CHAPTER SEVEN

GENERAL DISCUSSION AND CONCLUSIONS

"I have to work out theoretically

all the things that you just land yourselves at instinctively."

"To me the outside world is a totally baffling incomprehensible

Mayhem which terrifies me. It is a meaningless mass of sights and sounds,

Noises and movements, coming from nowhere, going nowhere"

(Ros Blackburn, in *Aut-Talk*, produced by Autism South Africa, 2006, p.7).

The aim of this chapter is to integrate the findings of this study by applying them to models of language, cognitive and theory of mind processing. A summary of the findings of the study is presented and these are discussed in relation to the relevant information processing models. First the communication results are discussed in terms of the revised language processing model presented in Chapter two. The cognitive processing results are then discussed in relation to the PASS model of cognitive processing (Naglieri & Das, 1990) presented in Chapter three. Then the theory of mind results are discussed in relation to Baron-Cohen's (1995) and Baron-Cohen and Ring's (1994) mind-reading model presented in Chapter four. The relationship between communication, cognitive processing and theory of mind is discussed and a combined model of language, cognitive and theory of mind processing is presented. This is followed by an evaluation of the study, discussion of implications of the study and concluding comments.

7.1 INTERPRETATION OF THE RESULTS OF THE COMMUNICATION ASSESSMENT IN TERMS OF THE VERBAL-PARALINGUISTIC-NON-VERBAL MODEL OF LANGUAGE PROCESSING

The communication results will be discussed in terms of the revised language processing model presented in Chapter two and also presented in figure 7.1. In figure 7.1 the areas where the primary breakdown appeared to occur in the HFPDD and SLI groups are marked. These will be explained in the discussion that follows.
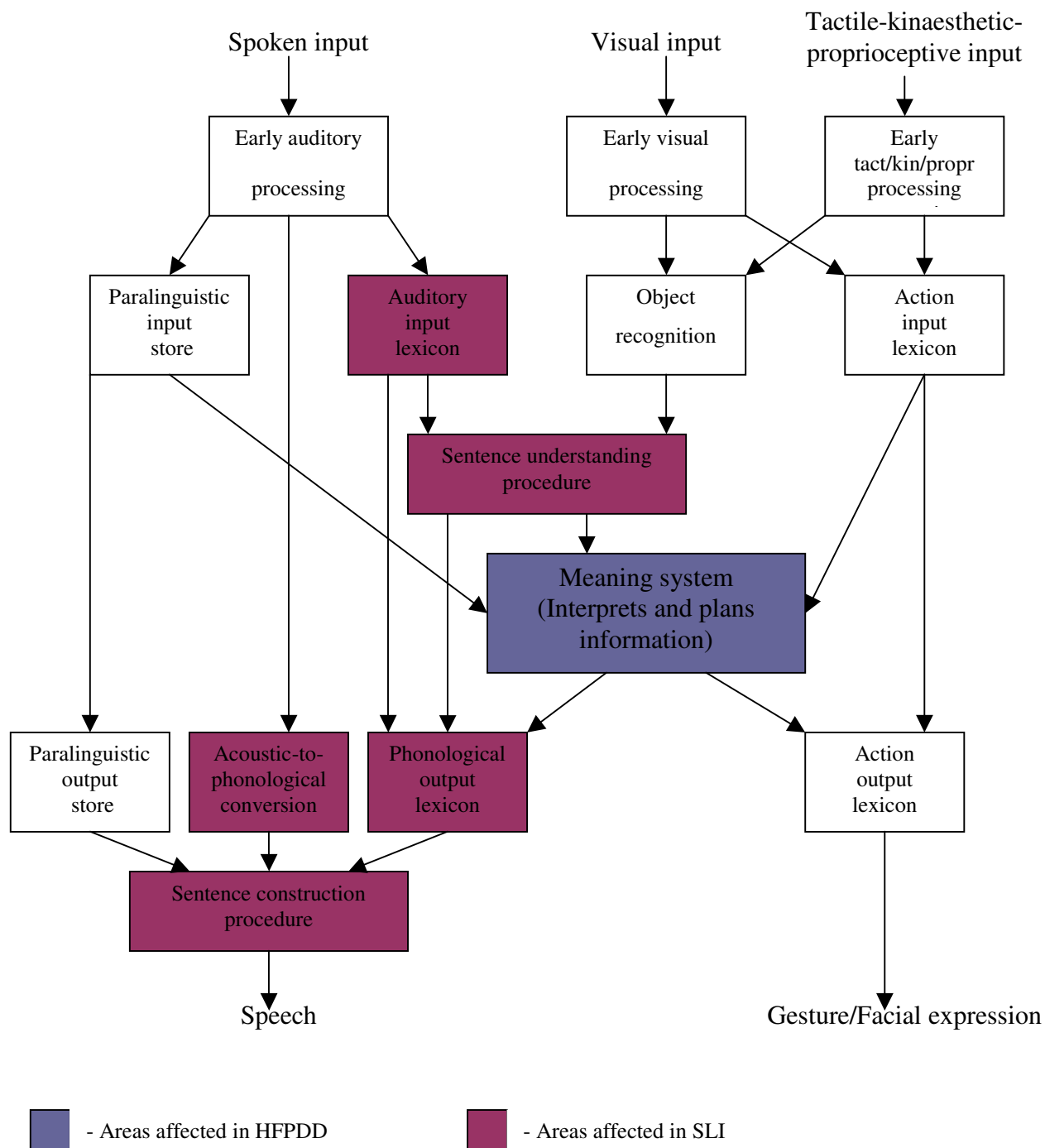
Figure 7.1: Areas of breakdown on the verbal-paralinguistic-non-verbal language processing model for the HFPDD and SLI groups

7.1.1 A verbal-paralinguistic-non-verbal language processing model encompassing different modalities of processing

As discussed in Chapter two, in the language processing model presented, language processing is divided into input, central processing and output levels. According to the revised language processing model presented, input could occur through the auditory, visual and tactile-kinaesthetic-proprioceptive modalities, while output occurs through either speech and/or non-verbal aspects of communication, such as gesture and facial expression. Incoming information would be processed through the paralinguistic input store, auditory input lexicon, object recognition system, action input lexicon and sentence understanding procedure, with processing at this level being largely modality specific. Some integration of information from different modalities may, however, occur at the level of the sentence understanding procedure. Information from all these modules would then be integrated in the meaning system, where processing would no longer be modality specific. Within the meaning system the outgoing message would also be created and planned. This message would then be communicated via the phonological output lexicon and sentence construction procedure into speech and/or through the action output lexicon into gesture/facial expression. Speech and gesture/facial expression can, however, take place by bypassing the meaning system. Auditory information could pass directly from the paralinguistic input store to the paralinguistic output store; from early auditory processing to the acoustic-to-phonological conversion system; from the auditory input lexicon to the phonological output lexicon; and from the sentence understanding procedure to the phonological output lexicon. In a similar manner gestural information could pass directly from the action input lexicon to the action output lexicon.

7.1.2 Discussion of communication results in relation to this model

As shown in Chapter six, the differences obtained between the three groups in the areas of receptive language, expressive semantics, expressive grammar, narrative discourse and pragmatics reached statistical significance. Each of these areas will be discussed in relation to the proposed language processing model.

7.1.2.1 <u>Receptive language</u>

As outlined in Chapter six, in the area of receptive language 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, although they did score more poorly than the NDD group on this measure. However, in relation to the norms found in the test manuals for the BPVS and Grammatic Understanding measures the HFPDD and SLI groups' ability in these areas still fell within the functional range. However, in relation to the norms in the test manual of the Basic Concepts sub-test, the HFPDD group experienced significant difficulty. This group's difficulty understanding conversation was also marked.

On the proposed model of language processing, receptive vocabulary (as measured by the BPVS) would appear to be stored in the auditory input lexicon and receptive grammar (as measured by the Grammatic Understanding sub-test) would appear to be stored in the sentence understanding procedure. However, for full processing to take place the meaning system would still need to be accessed. The understanding of concepts (as measured by the Basic Concepts sub-test), while stored in the auditory input lexicon, would, however, appear to rely on more access to the meaning system, as conceptual understanding appears to rely more on the integration of information. The understanding of conversation would appear to rely on the meaning system and the integration of information from different modalities (particularly the verbal and visual modalities) to an even greater extent. Results for the HFPDD group, therefore, appear to point to the receptive language difficulty in HFPDD lying more centrally in the language processing system and being due to a breakdown in semantic and pragmatic understanding. This ties in with the previous suggestions that receptive language difficulties in PDD are due to difficulty integrating linguistic input with real world knowledge and using knowledge about social events to assist with understanding (Tager-Flusberg, 2005), as well as difficulty integrating sources of information from different sensory systems in the understanding of verbal input (Lord & Paul, 1997). The SLI group's poorer performance than the NDD group in the area of receptive vocabulary (as measured by the BPVS) and on the Grammatical Understanding sub-test would appear to indicate that this

group may experience some difficulty within the auditory input lexicon and in the sentence understanding procedure.

7.1.2.2   Expressive semantics

As discussed in Chapter six, in the area of expressive semantics, when compared to the SLI group, the HFPDD group did not score significantly more poorly on the expressive vocabulary measure (Word Finding Vocabulary Test) but did on the pronoun alternation, Oral Vocabulary and modified TOPS measures. In addition the HFPDD group's performance appeared to deteriorate as greater depths of meaning were tapped, with this group experiencing the most marked difficulty with the pronoun alternation and modified TOPS measures. When compared to the NDD group, the SLI group scored significantly more poorly on all these measures except the pronoun alternation task.

Poorer performance that occurs as the expression of greater depths of meaning is tapped would appear to suggest greater difficulty as one goes deeper into the meaning system, confirming significant difficulty with the semantics of language in the HFPDD group. It is possible that the HFPDD and SLI group's similar and poor performance on expressive vocabulary (as measured by the Word Finding Vocabulary Test) is due to difficulty with different underlying processes. Word learning has been said to rely on theory of mind, categorisation and phonological short-term memory (Sabbagh & Baldwin, 2001). Theory of mind has been found to be poorer in PDD (Frith, 1989) and phonological short-term memory has been found to be poorer in SLI (Owens, 1999). Moreover, it has been suggested that individuals with PDD experience difficulty using meaning to facilitate word retrieval (Lord & Paul, 1997; Tager-Flusberg, 1991) and difficulty with word retrieval has been suggested to be due to difficulty with semantic organisation (Boucher, 1988). Difficulty in the area of semantic processing would appear to affect the functioning of the phonological output lexicon as adequate processing should occur first in the semantic system before the phonological output lexicon can be fully accessed. Word retrieval difficulty in children with SLI is thought to be due to a problem with serial recall of the phonological form of a word (Owens, 1999b). This would suggest that their difficulty with word recall occurs at the level of the phonological output lexicon, while the HFPDD group's problem is due to difficulty at the level of the meaning system.

The HFPDD group's individual's greatest difficulty with the pronoun alternation task and modified TOPS would appear to be due to these tasks tapping greater depths of meaning than the other measures of expressive semantics. Their greater difficulty on these measures may also be related to these tasks relying on integrating both visual and verbal information. It appears that it is only at the level of the semantic system that this inter-modal integration of information can take place. The SLI group's individuals' difficulty on the modified TOPS appeared more related to their language expression difficulties than due to higher level semantic difficulties. This group's answers often reflected appropriate meaning but poor expression of this meaning, which affected the score on that item. The SLI group's difficulty on the proposed language processing model may, therefore, occur due to processes that occur after the level of the meaning system being affected, these being the phonological output lexicon and sentence construction procedure, although it is possible that the meaning system is also partly affected. The SLI group's greater difficulty on the successive processing tasks of the CAS, which require verbal repetition, would confirm their difficulty with the phonological output lexicon and also suggest difficulty with the acoustic-to-phonological conversion system. The HFPDD group's successive processing results would suggest that as a group they did not experience significant difficulty with these repetition routes, but that some individuals within the HFPDD group may experience difficulty with these routes in addition to their difficulty at the level of the meaning system. The use of echolalia in PDD would suggest that these routes are generally intact. Furthermore, echolalia may be used as a strategy to learn language when individuals experience difficulty accessing the semantic system and have to rely on these repetition routes. In the same way, in hyperlexia words can be read using either a lexical or sub-lexical reading route, where the semantic system is not accessed. This possibly occurs when the individual experiences difficulty accessing the semantic system, so that word recognition and decoding are good but comprehension is poor.

7.1.2.3   Expressive grammar

As shown in Chapter six, in the area of expressive grammar, the HFPDD and SLI groups scored significantly more poorly than the NDD group on the measures of number of dependent clauses, MLU and number of different complex clauses used. In addition the SLI group also scored significantly more poorly than the NDD group on total number of clauses. Furthermore, they produced more phrasal utterances outside a clause than the NDD group. A qualitative analysis of the results indicated that the HFPDD group used less variety in their

complex clause usage (indicated by less variety in stage V LARSP structures) than the other two groups.

When interpreting these results in relation to the proposed language processing model, it would appear possible that the HFPDD group's expressive grammatical difficulty is due to an earlier difficulty in the processing chain at the level of the meaning system. If sentence construction is developed without complete access to the meaning system, this is likely to result in difficulty when grammar becomes more conceptual (i.e. at stage V of the LARSP). This may possibly result in constructions being learnt more superficially and there being less variety in the constructions used. As the meaning system would also appear to be involved in planning new information, the lack of variety noted in the HFPDD group's use of complex grammatical structures may be related to difficulty within the meaning system. In the SLI group subjects may have accessed (or at least better accessed) the meaning system, as evidenced by the results of the receptive and expressive semantic assessment. Their difficulty would, however, appear to occur at the level of the phonological output lexicon (evidenced by their poor performance on the expressive vocabulary measure) and at the sentence construction procedure level (evidenced by their poor performance on the expressive grammar measures).

7.1.2.4   <u>Narrative ability</u>

The results in Chapter six indicate that on the narrative measures the HFPDD group scored significantly more poorly than the SLI group on the measures of coherence and total narrative (coherence and clarity together), while the SLI group scored significantly more poorly than the NDD group on these measures. The results of the narrative analysis appeared to indicate that the SLI subjects experience relatively more difficulty with the clarity (structural aspects) of relating a story than they do with the coherence (integration) aspect, although difficulty with coherence was also noted. The HFPDD group subjects in contrast experienced markedly more difficulty with coherence than the SLI group did. Their performance on the clarity item was similar but slightly worse than the SLI group's performance.

Coherence would appear to be part of the meaning system, relying on much integration of information. Clarity would, however, appear to be more related to grammatical aspects and

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would not appear to lie as centrally in the language processing model. While linked to the meaning system, it would also appear to be strongly influenced by the phonological output lexicon and the sentence construction procedure. Narrative coherence would appear to rely on integrating information, as well as on cognitive planning in the organisation and generation and formulation of the story. Information within each picture and across different pictures needed to be integrated in order to determine the gist of the story. At the level of the meaning system this integration of information takes place. According to Das et al. (1996) story composition reflects conceptual planning skills. The meaning system and conceptual planning would, therefore, appear to be directly related to each other. This difficulty with integration of information and planning may be the reason that children with PDD are often much better at story retelling than story generation, as less integration of information and conceptual planning is required for story retelling than story generation. These results would support the meaning system, the planning system (which would appear to be closely related to the meaning system) and the integration of information from more than one modality being affected in HFPDD. In contrast to the children with HFPDD, the children with SLI's difficulty with story telling would appear to lie less centrally in this model, possibly occurring more at the level of the phonological output lexicon and sentence construction procedure. Part of their difficulty could also be due to difficulty in the meaning system. However, this difficulty would appear to be far less marked than that seen in the HFPDD group.

7.1.2.5   Pragmatic ability

As outlined in Chapter six, on the pragmatic assessment the HFPDD group scored significantly more poorly than the SLI 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 measures, but not on the non-verbal measure. A qualitative analysis of the results indicated that in all the components making up the verbal and paralinguistic aspects, the SLI group performed markedly better than the HFPDD group, except on the parameter of intelligibility, where they scored at a similar level. A qualitative analysis of the results appeared to suggest that the SLI group scored more poorly on this parameter due to speech sound errors, while the HFPDD group scored more poorly on this parameter due to insensitivity to their communication partner's needs.

The SLI group's good performance on the non-verbal aspects of pragmatics would appear to suggest that their difficulties are specific to the verbal modality, while the PDD group's difficulties appear to encompass both the verbal and non-verbal aspects of communication and the integration of the meaning of these. On the proposed language processing model the integration of information from different modalities takes place in the meaning system. The HFPDD group was noted to experience difficulty with the verbal, paralinguistic and non-verbal aspects of pragmatics. According to the proposed language processing model, for verbal, paralinguistic and non-verbal information to be adequately processed and used, it needs to pass through the meaning system, where it is integrated and acted upon. According to the alternate routes (to the meaning system route) on the proposed language processing model, it is possible that verbal information may not fully access the meaning system but may bypass it, moving from the auditory input lexicon and sentence understanding procedure to the phonological output lexicon and sentence construction procedure. This may occur when a child uses echolalia, for example, repeating a previously heard phrase that is only superficially understood and which is not quite appropriate to the context in which it is used. A child may also repeat a word or phrase that he/she does not understand. This could occur through the acoustic-to-phonological conversion route.

In the same way paralinguistic information may not fully access the meaning system and may bypass it, moving from the paralinguistic input store to the paralinguistic output store. This would, for example, happen when a child says a sentence again with the same intonation as the originally heard sentence without taking context into account. In a similar way non-verbal information may not fully access the meaning system and may bypass it, moving from the action input lexicon to the action output lexicon. This may, for example, occur when a child uses gestures in a stereotypical manner or imitates gestures (echopraxia), without taking the meaning of these into account. This partial processing (without full access to the semantic system) of verbal, paralinguistic and non-verbal information may account for the pragmatic oddities that were seen in the HFPDD group. This would support the locus of difficulty in HFPDD being in the meaning system. In SLI the meaning system may be accessed but due to difficulties at the level of the phonological output lexicon and sentence construction procedure some difficulties in the area of verbal pragmatics may appear evident. Furthermore, due to speech difficulties often occurring in SLI children (Rescorla & Carlson Lee, 2000), some difficulty with the paralinguistic aspects of pragmatics may also occur.

7.1.2.6   Synopsis of interpretation of communication assessment

The results of the communication assessment appeared to indicate that the primary underlying difficulty on the proposed language processing model for the HFPDD group is the meaning system. In contrast, the primary underlying difficulty for the SLI group would appear to be related to the auditory processing channel, including the auditory input lexicon, sentence understanding procedure, phonological output lexicon, acoustic-to-phonological conversion system and sentence construction procedure. While the SLI group appeared to experience difficulties with more components forming part of the proposed language processing model, this group's communication difficulties appeared far less severe than the HFPDD group's communication difficulties. This would appear to be related to their difficulties occurring less centrally in the proposed language processing model. The HFPDD group's primary difficulty with the most central aspect of the model would appear to account for the far reaching and pervasive nature of this group's communication difficulties.

7.2   **INTERPRETATION OF THE FINDINGS OF THE COGNITIVE PROCESSING ASSESSMENT IN TERMS OF THE PASS MODEL**

7.2.1   Summary of results of the cognitive processing assessment

As discussed in Chapter six, the three groups scored significantly differently from each other on all the cognitive processing variables including planning, simultaneous processing, attention, successive processing and on the full scale measure. The HFPDD group scored significantly more poorly than the SLI group on the planning measure and 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 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.

Two profiles emerged from the results. The HFPDD group appeared to have a profile with poorest performance in the areas of planning and attention. The SLI group appeared to have a profile with poorest performance on successive processing, as well as some difficulty in the area of planning. On an analysis of individual cognitive strengths and weaknesses a number of children with HFPDD presented with simultaneous processing and/or successive processing as a cognitive strength. A qualitative analysis of the results indicated 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. A more in-depth analysis of the data revealed three simultaneous-successive processing patterns in the HFPDD group: 1) simultaneous processing markedly stronger than successive processing; 2) successive processing markedly stronger than simultaneous processing; and 3) no significant difference between successive and simultaneous processing.

7.2.2   Interpretation of the results in relation to the PASS model

An adaptation of the PASS model as well as the different zones corresponding to each of the units is presented schematically in figure 7.2. This model is adapted from Naglieri and Das's (1990) model (which was previously presented and discussed in Chapter three) with some modifications/additions based on Luria's model (from which the PASS model was originally devised), as described by Kagan and Saling (1988). On this model the areas thought to be affected in HFPDD and SLI are marked. This model is presented here in a linear fashion, for the sake of simplicity only and in order to demonstrate where the strongest connections are between the different zones. It must, however, be stressed that many other connections occur between these different areas. The one connection that has been noted in figure 7.2 is the connection between higher level planning and attention, as this is such a strong connection. A discussion of how the results of the cognitive processing assessment relate to this model follows.

The following flowchart appears at the top of the page:

- **Attention** — Unit 1 (modality specific)
- **Modality specific input codes** — Receives impulses from periphery — Primary zone unit 2 (modality specific)
- **Success-ive** | **Simul-taneous** — Processes incoming information — Secondary zone unit 2 (generally modality specific, although some partial inter-modal processing may occur due to greater connections with other areas)
- **Inter-modal synthesis** — Tertiary zone unit 2 (inter-modal processing)
- **Higher level planning** — Tertiary zone unit 3 (supra-modal processing)
- **Preparation of programmes of action** — Secondary zone unit 3 (modality specific)
- **Impulses transmitted to muscles** — Primary zone unit 3 (modality specific)

Legend:
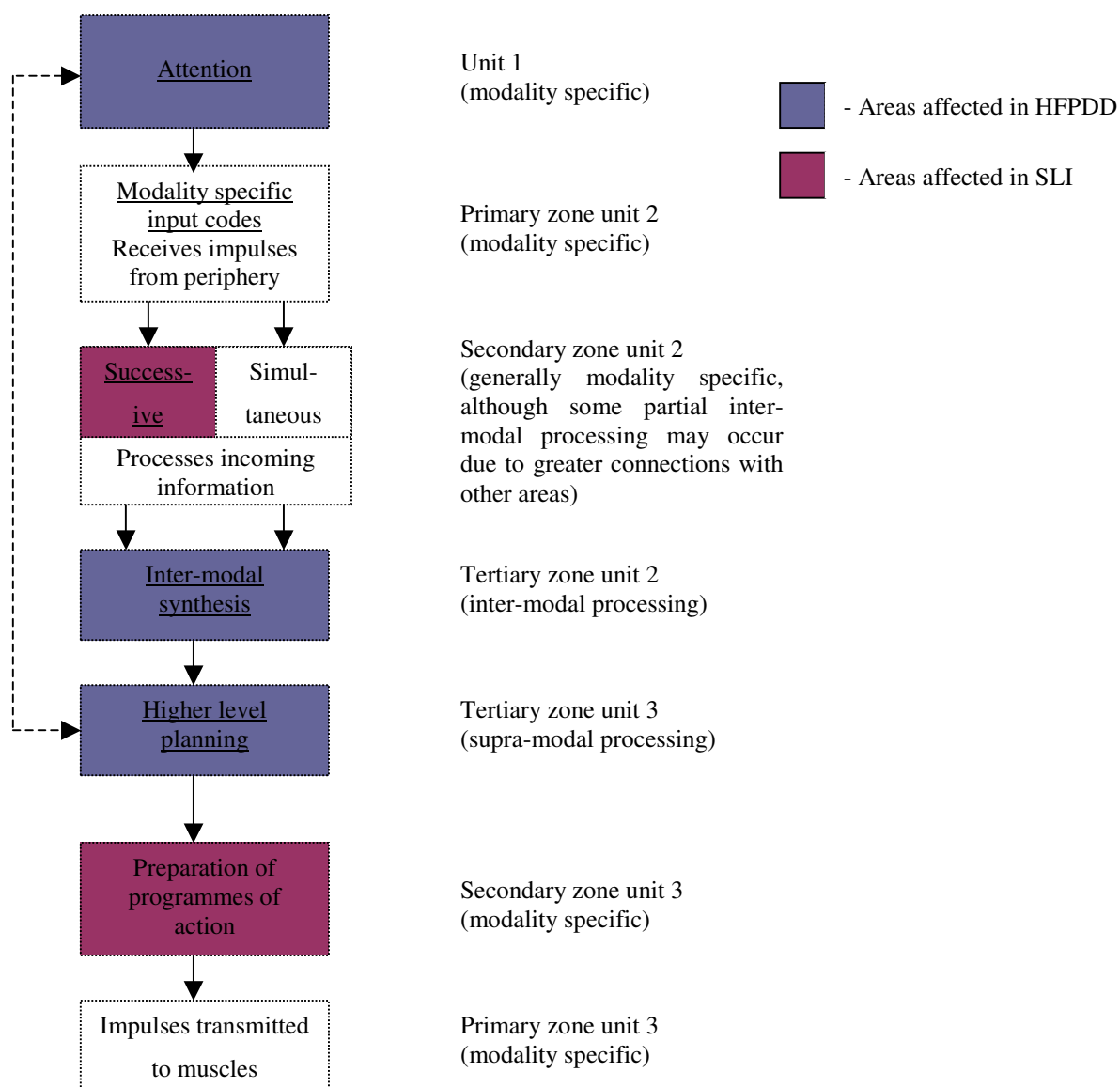- ▮ - Areas affected in HFPDD
- ▮ - Areas affected in SLI

Figure 7.2: Areas of breakdown for the HFPDD and SLI groups on the revised PASS model (PASS model adapted from Naglieri and Das (1990), with some modifications according to Luria's model taken from Kagan and Saling (1988))

7.2.2.1   Interpretation of the HFPDD group's results in relation to the PASS model

Results suggest that the primary problem in HFPDD on the PASS model would be with cognitive planning. Attention was, however, also poorer for this group. This could be explained by attention and planning being closely related (Kagan & Saling, 1988; Naglieri & Das, 1990), with attention often being under the conscious control of planning (Das et al., 1996). The relatively good simultaneous and successive processing, in relation to attention and planning, seen in the HFPDD group would suggest that children between 5.0 and 7.11 years with HFPDD have good low level perception in relation to high order processing. This

low level perception would be reflected in their relatively good simultaneous and successive processing. A sub-group performing far better on simultaneous than successive processing and a sub-group performing far better on successive than simultaneous processing would suggest that some children favour a particular modality of low level processing. According to the PASS model, as one moves from more low level to higher level processes and within the zones in the low level processes, there is a shift from uni-modal to inter-modal and supra-modal processing. The results of the CAS for the HFPDD group according to this model would also support the view that difficulties in HFPDD are related to difficulty in inter-modal synthesis and supra-modal processing, as the HFPDD group's difficulty appears most evident at the level of higher level planning, where processing is no longer modality specific. Also the observation that two sub-groups from the HFPDD group appeared to favour a particular type of processing (i.e. simultaneous or successive processing), being more closely linked to a particular modality of processing (i.e. visual or verbal) would appear to point to difficulty with inter-modal synthesis, i.e. the integration of information from more than one modality.

7.2.2.2 <u>Interpretation of the SLI group's results in relation to the PASS model</u>

In contrast to the HFPDD group, the SLI group's primary area of difficulty appeared to be with successive processing. This would suggest that this group's difficulties were due more to low level auditory processing difficulties. The planning difficulties seen in this group would, however, also suggest some higher level processing difficulties, although these were not noted to be as severe as those in the HFPDD group. The link between successive processing and planning in the SLI group may also be due to both these processes involving a motor component, with successive processing largely being involved with the motor and auditory systems (Naglieri & Das, 1990) and unit 3 (planning) having a single output channel being realized in movement (Kagan & Saling, 1988). Dividing the planning unit into its zones would appear to provide more insight into how the planning difficulties in the HFPDD and SLI groups may differ. The tertiary zone of unit 3 is not modality specific and is concerned with higher level planning, being involved with the assembly and planning of the information needed to execute action (Kagan & Saling, 1988). The secondary zone of unit 3 uses information from the tertiary zone to prepare programmes of action, while the primary zone is involved with transmitting impulses to the individual muscles to bring about action (Kagan & Saling, 1988). It has been suggested the delays in language development in SLI

children could be due to a primary motoric problem at the neurological level (Tallal, 1988, in Rescorla & Carlson Lee, 2000). It, therefore, may be possible that difficulty with planning in SLI children could be due to difficulty at the level of the secondary zone of unit 3 (i.e. with preparing programmes of action), while difficulty with planning in HFPDD children would appear to be due more to difficulty with the tertiary zone of unit 3 (i.e. with higher level conceptual planning and the assembly of the message).

7.2.2.3   How the PASS profiles obtained relate to previous research using this model

The SLI group appeared to have a PASS profile similar to that previously found in older reading disabled children with poor decoding skills (Naglieri, 1999). This is not surprising due to the close relationship between language impairment and dyslexia and children with resolved language impairment having been found to be at risk for later dyslexia (Shaywitz, 2003). The HFPDD group appeared to have a PASS profile most similar to that previously found in children with traumatic brain injury, who experienced significant difficulty with planning and attention, scoring poorest on planning (Naglieri, 1999). The difference between the HFPDD group and the children studied with traumatic brain injury would, however, appear to be in the relatively good simultaneous and/or successive processing in the HFPDD group. While the children with traumatic brain injury's simultaneous and successive scores were markedly better than their planning and attention scores, they were significantly weaker (with the means obtained for simultaneous and successive processing being between approximately 93 and 95 based on the standard score values) than in the HFPDD group (Guteng et al., 1998, in Naglieri, 1999). Future studies comparing children with HFPDD and traumatic brain injury on planning, attention, simultaneous and successive processing tasks may yield interesting results. The PASS profiles obtained for both the HFPDD and SLI groups appeared to differentiate them from PASS profiles obtained from previous studies with children with general developmental handicap, attention difficulties and general delinquency problems (Naglieri & Das, 1990).

7.3 INTERPRETATION OF THE FINDINGS OF THE THEORY OF MIND ASSESSMENT IN TERMS OF THE MIND-READING SYSTEM MODEL

7.3.1 Summary of theory of mind results

As discussed in Chapter six, the three groups performed significantly differently on all the theory of mind measures including visual perceptual role taking, the mental significance of the eyes, belief, deception and emotions. The HFPDD group performed significantly more poorly than both the SLI and NDD groups on all these measures. The SLI group was found to score significantly more poorly than the NDD group on the belief measure, emotion measure and pretence ratio. Poorer performance on the belief and emotion measures was possibly due to these measures requiring much language understanding and use in their administration and scoring. Regarding the pretence ratio the SLI group made significantly more attempts at pretence that were not true pretence than the NDD group. This may possibly be due to this group both being more impulsive than the NDD group and also experiencing more difficulty inhibiting ideas for pretence that were not actual pretence. There were, however, not significant differences between the SLI and NDD groups on the measures of visual perceptual role taking, the mental significance of the eyes, deception and true pretence. The fact that the HFPDD group subjects experienced difficulty on a number of the theory of mind tasks that were less verbally loaded (with which the SLI group coped) would appear to suggest that their theory of mind deficit is more deeply routed than just being secondary to language difficulties. A developmental aspect to theory of mind (the conceptual change account) was supported, with the NDD group coping best with visual perceptual role taking, followed by the mental significance of the eyes, then deception, then emotion and then belief. In this study belief included both first-order and second-order false belief tasks. While statistical analyses were run on the combined belief score (first-order and second-order false belief tasks together), a qualitative analysis of the results would suggest that the first-order false belief task would be mastered before the deception task, which would be mastered before the emotion task, which in turn would be mastered before second-order false belief task. Understanding emotions and second-order false belief would, however, appear to continue to develop for some time as children get older.

7.3.2   Interpretation of the results in relation to the theory of mind model

These results can be evaluated according to Baron-Cohen's (1995) and Baron-Cohen and Ring's (1994) mind-reading system model. An adaptation of Baron-Cohen's (1995) and Baron-Cohen and Ring's (1994) model is presented in figure 7.3. This consists of a simplification of Baron-Cohen's (1995) and Baron-Cohen and Ring's (1994) model, as well as the addition of an output level. According to the revised mind-reading model, theory of mind understanding can be reflected at this output level, either through language/speech or action. On this model   the primary areas of difficulty in the HFPDD and SLI groups are shown. According to Baron-Cohen (1995) and Baron-Cohen and Ring (1994) the intentionality detector and eye direction detector are low level perceptual processes involving dyadic representations. Children with PDD have been found not to experience difficulty on tasks tapping these mechanisms (Baron-Cohen, 1995; Baron-Cohen & Ring, 1994). As one moves from these low level perceptual processes to the shared attention mechanism, triadic representations are relied on. This would suggest that the shared attention mechanism and theory of mind mechanism consist of high level integrative processes. According to Baron-Cohen's (1995) and Baron-Cohen and Ring's (1994) description of this model the tasks of visual perceptual role taking, and understanding the mental significance of the eyes would appear to form part of the shared attention mechanism. The tasks of belief, deception, understanding emotions and pretence would appear to form part of the theory of mind mechanism. The increasing difficulty that the NDD group experienced with these tasks would support the developmental aspect to this model, supporting the conceptual change hypothesis.

It would appear that the difference between the tasks tapping the shared attention mechanism and the tasks tapping the theory of mind mechanism is that while understanding visual perceptual role taking and the mental significance of the eyes involved the use of language, the belief, deception and emotion tasks relied on greater semantic and verbal reasoning processing, appearing to involve interpreting and inferring skills. Furthermore, the pretence task would also appear to rely on greater semantic skills as, although verbal output was not required for performance on this task, a qualitative analysis of the results suggested that those children who used verbal output generally appeared to perform better and this task appeared to rely on the use of inner speech. The fact that the children with SLI performed at a similar level to the children with NDD on the measure of true pretence would suggest that their

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theory of mind mechanism is relatively intact. However, when the theory of mind mechanism is tapped using tasks with a greater verbal loading, particularly those requiring verbal output in their administration, the SLI children experienced more difficulty. The difficulties that the SLI group members experienced on certain theory of mind tasks, therefore, appear to be more secondary to their language difficulties.
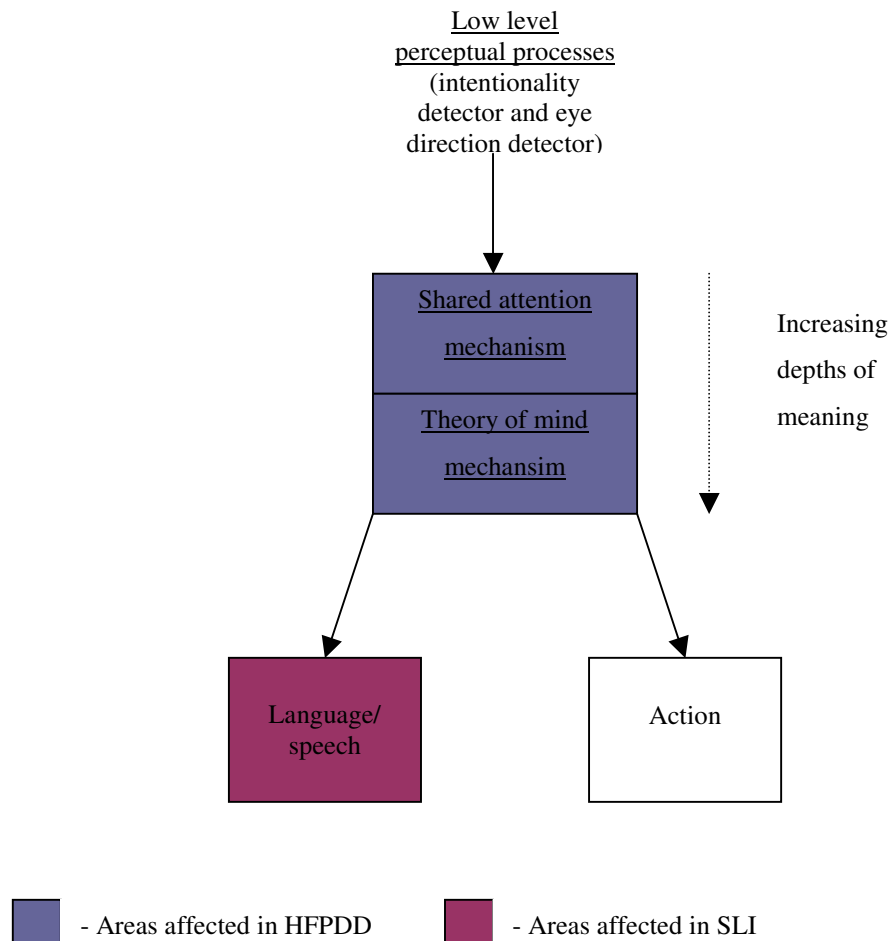

Figure 7.3: Areas of breakdown for the HFPDD and SLI groups on the revised theory of mind model (Adapted from Baron-Cohen (1995) and Baron-Cohen and Ring (1994))

As seen in figure 7.3, the HFPDD group experienced difficulty with both the shared attention mechanism and the theory of mind mechanism. Previous research has indicated difficulty with both these mechanisms in PDD (Baron-Cohen, 1995; Baron-Cohen & Ring, 1994). Greater difficulty would appear to be experienced with the tasks tapping the theory of mind mechanism due to these tasks requiring the processing of increased depths of meaning and greater ability to integrate information from different modalities. In contrast the SLI group's difficulty with language appeared to affect this group's performance on most of the tasks

tapping the theory of mind mechanism, except that of pretence, where performance was not directly related to expressive output. According to the revised model presented, performance on the pretence measure could occur through the action output route.

Many aspects of theory of mind development appear to require the higher integration of language with visual information, for example, "Show me the man so that I see him upside down"; "Show me the one who is thinking"; after acting out a story for the child asking him/her "Where will Sally look for the marble?"; and when shown pictures for a story asking "How does the boy feel?" and "Why does he feel this way?". It is possible that the problem children with HFPDD experience may lie with the integration of the verbal and visual information within these tasks. Tasks such as the deception task appear to require higher level problem solving and planning, i.e. planning how to win stars in different situations. The pretence task appeared to rely on integrating visual information (the props as well as visual imagery) with inner language. While a child did not necessarily have to use language expressively to be able to carry out the pretence task, the pretence task appeared to rely to some extent on the use of inner language. It is possible that this is why typically developing children have been shown not to perform necessarily better on non-verbal than verbal theory of mind tasks (Miller, 2006), as these tasks possibly require the use of inner language and still, therefore, the integration of verbal with other information. There would, therefore, appear to be a strong link between theory of mind and integrating information from different modalities. The ability to integrate information from different modalities has been shown to be central to semantic processing. Theory of mind, semantic and planning ability would, therefore, all appear to be closely related.

7.4 <u>RELATIONSHIP BETWEEN COMMUNICATION, COGNITIVE PROCESSING AND THEORY OF MIND ABILITY</u>

As shown in Chapter six, significant correlations were found between the following:
- Receptive language with: planning, attention, simultaneous processing and theory of mind.
- Expressive semantics with: planning, attention and theory of mind.

- Certain measures of expressive grammar (number dependent clauses and MLU) with: successive processing. MLU was also significantly correlated with theory of mind and planning.

- Narrative ability with: planning, attention and theory of mind.

- Pragmatic ability with: planning, attention and theory of mind.

- Within the areas of communication, receptive language, expressive semantics, narrative ability and pragmatic ability were all significantly correlated.

- Within the area of cognitive processing, attention and planning were significantly correlated.

- Theory of mind was strongly correlated with planning and attention, but also with receptive language, expressive semantics, narrative ability and pragmatics. Theory of mind appeared to be more strongly correlated with communication ability than planning or attention, even on theory of mind tasks that were less verbally loaded.

Planning and attention were particularly well correlated with receptive language, expressive semantics, narrative ability and pragmatics. These variables were also well correlated with theory of mind. This would appear to suggest that receptive language, expressive semantics, narrative ability, pragmatics and theory of mind ability all rely on central cognitive processes. Successive processing was only correlated with grammatical parameters (number of dependent clauses and MLU). Successive processing not being correlated with expressive semantics, narrative ability and pragmatics would suggest that these difficulties are more due to central processing difficulties than the level where successive processing occurs.

Expressive semantics, narrative ability and pragmatics were particularly well correlated. This would support the close relationship between these variables and these variables being centrally located in a communication processing model. Figure 7.4 schematically shows the relationship between the communication, theory of mind and cognitive processing variables that were most strongly correlated.
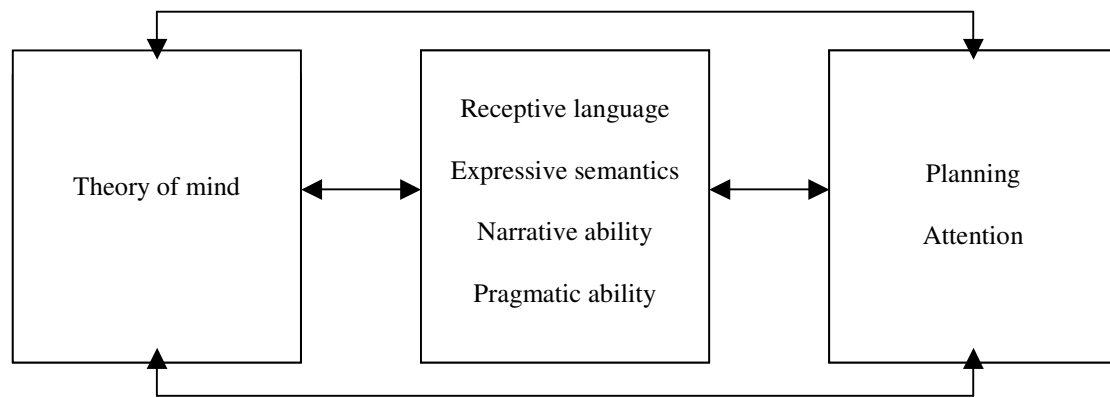
Figure 7.4: A schematic representation depicting relationships between the different variables measured based on their correlations

There would appear to be certain properties that are common to all these processes. As previously discussed receptive language, expressive semantics, narrative ability and pragmatic ability appear to rely strongly on the meaning system and the integration of information from a number of modalities. Planning, according to Luria's model and the PASS model, involves processing that is not modality specific. Attention, due to strong connections between the cortex and lower regions, is strongly related to planning and would appear to be controlled by higher order processes. Theory of mind, as discussed earlier, also appears to rely on integrating information from a number of modalities and appears to be closely related to the meaning system.

7.5 A COMBINED MODEL OF LANGUAGE, COGNITIVE AND THEORY OF MIND PROCESSING

According to Shaked and Yimira (2004) three conditions need to be met in order for a deficit to be regarded as the core deficit accounting for any particular disorder. These are: 1) how universal that deficit is, i.e. to what extent it is manifested in all individuals with the disorder, 2) how specific is the deficit, i.e. does the deficit involve a domain specific deficit, and 3) how unique is the deficit, i.e. to what extent is the deficit not manifested by other individuals with other clinical diagnoses (Shaked & Yimira, 2004). From the results of the present study planning, attention and theory of mind would appear to be the three deficits that may best account for the communication difficulties seen in HFPDD. However, on their own, none of these areas would appear to be able to be regarded as a core deficit. In the current study planning difficulties were not universal, i.e. they were not seen in all children in the HFPDD

group. Planning difficulties were not unique to HFPDD, being seen in some individuals with SLI. In a similar manner, attention difficulties were not universal, i.e. they were not seen in all the children in the HFPDD group. The simultaneous-successive discrepancy seen in the HFPDD group was also not seen in all the children in this group. Furthermore, simultaneous processing being significantly stronger than successive processing was also seen in a number of children in the SLI group. In a similar manner strong simultaneous processing, which would appear to indicate weak central coherence, was not seen in all the children in the HFPDD group and was also seen in some children in the SLI group.

Theory of mind difficulties have not been found to be universal, i.e. they are not seen in all individuals with PDD and three of the children from the HFPDD group in this study did as well on the theory of mind tasks as the SLI subjects. Moreover, one child with HFPDD did as well on the theory of mind tasks as the NDD subjects. Furthermore, in the present study the theory of mind difficulties did not appear to be specific, with some HFPDD subjects passing some theory of mind sub-tests at a similar developmental level to others, which they did not pass. The uniqueness of the theory of mind deficit would also appear to be brought into question, with theory of mind difficulties also being seen in the SLI group, although not to the same extent as the HFPDD group. The severity of the theory of mind deficit would appear to be unique to HFPDD but not the deficit itself. It would appear that on their own none of the discussed variables is able to explain adequately the communication difficulties seen in HFPDD.

7.5.1 The combined model

The results of the study suggest strong parallels between the areas of deficit seen in the proposed language processing model, the areas of deficit observed in the PASS model and the theory of mind deficits. It would appear that what is needed is a combined model of communication, cognitive processing and theory of mind to explain the difficulties seen and differences observed between the two clinical groups. This combined model is presented in figure 7.5, with the areas of breakdown of the two groups being marked. A description of this combined model and the areas of difficulty seen in each of the groups follows.
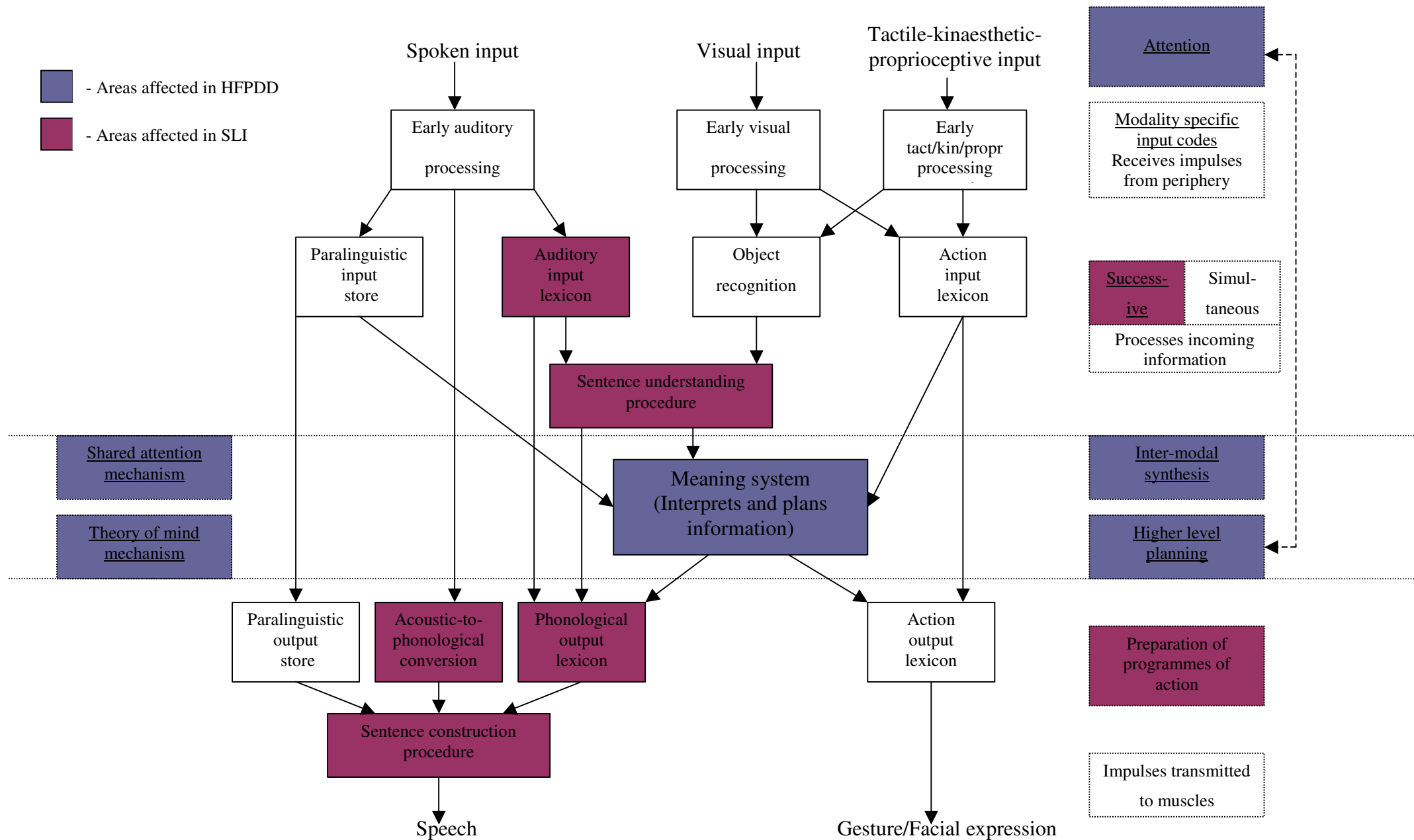
Figure 7.5: Combined model of language, cognitive and theory of mind processing

7.5.1.1 Relationship of communication, cognitive processing and theory of mind aspects on this model

The level of attention on the PASS model would appear to parallel input levels on the language processing model. The primary zone of unit 2 in the PASS model involves modality specific input codes, which receive impulses from the periphery. This would appear to parallel early auditory, visual and tactile-kinaesthetic-proprioceptive processing. The secondary zone of unit 2, which is involved with more in-depth processing of information and involves simultaneous and successive processing, would appear to occur at the same level as the paralinguistic input store, auditory input lexicon, sentence understanding procedure, object recognition system and the action input lexicon. Here processing is still, on the whole, modality specific, with successive processing generally being used where greater auditory processing is required and simultaneous processing generally being used where greater visual processing is required.

Information from these lexicons then needs to be interrelated in order for understanding to take place. This makes sense in that in order for a child to develop a concept of something he/she needs to integrate information from all the senses including the auditory, visual, proprioceptive and tactile-kinaesthetic senses. This integration would occur in the meaning system, which would appear to occur at the same level as the tertiary zone of unit 2, involving inter-modal synthesis of information, and the tertiary zone of unit 3, which consists of conceptual planning and does not involve processing in a particular modality, with it appearing to have the property of supra-modal processing. Inter-modal synthesis would appear to be more closely related to semantics, and planning to be more closely related to pragmatics. However, this model supports the close relationship between semantics and pragmatics and at this level of deeper meaning it is almost impossible to separate them

Modality specific output on the cognitive processing model would appear to correspond to the output levels of the proposed language processing model, these being the paralinguistic output store, the auditory-to-phonological conversion system, the phonological output lexicon, the sentence construction procedure and the action output lexicon. These would appear to correlate with the secondary zone of unit 2, which is involved with the preparation of programmes of action (Kagan & Saling, 1988). The final transfer into either speech and/or gesture/facial expression would appear to correlate with the primary zone of unit 3, which is

involved with the transmission of impulses to the muscles involved in action (Kagan & Saling, 1988).

A conceptual account of theory of mind would appear to suggest that theory of mind is closely related to the meaning system and to the level of inter-modal processing, as integration is required from a number of different systems in order to develop conceptual understanding. This would be supported by views that link theory of mind difficulty to both difficulty with central coherence and executive functioning (planning) difficulties. Furthermore, the literature that suggests that the understanding of certain complex grammatical structures needs to take place before further development of theory of mind abilities can take place, would suggest that theory of mind processing is related to, but occurs after, the sentence understanding procedure. Theory of mind processing, like semantic processing, pragmatic processing and planning would appear not to be a modality specific process. It would appear that theory of mind processing may be a parallel process on this model that occurs at the same level as semantic-pragmatic processing and inter-modal processing-planning. It would appear that as one moves within this theory of mind system, from the shared attention mechanism to the theory of mind mechanism, greater integrative processes and depths of meaning are tapped. The shared attention mechanism and theory of mind mechanism rely on triadic representations (Baron-Cohen, 1995), which would appear to involve higher level integration of information.

Theory of mind processing is said to have a frontal origin in the brain, with particular emphasis placed on pre-frontal areas (Baron-Cohen & Ring, 1994), which would suggest that it occurs at a similar level to planning. Castelli, Frith, Happe, and Frith (2002) and Kampe, Frith, and Frith (2003) have put forward the notion of a mentalizing network, involving the medial pre-frontal cortex, superior temporal sulcus at the temporo-parietal junction, paracingulate cortex and temporal poles. The areas proposed in this mentalizing network appear to overlap with the areas proposed by Luria to be involved in inter-modal synthesis as well as planning. Furthermore, a complex network of brain areas which appear to overlap these areas underlie semantic processing. The left posterior temporo-parietal regions, inferior temporal regions and left inferior frontal cortex, including the pre-frontal cortex have all been found to be important in semantic processing (Raymer & Gonzalez Rothi, 2000). Some studies have also suggested that right frontal, parietal and temporal cortices are involved in semantic processing (Raymer & Gonzalez Rothi, 2000).

7.5.1.2 The areas of breakdown on this model for the HFPDD and SLI groups

As previously discussed the breakdown at the level of the meaning system may account for the majority of the communication difficulties seen in the HFPDD group, including the receptive language difficulties, expressive semantic difficulties (including difficulty with pronoun alternation and deixis), difficulty with conceptual grammar, narrative difficulties and pragmatic difficulties. Furthermore, the use of alternate routes to bypass the semantic system may explain the phenomena of echolalia and hyperlexia often reported in PDD. A problem with inter-modal synthesis and higher level planning, occurring at the same level as the meaning system, would appear to be able to account for the particular cognitive processing profile observed in the HFPDD group. This would appear able to account for the planning and attention difficulties seen in this group, as well as some individuals favouring a particular modality of low level processing. Favouring a particular modality of processing may occur due to difficulty with inter-modal processing of information. Furthermore, the central theory of mind system (consisting of the shared attention mechanism and theory of mind mechanism) occurring at the same level as the meaning and inter-modal/planning systems and difficulty within this system, would appear to account for the difficulty on the theory of mind tasks observed by the HFPDD group. The theory of mind deficits seen would appear to be due to integration difficulties, with greater integration being required as one moves through the theory of mind system. This would explain why the belief, deception, emotion and pretence tasks were more difficult than the visual perceptual role taking and mental significance of the eyes tasks.

The SLI group's relatively good performance on the receptive language measures, but difficulty with expressive vocabulary and expressive grammar, occurring together with good non-verbal pragmatic skills, would appear to place the locus of their difficulty less centrally in the language processing model, possibly placing it somewhere within the auditory route, such as at the level of the phonological output lexicon and sentence construction procedure (possibly with added involvement of the acoustic-to-phonological conversion system). Some involvement of the auditory input lexicon and sentence understanding procedure might, however, also occur. In the SLI group difficulty in the verbal language processing route would appear to be strongly related to this group's successive processing difficulties. Furthermore, this would appear to affect their performance on theory of mind tasks that have a stronger verbal loading.

7.5.1.3   Discussion in relation to previous theories of PDD

The cognitive processing characteristics of the HFPDD group on this model appear to relate well to previous cognitive theories of PDD. Difficulty with planning would be supported by various studies of executive functioning in PDD. Difficulty with selective and shifting attention would also be supported by a number of studies. This model would appear to explain the better rote than semantic memory reported in the PDD population, due to memory processes at the level of simultaneous and successive processing being largely spared, while memory related to integrating meaning may be impaired. This model would tie in with the weak central coherence or detailed focused cognitive processing style that has been put forward, as it supports the development of strong lower level processes (simultaneous and successive processes). Problems with processing in specific modalities and stronger simultaneous or successive processing is explained by this model suggesting that individuals may tend to favour one modality over another in processing. Problems with sensory integration would be encompassed in the model by difficulties integrating information from a number of modalities. According to Williams (1998) we go through a developmental process from sensing the world to being able to interpret it and with greater interpretation our sensory processing becomes less acute. It is possible that individuals with PDD do not go through this developmental process so that their low level perceptual processing remains enhanced. The explanation of imitation difficulties in PDD due to problems with mirror neurons is not out of keeping with this model, as mirror neurons appear to require co-ordinated activity between different sensory modes and motor output (Williams et al., 2001a). With regard to the empathizing-systemizing account, difficulty with inter-modal integration of information may account for the poor empathizing skills seen in PDD. In contrast interpreting systems (based on rules and regularities) could possibly take place by relying on more low level processes.

Linguistic, spatial, musical, logical, mathematical or scientific strengths seen in some individuals with PDD could also be accounted for by this model. According to Fitzgerald (2005) these may consist of the over development of certain modular modality specific abilities. Lastly, this model would support the idea of local over-connectivity and lack of connectivity between cerebral areas (Bertone & Faubert, 2005).

Iarocci and McDonald (2006) suggest that one of the key problems in PDD is with multi-sensory processing. Neurons have been detected in the brain that respond to firing from more than one modality (Iarocci & McDonald, 2006). These include both areas of multisensory 'association' cortex and areas of modality specific cortex which appear to be modulated through feedback from higher multi-sensory areas (Iarocci & McDonald, 2006). Most objects in the environment around us stimulate more than one sense at the same time. The use of multiple senses simultaneously is most noticeable during face-to-face communication, where both verbal and non-verbal information needs to be assimilated (Iarocci & McDonald, 2006). Mottron and Burack (2001, in Heaton & Wallace, 2004) proposed a model to explain enhanced perceptual functioning in autism that appears to tie in with a model of multi-sensory processing. In this model low level mechanisms are domain specific and higher level mechanisms are domain general. Low level mechanisms are neurally specified, while higher level mechanisms are distributed across a number of brain regions. According to Mottron and Burack (2001, in Heaton & Wallace, 2004) in autism there is over development of low level perceptual abilities at the expense of the development of higher level processing.

Research by Castelli et al. (2002) has suggested that the difficulty in autism is due to a bottleneck between the communication between higher order, particularly mentalizing, and lower level processes. In a similar manner the problem in HFPDD according to this model would appear to be with higher level processing involving both the integration of information (particularly the integration of information from different modalities) and with the conceptual planning of information. It may be possible that information from multiple modalities may be unable to pass from these lower order to higher order processes simultaneously due to a problem of inter-modal synthesis and, as a result, higher order processing will be affected. Sensory integration has been said to be closely related to ideation, the highest level of planning (Murray-Slutsky & Paris, 2000). Concept formation, ideation and motor planning appear to be closely related and are all suggested to be affected by sensory integration difficulties (Murray-Slutsky & Paris, 2000). Performance on executive tasks is said to involve encoding rules in a verbal form (Russell et al., 1999), indicating the close relationship between semantics and higher level planning.

In this model theory of mind difficulties would appear to be seen as part of a difficulty with higher level information processing and the simultaneous integration of information from a number of modalities. This model would support the close relationships between theory of

mind and language, and theory of mind and cognition. This model, therefore, draws strong parallels between the language processing, cognitive processing and theory of mind difficulties seen in HFPDD. It would appear that a problem with higher level and inter-modal and supra-modal processing may underlie the difficulties seen in this disorder. While this hypothesis is able to draw together a number of previous hypotheses put forward it is still in its infancy and requires much further investigation. This model suggests the very complex nature of the difficulties in PDD and that much is still needed to be known about the relationship between central language processing, higher level cognitive processes and theory of mind processes. Possibilities that exist are that in PDD these areas may all be affected due to overlapping brain areas accounting for their functions, or due to a common underlying mechanism that is impaired. As Boucher (2006) suggests it is unlikely that there is a common underlying mechanism that is able to account for the core symptoms seen in PDD. It would appear rather that the difficulties (and strengths) observed in PDD are due to the complex interplay of related and overlapping systems. The extent to which inter-modal synthesis may underlie these systems, however, requires further investigation.

7.6   **EVALUATION OF THE STUDY**

This study has taken a broad view at looking at the communication, cognitive processing and theory of mind abilities of children with HFPDD. This allowed for associations between different areas of difficulty to be detected. In this study, the difficulties observed were related to information processing models and commonalities between various processes making up models of language, cognitive and theory of mind processing were found. Comparing HFPDD to a contrasting communication disorder such as SLI was useful in providing insights into where the specific breakdown in HFPDD may be. It would appear that the proposed combined model of language, cognitive and theory of mind processing would be useful to test further in future studies of PDD. Some possible considerations stemming from the current research may need to be taken into account in future studies.

The difficulties (as outlined by Bishop, 1999) of applying models such as the one described in this chapter to developmental language disorders are acknowledged. The two aspects outlined by Bishop (1999) that would seem the most problematic in the application of this model to the results of this study would be a static model being applied to a developmental disorder and the effects of processing deficits on the results. As the children in the study's

patterns of impairment may change over time, longitudinal studies would be of benefit to determine which patterns of impairment remain the same (possibly indicating primary underlying difficulties) and which patterns change with time (possibly indicating secondary difficulties). In order to evaluate the effects of processing deficits in children with HFPDD, Bishop's (1999) suggestion of processing studies using a within-subject design would appear to be particularly valid. Here the aim would be to determine how various experimental manipulations affect the child's performance. Based on the results of the current study, it would seem that tasks ranging from those requiring processing in one modality to those requiring greater inter-modal processing may be particularly useful to investigate in HFPDD and in PDD in general.

One of the possible difficulties in conducting a group study in this area, is that this does not allow for individual differences to be observed. It would seem that there is much variation within the PDD group as a whole and within the smaller group of HFPDD. In group studies interesting variations between subjects are generally not able to be focused on. It would appear useful to see if this model could be applied to a number of single case studies in order to see if it could account for variation between individual cases. This study was, however, able to capture the variation in simultaneous and successive processing in the HFPDD group by evaluating individual participants' strengths and weakness on the cognitive battery. This would appear to support an approach of comparing a child's performance in a particular area to their general performance, as obtaining a profile of an individual's strengths and weaknesses should provide clues to the underlying cognitive processes that may be affected.

One possible limitation of the study was the use of diagnostic criteria to include children in the study. As in South Africa, children are generally not required to have a specific diagnosis to access many services, many children at this age's difficulties tend to be described in descriptive terms rather than them being given a fixed diagnosis. This appears to occur particularly for children on the higher end of the spectrum. As a result children with a description of semantic-pragmatic language difficulties and some features of PDD were included in the study. As PDD is a continuum disorder overlapping with other disorders such as attention deficit disorder, there was a danger of including children who did not fit strictly into the PDD group. The researcher, however, feels that these concerns would only apply to a small number of participants within the entire HFPDD group assessed. Carrying out the research in this way did, however, allow the researcher to include children on the very high

end of the spectrum into the study. It could be hypothesized that if differences can be seen between children on the very high end of the spectrum and other diagnostic groups, these will be seen in children further down the spectrum too.

While testing such young children may have assisted in HFPDD being viewed in its purer form, due to their young age children from the diagnostic groups were at times difficult to test. As a result some adaptations had to be made for different children, for example using motivators in testing, the frequency of breaks given etc. This resulted in the testing, while similar, not being completely uniform for all the children assessed. It would appear that this is one of the difficulties in research when younger subjects are used. Furthermore, during the pre-school years children's diagnoses are still evolving and it is possible that some of the children in the study's diagnoses may change with time.

While the rating measures for the narrative, pragmatic and pretence tasks were found to be useful, these measures involve an element of subjectivity. While overall acceptable levels of agreement were obtained between the raters on these measures, this element of subjectivity was evident. This could possibly have been reduced, by more extensive training of the raters. However, as individuals with HFPDD's difficulties are most evident in context, the use of rating scales would continue to be valid.

The fact that the researcher conducted all the testing, scoring and rating could be viewed as a limitation of the study. Future similar studies would be more powerful if the person carrying out the testing, scoring and rating was blind to the diagnosis of the subjects.

A further difficulty in this study was that in order to be able to take a broad based view, the children were exposed to a lot of evaluation and assessment. Results were fed back to the parents and with the parents' consent the professionals working with the children, in order for the assessment also to be of benefit to the children in the study. When requested, suggestions for intervention and management were provided. This, as well as the assessment conducted, was very time consuming, limiting the extent to which similar studies may be carried out in the future.

The results of this study do, however, appear to have important implications for future research, as well as assessment and therapy. These will be discussed below.

7.7   **IMPLICATIONS OF THE STUDY**

7.7.1   Implications for future research

Over many years, valuable theories and hypotheses have been put forward that provide a better understanding of PDD. The results of the current study generally do not appear to be in conflict with these, but rather provide a framework of how these different theories and hypotheses may be related. While supporting studies that focus on one or a limited number of aspects in PDD, this study highlights the importance of studies that also take a broad view in helping us better understand the overall symptom picture. An important aspect that emerges from the current study is the important role that inter-modal processing and supra-modal processing (reflected in high level planning) may play in PDD. This notion of inter-modal and supra-modal processing difficulties in PDD requires much further research. Research in this area could, for example, compare single versus multiple modality processing tasks in PDD. Another important aspect that emerges that would appear to require more research, is the relationship between low level versus higher order processing in individuals with PDD.

This study highlights the need to obtain a better understanding of how semantics, discourse and pragmatics are linked to the cognitive processing areas of planning and attention, and theory of mind in PDD. In particular future studies may provide insights into whether these areas are all affected in HFPDD due to the neurological circuits that support these areas overlapping, or whether they are all affected due to similar or common underlying processes.

Owing to the limitations highlighted earlier regarding carrying out this research with such young children, it may be useful to repeat this research with older subjects. As children's language and cognitive processing profiles tend to become more stable with age, a replication of these results in a group of older children would be powerful. A longitudinal study that follows up how children with PDD's processing styles may change with time would also be particularly useful. Bishop (1999) highlights the value of longitudinal studies in clarifying the direction of causal relationships. Longitudinal studies also help us to understand how children's diagnoses may evolve with time (Bishop, 1999).

The current study focused on children on the very high functioning end of the PDD spectrum. When studying children on the very high end of the spectrum, there is the danger of

including children with related and overlapping diagnoses, for example attention deficit disorder. It would be useful to see if these results could be replicated with children on the lower end of the spectrum, whose diagnoses may be clearer.

This study emphasises the importance of including studies that take a broad-based view of PDD into research with this population. Broad-based studies would appear to need to be balanced with studies focusing on more isolated or specific aspects of impairment.

7.7.2   <u>Implications for assessment</u>

The implications for clinical assessment would come from the results of the discriminant function analysis, which were interpreted in relation to the overall results of the study. In this study children with HFPDD were assessed using a comprehensive battery of measures. In clinical work it is neither cost effective nor usually possible due to time limitations to carry out such a large battery of measures. Furthermore, this could be taxing for the individual child. The results of the discriminant function analysis indicated which measures best discriminated between the three groups. Viewed in isolation, results could be slightly misleading as the discriminant function analysis did not investigate which measures best discriminated between only the two clinical groups but rather between all three groups. These results were, therefore, also interpreted in relation to the overall results of the study. The general results of the study and the results of the discriminant function analysis suggest that the following areas should receive particular focus in the assessment of a child with HFPDD:

Communication measures – In the area of communication an in-depth pragmatic and narrative assessment would need to be conducted, with the narrative assessment focusing particularly on narrative coherence. A grammatical language assessment such as a LARSP analysis would also be useful. In particular, the more conceptual aspects of grammar, such as the use of different subordinate clauses and the use of a variety of different structures should be looked at. Clinician constructed tasks tapping specific aspects of communication known to be impaired in PDD, such as first and second person pronouns, should also be carried out. It is also felt that including measures of expressive semantics, where greater depths of meaning are tapped, would be of benefit.

Cognitive processing measures – In particular, tasks tapping planning and attention should be carried out, although measures of simultaneous and successive processing would also be useful and would allow an overall profile to be obtained.

Theory of mind measures – Useful measures in a theory of mind assessment would consist of assessing belief, the mental significance of the eyes and/or pretence. Measures chosen should include a measure that has a higher loading on language and a measure that has a lower loading on language. Tasks should be chosen that are at a developmentally appropriate level for the child being assessed, due to ceiling effects existing in certain of these measures. For example, when assessing a pre-school child, a measure of first-order false belief may be most appropriate, while when assessing a child who is entering formal schooling a second-order false belief task may be more appropriate, provided that the child's structural language and cognitive abilities are not significantly delayed.

7.7.3   Implications for therapy

The importance of focusing on the meaning system, including therapy dealing with semantic, narrative and pragmatic ability is highlighted. The results of this study would suggest that when treating a child with HFPDD one cannot focus only on communication, without also giving attention to processes that would appear to parallel or underlie the communication difficulties in this group and which the study indicated had strong associations with communication. Therefore, communication therapy should also include improving theory of mind skills, assisting the child to integrate information from different modalities, improving planning skills and improving attention skills (particularly shifting attention). In SLI the focus would need to be more on structural language aspects such as word retrieval, sentence construction, memory aspects and successive processing. While group results provided profiles highlighting where to focus intervention for children with HFPDD and SLI between 5.0 and 7.11 years, when looking at individual children individual variation within the obtained profiles was seen. The importance of treating each child as an individual based on his or her particular profile, therefore, cannot be stressed enough. It would seem that certain interventions put forward for PDD, for example, using visual support, while of great value generally may not be appropriate for all children with PDD. If for example a child favours the auditory modality more than the visual modality in their processing, using visual supports may not be useful. It would appear that what would be the most valuable clinically would be

to determine each individual child's processing style and strengths and difficulties according to this model and to plan intervention in relation to this.

7.8 <u>**CONCLUDING COMMENTS**</u>

This study highlights the extremely complex nature of PDD. As suggested by Boucher (2006), the search for a unitary underlying explanation for PDD does not appear to be a realistic one. Results do, however, point to the communication difficulties, cognitive processing differences and theory of mind difficulties in PDD being due to higher level processing and integration difficulties, particularly with difficulty integrating information from different modalities and with processing that is supra-modal. Occurring together with these difficulties may be strengths in lower level perceptual processes, with some individuals appearing to focus more on processing in one modality than another. The close relationship observed between the meaning system, inter-modal processing, planning, attention and theory of mind; and between grammatical ability and successive processing, would assist in understanding certain brain-behaviour relationships, both in PDD and in the population in general. The results of this study should caution researchers to include broad-based studies in current research in PDD. Furthermore, these results would stress to clinicians the importance of looking at communication together with cognitive processing and theory of mind in this population. It is acknowledged that learning about a disorder as complex as PDD is a continual process. According to Peeters and Gillberg (2004, p. 83) "the professional who thinks he has found it, has lost it". The suggestions stemming from and implications of this research are by no means an end, but only a beginning, forming part of the larger drive to better understand PDD.