely on the meaning/semantic system and the integration of information from different modalities. All the areas that the SLI group experienced as a significant concern, i.e. with expressive grammar (G) and narrative clarity (CL) appear to rely more on structural language aspects. This would suggest different underlying processes accounting for these two groups' communication difficulties.

6.2 COGNITIVE PROCESSING RESULTS

6.2.1 <u>Overview of results</u>

An overview of the results of the cognitive processing assessment will first be provided followed by a discussion of these in relation to previous studies. This will be followed by a summary of these results.

6.2.1.1 Overall results of cognitive processing battery

Results of the Cognitive Assessment System (CAS) are presented in figure 6.12. This includes the mean standard scores, analysis of variance results (indicating whether groups were significantly different on these measures), and Bonferroni t test results (indicating which groups scored significantly differently on these measures). Stars indicate significant differences between groups on the analysis of variance measures. Different letters indicate significant differences between groups on the Bonferroni t test. Additional descriptive statistic values and additional values for the analysis of variance and Bonferroni t test are presented in appendix C6.





** p<.01; *** p<.001

Figure 6.12: Cognitive Assessment System results

Analysis of variance results indicated that the three groups scored significantly differently to each other on all the variables: planning, simultaneous processing, attention, successive processing and on the full scale; with a more significant difference being found for planning, attention, successive processing and the full scale results than for simultaneous processing. Bonferroni t test results indicated that the HFPDD group scored significantly more poorly than the SLI group on the planning measure and that the SLI group scored significantly more poorly than the NDD group on this measure. The HFPDD and SLI groups did not score significantly differently on the simultaneous processing measure, but both groups scored significantly more poorly than the NDD group on this measure. The HFPDD group scored significantly more poorly than both the SLI and NDD groups on the attention measure, while the SLI and NDD groups did not score significantly differently on this measure. The SLI group scored significantly more poorly than the HFPDD group on the successive processing measure, while the HFPDD group scored significantly more poorly than the NDD group on the SLI and NDD group on the successive processing measure, while the HFPDD group scored significantly more poorly than the NDD group on the successive processing this measure. The HFPDD and SLI groups did not score significantly differently on the full scale results but both scored significantly more poorly than the NDD group on the full scale results. A qualitative analysis of the mean scores, while taking the above statistical results into account, would appear to indicate two different profiles for the HFPDD and SLI groups. The HFPDD group appeared to have a profile with poorest performance in the areas of planning and attention, with particular difficulty in the area of planning being evident. The SLI group appeared to have a profile with poorest performance on successive processing, as well as some difficulty in the area of planning.

6.2.1.2 Cognitive strengths and weaknesses

On the CAS each individual's individual cognitive strengths and weaknesses can be calculated. This consists of areas of cognitive strength and weakness in relation to the individual's overall performance. This is determined by calculating whether a particular cognitive construct is a strength, weakness or not significantly different from that particular child's cognitive processing mean. The cognitive strengths and weaknesses, obtained for each group, are shown in figure 6.13. A positive value indicates a cognitive strength, while a negative value indicates a cognitive weakness.



Cognitive Strengths and Weaknesses

Figure 6.13: Number of participants in each group presenting with cognitive strengths/weaknesses in the areas of planning, simultaneous processing, attention and successive processing
In the HFPDD group no HFPDD participants presented with planning as a cognitive strength, while a marked number (21 children) presented with it as a cognitive weakness. A marked number of HFPDD participants (17 children) presented with simultaneous processing as a cognitive strength, while no participants presented with it as a weakness. No HFPDD participants presented with attention as a cognitive strength, while a fairy large proportion (7 children) presented with it as a weakness. A large number of HFPDD participants (13 children) presented with successive processing as a cognitive strength, while a proportion (5 children) presented with it as a weakness.

In the SLI group a small number of participants (1 child) presented with planning as a strength, while a number of participants (5 children) presented with it as a weakness. This number was, however, far smaller than that seen in the HFPDD group. For simultaneous processing a number of SLI participants (8 children) presented with this as a cognitive strength, while no subjects presented with this as a cognitive weakness. These results would appear to correlate with reports of typical non-verbal intelligence in children with SLI (Owens, 1999). The finding that a number of SLI participants (5 children) presented with attention as a cognitive strength and that no SLI subjects presented with it as a cognitive weakness was unexpected. These cognitive strengths would also, however, be influenced by their very weak successive processing, which would have brought down their overall mean. In the SLI group no subjects presented with successive processing as a cognitive strength, while a large proportion (16 children) presented with it as a weakness. There, were, however a number of SLI subjects who did not present with it as a cognitive weakness. This points to the complex nature of language difficulties, i.e. a successive processing difficulty cannot account for all language difficulties.

In the NDD group 4 children presented with simultaneous processing as a cognitive strength, 1 child presented with successive processing as a strength and 2 children presented with successive processing as a weakness. In relation to the HFPDD and SLI group, the NDD children appeared to have a more even cognitive profile, with far fewer cognitive strengths and weaknesses (deviations from that individual's cognitive processing mean) being found. It would appear that the unevenness seen in the cognitive processing of the HFPDD and SLI groups should provide some clues to where the breakdown in their processing is taking place. A qualitative analysis of the results suggested that often in the HFPDD group when a child did well on simultaneous processing, this same strong performance was not seen on successive processing and vice versa. As a result it was decided to evaluate the differences between simultaneous and successive processing seen across the three groups. It was felt that this would also provide valuable information regarding the ability to process information in different modalities, as well as the relationship between simultaneous and successive processing scores for the three groups are presented in figures 6.14, 6.15 and 6.16. On these figures a negative difference would be in favour of successive processing and a positive difference would be in favour of simultaneous processing.



Figure 6.14: Differences between simultaneous and successive processing scores for all the participants in the HFPDD group



Figure 6.15: Differences between simultaneous and successive processing scores for all the participants in the SLI group



Subjects Sorted in Order of Difference



As can be seen in figure 6.14, three patterns seem to emerge in the HFPDD group: successive processing being markedly stronger than simultaneous processing; simultaneous processing being markedly stronger than successive processing; and no marked difference between simultaneous and successive processing. As can be seen in figure 6.15, in the SLI group the main pattern was that simultaneous processing was significantly stronger than successive processing, although for some subjects there did not appear to be a significant difference between simultaneous and successive processing. As can be seen in figure 6.16, in the NDD group, the main pattern appeared to be one of there not being a marked difference between simultaneous and successive processing, although some subjects did present with markedly stronger simultaneous than successive processing skills. Based on the differences of simultaneous markedly stronger than successive processing markedly stronger than simultaneous processing and successive processing markedly stronger than simultaneous processing shills. Based on the differences of simultaneous markedly stronger than successive processing markedly stronger than simultaneous processing similar to successing and successive processing markedly stronger than simultaneous processing similar to successing and successive processing markedly stronger than simultaneous processing similar to successing and successive processing markedly stronger than simultaneous processing similar to successing and successive processing markedly stronger than simultaneous processing similar to successing and successive processing markedly stronger than simultaneous processing similar to successing and successive processing markedly stronger than simultaneous processing similar to successive processing and successive processing markedly stronger than simultaneous processing of 8, 9 and 9 subjects respectively). Based on grouping the HFPDD subjects in this way three different cognitive profiles were obtained. These are presented in



Figure 6.17: Cognitive profiles observed in the HFPDD group

In all three groups planning was found to be a significant weakness. In the group where simultaneous processing was significantly stronger than successive processing, the mean for

simultaneous processing (124.9) fell slightly above the NDD group mean (120.1). In this group the mean for attention (98.9) and the mean for successive processing (96.8) were achieved at a similar level. In the group where simultaneous processing and successive processing were similar, the attention mean (85.3) was almost as weak as the planning mean (78.7). In the group where successive processing was stronger than simultaneous processing, the attention mean (75.6) was weaker than the simultaneous processing mean (89.3), but not as weak in relation to simultaneous processing as seen in the simultaneous equal to successive processing group. However, the planning mean (64.1) and the attention mean (75.6) were weaker in this group than in either of the other two groups. These results suggest that there may be sub-groups within the HFPDD group, who may have different cognitive profiles, so that different cognitive processing difficulties may possibly account for the communication difficulties seen in a related and dynamic way.

6.2.2 Discussion of results in relation to previous studies

Attention difficulties: The attention difficulties that were noted for the HFPDD group on the CAS would support attention as one of the underlying cognitive processes affected in PDD (suggested by Burack et al., 1997). According to Naglieri and Das (1997) the CAS attention sub-tests assess sustained, selective and shifting attention. Studies on sustained attention in PDD have been mixed with some studies finding sustained attention to be intact (Burack et al., 1997). However, Schatz et al. (2002) found sustained attention to be a problem in Asperger's syndrome. Selective attention has been reported to be impaired in autism (Tsatsanis, 2005). Studies of shifting attention have generally found this to be affected in PDD (Burack et al., 1997; Courchesne, 2004; Goldstein et al., 2001). Difficulty shifting attention between visual and auditory information as well as within the visual modality has been reported (Courchesne, 2004). It has been suggested that difficulty with shifting attention in PDD occurs due to executive dysfunction, owing to frontal lobe dysfunction (Pascuakvaca et al., 1998, as cited by Goldstein et al., 2001). Shifting attention relying on pre-frontal cortical damage has been found to be impaired, with other types of shifting attention being found to be intact (Ozonoff et al., 2004). According to Naglieri and Das (1997) the attention sub-tests on the CAS assess higher level complex forms of attention and the results, therefore, give support to higher order level attention difficulties. On the cognitive strengths and weaknesses analysis, many subjects with HFPDD did not have attention as a cognitive weakness, with only 7 children presenting with it as a cognitive weakness. This would

suggest that other aspects need to be looked at in addition to attention to gain a better understanding of cognitive processing in HFPDD.

Memory difficulties: Memory tasks formed part of the simultaneous and successive processing sub-tests. These consisted of figure memory within the simultaneous processing battery and word series and sentence repetition as part of the successive processing battery. These memory tasks from the CAS appear to consist of short-term and rote memory and do not involve semantic processing. The results of the HFPDD group on the CAS do not suggest specific memory difficulties with these aspects of memory, when evaluated according to the CAS norms and relative to their other areas of strength and difficulty. This is in keeping with literature that has suggested intact short-term and rote memory in autism, with rote memory even being an area of strength (O'Shea et al., 2005). However, the different cognitive profiles obtained for the HFPDD group would appear to suggest that memory may be stronger in either the visual or verbal modalities in some children with HFPDD, although it may also be equal. Bogdashina (2005) reports stronger memory in one modality over others in some children with PDD. Both simultaneous and successive processing were found to be cognitive strengths in some children with HFPDD, suggesting that short-term and rote memory may even be areas of relative strength in some individuals. This is supported in the literature (0'Shea et al., 2005).

Executive functioning difficulties: Results for the HFPDD group support the results of previous studies, which have reported planning difficulties in autism (Lopez et al., 2005; Ozonoff & Jensen, 1999; Ozonoff et al., 2004). However, not all of the children with HFPDD presented with planning as a cognitive weakness, with 5 children not presenting with it as a cognitive weakness. This would suggest that there may be some individuals with HFPDD where other accounts may better explain their difficulties. However, when dividing the children with HFPDD into three different cognitive profiles according to their simultaneous versus successive processing performance, all three cognitive profiles obtained indicated planning as a weak area. These results would, therefore, appear to support the strong role that planning difficulties seem to play in accounting for the symptom complex in HFPDD.

Weak central coherence or a detailed focused cognitive style: Individuals with autism's good performance on visual-spatial constructional tasks such as block design have been said to support the weak central coherence or detailed cognitive processing style view of PDD

(Martin & McDonald, 2004). According to Das and Abbott (1995) block design loads high on simultaneous processing. The weak central coherence or detailed cognitive processing style view, would, therefore be supported by the strong simultaneous processing performance in one sub-group from the HFPDD group. These results would appear to suggest an analytic processing style (Jarrold & Russell, 1997), detailed focused cognitive style (Happe & Frith, 2006), enhanced visual discrimination (Plaisted and colleagues, as cited by Happe, 2005) and enhanced perceptual functioning (Mottron et al., 2006) in at least a sub-group of children with HFPDD. These results would also support previous findings that only a sub-set of the PDD population present with weak coherence or a detailed focused cognitive style (Happe & Frith, 2006), as only a group within the total HFPDD group performed well on the simultaneous processing tasks. In the literature this detailed focused cognitive style has mainly been only studied in the visual modality. The good performance of certain children with HFPDD on successive processing, as seen in the cognitive strengths and weaknesses analysis, would suggest that this style should possibly also be evaluated in other modalities. It is possible that these participants' good performance on the successive processing measures may be due to them being able to remember the detail of the items presented.

Problems with specific modalities of processing: Similar to Joseph et al.'s (2002) and Ghaziuddin and Mountain-Kimchi's (2004) results, three patterns appeared to emerge when looking at differences between the visual and verbal modalities of processing. These consisted of a visual stronger than verbal pattern (reflected in simultaneous processing being stronger than successive processing for a sub-group of the HFPDD subjects), a verbal stronger than visual pattern (reflected in successive processing being stronger than simultaneous processing for a sub-group of the HFPDD subjects) and a visual similar to verbal pattern (reflected in simultaneous processing being similar to successive processing in a sub-group of the HFPDD subjects). In an evaluation of the SLI and NDD groups, three such distinct patterns were not able to be seen. These results would appear to give some support to Blakeslee's (2002) suggestion that individuals with PDD may choose or favour one sensory modality over others to process information.

Simultaneous versus successive processing: Previous research appears to present conflicting results regarding simultaneous and successive processing in PDD, with some studies indicating difficulty with simultaneous processing (Jarrold & Russel, 1997) and some studies indicating difficulty with successive or sequential processing (Tanguay, 1984). To

some extent this appears to be due to the definitions of these terms not appearing to be clear in the literature. However, another reason for this difference that would be supported by the results of this study would be that some children with HFPDD may favour simultaneous processing while other children with HFPDD may favour successive processing, with a subgroup of children being relatively strong on simultaneous processing and a sub-group of children being relatively strong on successive processing. However, when looking at the HFPDD group as a whole, results would appear to suggest that there is not a significant difference between simultaneous and successive processing. This would appear to be due to total group results evening out the differences found between sub-groups of children in the HFPDD group. Overall group results in the area of successive processing appear to be similar to the findings of Allen et al.'s (1991) study on the processing abilities of HFA children. Allen et al. (1991) found a relative sequential processing deficit in both the HFA children and language impaired children. In the current study both the HFPDD group and the SLI groups' successive processing, were significantly poorer than the NDD group's successive processing, with the SLI group's successive processing also being significantly poorer than the HFPDD group's successive processing.

Sensory integration and perception: The current study did not look at sensory processing in HFPDD per se. However, when analysing the differences between their simultaneous and successive processing, the fact that some children within the HFPDD group appeared to favour one sensory modality over another, would appear to give indirect support to the sensory integration hypothesis. It has been previously suggested that certain individuals with PDD over focus on one sensory modality (Bogdashina, 2005; Paris, 2000). Difficulties noted with planning and higher order attention in the current study would also appear to give support to this hypothesis. According to Ayres (1973, 1975, 1980, 1989, as cited by Paris & Murray-Slutsky, 2000) the development of higher-cortical functions relies on the integrity and integration of information from different sensory systems. Difficulty with shifting attention between the visual and auditory modalities has been suggested by a number of studies (Iarocci & McDonald, 2006) and executive functioning has been said to involve the co-ordination of information from different sources and modalities (Iarocci & McDonald, 2006). According to the PASS model the processing of planning is not modality specific, involving inter-modal or supra-modal processing (Das et al., 1994). Such significant difficulty in the area of planning would, therefore, appear to give indirect support to the difficulty with multi-sensory processing hypothesis put forward by Iarocci and McDonald (2006).

Differences in systemizing-empathizing: According to the 'extreme male brain' view of autism systemizing, which involves analysing and building systems (Baron-Cohen, 2002) and making sense of underlying rules and regularities (Baron-Cohen et al. 2005), is not impaired in autism (Baron-Cohen et al., 2005). The poor planning results of the current study would, however, appear to bring this view into question when applied to the group of PDD as a whole, as an analysis of the planning tasks appeared to suggest that they encompassed many features of systemizing. There was, however, one particular child with HFPDD in the study who performed well on the planning tasks (even more superior than his matched controls) yet did poorly on the theory of mind measures. He also, in addition, performed well on the attention, simultaneous processing and successive processing measures. It could be argued that on all the measures of the CAS a child could perform well if he/she can make sense of the rules and regularities underlying these measures, which is possibly what this child did. This would appear to suggest that there may be a sub-group within the HFPDD population that has good systemizing and poor empathizing skills. Baron-Cohen et al. (2005) suggest just that, that there is a sub-group of children with autism, who do not have executive functioning difficulties, but who do have difficulties with empathizing and who have good systemizing abilities. What these results appear to suggest is that one cannot look at just cognitive processing when attempting to explain the communication difficulties in PDD. How theory of mind relates to this also needs to be looked at. It would appear that one of the most valuable contributions of Baron-Cohen's (2002) "extreme male brain" view of autism is that it attempts to combine theory of mind and cognitive explanations.

Imitation and a problem with motor neurons: The mirror neuron research reported in Chapter three would not appear to be in conflict with the results of the current study as mirror neurons are seen to be 'supra-modal representations' of action (Williams et al., 2004). The results of the current study appear to suggest that aspects linked to inter-modal or supra-modal processing may be affected in HFPDD. Furthermore, the site of motor neurons in the frontal lobes (Williams et al., 2004) would appear to link them to executive functioning and theory of mind.

Neurological aspects: The poor planning and attention results and relatively strong simultaneous and successive processing results for the HFPDD group would appear to support Minshew et al's (1997, in Bertone & Faubert, 2005) complexity deficit hypothesis. According to this account, complex perceptual processing is affected by dysfunction of neuro-integrative mechanisms. According to this hypothesis the problem in PDD is thought to be due to local over-connectivity and lack of connectivity between cerebral areas (Bertone & Faubert, 2005). According to Luria's model (Kagan & Saling, 1988) and the PASS model (Das et al., 1994), simultaneous and successive processing would appear to rely mainly on localised processing, while attention and planning involve connectivity between many different cerebral areas. Planning and attention being weak in the HFPDD group and simultaneous and successive processing being stronger would, therefore, appear to provide indirect support for the notion of local over-connectivity and lack of connectivity between cerebral areas.

6.2.3 <u>Summary of cognitive processing results</u>

The results of the cognitive processing assessment indicated that the HFPDD group experienced marked difficulty in the areas of planning and attention, while the SLI group experienced significant difficulties in the areas of successive processing and less marked but still significant difficulties in the areas of planning. In the area of planning the HFPDD group scored significantly more poorly than the SLI group. A more in-depth analysis of the results indicated three sub-groups within the HFPDD group in relation to their successive and simultaneous processing results, these being a group with simultaneous processing being markedly stronger than successive processing and a group with simultaneous and successive processing appearing to occur at a similar level. Results do not appear to be in conflict with most of the previous studies that have investigated cognitive processing in PDD, but rather appear to integrate findings into one framework.

6.3 THEORY OF MIND RESULTS

An overview of the results obtained on the theory of mind battery will be presented. This will then be followed by a discussion of these results in relation to previous studies looking at theory of mind in PDD. Lastly a summary of the theory of mind results will be presented.

6.3.1 <u>Overview of results</u>

Results of the visual perceptual role taking, mental significance of the eyes, deception and understanding emotions theory of mind measures are presented in figure 6.18. This includes the means of percentage correct scores obtained on these measures, analysis of variance results (indicating whether groups were significantly different on these measures), and Bonferroni t test results (indicating which groups scored significantly differently on these measures). Stars indicate significant differences between groups on the analysis of variance measures. Different letters indicate significant differences between groups on the Bonferroni t test. Further descriptive statistic values and additional values for the analysis of variance and Bonferroni t tests are presented in appendix C7. The results of the pretence analysis are presented separately as this was an open-ended task, with there being no ceiling on the possible score that a child could receive. A percentage correct score could not, therefore, be obtained for this measure.



Sub-tests

*** p<.001

Figure 6.18: Theory of mind results

The analysis of variance results indicated that the three groups performed significantly differently statistically on all the theory of mind measures depicted in figure 6.18. The Bonferroni t test results indicated that the HFPDD group performed statistically more poorly than both the SLI and NDD groups on all the theory of mind measures. The SLI group was found to perform significantly more poorly than the NDD group on the belief measure and emotion measure. This was possibly due to the belief and emotion measure requiring much language understanding and use in their administration and scoring. There, however, were not significant differences between the SLI and NDD groups on the measures of visual perceptual role taking, the mental significance of the eyes and the deception measures. These measures appeared to involve less language in their administration and responding than the other measures.

An analysis of the means (percentage correct) indicated that belief appeared to be the most difficult measure for all the groups. Belief was found to be more difficult than deception and emotion. Qualitative analysis of the results suggested that this was due to the justification question during the second-order false belief task. Many participants in both the NDD and SLI groups were able to pass the belief question but experienced difficulty with the justification question, which required them to explain their answer. Difficulty justifying their answer using language would appear to be difficult for the SLI group due to their language difficulties. This would also appear to be particularly difficulties). The NDD subjects also, however, experienced difficulty with the second-order false belief task, particularly the justification question and it would appear that of all the theory of mind tasks presented this developmentally was the most difficult task. The emotion measure also relied heavily on language, which possibly made this task more difficult for all three groups and developmentally this would also appear to be one of the more difficult tasks.

The measure of visual perceptual role taking appeared easiest for the NDD group, followed by the measure of the mental significance of the eyes, the deception measure, the emotion measure and finally the measure of belief. It would seem that the belief task was most difficult because there was a strong loading on the justification question in the second-order false belief task and because understanding of second-order belief was included in the overall belief score. If the belief score had been split into the first-order false belief tasks and the second-order false belief task for the analysis of the results, it is likely that first-order false belief would have been found to be easier than the emotion task, and second-order false belief more difficult than this. The SLI group did not score as closely to the NDD group on the belief measure and then the emotions measure, as the other measures. This would appear to be due to these measures involving more language than the visual perceptual role taking, mental significance of the eyes and deception measures. The deception measure differentiated the HFPDD and SLI subjects well but some NDD subjects failed this measure. It appeared that some NDD children were reluctant to deceive the bad puppet for moral reasons. When asked afterwards why they did not trick the bad puppet, they said things such as "It is wrong to lie" and "You must always tell the truth". Some of these children seemed to think that the researcher was trying to 'trick' them into lying and appeared to think that the aim was not to let her. This would appear to reflect a higher development of theory of mind, which resulted in them not doing as expected on this task. The deception task may, therefore, be at risk of falsely identifying children as having a difficulty when they in fact may have developed higher level theory of mind ability and moral reasoning.

The instances of true pretence and attempts at pretence for the three groups are presented in figure 6.19 and the pretence ratios for the three groups are presented in figure 6.20. The pretence measure was divided into true pretence, which was the number of instances of attempts at pretence that were scored as true or actual pretence and the attempts at pretence, which included any attempts at pretence, whether they were true or not. A pretence ratio, which was the number of instances of true pretence divided by attempts at pretence, was then obtained. Analysis of variance and Bonferroni t tests were carried out on the true pretence and pretence ratio scores. Stars indicate significant differences between groups on the analysis of variance and Bonferroni t tests are presented in differences between groups on the Bonferroni t test. Further descriptive statistic values and additional values for the analysis of variance and Bonferroni t tests are presented in appendix C7.



*** p<.001

Figure 6.19: Number of instances of true pretence and attempts at pretence for the three groups

Results from the analysis of variance indicated that the three groups were significantly different on instances of true pretence. The Bonferroni t test results indicated that the HFPDD group scored significantly more poorly than both the SLI and NDD groups on instances of true pretence and that the SLI and NDD groups were not statistically different from each other on this measure. These results would suggest that a pretence task such as this one would be useful to differentiate children with HFPDD from those with SLI.



*** p<.001

Figure 6.20: Pretence ratio results for the three groups

The analysis of variance results indicated that the three groups were statistically different on the pretence ratio. The Bonferroni t test results indicated that the HFPDD group's score on the pretence ratio was significantly poorer than the SLI group's score, which in turn was significantly poorer than the NDD group's score. The difference on the pretence ratio would appear to be due to the SLI group generating more attempts at pretence but less true instances of pretence than the NDD group. Most of the NDD group's attempts at pretence consisted of true pretence (90%). A large portion of the SLI group's attempts at pretence consisted of true pretence (74%). A significantly smaller portion of the HFPDD group's attempts at pretence consisted of true pretence (44%). Interestingly the SLI group had more attempts at pretence than the NDD group, but less correct attempts at pretence (true pretence). It is possible that this group experienced more difficulty evaluating their ideas for pretence and inhibiting ideas that were not actual pretence. The HFPDD group did not attempt instances of pretence as much as these other two groups. This may suggest an underlying generativity problem. They, however, presented with a significantly greater number of instances of attempts at pretence when compared to true pretence, than seen in the other two groups, resulting in their ratio score being markedly smaller than that seen in the other two groups.

Clinically the measure of pretence may be the most useful as it differentiated the HFPDD group well from the SLI and NDD group and also differentiated the SLI from the NDD groups but involved little language. As it involves little language, poor language ability would not appear to influence the results negatively. There was a significant difference between the number of attempts at pretence and actual instances of pretence (true pretence) in the HFPDD group pretence ratio. This group often acted out things that were not 'pretence', not appearing to understand the concept of pretence. One child, for example, appeared to think that pretence was doing something that was different to what you said you were doing, so that he would, for example, say "I am pretending that I am running" but would then stand still. He appeared to have attached a rule to pretence, i.e. 'doing something different to what you say you are doing'. Such a superficial view of pretence must make play very confusing for a child such as this and he would appear to have developed this to make sense of instances such as a child picking up a bag and saying "I'm going to work" and then not actually going anywhere. This superficial view of pretence reflects poor perspective taking and poor integration of actions with thoughts.

Results of the discriminant function analysis (presented later) indicated that, based on the theory of mind battery, three of the participants with HFPDD would not be classified as HFPDD, but as SLI, i.e. three participants from the HFPDD group did as well as the SLI subjects on the theory of mind measures. Furthermore, according to the results of the discriminant function analysis based on the theory of mind battery, one participant with HFPDD would be classified as NDD, i.e. one HFPDD participant did as well as the NDD children on the theory of mind measures. A qualitative analysis of the results indicated that some children from the HFPDD group passed isolated measures of theory of mind, with one child passing the visual perceptual role taking measure, four passing the mental significance of the eyes assessment, four passing the first-order false belief assessment and five passing the deception assessment. However, when looking at the theory of mind assessment in its entirety, all except one of the children from the HFPDD group experienced difficulty.

Part of the reason that some participants passed some theory of mind measures may have been due to a ceiling effect, i.e. these measures are expected to be mastered by a particular age. If a child who is markedly older than this age passes this measure (e.g. a 6 year old passing a test, that children of 4 years are expected to pass), this does not confirm the absence of a theory of mind deficit. It would appear that a battery of developmentally appropriate tasks and not an isolated task needs to be administered to obtain a full picture of an individual's theory of mind ability. In this study when using a battery of tasks a theory of mind difficulty does appear to be a significant factor in HFPDD. The results would, however, suggest that a battery of theory of mind tasks alone does not appear sufficient to discriminate between all children with HFPDD and SLI, as well as between all children with HFPDD and SLI as well as between all children with HFPDD and SLI.

	Visual perceptual role taking	Mental significance of the eyes	Belief	Deception	Emotion	Pretence
Functional						
Concern						
Significant	*	*	*	*	*	*
concern						

Table 6.20: Profile of HFPDD group's theory of mind results

Table 6.21: Profile of SLI group's theory of mind results

	Visual perceptual role taking	Mental significance of the eyes	Belief	Deception	Emotion	Pretence
Functional	*	*		*		
Concern						*
Significant			*		*	
concern						

6.3.2 Discussion of results in relation to previous studies

Results of the visual perceptual role taking sub-tests provide support for pre-school children with HFPDD experiencing difficulty with higher level visual perceptual taking, as found by Dawson and Fernald (1987) with children with autism. Results of the mental significance of the eyes measures are in keeping with earlier studies that have shown children with PDD experience difficulty understanding that seeing leads to knowing (Baron-Cohen & Goodhart, 1994; Baron-Cohen & Swettenham, 1997; Kazak et al., 1997; Leslie & Frith, 1988; Perner et al., 1989), that reading the direction where the eyes are pointing indicates where they are looking and what that person may want (Baron-Cohen & Cross, 1992; Baron-Cohen et al., 1995; Leekam et al., 1997) and with inferring the mental state of 'thinking' where the clues

for this information are provided in the person's eyes (Baron-Cohen & Cross, 1992; Baron-Cohen et al., 1995).

Result of the belief tasks are in keeping with earlier studies that show that children with PDD experience difficulty with both first-order false belief tasks such as unexpected identity (Charman & Baron-Cohen, 1995; Naito et al., 1994; Peterson & Siegal, 1998) and unexpected location tasks (Baron-Cohen et al., 1985; Bowler & Strom, 1998; Leslie & Frith, 1988; Reed, 1994; Scott & Baron-Cohen, 1996) and with second-order false belief tasks (Baron-Cohen, 1989; Happe, 1994; Holroyd & Baron-Cohen, 1993). The fact that the SLI group still did markedly better than the HFPDD group would support the uniqueness of the belief deficit to PDD, in relation to other disorders, a proposal that has been previously challenged by some (Zelazo et al., 1996). Results of the deception task are in keeping with earlier studies showing that children with PDD experience difficulty with deception tasks (Baron-Cohen, 1992; Russell et al., 1991; Sodian & Frith, 1992). Results of the emotions tasks are in keeping with Happe's (1994) finding that children with autism experience difficulty understanding story characters' thoughts and feelings, and Tager-Flusberg and Sullivan's (1995) finding that children with autism experience difficulty attributing mental states to story characters. The fact that the children with SLI as a group also experienced difficulty with the belief and emotions tasks would appear to support the influence of language both in developing theory of mind and being able to perform on theory of mind measures (Miller, 2006). The difficulty noted in the HFPDD group on the measure of pretence would add support to previous findings that have reported difficulty with symbolic play in autism (Baron-Cohen, 1987; Jarrold et al., 1993; Leslie, 1987; Libby et al., 1997; Ungerer & Sigman, 1981). In particular, they would appear to support the proposal that impairments in producing pretence are due to generativity problems (Lewis & Boucher, 1988; Jarrold et al., 1993, 1996).

Results from the theory of mind assessment appear to confirm a developmental basis to theory of mind, with certain tasks being easier for the NDD group than others. This would support a conceptual change hypothesis of theory of mind. Results would seem to suggest that children with HFPDD have difficulty with this conceptual change development. A developmental account of understanding false belief in children between 2 and 5 years has been reported in the literature (Povinelli & Giambrone, 2001; Wellman et al., 2001). The SLI group appeared to cope better than the HFPDD group on a number of the theory of mind

tasks, when the verbal demands of these tasks appeared within their processing capacity. However, even on tasks that were less verbally loaded the HFPDD group still experienced more difficulty. This would appear to support a theory of mind deficit or at least the severity of the theory of mind deficit being unique to PDD. While some children from the HFPDD group passed isolated measures of theory of mind, when looking at the theory of mind assessment in its entirety, all the children from the HFPDD group except one demonstrated impairment. Results from the current study suggest that, when using a battery of developmentally appropriate tasks such as this one, a theory of mind difficulty does appear to be a significant factor in PDD. However, the fact that three of the HFPDD subjects did as well as the SLI subjects on the theory of mind tasks, would suggest that theory of mind difficulty alone cannot account for the difficulties seen in all children with HFPDD and that additional factors also need to be looked at. Reports of some individuals with PDD passing theory of mind measures have been previously noted in the literature (Happe, 1995; Happe & Frith, 1995; Sicotte & Stemberger, 1999).

The children with SLI's poorer performance on the false belief tasks would appear to be related to their language difficulty. Language is proposed as an important factor in the performance of certain tasks such as false belief tasks (Astington, 2001). Language, however, has also been felt to be important for developing false belief itself (Astington, 2001). Understanding belief has been reported to be dependent on understanding the syntax of complementation (de Villiers & de Villiers, 2000). Children with language deficits performing more poorly on false belief tasks has been previously reported (Miller, 2006). The SLI group's poorer performance on certain theory of mind tasks would appear to confirm the close relationship between language and theory of mind.

6.3.3 <u>Summary of theory of mind results</u>

The HFPDD group performed significantly more poorly on all the theory of mind measures, when compared to both the SLI and NDD groups. The SLI group scored more poorly than the NDD group on the belief and emotion tasks, possibly as these tasks appear to be more verbally loaded than the other theory of mind tasks. Overall, results would appear to suggest that the severity of the theory of mind deficit is specific to PDD. However, the fact that three subjects with HFPDD did as well on the theory of mind

measures as the children with SLI and that one subject with HFPDD did as well as the children with NDD on the theory of mind measures would suggest that a continuum of theory of mind ability may exist in HFPDD. It would, therefore, appear that while theory of mind difficulty is a significant factor in HFPDD, it alone cannot account for all the difficulties seen in this population.

6.4 **CORRELATIONS**

In order to address the second aim of the study, correlation coefficients were carried out. Here the aim was to determine whether particular communication deficits are linked to particular cognitive processing deficits and particular theory of mind deficits. Correlations show the degree of relationship between variables (Spiegel, 1972).

Table 6.22 represents the overall sample correlations, i.e. it includes the data from all three groups. These correlations are on the whole for summary scores and not for the scores for individual sub-tests. The only scores included for individual measures were for dependent clauses, MLU and receptive pragmatics. Correlations were taken on the following:

- Planning standard score This was obtained from the three planning sub-tests.
- Simultaneous processing standard score This was obtained from the three simultaneous processing sub-tests.
- Attention standard score This was obtained from the three attention sub-tests.
- Successive processing standard score This was obtained from the three successive processing sub-tests.
- CAS full scale standard score This was obtained from a combination of the planning, simultaneous processing, attention and successive processing scores.
- Theory of mind score This consisted of a combination of the visual perceptual role taking score, mental significance of the eyes score, belief score, deception score, emotion score and true pretence score.
- Receptive language score This consisted of a combination of the BPVS raw score, the Basic Concepts sub-test raw score and the Grammatic Understanding sub-test raw score.
- Expressive semantics score This consisted of the Word Finding Vocabulary Test raw score, pronoun alternation score, Oral Vocabulary raw score and modified TOPS raw score.

- Dependent clauses This was chosen as it was found to be a useful measure of grammar as it had the second highest F value on the analysis of variance showing significant differences between the three groups for the grammatical analysis.
- Mean length of utterance This was chosen as it was found to be a useful measure of grammar because it had the highest F value on the analysis of variance showing significant differences between the three groups for the grammatical analysis.
- Total Narrative score This consisted of a combination of the narrative coherence and narrative clarity scores.
- Receptive pragmatic score This consisted only of the receptive pragmatic/understanding conversation score.
- Expressive pragmatic score This consisted of a combination of the verbal aspect, paralinguistic aspect and non-verbal aspect scores.
- Total pragmatic score This consisted of a combination of the receptive pragmatic score and expressive pragmatic score.

A correlation of 0.50 is frequently accepted as large in psychological and educational research (McCall & Kagan, 1990). A correlation was regarded as significant at the p<.0001 level. Both the size and the significance value of the above correlations are shown in table 6.22.

Three aspects can be looked at when analysing the correlations. These are: 1) how the cognitive and theory of mind variables correlate with the communication variables; 2) how the communication variables correlate with each other; and 3) how the cognitive and theory of mind variables correlate with each other.

	Recept.	Express.	Depend.	MLU	Narrative	Recept.	Express.	Pragmat.	Theory of	Planning	Simultan	Attentior	Succ.	Full scale
	Lang.	Semant.	clauses			Pragmat.	Pragmat.	total	mind		Process.		process.	CAS
Receptive	1	0.86	0.49	0.57	0.74	0.63	0.63	0.63	0.76	0.62	0.50	0.71	0.36	0.67
language		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0012	<.0001
Expressive	0.86	1	0.52	0.63	0.89	0.82	0.83	0.83	0.87	0.69	0.42	0.70	0.36	0.67
semantics			<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0001	<.0001	0.0013	<.0001
Dependent	0.49	0.52	1	0.75	0.40	0.33	0.37	0.37	0.40	0.33	0.26	0.33	0.48	0.42
clauses	<.0001	<.0001		<.0001	0.0003	0.003	0.0009	0.001	0.0004	0.003	0.0244	0.0031	<.0001	0.0001
MLU	0.57	0.63	0.75	1	0.50	0.38	0.47	0.46	0.47	0.45	0.31	0.42	0.54	0.52
	<.0001	<.0001	<.0001		<.0001	0.0006	<.0001	<.0001	<.0001	<.0001	0.0062	0.0002	<.0001	<.0001
Narrative	0.74	0.89	0.40	0.50	1	0.82	0.86	0.86	0.86	0.66	0.37	0.67	0.20	0.59
	<.0001	<.0001	0.0003	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001	0.0008	<.0001	0.088	<.0001
Receptive	0.63	0.82	0.33	0.38	0.82	1	0.94	0.95	0.86	0.56	0.25	0.64	-0.05	0.45
pragmatics	<.0001	<.0001	0.003	0.0006	<.0001		<.0001	<.0001	<.0001	<.0001	0.03	<.0001	0.6901	<.0001
Expressive	0.63	0.83	0.37	0.47	0.86	0.94	1	0.99	0.88	0.61	0.26	0.65	-0.01	0.49
pragmatics	<.0001	<.0001	0.0009	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	0.0233	<.0001	0.9322	<.0001
Pragmatics	0.63	0.83	0.37	0.46	0.86	0.95	0.99	1	0.89	0.61	0.26	0.65	-0.01	0.49
total	<.0001	<.0001	0.001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	0.0226	<.0001	0.9084	<.0001
Theory of	0.76	0.87	0.40	0.47	0.86	0.86	0.88	0.89	1	0.70	0.44	0.73	0.05	0.61
mind	<.0001	<.0001	0.0004	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	0.6388	<.0001
Planning	0.62	0.69	0.33	0.45	0.66	0.56	0.61	0.61	0.70	1	0.74	0.88	0.38	0.93
-	<.0001	<.0001	0.003	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	0.0006	<.0001
Simultaneou	0.50	0.42	0.26	0.31	0.37	0.25	0.26	0.26	0.44	0.74	1	0.72	0.46	0.87
processing	<.0001	0.0001	0.0244	0.0062	0.0008	0.03	0.0233	0.0226	<.0001	<.0001		<.0001	<.0001	<.0001
Attention	0.71	0.70	0.33	0.42	0.67	0.64	0.65	0.65	0.73	0.88	0.72	1	0.28	0.89
	<.0001	<.0001	0.0031	0.0002	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		0.0141	<.0001
Successive	0.36	0.36	0.48	0.54	0.20	-0.05	-0.01	-0.01	0.05	0.38	0.46	0.28	1	0.61
processing	0.0012	0.0013	<.0001	<.0001	0.088	0.6901	0.9322	0.9084	0.6388	0.0006	<.0001	0.0141		<.0001
Full scale	0.67	0.67	0.42	0.52	0.59	0.45	0.49	0.49	0.61	0.93	0.87	0.89	0.61	1
CAS	<.0001	<.0001	0.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	

Table 6.22: Correlation results for overall sample (including the HFPDD, SLI and NDD groups)

6.4.1 How the cognitive and theory of mind variables correlate with the communication variables

6.4.1.1 <u>Receptive language</u>

Theory of mind (0.76), planning (0.62), attention (0.71), simultaneous processing (0.50) and the full scale CAS measure (0.67) correlate significantly with receptive language, obtained on the formal receptive language measures. Theory of mind (0.86), planning (0.56), attention (0.64) and the full scale CAS measure (0.45) correlate significantly with understanding conversation (receptive pragmatics). The fact that simultaneous processing was not found to correlate with understanding conversation would suggest that understanding conversation involves processes that are more central than the level of simultaneous processing. The measure that correlated best with receptive language, both receptive language measured on formal language measures and receptive language measured through understanding conversation, was the theory of mind measure.

6.4.1.2 Expressive semantics

Theory of mind (0.87), planning (0.69) and attention (0.70) were found to correlate significantly with expressive semantics.

6.4.1.3 Expressive grammar

Successive processing was found to correlate significantly with number of dependent clauses (0.48). Successive processing (0.54), theory of mind (0.47), planning (0.45) and the full scale CAS measure (0.52) were found to correlate significantly with MLU. Successive processing being correlated with the measures of dependent clauses and of MLU would support successive processing having strong syntactic components (Naglieri & Das, 1997). The observation that successive processing was not as strongly correlated (although it was still significantly correlated) with the number of dependent clauses (0.48) and MLU (0.54) as some of the other variables were correlated may be because the grammatical difficulties in the SLI and HFPDD groups have slightly different underlying bases. In the SLI group the grammatical difficulties noted would appear to be related to a difficulty with successive processing. In the HFPDD group the grammatical difficulties noted would seem to possibly

be due to generativity difficulties and difficulties with the conceptual aspects of complex grammar. It is interesting that theory of mind and planning also correlated with MLU. Correlations between theory of mind (0.47), planning (0.45) and MLU could possibly indicate that planning and theory of mind are linked to language generativity (creative use). These associations may also indicate the motoric relationship between planning and successive processing, with planning being carried out through motor output and successive processing being carried out through auditory and motor channels (Naglieri & Das, 1990).

6.4.1.4 Narrative ability

Theory of mind (0.86), planning (0.66), attention (0.67) and the full scale CAS measure (0.59) correlated significantly with narrative ability. According to Das et al. (1996) story composition is a measure of conceptual planning.

6.4.1.5 Pragmatic ability

Theory of mind (0.86), planning (0.56) and attention (0.64) were significantly correlated with receptive pragmatics. Theory of mind (0.88), planning (0.61), attention (0.65) and full scale (0.49) were significantly correlated with expressive pragmatics. Theory of mind (0.89), planning (0.61), attention (0.65) and the full scale CAS measure (0.49) were significantly correlated with overall pragmatic ability.

6.4.1.6 General comments

Planning and attention correlated particularly well with receptive language, expressive semantics, narrative ability and pragmatics. This would appear to suggest that receptive language, expressive semantics, narrative ability and pragmatics all rely on central cognitive processes. Simultaneous processing was only found to correlate with receptive language. This makes sense as one of the three measures of simultaneous processing, verbal-spatial relations, is also a measure of receptive language. According to the central coherence explanation of PDD, one might have expected that better simultaneous processing (on the non-verbal matrices and figure memory sub-tests) would correlate with poorer performance on the communication measures. Such a negative correlation was not found. Simultaneous processing, however, not positively correlating with expressive semantics, narrative ability

and pragmatics, would suggest that these difficulties are due to more central processing difficulties, than the level where simultaneous processing takes place. The receptive language measure that correlated with simultaneous processing did not include understanding conversation. This would appear to support the notion that understanding conversation relies on more central processes.

In the areas of language, successive processing was only correlated with grammatical parameters (number of dependent clauses and mean length of utterance). Successive processing not being correlated with expressive semantics, narrative ability and pragmatics would suggest that these difficulties are due to more central processing difficulties, than the level where successive processing occurs.

The measure of full scale cognitive ability was found to correlate with receptive language, expressive semantics, MLU, narrative ability and pragmatics. This would suggest that the higher the general cognitive ability of an individual the better his or her communication skills may be. This is significant as the overall cognitive ability of the NDD group was found to be significantly higher than the SLI group, while the HFPDD group's overall cognitive ability was found to be lower (although not significantly so) than that of the SLI group. This would also confirm an underlying cognitive basis to the communication difficulties seen in HFPDD.

6.4.2 <u>How the communication variables correlate with each other</u>

Receptive language was correlated with all the other measures of communication, being particularly well correlated with expressive semantics (0.86), narrative ability (0.74) and pragmatic (0.63) ability. Receptive pragmatics (understanding conversation) correlated significantly with receptive language (0.63), expressive semantics (0.82), narrative ability (0.82) and expressive pragmatics (0.94). Its stronger correlation with expressive semantics, narrative ability and expressive pragmatics would suggest that it involves more central processes than receptive language assessed by formal language measures alone. Expressive semantics correlated with all the other measures of communication, correlating particularly well with receptive language (0.86), narrative ability (0.89) and pragmatic ability (0.83). The measure of dependent clauses correlated with receptive language (0.49), expressive semantics (0.52) and MLU (0.75), being particularly well correlated with MLU. MLU correlated with all the other communication variables, being particularly well correlated with

dependent clauses (0.75). These results would support dependent clauses and MLU having similar underlying processes. Narrative ability correlated with all the other communication variables except dependent clauses, correlating well with receptive language ability (0.74) and extremely well with expressive semantic (0.89) and pragmatic ability (0.86). Pragmatic ability correlated with all the other communication variables except dependent clauses, being extremely well correlated with expressive semantics (0.83) and narrative ability (0.86).

Expressive semantics, narrative ability and pragmatics being so well correlated would support the close relationship between these variables and would support these variables all being centrally located in a communication processing model. Receptive language and expressive semantics being particularly well correlated may also suggest that these parameters rely on similar underlying processes. The grammatical constructs (dependent clauses and MLU) and semantics, narrative ability and pragmatics being less well correlated (or in some cases not correlated), would suggest that they consist of different types of language processing. This would support a different location of these variables on a language processing model. Their relationship would appear to be due to their joint occurrence in the communication process, but at the same level of processing.

6.4.3 <u>How the cognitive variables correlate with each other</u>

Planning, attention and simultaneous processing were found to be well correlated, with planning and attention (0.88) being particularly well correlated but planning and simultaneous processing (0.74) and attention and simultaneous processing (0.72) also being well correlated. According to Naglieri and Das (1997) the attention measures of the CAS are measures of higher level complex forms of attention, which explains the strong relationship between planning and attention (0.88). The fact that theory of mind correlated so well with planning (0.70) and attention (0.73) would support all three of these variables being central processing constructs and would support the close relationship between executive functioning and theory of mind. Successive processing only correlated with simultaneous processing (0.46) and the full scale CAS (0.61). These results would appear to suggest that successive and simultaneous processing would occur at a similar level on a processing model. Results would support a close relationship between planning, attention, theory of mind, receptive language – particularly at the level of understanding conversation, expressive

semantics, narrative ability and expressive pragmatics and it is possible that similar processes may underlie these variables.

6.4.4 How the theory of mind variables correlate with the other variables

Theory of mind ability was found to correlate strongly with expressive semantics (0.87), narrative ability (0.86) and pragmatics (0.89); to be well correlated with receptive language (0.76); and to be acceptably correlated with MLU (0.47). Theory of mind, however, also correlated well with planning (0.70) and attention (0.73) and correlated acceptably with simultaneous processing (0.44). These results would appear to suggest that theory of mind is more strongly correlated with communication ability, than planning or attention. However, a number of the theory of mind tasks had a strong verbal component, resulting in the nature of this relationship being less clear. Looking at these results the direction of the correlation, i.e. whether theory of mind ability affects language, whether language affects theory of mind ability, or whether they both influence each other is unclear. As many of the theory of mind tasks had a strong verbal component, it was decided to look at the individual sub-categories of the theory of mind tasks to understand better the relationship between theory of mind ability and communication. This is presented in table 6.23. In this analysis visual perceptual role taking and understanding the mental significance of the eyes were combined into one score - perception - as they are felt to assess similar aspects of theory of mind. Furthermore, belief and deception were also combined as they are believed to assess similar aspects. This was done in order to make interpretation of results less cumbersome. The first two groups of theory of mind measures - perception and pretence - involve much less language in their administration than the second two groups of theory of mind tests, belief + deception and emotion.

	Perception	True	Belief +	Emotion
	_	pretence	Deception	
Planning	0.67	0.57	0.68	0.61
_	<.0001	<.0001	<.0001	<.0001
Simultaneous	0.44	0.30	0.34	0.44
	<.0001	0.007	0.002	<.0001
Attention	0.73	0.58	0.69	0.62
	<.0001	<.0001	<.0001	<.0001
Successive	0.011	-0.04	0.15	0.12
	0.9238	0.7318	0.1768	0.2894
Full scale CAS	0.59	0.45	0.59	0.56
	<.0001	<.0001	<.0001	<.0001
Theory of mind total	0.96	0.83	0.89	0.90
	<.0001	<.0001	<.0001	<.0001
Receptive language	0.71	0.56	0.79	0.71
	<.0001	<.0001	<.0001	<.0001
Expressive semantics	0,80	0.68	0.88	0.81
	<.0001	<.0001	<.0001	<.0001
Dependent clauses	0.32	0.33	0.38	0.43
	0.0044	0.0032	0.0006	<.0001
MLU	0.41	0.36	0.51	0.46
	0.0002	0.0012	<.0001	<.0001
Narrative	0.82	0.65	0.82	0.81
	<.0001	<.0001	<.0001	<.0001
Receptive pragmatics	0.83	0.67	0.81	0.77
	<.0001	<.0001	<.0001	<.0001
Expressive pragmatics	0.86	0.70	0.83	0.77
	<.0001	<.0001	<.0001	<.0001
Pragmatic total	0.87	0.70	0.83	0.77
	<.0001	<.0001	<.0001	<.0001

Table 6.23: Correlations between the different sub-categories of the assessment of theory of mind and the other parameters measured

As can be seen in table 6.23, belief + deception and emotion correlate well with: receptive language (with correlations of 0.79 and 0.71 respectively being obtained), expressive semantics (with correlations of 0.88 and 0.81 respectively being obtained), narrative ability (with correlations of 0.82 and 0.81 respectively being obtained) and pragmatics (with correlations of 0.83 and 0.77 respectively being obtained). The very strong correlation between belief + deception and expressive semantics may be due to the strong reasoning component underlying higher level semantics and these theory of mind tasks. Furthermore, the higher level belief tasks required verbal explanation, a higher level expressive semantic skill. However, perception and pretence that involved less language in their administration and scoring still correlated with receptive language (with correlations of 0.71 and 0.56 respectively being obtained), expressive semantics (with correlations of 0.80 and 0.68

respectively being obtained), narrative ability (with correlations of 0.82 and 0.65 respectively being obtained) and pragmatics (with correlations of 0.97 and 0.70 respectively being obtained). This would suggest that the relationship between theory of mind and communication is due to far more than the language used in the administration of some of these tasks. The very strong correlation between perception and pragmatics (0.87), particularly, supports a strong relationship between theory of mind and pragmatic ability. That language ability affects performance on theory of mind tasks is particularly demonstrated by the relationship between MLU and the belief + deception (0.51) and emotion (0.46) tasks and the relationship between dependent clauses and the emotion task (0.43). The observation that pretence was less related to overall cognitive ability (full scale) (0.45) than the other theory of mind measures would suggest that this may be a useful measure to use when cognitive and language ability are high and a measure that may be sensitive to tapping theory of mind is needed. A qualitative analysis of the results indicated that certain of the very HFPDD subjects who did relatively well on the cognitive and other theory of mind measures, still experienced difficulty with the measure of pretence, suggesting that it may be a sensitive measure of theory of mind difficulty. The results of the above analysis would appear to confirm that theory of mind seems to be correlated more strongly with communication ability than planning or attention, even on theory of mind tasks that are less verbally loaded. This would suggest that theory of mind is closely related to communication, particularly receptive language, expressive semantics, narrative ability and pragmatic ability, and that possibly theory of mind and these aspects of communication use similar underlying processes.

6.4.5 <u>Summary of results of correlations</u>

Results of the correlation analysis indicated strong correlations between receptive language, expressive semantics, narrative ability and pragmatic ability. Furthermore, strong correlations were found between these aspects of communication and planning and attention and theory of mind, all of which were also strongly correlated. Aspects of expressive grammar were found to correlate significantly with successive processing. The only cognitive processing variable that successive processing correlated with was simultaneous processing. Results would appear to suggest that grammatical ability and successive processing may rely on similar underlying constructs and may occur at a similar level to simultaneous processing in an information processing model. In contrast, receptive

198

language (particularly understanding conversation), expressive semantics, narrative ability and pragmatic ability would appear to rely on similar underlying constructs to planning, attention and theory of mind.

6.5 **DISCRIMINANT FUNCTION ANALYSES**

In order to address the third research aim, discriminant function analyses were undertaken. Here the aim was to determine which measures from the research battery best differentiated the three groups. Discriminant function analyses, therefore, included all three groups of subjects. An overall discriminant function analysis of the three batteries of measures combined, as well as discriminant function analyses of the communication, cognitive processing and theory of mind batteries, were undertaken. Results are presented below.

6.5.1 Discriminant function analysis of all three batteries combined

A discriminant function analysis was carried out on all three batteries together (i.e. the communication, cognitive processing and theory of mind batteries). The variables selected by the stepwise procedure are presented in table 6.24. The number of observations and percent classified into each group based on the selected variables are presented in table 6.25.

Variables	Partial R-Square	F Value	Pr>F
Total pragmatic Score	0.5195	37.84	<.0001
Total narrative Score	0.2380	10.93	<.0001
Successive standard score	0.1938	8.41	0.0005
Mean length of utterance	0.1824	7.81	0.0009
Theory of mind score	0.1035	4.04	0.0218

Table 6.24: Variables selected by the stepwise procedure on all three batteries together

Statistics for removal, DF=2.70

The results in table 6.24 indicate that when taking all three batteries together the total pragmatic score was most useful in differentiating between the three groups, followed in order by the total narrative score, the successive standard score, the mean length of utterance and the total theory of mind score. These results would appear to suggest that a communicative assessment may be a more sensitive measure to assist in diagnosing HFPDD than cognitive processing or theory of mind measures, although cognitive processing and theory of mind measures were also shown to be sensitive. The fact that the pragmatic and

narrative measures were most sensitive supports the importance of qualitative assessment in this group.

The results of the discriminant function analysis can, however, be misleading as in the analysis the variables that best discriminated between all three groups were looked at. The results of the discriminant function analysis, therefore, would not necessarily show which variables best discriminated between the HFPDD and SLI groups. Successive processing, for example, came out as a variable that best discriminated between the three groups. This would appear to be due to successive processing coming out at a significantly different level in all three groups. However, when differentiating HFPDD from SLI and NDD, planning and attention measures may still be the most useful. In the same way MLU came out as a variable that best differentiated between the three groups. However, MLU on its own would not appear to be that useful in discriminating between the HFPDD and SLI groups. In retrospect, it may have been useful to run a discriminant function analysis between these two groups.

From group	HFPDD	SLI	NDD	Total
HFPDD	26	0	0	26
	100.00%	0.00%	0.00%	100.00%
SLI	0	24	2	26
	0.00%	92.31%	7.69%	100.00%
NDD	0	1	24	25
	0.00%	4.00%	96.00%	100.00%
Total	26	25	26	77
	33.77	32.47	33.77	100.00%
Priors	0.33333	0.33333	0.33333	

Table 6.25: Number of observations and percent classified into each group based on the variables selected for all three batteries together

From table 6.25 it can be seen that using the selected variables all of the HFPDD subjects would still be classified into the HFPDD group. Twenty-four of the SLI subjects would be classified into the SLI group, while two would be classified into the NDD group. Twenty-four of the NDD subjects would be classified into the NDD group, while one would be classified into the SLI group. (One of the NDD subjects was excluded from this analysis due to the missing data for this subject for the assessment of expressive grammar noted earlier.)

6.5.2 Discriminant function analysis of communication battery

A discriminant function analysis was carried out on all the sub-tests of the communication battery. The variables selected by the stepwise procedure are presented in table 6.26 and the number of observations and percent classified into each group based on the selected variables is presented in table 6.27.

Variable	Partial R-square	F value	Pr>F
Pragmatic verbal aspect score	0.7266	91.69	<.0001
Narrative clarity score	0.4631	29.76	<.0001
Narrative temporal	0.2175	9.59	0.0002
organisation score			
Mean length of utterance	0.2070	9.00	0.0003
Phrasal utterances	0.1104	4.28	0.017
Pronoun alternation score	0.0996	3.82	0.0268

Table 6.26: Variables selected by the stepwise procedure for the communication battery

Statistics for removal, DF=2.69

From table 6.26 it can be seen that the variable that was selected as best discriminating between the three groups was the pragmatic verbal aspect score, followed in order by the narrative clarity score, the narrative temporal organisation score, MLU, phrasal utterances and then the pronoun alternation score. It would appear that the variables where both the HFPDD group and the SLI group differed from the NDD group and differed from each other have been selected. In future a discriminant function analysis that investigates which variables best separate the HFPDD and SLI groups and the HFPDD and NDD groups would be useful. However, what is interesting is that none of the formal language tests were selected. This would stress the importance of doing a pragmatic analysis, narrative analysis and grammatical analysis in this population, as well as clinician constructed measures such as the pronoun alternation task, designed to tap specific language areas thought to be impaired in PDD. This highlights the importance of doing qualitative assessment in the HFPDD group rather than formal tests, which do not always tap this population's areas of difficulty. The pragmatic and narrative analyses would appear to tap the children with HFPDD's difficulties the best, while the grammatical analysis would seem to tap the children with SLI's difficulties the best.

Table 6.27: Number of observations and percent classified into each group based on the variables selected for the communication battery

From group	HFPDD (n=26)	SLI (n=26)	NDD (n=26)	Total
HFPDD (n=26)	26	0	0	26
	100.00%	0.00%	0.00%	100.00%
SLI (n=26)	0	25	1	26
	0.00%	96.15%	3.85%	100.00%
NDD (n=25)	0	1	24	25
	0.00%	4.00%	96.00%	100.00%
Total	26	26	25	77
	33.77%	33.77%	32.47%	100.00%
Priors	0.33333	0.33333	0.33333	

The results in table 6.27 indicate that, according to the selected communication variables, all the HFPDD subjects would still be classified into the HFPDD group, twenty-five of the SLI subjects would be classified into the SLI group and one would be classified into the NDD group. Twenty-four of the NDD subjects would be classified into the NDD group and one would be classified into the SLI group. (One of the NDD subjects was excluded from this analysis due to the missing data for this subject for the expressive grammar assessment noted earlier.)

6.5.3 Discriminant function analysis of CAS variables

A discriminant function analysis was carried out on the different parameters which made up the CAS. The variables selected by the stepwise procedure are presented in table 6.28. The number of observations and percent classified into each group based on the selected variables are presented in table 6.29.

C A C I

<i>1 able 0.28</i> :	variables	selected D	y the ste	pwise p	rocedure I	or the C	CAS batter	ry

41

Variable	Partial R-Square	F Value	Pr>F
Successive processing	0.4411	28.41	<.0001
Simultaneous processing	0.2788	13.92	<.0001
Attention	0.2037	9.21	0.0003
Planning	0.1572	6.71	0.0021

Statistics for removal, DF=2.72

(30 17

The results in table 6.28 indicate that all of the four processes that make up the CAS were found to be useful in discriminating the three groups. As mentioned previously results can be misleading as the discriminant function analysis was run on all three groups. While the

successive processing variable best discriminated all three groups on the CAS, an analysis of the overall results would suggest that this variable may not be the most useful variable to discriminate between the HFPDD and SLI groups and that to do this the variables of planning and attention may be more useful.

The results of the discriminant function analysis on the CAS, however, do indicate that all four aspects - planning, attention, simultaneous and successive processing - are needed to discriminate between the three groups. Ideally this battery would be useful to use with children suspected of having HFPDD. However, should time limitations not allow this, it is felt that once a clinician understands these cognitive processes these could also be informally assessed, with some of them being included within a communication battery. For example, story telling would appear to tap planning abilities, certain receptive language measures would appear to tap simultaneous processing, word and digit recall would appear to tap successive processing, and attention could be evaluated through informal observation. According to the CAS administration and scoring manual (Naglieri & Das, 1997) a shortened version of the CAS could also be carried out, with only two of the three sub-tests for each process being administered.

Table 6.29: Number of observations and percent classified into each group based on the variables selected for the CAS battery

From group	HFPDD	SLI	NDD	Total
HFPDD	22	1	3	26
	84.62%	3.85%	11.54%	100.00%
SLI	0	24	2	26
	0.00%	92.31%	7.69%	100.00%
NDD	0	1	25	26
	0.00%	3.85%	96.15%	100.00%
Total	22	26	30	78
	28.21%	33.33%	38.46%	100.00%
Priors	0.33333	0.33333	0.33333	

As can be seen in table 6.29, based on the CAS profiles, twenty-two subjects from the HFPDD group would still be classified as HFPDD, while one would be classified as SLI and three would be classified as falling into the NDD group. Twenty-four subjects from the SLI group would still be classified as SLI, while two would be classified as falling into the NDD group. Twenty-five subjects from the NDD group would still be classified as SLI, while two would be classified as falling into the NDD group. Twenty-five subjects from the NDD group would still be classified as falling into the SLI group.

Four HFPDD subjects not classified as falling into the HFPDD group would appear to suggest two things. The one would be the continuity of children with HFPDD, with both mild and more severe forms of this disorder occurring. The other would be that cognitive profiles alone cannot be used in both the diagnosis of this group and in explaining the underlying impairments. It would appear that cognitive profiles need to be looked at together with theory of mind and the profile of communication difficulties seen in order to explain the symptom complex seen in HFPDD. Furthermore, as children of the age that were included in the study's diagnoses are often still evolving, these four subjects or at least some of them may not be true cases of PDD. It would be interesting to follow these children up to see if their diagnoses change with time.

6.5.4 Discriminant function analysis of theory of mind variables

A discriminant function analysis was carried out on the different sub-tests which made up the theory of mind battery. The variables selected by the stepwise procedure are presented in table 6.30. The number of observations and percent classified into each group based on the selected variables are presented in table 6.31.

Table 6.30: Variables selected by the stepwise procedure on the theory of mind battery

Variable	Partial R-Square	F value	Pr>F
Belief raw score	0.3574	20.30	<.0001
Mental significance of the eyes	0.1680	7.37	0.0012
raw score			
Deception raw score	0.1443	6.16	0.0034

Statistics for removal, DF=2.73

Results in table 6.30 indicate that the sub-tests on the theory of mind battery that best discriminated between the three groups were the belief sub-tests (first- and second-order false belief sub-tests), then the mental significance of the eyes sub-tests and then the deception sub-test. This would support research suggesting that measures of belief are the litmus test of theory of mind ability (Baron-Cohen, 1993). The belief and deception measures would appear to tap similar things. The fact that a number of the NDD participants failed the deception task would question its usefulness in a theory of mind battery. It would appear that use of a task with a less high loading on language (such as the mental significance of the eyes sub-test) together with a task with a higher loading on language (such as the belief measures) would be useful to include in a battery. As the belief measures used consisted of both first-

order false belief tasks and a second-order false belief task, they encompass the developmental aspects of theory of mind in this age group and, therefore, would appear to be a particularly useful measure for this age group. In contrast a ceiling effect on the mental significance of the eyes measure may be seen for the older children in this age group. Using a task with a less high loading on language such as the pretence measure may, therefore, be a more useful measure, as one would expect a child to generate more instances of pretence as he/she gets older and results could, therefore, be interpreted in relation to the child's age. From qualitative analysis of the battery, the researcher felt that the pretence measure was a particularly useful measure in discriminating between the HFPDD and SLI groups. This was felt to be a particularly child friendly measure and the children with SLI and NDD in particular appeared to enjoy this measure. This measure did not place high language demands on the SLI group. It was generally possible to evaluate the children's pretence abilities within a short time of starting this measure. Further research to establish norms for generativity pretence tasks such as this would be useful.

Clinically it is suggested that the theory of mind assessment includes measures of the mental significance of the eyes, a belief measure appropriate to the child's age, and the measure of pretence. This would also appear to tap all three aspects of Baron-Cohen's (1995) and Baron-Cohen and Ring's (1994) model of mind-reading, the mental significance of the eyes measure tapping into the shared attention mechanism, the belief measure tapping into the shared attention mechanism and the pretence measure tapping into the predictive and active aspect of the theory of mind mechanism. Furthermore, the inclusion of both theory of mind measures with a higher loading on language and measures with a lower loading on language, should help clinically differentiate between children with HFPDD and SLI.
From group	HFPDD	SLI	NDD	Total
HFPDD	22	3	1	26
	84.62%	11.54%	3.85%	100.00%
SLI	0	20	6	26
	0.00%	76.92%	23.08%	100.00%
NDD	0	4	22	26
	0.00%	15.38%	84.62%	100.00%
Total	22	27	29	78
	28.21%	34.62%	37.18%	100.00%
Priors	0.33333	0.33333	0.33333	

Table 6.31: Number of observations and percent classified into each group based on the variables selected for the theory of mind battery

As indicated in table 6.31 based on the selected variables, twenty-two of the HFPDD subjects were still classified as being in the HFPDD group, while three were classified in the SLI group and one in the NDD group. This would support studies that have shown that a percentage of individuals with PDD pass theory of mind tasks. Twenty of the SLI subjects were still classified as being in the SLI group, while six were classified as falling in the NDD group. Twenty of the NDD subjects fell into the NDD group, while four of the NDD subjects fell into the SLI group. Four participants from the HFPDD group not being classified in this group based on their theory of mind results could suggest one of two things. Firstly, these children were possibly not true cases of HFPDD and their diagnoses may still be evolving. Secondly, an alternative view may be that they are true cases of HFPDD but that theory of mind tasks. While the theory of mind tasks were found to have great value, these results would suggest that they alone cannot necessarily differentiate children from the three groups with certainty. At this stage it would appear that theory of mind tasks should be used as part of a larger battery that also encompasses communication and cognitive processing.

In an examination of the percentage of subjects classified into each group based on the variables selected, it would seem that the communication assessment best differentiated the HFPDD group from the other two groups, with all twenty-six participants still being placed in the HFPDD group. The cognitive processing and theory of mind assessments appeared equally able to differentiate the HFPDD group from the other two groups, with each of these batteries still assigning twenty-two of the twenty-six participants to the HFPDD group.

The results of the discriminant function analysis, interpreted in relation to the rest of the results, stress the importance of assessing communication, particularly pragmatic and discourse skills when assessing children with HFPDD. The importance of assessing planning, attention, simultaneous and successive processing as well as a developmentally appropriate aspect of theory of mind with a higher loading on language and a developmentally appropriate aspect of theory of mind with a lower loading on language is highlighted. Belief was emphasized as a particularly importance aspect of theory of mind to measure.

Based on the discriminant function analysis results, interpreted in relation to the overall results of the study, it would appear that a revised battery to assess children between 5.0 to

- 7.11 years with HFPDD should focus on the following:
- An assessment of pragmatic ability
- An assessment of narrative ability, particularly narrative coherence
- A grammatical language assessment, with particular emphasis being placed on stage V of the LARSP
- Clinician constructed tasks tapping aspects of language expected to be problematic in HFPDD, such as the pronoun alternation task
- Measures of planning ability
- Measures of attention
- Measures of simultaneous processing
- Measures of successive processing
- Developmentally appropriate measures of belief
- Measures of the mental significance of the eyes and/or measures of pretence.

The results of the discriminant function analysis also indicated that on their own the cognitive and theory of mind batteries were unable to place all the HFPDD participants into the HFPDD group. This would appear to suggest that on their own the cognitive processing profile observed in the HFPDD group, as well as the theory of mind difficulties seen are unable to account for all the difficulties seen in this group.

6.6 SUMMARY OF RESULTS AND CONCLUSIONS

The results of the study can be summarised according to the three research aims. The first aim of the study was to determine whether specific communication, cognitive processing and theory of mind profiles exist in children with HFPDD, when compared to children with SLI and NDD. Results of the study indicated that specific communication, cognitive processing and theory of mind profiles do exist in children with HFPDD, when compared to children with SLI and NDD.

In the area of communication the HFPDD group experienced particular difficulty with receptive abstract language (basic concepts), understanding conversation, expressive semantics, the more conceptual aspects of grammar, narrative ability (particularly narrative coherence) and with the verbal, paralinguistic and non-verbal aspects of pragmatics. The SLI group performed relatively well on the measures of receptive language, but experienced difficulty in the areas of expressive semantics and expressive grammar. Overall, their performance on the expressive grammar measures appeared to be weaker than the HFPDD group's difficulties. While they also experienced difficulty with narrative ability, they appeared to experience particular difficulty with narrative clarity. They also experienced some difficulty with the verbal and paralinguistic aspects of pragmatics, although their difficulties in these areas were not as marked as the HFPDD group. In contrast to the HFPDD group, the SLI group performed with good non-verbal pragmatic skills. In the areas of semantics, the HFPDD group performed markedly more poorly than the SLI group and appeared to experience greater difficulty as greater depths of meaning were tapped.

In the area of cognitive processing the HFPDD group experienced the most difficulty with measures of planning and attention, experiencing the most difficulty with planning. In contrast the SLI group experienced the most difficulty with measures of successive processing, but also appeared to experience some difficulty with measures of planning. When the relationship of simultaneous and successive processing was examined, three patterns appeared to emerge in the HFPDD group; the first was simultaneous processing markedly stronger than successive processing, the second was successive processing markedly stronger than simultaneous processing, and the third was simultaneous and successive processing occurring at a similar level. This may suggest that some individuals with HFPDD may favour one modality or type of processing over another.

208

The results of the theory of mind assessment indicated that on all areas of theory of mind that were tapped, the HFPDD group experienced significant difficulty in relation to both the SLI and NDD groups. The SLI group, however, also experienced difficulty with certain of the theory of mind tasks. These consisted of the measures of belief and understanding emotions, which appeared to be measures which loaded highest on language. In contrast to the SLI group the HFPDD group experienced significant difficulty on both the theory of mind measures that involved more language, as well as those that involved less language, suggesting that their theory of mind difficulties were more primary in nature.

The second research question was concerned with determining whether relationships existed between certain aspects of communication and certain aspects of cognitive processing and theory of mind ability. Strong correlations were noted between the areas of receptive language (particularly understanding conversation), expressive semantics, narrative ability and pragmatic ability. In turn these areas of communication were found to correlate strongly with planning, attention and theory of mind, with the areas of planning, attention and theory of mind also strongly correlating. Measures of grammatical ability were found to correlate significantly with successive processing.

The third research question was concerned with whether different measures of the research battery discriminated better between the three groups than others. Results of the discriminant function analysis and overall results of the research battery suggested that certain aspects of the research battery were particularly powerful in discriminating HFPDD from SLI and NDD. In the area of communication, pragmatic ability and narrative ability (particularly narrative coherence) were noted to be particularly important. In the area of cognitive processing planning, attention, successive and simultaneous processing were all found to play an important role. In the area of theory of mind the assessment of belief was found to be a particularly important measure. It seemed that a measure of belief should be paired with a developmentally appropriate measure of theory of mind that is less heavily loaded on language. The two measures that seemed particularly useful in this regard were an assessment of the mental significance of the eyes and the pretence measure.

This concludes the results section of the study. The results of this study, however, appear to indicate that common processes may underlie the communication, cognitive processing and theory of mind difficulties seen in the HFPDD group. In the following chapter (Chapter

seven) the results of the study will be discussed in relation to a combined model of communication, cognitive and theory of mind processing in order to add to our understanding of this. This chapter will also include sections evaluating the study, including limitations of the study, as well as implications of the study.