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AN INVESTIGATION OF SENTENCE-LEVEL ABILITIES IN CHILDREN WITH DIFFERENT TYPES OF SPEECH DISORDER

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ABSTRACT

Recent studies have highlighted the co-occurrence of speech disorders with language disorders, yet few studies have attempted to explore the relationship between them. This thesis examines the sentence-level abilities of children with different types of speech disorders, and addresses the following questions: (i) Can children with different types of speech disorders be differentiated according to their sentence-level performance? (ii) Is there a more-than-chance co-occurrence of sentence-level difficulties in children with different types of speech disorders? (iii) What is the relationship between speech disorders and sentence production? (iv) Is sentence imitation an efficient, effective and reliable method of assessing expressive syntax in children with severe speech difficulties?

The research focuses on two groups of children, each with a different type of speech disorder: one using atypical phonological processes consistently (CPD) and the other using atypical phonological processes inconsistently (IPD). Their performance was compared to children with SLI and typical development. Results of a group study assessing sentence imitation revealed that children with CPD were no more likely to have co-occurring sentence-level difficulties than typically developing children. The IPD group showed difficulties at the sentence level, with significant variation within the group. Further investigations of sentence processing-related skills found that the IPD group could be divided into those who had IPD only and obtained high sentence imitation scores, and those who had co-occurring IPD and sentence-level difficulties, reflected in their low sentence imitation scores. The performance of the low-scoring IPD children was similar to the SLI group's performance in terms of their sentence imitation accuracy scores and most sentence processing-related abilities. However, they could be differentiated by the types and proportions of their errors and their sentence imitation performance when repeating sentences containing multi-syllabic words. The theoretical and clinical implications of the research outcomes are explored.

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PART I

INTRODUCTION

AND

LITERATURE REVIEW

CHAPTER 1

INTRODUCTION

AND

SPEECH DISORDERS: DEFINING PERSPECTIVE

1.1 INTRODUCTION TO THESIS

Speech and language difficulties in children are traditionally kept quite separate, despite evidence of co-morbidity (Broomfield & Dodd, 2003, 2004a; Shriberg & Austin, 1998; Shriberg, Tomblin, & McSweeny, 1999). Most research on children with speech difficulties has focused on single words and has failed to take account of these children's sentence-level abilities. In practice it is common for children to be diagnosed and treated according to their most prominent difficulty – either speech or language. This status quo may, in part, be due to the unintelligible productions of some children with speech disorders, which make it difficult to determine their sentence-level abilities.

The result of this is a limited understanding of the relationship between speech disorders and language, with implications for the design and implementation of effective interventions. This thesis explores the expressive sentence-level abilities of children with speech disorders.

The following key questions that grow out of the literature review are addressed in the thesis:

- Can children with different types of speech disorders be differentiated according to their sentence-level performance?
- Is there a more-than-chance co-occurrence of sentence-level difficulties in children with different types of speech disorders?
- What is the relationship between speech disorders and sentence production?
- Is sentence imitation an efficient, effective and reliable method of assessing expressive syntax in children with severe speech difficulties?

The investigations are carried out in two phases that build upon one another to reveal an increasingly clear picture of speech and sentence profiles and the relationship between them. Based on this, discussions following each investigation are limited to specific points emerging from that investigation, and the cumulative outcomes are discussed together at the end of the thesis.

1.2 INTRODUCTION TO SPEECH DISORDERS

Childhood speech disorders are one of the most frequent types of communication problem that Speech and Language Therapists (SLTs) are likely to encounter (Enderby & Philipp, 1986) and it is estimated that they represent 70% of paediatric SLTs' caseloads (Weiss, Gordon, & Lillywhite, 1987). They are interpreted and treated from a multitude of different perspectives. A prerequisite to addressing the relationship between speech disorders and sentence-level ability is the understanding of what speech disorder means and how it is currently approached. This chapter serves to frame the perspective on speech disorder that will be adopted and carried through this thesis.

1.3 CLASSIFICATION OF SPEECH DISORDERS

The prevalence of children with speech disorders is between 2% and 25% of the pre-school/school population (Enderby & Philipp, 1986; Law, Boyle, Harris, Harkness, & Nye, 2000; Shriberg et al., 1999). This large range is testimony to the well-recognised problem of a lack of clear definition of speech disorders (Dodd, 1995; Shriberg et al., 1999; Stackhouse & Wells, 1997). Numerous studies of children with speech disorders show considerable variation in terminology and provide sketchy details of the participants' speech profiles. For example, children with speech disorders have been described as 'speech-delayed' (Paul & Shriberg, 1982), or with 'articulation deficits' (Panagos & Prelock, 1982), 'speech sound disorders' (Lewis, Freebairn, & Taylor, 2000), 'phonological disorder' (Ruscello, St. Louis, & Mason, 1991) or 'functional articulation problems' (Panagos, Quine, & Klich, 1979).

While it is widely recognised that there is extensive variation in the type of speech errors shown and the extent of involvement (Bernthal & Bankson, 1988), most

reviewed studies fail to acknowledge or address heterogeneity within their samples. As heterogeneity can differentially determine the type of intervention, as well as study outcomes, it is crucial that it be addressed in subject selection and description. One way of accounting for heterogeneity is to divide children with speech disorders into sub-groups and classify these groups according to common features. Stackhouse and Wells (1997) and Dodd (2005a) provide comprehensive reviews of the different approaches to the classification of speech disorder. These include:

1.3.1 AGE OF ACQUISITION

The use of this approach to classification is limited to the differentiation between congenital, developmental and acquired disorders.

1.3.2 SEVERITY OF DISORDER

Researchers such as Shriberg, Austin, Lewis, McSweeney and Wilson (1997a) have categorised speech disorders according to 'percentage consonants correct' (PCC) scores: a classification of 'mild' speech disorder reflects a PCC score greater than 90%, 'mild-moderate' reflects a PCC score between 65% and 85%, 'moderate-severe' reflects a PCC score between 50% and 65%, and a PCC score below 50% is categorised as 'severe'. While this method of classification describes the level of difficulty, there seems to be no evidence, so far, that it provides useful information for the differential diagnosis of sub-groups of speech disorders (Dodd, 2005a), or that it discriminates between children with speech disorders in terms of the type of intervention indicated, or intervention outcomes.

1.3.3 MEDICAL

This approach prescribes that speech difficulties be classified as clinical entities (Crystal & Varley, 1993), and their etiological causes identified where possible. An example of this is the Speech Disorders Classification System (SDCS) devised by Shriberg and colleagues (Shriberg, Austin, Lewis, McSweeny, & Wilson, 1997b; Shriberg & Kwiatkowski, 1994a). This system characterises children below the age of nine years who have a 'speech delay' – the presence of consonant deletions and

substitutions characteristic of Ingram's (1976) Phonological Stage III that persist in a child's conversational speech past four years of age (Shriberg, 2003). Shriberg proposes four different etiological sub-types for children with speech delay. These are (i) speech delay: unknown origin (SD), (ii) speech delay: otitis media with effusion (SD-OME), (iii) speech delay: developmental apraxia of speech (SD-DAS) and (iv) speech delay: developmental psychosocial involvement (SD-DPI).

There are a number of criticisms of this system. While it has been used extensively in research settings, its clinical applicability is questioned. Firstly, despite recent research to identify diagnostic markers for some of the etiological sub-types (Shriberg, Flipsen, Kwiatkowski, & McSweeny, 2003; Shriberg, Kent, Karlsson, McSweeny, Nadler, & Brown, 2003), it is still unclear what the surface speech characteristics for each sub-type are. Secondly, researchers (Fox, Dodd, & Howard, 2002; Stackhouse & Wells, 1997) have pointed out that, in many cases, medically-based etiologies are not easily identifiable. In such cases, a child with a speech disorder may be classified in more than one way according to different etiological groups. Lastly, even when an etiological basis for an overt disorder is identified, it is not always differential in terms of the intervention indicated.

1.3.4 LINGUISTIC

This approach is concerned with the description of overt speech behaviour. Early procedures for analysing phonological processes were developed by researchers such as Weiner (1979), Hodson (1980), Grunwell (1981) and Ingram (1981). Grunwell (1988) later identified three groups of phonological disorder:

- Delayed: where a child appears to be following the normal pattern of development but at a slower rate than is expected for his/her age.
- Uneven development: where phonological processes from one stage of development co-exist with processes from a later stage in development.
- Deviant development: where some phonological processes identified in the child's speech are unusual or idiosyncratic.

While linguistic classification systems such as this one do provide a framework for approaching speech difficulties, their groupings have not been systematically validated.

In 1995, Dodd published a classification system of developmental speech difficulties based on the symptomatology of presenting speech. Within this classification system four sub-types of speech disorder are identified:

- Phonological delay (PD): where "all the phonological processes derived to describe a child's speech occur during normal development but are typical of a younger chronological age" (Dodd, 1995, p.55).
- Consistent phonological disorder (CPD): where there is systematic use of deviant phonological rules, specifically error patterns that are atypical of normal phonological development (Ingram, 1989). "Most children who use non-developmental rules also use some developmental rules that may... be appropriate for their chronological age. They should be... classified as having a consistent deviant disorder, since the presence of unusual processes signals an impaired understanding of their native phonological system" (Dodd, 1995, p.56).
- Inconsistent phonological disorder (IPD): where there is variable production of the same word or phonological features in the same contexts: in addition to delayed and non-developmental rules, these children's phonological systems show at least 40% variability that does not reflect a maturing system: on a 25-word test they produce ten or more of the words differently on at least two of the three occasions that they are elicited (Dodd, Hua, Crosbie, Holm, & Ozanne, 2002).
- Articulation disorder (AD): where a child shows an "inability to produce a perceptually acceptable version of particular phones" (Dodd, 1995, p.54).

The existence of these sub-types of speech disorder has been validated in a number of ways. Firstly, there is broad agreement on their prevalence rates: "around half of speech disordered children have PD, a quarter have CPD, and the remaining quarter are equally distributed between AD and IPD" (Broomfield & Dodd, 2004c, p.139). Secondly, the different groups identified in this system have been differentiated according to both linguistic and non-linguistic abilities (Bradford & Dodd, 1994, 1996; Bradford-Heit & Dodd, 1998; Dodd, Leahy, & Hambly, 1989). Thirdly,

intervention studies have shown different therapies to be more or less effective with the different types of speech disorder (Dodd & Bradford, 2000; Holm & Dodd, 1999). Lastly, this classification system has successfully been applied to linguistically diverse population groups (Fox & Dodd, 2001; Holm, Dodd, Stow, & Pert, 1999; Hua & Dodd, 2000a, 2000b; So & Dodd, 1994).

Based on these various sources of validation, together with the comprehensiveness of the speech sub-type description, Dodd's classification system of overt speech behaviours will be adopted in this thesis as one method of approaching the heterogeneity of children's overt speech difficulties. However, while categorising children's speech difficulties according to overt speech production patterns is effective and relatively simple, using a linguistic-based system alone does not provide explanations for speech disorders, as it fails to take account of underlying cognitive processes. For that we turn to psycholinguistics.

1.3.5 PSYCHOLINGUISTICS

Psycholinguistic models of speech processing highlight the psychological processes involved in the "perception, storage, planning and production of speech as it is produced in real time in real utterances" (McCormack, 1997, p.4). They are primarily concerned with identifying components within the processing chain that may be impaired. As will be described below, this can be done in relation to the speech processing of individual children or groups of children who present with similar overt speech patterns.

STACKHOUSE AND WELLS MODEL

One of the most recent psycholinguistic models, which focuses on individual case studies, was developed by Stackhouse and Wells (1997). The model is graphically depicted in Figure 1.1.

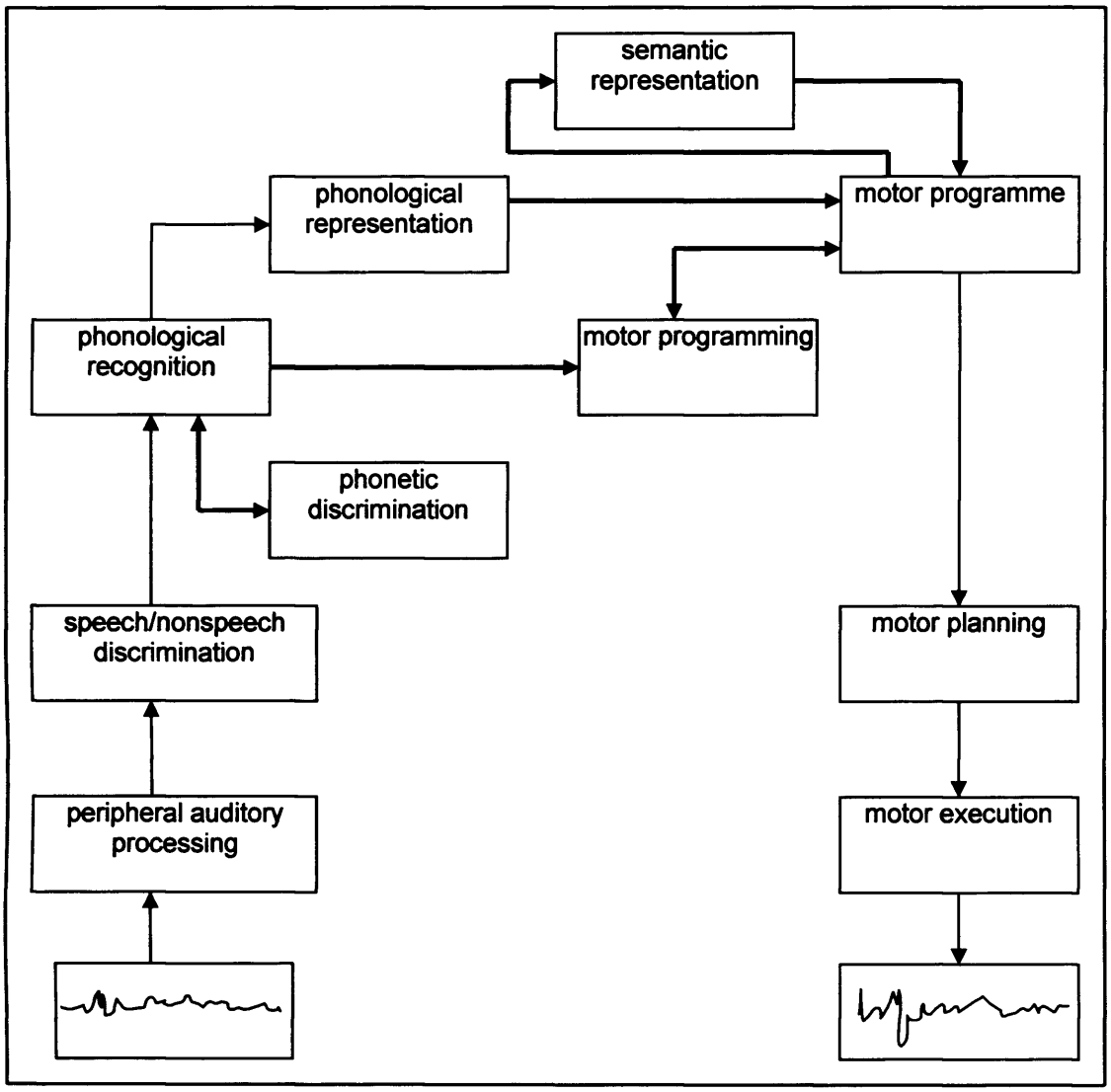

Figure 1.1 Stackhouse and Wells (1997) model of speech processing

The various stages or levels within the speech processing chain are explained as follows:

Perception

As shown in Figure 1.1, Stackhouse and Wells give considerable attention to perception as they delineate a number of progressive steps in input processing:

- peripheral auditory processing involving general audition, unrelated to speech
- discriminating between speech and non-speech sounds
- phonetic discrimination to make sense of speakers of the same language with different regional accents

- phonological recognition to assess whether the speech heard belongs to the speech patterns of the listener's first language

Representation

Lexical representations contain information about individual words, including phonological representations, semantic representations (information relating to the meaning of words), and motor programmes (specification of articulatory gestures that are required for the pronunciation of words) (Figure 1.1). The phonological representations do not contain all the information needed to pronounce the word correctly, just enough information to distinguish it from other words. Although Stackhouse and Wells focus on phonological representation and semantic representation, they state that the lexical representation also contains information regarding grammatical representations. These representations are not shown on their model but are described briefly as containing information regarding the grammatical category and whether it has irregular forms, for example *bring – brought* and *mouse – mice*.

This model separates input phonology (phonological representations) from output phonology (motor programmes), which is in contrast to earlier models of psycholinguistic processing that advocated that children have one lexicon to hold their underlying representations of speech (Macken, 1980; Smith, 1973). While these models were able to explain why a child would be able to discriminate between words and yet produce the words as homonyms through the action of phonological rules, they were unable to account for the variability in children's productions. Two-lexicon models, on the other hand, account for this variability by proposing that children have two lexicons for their underlying representations: an input lexicon for word recognition and an output lexicon for word production (Hewlett, 1990; Menn, 1978; Spencer, 1986)

Output processing

During speech production, motor programmes of words are assembled into a motor plan that incorporates all the necessary articulatory gestures for the correct sequence of production in real time. This level of motor planning is where "the motor programs

of individual words are assembled into a singe utterance plan" (Stackhouse & Wells, 1997, p.165). For the production of utterances, contextual specifications such as rhythm, intonation patterns and even grammar are taken into account. Pronunciation of single words may be influenced by factors such as function. For example, a different intonation is required depending on whether a word is to function as a question or a statement.

According to this model, when a child is required to produce a new or non-word this requires a new motor programme, which is created by the process called 'motor programming', depicted in Figure 1.1.

Finally, 'motor execution' involves the movement of the physical organs involved in speech, including the lungs, larynx, and oral and nasal cavities.

According to this model of speech processing, a child's performance on a range of speech and language tasks may be linked to deficits occurring simultaneously at different processing levels. For example, a child who obtains a low score on The Auditory Discrimination and Attention Test (MorganBarry, 1989) and shows difficulty repeating multi-syllabic non-words may be experiencing difficulties at the levels of lexical representation and motor programming.

PSYCHOLINGUISTIC EXTENSION OF DODD'S CLASSIFICATION SYSTEM

In contrast to the single-case targeted approach adopted by Stackhouse and Wells, the psycholinguistic extension of Dodd's classification system focuses exclusively on the four groups of children defined by overt speech patterns: children with PD, children with CPD, children with IPD, and children with AD. Unlike Stackhouse and Wells, Dodd, Holm, Crosbie and McCormack (2005) make claims regarding underlying difficulties responsible for the different types of overt speech patterns. This section outlines claims made by Dodd and colleagues regarding the two sub-groups of speech disorders that will be the focus of investigation in this thesis, namely CPD and IPD.

CPD

Dodd and colleagues propose that the underlying difficulty associated with the consistent use of atypical patterns of phonology is a cognitive-linguistic one: they suggest that these children may have an impaired ability to abstract, from their mental lexicon, knowledge concerning the nature of the phonological system of the language they are using (Leonard, 1985). These children select the wrong parameters of the perceived speech signal as salient in their native phonology. According to Grundy (1989), this would be classed as a cognitive-linguistic deficit. This type of difficulty does not readily map onto the Stackhouse and Wells (1997) model of speech processing since it does not refer to online processing or stored representations, but to core abilities associated with executive function, including concept formation, abstract thinking, rule derivation and cognitive flexibility (Dodd, 2005a).

Dodd et al (2005) cite two studies to support their claim. The first study, carried out by Dodd, Leahy and Hambly (1989), assessed knowledge of phonological legality of the following sub-groups of children with mean ages of 4.3 to 4.4 years: (i) children with PD, (ii) children with CPD, (iii) children with IPD, and (iv) children with typical development. Twelve pairs of nonsense words were presented, with each pair differing by one phoneme in such a way that one of the words was phonologically legal and the other phonologically illegal according to the rules of Australian English. The child was required to pick the best name for an animal from each word-pair.

Results showed that the group of children with CPD had little awareness of what was phonologically legal, in contrast to the other three groups of children who showed a preference for phonologically legal nonsense words. Dodd et al concluded that this group of children showed a deficit in the mental processes involved in deducing the constraints of their native sound system. Methodological issues to consider with regard to this task relate to it being conceptually difficult for children who are 4.3 to 4.4 years of age, and the fact that there were only ten children in three of the groups and 11 in the CPD group.

The second study, carried out by (Brierly, 1987) assessed the phonological awareness skills of children aged between 4 and 5 years, categorised into the same four sub-

groups. The performance of the four groups was compared with regard to their ability to detect alliteration and rhyme. Results showed that the group of children with CPD performed poorly compared with the groups of children with IPD, typical development and PD. The performance of the group of children with IPD did not differ from that of the typically developing children. These results support previous studies cited by Dodd (2005b) (Brierly, 1987; Dodd & Gillon, 1997; Dodd et al., 1989). Dodd and colleagues assert that the poor phonological awareness skills demonstrated by the CPD group are testimony to their cognitive-linguistic deficit, and it is these children who will go on to experience difficulties with literacy development.

As the language abilities of the participants in this study are not identified, it is not possible to determine whether the findings of this study are in keeping with studies which have found that only children experiencing *both* speech and language difficulties are at risk for later literacy problems. In a study carried out by Nathan, Stackhouse, Goulandris and Snowling (2004), children aged 4 years who experienced expressive speech difficulties only, were found to perform as well as IQ-matched controls on measures of phonological awareness, reading and spelling two years later. Children with both speech and language difficulties were impaired in phonological awareness, and there was a trend for their reading and spelling skills to be poorer. These findings support those obtained by Bishop and Adams (1990), which revealed that all but one of 12 children with isolated phonological impairment at 4 years of age showed normal literacy skills at 8.5 years. Crucially, however, the speech difficulties experienced by the children in these two studies were not differentiated. The outcomes of these studies may therefore be reflective of a heterogeneous group of speech difficulties, the majority of which may not be associated with literacy problems.

IPD

The speech production of children with IPD is characterised by significant variability in addition to the use of delayed and atypical phonological rules. Dodd and colleagues propose that the deficit associated with this speech disorder is at the level of output processing, specifically phonological planning. The notion of a phonological plan is based on a 'template' that contains the specifications for word production (Velleman & Vihman, 2002). It is proposed that children whose speech is characterised by

inconsistent errors may have difficulty selecting and sequencing phonemes in assembling phonological templates.

This claim is supported by a comparison of productions by the four sub-groups of children above, on the Inconsistency Subtest of the Diagnostic Evaluation of Articulation and Phonology (DEAP)(Dodd et al., 2002), in which a set of 25 single words must be produced three times within one session.

As defined in Section 1.3.4 above, the group of children with IPD show at least 40% variability in their productions: they pronounce many more of the words differently than the other three groups. In this case a qualitative analysis of the types of errors made by the four groups revealed the following: 71% of the variability of the group of children with typical development arose from the inconsistent substitution of a developmental error for the target. An example of this could be *shark* [ʃat] [ʃak] [ʃat]. A similar percentage (73%) of the same type of inconsistent error was obtained by the group of children with PD. The errors of the group of children with CPD were divided between developmental errors (35%), non-developmental errors alternating with a correct form (29%) such as *fish* [wɪʃ] [fɪʃ] [wɪʃ], and different non-developmental errors (36%) such as *ladybird* [leijibɛd] [leijibɛd] [leidisɛd]. In contrast to this, only 18% of the variability produced by the group of children with IPD involved alternating developmental errors and correct productions, and 13% involved alternating non-developmental errors and correct productions. The majority of their variability (69%) arose from a variety of error forms for the same word. Examples of this are *jump* [lʌmp] [gʌmp] [ʌmp], and *zebra* [fɛdæ] [dwɛlæ] [ɛbwæ].

This qualitative analysis of the patterns of inconsistency demonstrated that the difference between the groups is not simply one of scale of variability on the Inconsistency Subtest of the DEAP, which is after all how the groups are defined. Rather, the results suggest that children with IPD have a specific problem in assembling plans for word production.

While this difficulty may be mapped onto the output processing arm of the Stackhouse and Wells model (Figure 1.1), there is no direct correspondence between phonological

planning, as defined by Dodd (1995) and any specific level on the Stackhouse and Wells model. This may be due to the 'boxing-up' of complex processes on developmental models and the different cut-offs the two models use for activities occurring at different processing levels. For example, Dodd's phonological planning includes prosodic and segmental information whereas these details, and others relating to production of the word within an utterance, appear to be included in the motor planning stage of production in the Stackhouse and Wells model.

Input processing

According to Dodd and colleagues, studies show no underlying deficits in the input processing abilities of children with CPD and IPD. Dodd et al (1989) investigated the auditory discrimination abilities of groups of children with PD, CPD and IPD. Children were presented with audio recordings of correct adult productions of targets and their own productions of those targets, and were required to select the corresponding picture from a set of four, including the target and three distractors that were phonologically related to the child's pronunciation. All three groups were more successful at identifying the adult pronunciations than their own, and when their own pronunciation resulted in a real-word homophone, such as *tree* pronounced [ti] (a homophone for *tea*) they chose the distractor picture corresponding to that homophone. From these results Dodd et al inferred that the auditory discrimination and word recognition of all three groups were intact. Hence, "auditory input-processing is unlikely to underlie developmental phonological disorder, [rather] the impaired mental process causing the disorders must lie in output" (p.66).

A study supporting this view was carried out by Thyer and Dodd (1996), in which the auditory processing abilities of the three groups of children described above were compared with those of a group of children with typical development. There were between 10 and 12 children in each group, and the ages ranged between 2.9 and 4.6 years. The Paediatric Speech Intelligibility Test (Jerger & Jerger, 1982) was used: participants heard competing but semantically related sentence pairs contralaterally or ipsilaterally, at two message-to-competition noise ratios. The participants were required to point to one of a set of five pictures that best matched the message heard. No significant difference in performance was found between the groups.

1.4 CONCLUSION

As this chapter has shown, there are multiple perspectives in understanding speech disorders. It seems likely that a comprehensive approach to speech disorder must consider both the overt patterns and the underlying abilities of children with speech difficulties. This is in line with the concept that the linguistic and psycholinguistic approaches are dependent on each other (Stackhouse & Wells, 1997).

Investigating hypotheses or claims regarding the specific levels of deficit associated with CPD and IPD is not the objective of this research. However, these claims will invariably come up in later chapters and be discussed in relation to sentence processing. This thesis takes the position that since there is evidence that the CPD/IPD classification reflects a genuine difference in performance on psycholinguistic tasks, it makes sense to adopt this classification when exploring sentence-level production, in case there are differences at this level too. Hence, the first key question of this thesis is:

Can children with different types of speech disorders be differentiated according to their sentence-level performance?

CHAPTER 2

LANGUAGE SKILLS IN CHILDREN WITH SPEECH DIFFICULTIES

2.1 INTRODUCTION

There is a growing body of literature regarding the incidence and prevalence of children with speech and/or language difficulties (Beitchman, Nair, Clegg, & Patel, 1986; Broomfield & Dodd, 2004b, 2004c; Law et al., 2000; Tomblin, Records, Buckwalter, Zhang, Smith, & O'Brien, 1997). But, little of this literature looks at the relationship between speech and language disorders. This is evident even in the diagnosis of children with speech and language difficulties. In the vast literature on speech and its disorders, the diagnosis of speech disorder makes no reference to language or any other ability, either linguistic or non-linguistic. The diagnosis of language disorder – in particular Specific Language Impairment (SLI)[1] – is carried out with reference to a variety of abilities, including speech, but children with phonological difficulties are excluded from this category unless they also perform poorly on other measures of language (Leonard, 1998).

The perceived independence of these two linguistic domains has significant clinical implications for treating children who are suspected of having both speech and expressive language difficulties because a pre-requisite of providing intervention that is both efficient and effective is an understanding of the component systems and their interaction.

This chapter explores what is known about the language skills of children with speech difficulties. As will be revealed, the relationship between these two linguistic domains is complex and not well understood. The chapter begins with a brief synopsis of research regarding the relationship between speech and language development in very young typically developing children. Research concerning the relationship between atypical speech development and language will then be considered, focusing on the

[1] While the term SLI can refer to both receptive and expressive language difficulties (Bishop, 1997), in this thesis children with expressive language difficulties will be referred to as having SLI.

extent to which difficulties in each have been found to co-occur and possible relations between these. The chapter ends by highlighting the unanswered questions that will be addressed in this thesis.

2.2 THE CONNECTION BETWEEN SPEECH AND LANGUAGE IN EARLY TYPICAL DEVELOPMENT

While "for the most part, the acquisition of words and sounds have been investigated independently" (Storkel & Morrisette, 2002), there is a body of literature that supports the existence of a relationship between the development of these two linguistic domains in the early stages of typical development. This is based on the notion of continuity between babbling and speech, which has support from three types of study:

- The biological approach to speech development, where longitudinal investigations of infant vocalisations have revealed the logical developmental progression of babbling during the first year of life, from primary-vocalic sounds to adult-like consonant-vowel syllables just before the onset of meaningful speech (Oller, Eilers, Neal, & Schwartz, 1999; Oller & Smith, 1977, 1980).
- The environmental approach to speech development, where cross-linguistic studies have uncovered the existence of language-specific features of babbling such as the formant structure of vowels (De Boysson-Bardies, Halle, Sagart, & Durand, 1989; De Boysson-Bardies, Sagart, & Durand, 1984), the timing of syllables (Levitt & Aydelott Utman, 1992) and intonation patterns (Whalen, Levitt, & Wang, 1991).
- The study of similarities between babbling and the early lexicon, where specific phonological characteristics of babbling have been linked to the production of words in the first 50-word stage (Stoel-Gammon & Cooper, 1984; Vihman & Ferguson, 1986).

Irrespective of the perspective adopted, it is clear that since babbling precedes language, during this very early stage of development it is phonology that influences lexical acquisition. Beyond the 50-word stage, however, there is evidence to suggest that the relationship between speech and language becomes bi-directional. This

phenomenon is highlighted by studies that have focused on lexical acquisition in children who are 'late talkers' versus children who are 'precocious talkers'. For example, Stoel-Gammon and Dale (1988, as cited by Stoel-Gammon1998), found that precocious talkers at 20 months had larger phonetic inventories than typically developing children aged 24 months. In contrast to this, Paul and Jennings (1992), as well as Rescorla and Bernstein Ratner (1996) found the phonological systems of late talkers below 3 years of age to be delayed. Based on these findings Stoel-Gammon (1998) hypothesised that while phonological development may inhibit lexical growth in late talkers, the large vocabulary of precocious talkers may create a demand for a more advanced phonological system.

From research on the very early stages of typical development we see that there is a relationship between speech and aspects of language (in this case word production), the nature of which changes over the course of development. The issues which are still unaddressed are:

- What is the nature of the relationship at later stages of linguistic development?
- What is the nature of the relationship between phonology and other aspects of linguistic development, such as syntax?
- How is the relationship affected when one domain, either speech or language, is impaired?

The remainder of this chapter reviews the literature regarding the relationship between atypical speech development and language.

2.3 THE RELATIONSHIP BETWEEN ATYPICAL PHONOLOGY AND LANGUAGE

While extensive research has been carried out with children who have speech disorders, the vast majority of it has focused on single words. This may simply be because words are convenient contexts in which the production of speech sounds can be studied. However, it may be also be due to the assumption that a speech disorder only affects single words, leaving the ability to combine words to develop completely normally. Alternatively, even if the development of sentence structure is affected,

researchers may assume that speech development – and hence speech difficulties – represent an entirely independent linguistic domain, and therefore a topic for independent research. Either way, in some cases the speech disorder itself makes it difficult to determine whether sentence structure is developing normally, because the child's speech is too unintelligible to identify words and therefore sentence structure.

In order to explore the validity of the assumptions behind single-word research, this chapter reviews the limited body of research into the relationship between speech disorders and language disorders in children. The intelligibility issue, which presents a challenge in assessing children with severe speech difficulties, will be taken up in Chapter 3.

2.3.1 CO-OCCURRENCE

The assumption that speech disorders only affect single words, while syntactic development continues as normal, can be evaluated in the light of research on the co-occurrence between speech and language disorders. In this regard it is important to establish whether disorders of speech and language exist independently or whether there is evidence to suggest a 'more-than-chance' co-occurrence of these two disorders.

In a review of early studies of co-occurrence (Winitz, 1969) an inconsistency in results was already evident. Williams (1937) investigated the relationship between articulation and language performance of 38 3- and 4-year-old children. He found significant correlations between articulation and the number of grammatically correct words used, the mean length of response, the number of complete sentences and sentence complexity. In another study Davis (1937) found 5.5 year old children with 'faulty articulation' to have lower scores than children with 'perfect articulation' on mean length of response, time required to elicit responses, number of different words and number of spontaneous remarks. In contrast to this, children of 6.5 and 9.5 years of age who had 'faulty articulation' produced longer utterances than children with 'perfect articulation'. In yet another study, Van Demark and Mann (1965) found no relation between speech and seven measures of language, except for structural complexity in 8- to 13-year olds. Winitz (1969) hypothesised that the inconsistencies

found in the studies reviewed were due to variation in the tests used, test administration or participant groups.

The most recent and extensive review of co-occurrence was carried out by Shriberg and Austin in 1998. They approached the relationship between speech and language disorders from a medical perspective and focused on co-morbidity, which they based on Last's (1988) definition: "disease/s that coexist in a study participant in addition to the index condition that is the subject of the study". Their objective was to determine whether an independent phenotype marker exists for a genetically transmitted form of child speech disorders as opposed to "a common phenotype marker at a processing level which does not involve productive speech" (Shriberg & Austin, 1998, p.74).

They initially reviewed a broad range of studies with children between the ages of 3 and 12 years, where various assessment measures were used to determine the presence of a speech or language disorder. From the ten studies where speech was used as the index disorder, co-morbidity estimates ranged from 21% to 77% with an average of 55.7%. From a sub-set of six studies where the children were between the ages of 3 and 6 years, they found approximately the same average co-morbidity estimate (60%), but with a smaller range of 43-77%. A lower average co-morbidity estimate (47.6%) was obtained when language was used as the index disorder (range 16-75%).

They then focused on a sub-set of four studies where speech status across the studies was determined by the same criteria, using the Speech Disorders Classification System (SDCS) developed by Shriberg and colleagues (Shriberg et al., 1997b; Shriberg & Kwiatkowski, 1994a). In addition, children were further grouped according to the severity of the disorder: children with normalised speech acquisition/speech delay (NSA/SD) were regarded as having sub-clinical speech involvement, and children with a speech delay (SD) were regarded as having clinical speech involvement.

Where the speech disorder was used as the index disorder, a co-morbidity range of 6-21% was obtained for receptive language and a range of 38-64% was obtained for expressive language. In terms of severity, Shriberg and Austin found that compared with children with sub-clinical speech disorders, those with clinical speech disorders

had higher co-morbidity estimates for receptive grammar as well as expressive grammar and vocabulary.

One study used language disorder as the index disorder and included children who were approaching six years of age. Shriberg and Austin found that 9% of the children with language disorder had a clinical speech disorder and 29% had a sub-clinical speech disorder (for a total of 38%). Where SLI was defined according to receptive language involvement, 28% of children had a sub-clinical speech disorder, and 6% had a clinical speech disorder (for a total of 34%). In relation to expressive language involvement, 31% had a sub-clinical speech disorder and 9% had a clinical speech disorder (for a total of 40%).

The most striking feature of Shriberg and Austin's review is the enormous variability in both the means and ranges of the co-morbidity estimates. The greater variability in co-morbidity estimates in the first broad review could be partially explained by the fact that there was no consistency in either the speech or language measures used, and the studies covered a wide range of ages, from 3 to 12 years of age. In the four reviews where the SDCS was used, Shriberg and Austin hypothesised that the variance in co-morbidity estimates (in the same language domain) could be partly due to the "differences inherent in the variety of language measures, measure composites, and/or cut-off criteria used to classify language involvement" (p.103).

An additional source of variability might be insufficient differentiation within the groups studied. While Shriberg and Austin attempted some differentiation in the form of clinical versus sub-clinical grouping, they failed to differentiate the clinical groups further in terms of type or severity of the disorder. It may well be that different types of difficulties within each domain may have been responsible for the range of co-morbidity estimates obtained within the clinical groups. This highlights the need for careful differentiation of clinical groups in order to explain observed patterns of linguistic behaviour.

An example of differentiation is found in a recent epidemiological study carried out in the UK by Broomfield and Dodd (2004a). Data were collected from 1,100 children between the ages of 0 and 16 years who were referred to speech and language therapy.

A total of 320 children with primary speech impairment were divided into sub-groups according to overt speech patterns: Articulation Disorder (AD), Phonological Delay (PD), Consistent Deviant Phonological Disorder (CPD) and Inconsistent Deviant Phonological Disorder (IPD), as defined in Chapter 1, Section 1.3.4. Depending on the age of the child, the Receptive Expressive Emergent Language Scales (REEL), Reynell Developmental Language Scales III (RDLS) and the Clinical Evaluation of Language Fundamentals (CELF-UK) were used to measure receptive and expressive language ability. The IPD group obtained the highest co-occurrence rate of all the speech groups, with both receptive and expressive difficulties (40% and 66.7% respectively). Co-occurrence was lower for the CPD group, which obtained co-occurrence percentages of 30.3% and 45.5%. The PD group obtained even lower co-occurrence percentages of 23.4% and 34.2%, while the lowest co-occurrence was found for the AD group (17.5% and 22.5%). The fact that the ranges of co-occurrence found and explained in this study are similar to those reported in Shriberg and Austin's study (particularly where expressive language difficulties are involved: 22.5-66.7% in this study compared with 38-64% in Shriberg and Austin's study) provides strong evidence to suggest that the differentiation of speech disorders is essential in explaining the association between speech and language disorders.

A final source of variability relates to the index disorder used. It is interesting to note that higher co-morbidity estimates were calculated when the speech disorder was used as the index disorder. One explanation proposed by Shriberg and Austin relates to the difference in recovery rates of speech versus language disorders. This is based on the assumptions that (i) speech normalises earlier than language, by approximately 6 years of age and (ii) the more severe the involvement in one disorder, the greater the chance of involvement in the other. Therefore, as was the case in the study where language was used as the index disorder, if a child of 6 years of age was identified as having a speech disorder, it was most likely to be severe and hence there was a significant likelihood of language involvement as well.

Another possible explanation is that normal speech skills, as assessed in speech tests, reach ceiling, whereas language skills, as assessed in language tests, do not. In addition, as a result of test construction there is no ceiling effect for language ability. Hence, of the children diagnosed with a speech disorder a certain proportion would be

expected to fall on the lower end of the distribution on language assessments, even if they were developing normally. In contrast, children diagnosed with a language disorder would, at a certain point, be expected to reach ceiling performance on speech assessments if their speech were developing normally.

The central outcome of the above studies is that while speech and language disorders are observed to co-occur, the relationship between them remains uncertain. On the other hand, it is clear that a percentage of children do have isolated speech disorders. Shriberg and Austin (1998) found almost 50% of the children in their studies to have either a speech or a language difficulty. Broomfield and Dodd (2003) investigated a broad range of abilities and found that isolated speech impairments, without any other co-occurring difficulties including phonological awareness, pragmatics and oromotor difficulties, to be rare. Beyond this, however, it is extremely difficult to draw conclusions from these sizable quantitative studies regarding the association between speech and language disorders. The source of variation in co-occurrence estimates needs to be uncovered. To do this, a quantitative analysis based on a more qualitative approach is necessary.

2.3.2 CAUSAL RELATIONSHIPS BETWEEN SPEECH AND LANGUAGE DIFFICULTIES

Some researchers have extended the research in this area beyond co-occurrence, to investigate how one domain – either speech or language – impacts upon the other. Such investigation is relevant to the second assumption behind the single-word focus of research: that speech and language exist as two independent linguistic entities.

Causal relations between speech and language have been researched over many years from various perspectives. Some early researchers adopted a 'top-down' approach to sentence production. According to this approach, sentence structure organises and controls phonological structure. This is supported by evidence from studies that have found that children with syntactic and phonological deficits made more articulatory errors when producing increasingly more complex syntactic utterances. For example, in a study on nine 5-year-old children who had speech and language disorders, Schmauch, Panagos and Klich (1978) varied syntactic structures while holding

constant the target consonants embedded in these structures. Syntactic contexts included noun phrases, simple active declarative sentences and passive sentences. They found a significant increase in the quantity of consonant errors produced in sentences – both simple and passive – than in noun phrases. In addition, case study data presented by de Villiers and de Villiers (1978) showed the use of simplification processes in words produced in multiword strings, whereas some of the same words were produced correctly in isolation. Contradictory evidence to these findings is found in a preliminary study conducted by Paul, Cambell and Shriberg (1979), cited by Paul and Shriberg (1982), in which they analysed continuous speech samples of seven children with speech delay. They found that these children were not more likely to use simplification processes on constituent morphemes when they were in long or complex sentences than in sentences that were short or simple.

It is extremely difficult to compare Paul et al's (1979) results to those of other researchers, as in all cases the population groups are so loosely defined that the researchers may in fact be reporting on different groups. In addition, different methodologies may have been responsible for yielding inconsistent findings. Paul et al (1979) analysed speech production from a continuous speech sample. In this instance, it could be that children only produced short sentences that they had mastered. The other studies used sentence imitation as a measure of syntactic performance, where the children may have been challenged by targets of greater length or complexity.

Panagos et al. (1979) seek to explain the increased speech difficulties they found to occur in disyllabic versus monosyllabic words, and in complex versus simple sentences. They proposed that the relationship between syntactic and phonological difficulties can be attributed to a common underlying limitation in organisational ability: children with phonological disorders may have limited capacities to manage hierarchical complexity during grammatical encoding. Therefore, as a result of competing demands on processing resources at higher linguistic levels, children with phonological disorders will exhibit an increase in phonological errors as the syntactic load is increased.

Other researchers have challenged the 'top-down' approach and speculated about the relationship between phonology and syntax from a phonological perspective. They

have entertained the reverse scenario: that variability in phonology can affect syntactic performance (Shriner, Holloway, & Daniloff, 1969; Whitacre, Luper, & Pollio, 1970). From a clinical perspective Crystal, Fletcher and Garman (1976) recommend that syntactic intervention not proceed too far without work on articulation because phonological deficiencies can interfere with productive syntactic development. When speculating as to what underlies this relationship, Shriner et al (1969) suggested that "defective auditory or proprioceptive feedback leading to misarticulation may induce syntactic deficits" (p. 323). Although this view of what underlies the speech-language relationship is contrary to that of Panagos et al. (1979), they too implicated processing in the overt performance of children with speech disorders.

Later, Panagos and Prelock (1982) attempted to unravel this causal relationship by determining the effects of manipulating both phonological and syntactic variables on sentence imitation performance. They analysed the sentence imitation performance of ten children, between the ages of 5.8 and 6.9 years, who they classed as having both language disorders and 'articulation deficits' (p.172). The children were required to repeat sentences eight words in length, where phonological complexity was manipulated in terms of syllable structure, and syntactic complexity was manipulated in terms of embedded versus simply constructed sentences. They found that when repeating sentences matched in complexity but containing words with greater syllable complexity, 27% more syntactic errors were made. They also found that syntactic errors increased by 57% when embedded sentences were used. They concluded that "syntactic and phonological structures influence one another such that complexity added on either level disrupts performance on the other" and that "the outcome of complexity mismanagement is the simplification of sentence structures on all levels of hierarchical organisation" (p.176).

Although this study raises the possibility of a reciprocal relationship between speech and language, there are a number of methodological factors which may bring into question the conclusions reached.

First, the study involved a small number of children whose profiles are poorly described. Nothing is mentioned about their non-verbal performance, receptive language abilities, or the range of severity of their problems in either speech or

language domains. It is therefore unclear as to which of their strengths and weaknesses may have accounted for the results obtained.

Secondly, the study did not include children with typical development, so we do not know how they would perform on this task. It could be that increasing the phonological and syntactic load would have similar effects on children with typical development, in which case the results reported would be a consequence of the task itself rather than the nature of the children's difficulties.

Thirdly, with regard to task construction, only one type of phonological complexity was assessed, namely syllable complexity. Panagos and Prelock (1982) failed to take into account that the distribution of phoneme types could affect the performance of the children (Ferguson & Farwell, 1975; Stoel-Gammon, 1998). They also failed to take into account other linguistic factors, for example semantics, that may have affected performance in the different conditions.

The conclusions that may be drawn from the research on causal relations are limited. It is evident that the linguistic domains of speech and language do influence each other in some way. However, there are a number of masking factors that bring us no closer to understanding the level of independence of speech and language and the nature of interaction between them. There is considerable heterogeneity of participants, sometimes presenting with phonological and syntactic deficits and other times just with phonological deficits. In addition, failure to include children with normal development has prevented us from establishing what normal interaction between phonology and syntax is. To determine the interaction between normal and disordered speech and language, systematic studies with clearly defined groups and focus are required.

2.4 CONCLUSION

Research thus far has failed to unravel the complex relationship between speech disorders and language disorders. Each realm is heterogeneous so the relationship between them cannot be addressed at too general a level. It may be that children with different types of speech disorders have difficulties at different stages of single-word

processing and have different profiles of overt syntactic performance; or that certain problems in speech processing have effects at the sentence level, while others do not. Where sentence-level problems exist, it is important to determine their nature, as well as their relationship to sentence-level processing abilities. In exploring these issues, more systematic in-depth studies are required that address the following key questions:

- *Is there a more than chance co-occurrence of sentence-level difficulties in children with different types of speech disorders?*
- *What is the relationship between speech disorders and sentence production?*

CHAPTER 3

THE CHALLENGES OF INCONSISTENCY

3.1 INTRODUCTION

This chapter is concerned with the surface patterns of behaviour in children with speech disorders, specifically in relation to speech inconsistency and expressive language assessment. As addressed in Chapter 1, children with speech disorders do not present as a homogeneous group. Dodd (1995) has proposed one way of differentiating this group – by dividing speech disorders into those that are consistent and those that are inconsistent (Chapter 1, Section 1.3.4). However, the notion of inconsistency is not straightforward.

This chapter begins by exploring what is meant by inconsistency in the speech production of typically developing children and those with speech disorders, outlining the degree and type of inconsistency as well as the factors that influence it. Sentence imitation is then explored in light of the problems associated with assessing the expressive syntactic abilities in children with inconsistent speech.

3.2 DEFINITIONS

The lack of clarity regarding inconsistency in speech production is evident in the way in which the terms 'inconsistency' and 'variability' are used interchangeably in the literature.

Marquardt, Jacks and Davis (2004) highlight the "lack of operational definitions for consistency and variability" (p.128). They base their definition of 'variability' on Miller's (1992) view of repeated productions of words or phonetic sequences that are different in the absence of contextual variation. Holm, Crosbie and Dodd's (submitted) definition of 'inconsistency' seems roughly to match this view of variability and they provide operational definitions for each of these terms:

- "*Variability* is repeated productions that differ, with the variability attributed to factors described in the normal acquisition and use of speech (e.g. phonetic context, pragmatic influences, maturation or cognitive-linguistic influences)" (p.3).
- "*Inconsistency* is differing repeated productions characterised by multiple error types (unpredictable variation between a relatively large number of phones) that cannot be attributed to factors responsible for normal variability" (p.3).

These definitions look as if Holm and colleagues use the term 'variability' to describe typical variation in production and 'inconsistency' to describe abnormal variation. However, within their article they use the terms interchangeably as they explore the continuum between typical and atypical inconsistency in the speech production of children.

In contrast to Holm et al., Forrest, Elbert and Dinnsen (2000) do not use the term 'inconsistency' to describe atypical variation, but rather make a distinction between 'variability and consistency' in relation to children's speech substitution patterns.

Despite the lack of clarity relating to the above terms, there appears to be a general consensus concerning the existence of typical variability (which Forrest et al, 2000 refer to as consistency) and variability or inconsistency indicative of disorder. Within this review, the term 'variability' will be used to refer to typical variability in speech production and 'inconsistency' will be used in relation to speech disorder, as defined by Holm et al. (submitted).

3.3 FACTORS AFFECTING VARIABILITY IN SPEECH PRODUCTION

It is common for there to be variability in the speech production of young children, particularly during the early stages of development (Ingram, 1989; Vihman, 1996), and it exists both between and within individuals. The sources of variability between children are primarily internal "factors such as different anatomical structures, differences in rates of physiological maturation, differences in attention, memory and learning, or the integration of auditory, visual and kinaesthetic stimuli which provide clues to language" (Vihman, 1993, p.69). Gender differences have also been found to

contribute to the variability between children below the age of six years, with the productions of girls being less variable than the productions of boys (Holm et al., submitted; Kenney & Prather, 1986). This review will focus on variability in production within individual children.

Researchers have highlighted that variability in speech production is exhibited by all children to some degree (Dodd 1995; Grunwell 1981). The causes of this variability are numerous. For example, causes of phonetic variability may be related to the phonetic context of a sound (Kenney & Prather, 1986) or the motor variability inherent in the developing motor systems of young children (Green, Moore, & Reilly, 2002). Different situational contexts may also affect variability in production. An example of this is when the linguistic context of a word is changed from elicited single-word imitation to spontaneous speech (Dodd et al., 1989; Healey & Madison, 1987). Age and word length are also factors which can significantly affect variability in production, and are discussed in more detail below.

3.3.1 AGE

Variability in word production may merely signal a transition in the development of a child's phonological system as more mature realisations of words emerge (Dodd & Bradford, 2000; Forrest et al., 2000; Grunwell, 1981). As developmental transitions are prevalent in young children, the occurrence of variability has been linked with age. In a recent study by Holm et al (submitted), 409 typically developing British children between the ages of 3.0 and 6.11 years were asked to name 25 pictures on three separate occasions during one session, as prescribed by the Inconsistency Subtest of the DEAP (Dodd et al., 2002). It emerged that children between the ages of 3.0 and 3.5 years showed significantly more variability than older children. By 3.6 years of age, their speech productions were highly consistent.

These findings are in line with results obtained by Williams and Stackhouse (2000), who compared the consistency of production in 30 typically developing children between the ages of 3 and 5 years when repeating real words, non-words and syllable sequences. They found that the 3-year olds performed less well than the older children. However, their inconsistencies remained minimal. Production consistency

improved significantly between 3 and 4 years of age, so that by 4 years the children's productions were consistent.

Thus, variability in speech production of typically developing children is extremely limited, may reflect phonological maturation, and decreases with age.

3.3.2 WORD LENGTH

Different characteristics of words have been found to have a significant impact on the accuracy of single-word production (Roy & Chiat, 2004; Vance, Stackhouse, & Wells, 2005; Young, 1991). Word length is one of the key factors. Whether measured in terms of the number of phonemes or the number of syllables (Bradford & Dodd, 1996; Young, 1991), it is clear that children find it more difficult to produce longer words, especially before the maturation of their phonological system (Young 1991).

Studies investigating the effect of word length on the variability of production are limited. In Holm et al.'s study referred to in Section 3.3.1 above, the picture-naming responses of the children were categorised in one of four ways:

(i) consistent and correct: all three responses were the same and produced accurately.
(ii) consistent and incorrect: all three responses were the same but contained an error.
(iii) variable and incorrect: the three responses differed and all contained phonological errors.
(iv) variable correct: all three responses differed but at least one was accurate.

Holm et al (submitted) found that while most items of the Inconsistency Subtest were produced consistently and correctly by typically developing children, short items, containing only one syllable and three phonemes, had a higher proportion of consistent and correct responses. Words containing more syllables and phonemes were more likely to elicit the other types of responses.

On Williams and Stackhouse's repetition tasks referred to in Section 3.3.1 above, they found that for 3- and 4-year olds there was higher variability across five productions,

for three-syllable productions compared with two-syllable productions: the 3 year olds achieved a mean of 87.6% for two-syllable productions, and a mean of 60.5% for three-syllable productions, while the 4-year olds achieved a mean of 92.6% for two-syllable productions and 80.5% for three-syllable productions.

Despite the differing methodologies used in these studies, both Holm et al.'s and Williams and Stackhouse's results support the notion that word length has a significant effect on production variability. In addition, both studies highlight the need for normative data against which the performance of children with speech disorders may be compared. As both studies outline the effect of word length on the production of words in isolation, an extension of this work would be to investigate the impact of word length on the production of words in sentences.

3.4 ATYPICAL INCONSISTENCY

While this review has established that variability exists in the word production of typically developing children, it is important to differentiate between 'normal variability' and 'atypical inconsistency'.

In terms of degree, it is difficult to pinpoint when behaviour evident in typical development exceeds typical occurrence and becomes a characteristic of impairment (McLeod & Holm, 2004). Forrest et al. (2000) state that "variation must remain within certain limits... without these constraints, variability .... may contribute to a profile that characterises children with persistent phonological disorders" (p.530). Increased variability has also been seen as an indicator of deviant or disordered speech (Grunwell, 1981), developmental apraxia of speech (Forrest, 2003), persistent phonological disorders (Powell, 1996), and pervasive speech processing difficulties (Williams & Stackhouse, 2000).

Dodd and colleagues (Dodd, 1995; 2005b; Dodd et al., 2005) have attempted to provide a quantitative basis for defining 'increased variability' categorically, as they distinguish between the different types of functional speech disorder, which include PD, CPD and IPD (Chapter 1, Section 1.3.4). Within this system of categorisation, they propose a minimum of 40% variability (when naming the same 25 pictures on

three separate occasions within one session) as indicative of IPD, whereas in PD and CPD, either developmental or non-developmental phonological patterns respectively, are used more consistently. Support for this categorisation is found in two separate studies, one with German speaking children (Fox & Dodd, 2001) and the other with English speaking children (Dodd, 2005b). The productions of children with PD (when naming the same 25 pictures on three separate occasions within one session) were less than 15% inconsistent and those of children with CPD were between 19% and 24% inconsistent. The average inconsistency of children with IPD was above 50%. Predictably, the higher the inconsistency rate the more unintelligible speech productions will be. Therefore, it is children with IPD that present the greatest challenge for SLTs regarding the assessment of their expressive language abilities.

In terms of its nature, as stated in Section 3.2 above, Holm et al. (submitted) describe IPD as "characterised by multiple error types (unpredictable variation between a relatively large number of phones)" (p.7), and suggestive of a lack of systemic stability. This is in contrast to correct/incorrect realisations that may reflect a maturing system. As these unpredictable multiple error types are also features characteristic of developmental verbal dyspraxia, Holm et al. (submitted) make a distinction between IPD and developmental verbal dyspraxia based on a number of qualities, including surface speech characteristics. They propose that IPD differs from CAS in that children with IPD have "age appropriate oro-motor ability, normal prosodic patterns and their speech accuracy (PCC) increases on imitation tasks" (p.8). This is in line with recent research that suggests that CAS is a multi-deficit motor-speech disorder (Ozanne, 2005), which includes difficulties with oro-motor planning and implementing fine motor actions, in addition to a distinctive pattern of speech errors.

Hence, children with IPD are distinguished by the nature of their inconsistent productions compared with those children with typical development, PD or CPD. These results, together with assertions made by other researchers (Forrest, 2003; Powell, 1996; Williams & Stackhouse, 2000), confirm that there is a level and type of variability in clinically referred children with speech disorders that is not observed in typically developing children.

3.5 EFFECTS OF INCONSISTENCY ON EXPRESSIVE LANGUAGE ASSESSMENT

There are two unique characteristics associated with children who have IPD that can make it difficult to assess their expressive syntactic abilities.

First and foremost, as mentioned in Chapter 2, Section 2.3, inconsistency across and within words typically results in productions that are unintelligible. This presents a significant challenge when assessing the expressive abilities of children with inconsistent speech: when the child does attempt assessment items, his/her production may be so unintelligible that is impossible to identify words and structures.

Secondly, it is known that during early linguistic development children may avoid saying words with phonemes that are not in their repertoire (Ferguson & Farwell, 1975), or which they perceive as being difficult (Stoel-Gammon, 1998). This is even more apparent, and may occur at a later stage, with children who have speech disorders: they may refuse to attempt to produce assessment items, or produce utterances at a level below their true linguistic potential.

3.6 APPROPRIATENESS AND PROBLEMS OF COMMONLY USED ASSESSMENTS

Standardised assessments of expressive language typically use pictures to elicit language. Two of the commonly used assessments in the UK are:

(i) STASS: South Tyneside Assessment of Syntactic Structures (Armstrong & Ainley, 1988). This is a syntactic screening tool based on the Language Assessment Remediation and Screening Procedure (LARSP, Crystal, 1982). The child is presented with a set of pictures (32 in total) and is asked questions designed to elicit one or more grammatical structures per picture. It is standardised on 204 children between the ages of 3 and 5 years.

(ii) RAPT: The Renfrew Action Picture Test (Renfrew, 1997). This test aims to elicit samples of spoken language, which are evaluated in terms of information given and the grammatical structures used. Elicitation is also based on the principle of asking the child questions relating to a set of pictures (10 in total). It is standardised on children between the ages of 3.6 and 8.5 years.

Both these assessments use questions to elicit responses from children. For the reasons stated above, this method of assessment may prove to be uninformative when used with children who have inconsistent speech disorders, as they may refuse to attempt to answer the questions or produce utterances below their potential. In addition, although this method of assessment does create a context for the listener, it does not specifically identify target words and structures. Hence, these assessments do not overcome the challenges associated with assessing a child with IPD whose productions are unintelligible.

Another way of assessing children's expressive syntactic abilities is by analysing their spontaneous productions. While this method does not put pressure on a child to produce specific phonological forms or structures, its effectiveness in assessing children with inconsistent speech disorders is questionable. Just like other children, what the child says may not be an accurate representation of what s/he knows. As Bernstein Ratner (2000) states, "extrapolating control over linguistic forms from spontaneous language may over-, under- or misrepresent the degree to which a child has mastered a particular language skill" (p.291). Furthermore, without knowing what word or structure the child is intending to say, the unintelligibility of his/her speech may render it impossible to determine what words and linguistic structures have been produced.

In light of these challenges, the remainder of this chapter explores the suitability of using a sentence repetition[2] task as a measure of expressive syntactic ability in children with severe/inconsistent speech disorders. Two issues will be addressed: (i) whether sentence repetition is an informative assessment measure, and (ii) whether it has the potential for overcoming the problems associated with assessing children who have IPD and are unintelligible.

2 The terms 'sentence repetition' and 'sentence imitation' will be used interchangeably throughout the thesis.

3.7 SENTENCE REPETITION AS AN ALTERNATIVE ELICITATION METHOD

An alternative to elicited or spontaneous language analysis is to analyse a child's productions in a sentence repetition task. This method goes some way to overcoming the difficulty in identifying the structures produced by children with unintelligible speech: within this structured context, the listener knows the target the child is supposed to produce (providing the child co-operates), and is therefore able to evaluate the production of the child in relation to the target words and structures. The usefulness of this method has been recognised since the 1960s, when researchers claimed that a child's imitation of a verbal stimulus can reflect the status of his/her 'internal grammar' (Chomsky, 1965; Ervin-Tripp, 1964).

When comparing imitation and spontaneous language production, early researchers found a close relationship between the results obtained when using these two methods of assessment in typically developing children (Bonvillian, Raeburn, & Horan, 1979) and children with language disorders (Fujiki & Willbrand, 1982). Others found that children would omit or inaccurately repeat structures not yet used spontaneously (Ervin-Tripp, 1964; Sturner, Kunze, Funk, & Green, 1993). A qualitative analysis carried out by Ervin-Tripp (1964) found the grammar used by children in sentence repetition to be the same as in spontaneous utterances.

However, not all researchers agree on the interchangeability of these two methods. Some early researchers, such as Muma (1978), proposed that sentence repetition may in some circumstances under-estimate linguistic competence, while others, such as McDade, Simpson and Lamb (1982), suggested that sentence repetition could over-diagnose difficulties because children may fail to repeat structures demonstrated in spontaneous speech. Still others asserted that language sampling and analysis gives more accurate information (Bloom, Hood, & Lightbrown, 1974; Slobin & Welsh, 1973).

On the other hand, in defending sentence repetition as a valid and reliable method of assessment, Newcomer and Hammill (1997) state that while "the demonstration of

syntactic knowledge through imitation does not guarantee mastery of the forms in question, failure on the imitation task strongly indicates an absence of syntactic ability and the existence of a significant deficit in the area" (p.68). Furthermore, research in the 1980s suggested that spontaneous speech production produces less robust effects than elicited speech production (Kamhi, Catts, & Davis, 1984; Paul & Shriberg, 1982), presumably because subjects have greater control over linguistic encoding and can selectively avoid complex structures in the process (Panagos & Prelock, 1982; Panagos & Prelock, 1984).

In an evaluation of the two methods for assessing expressive language, Fujiki and Willbrand (1982) found significant correlations between the results obtained using elicited imitation and spontaneous language sampling. They concluded that spontaneous language sampling may be used to identify general problem areas that could be explored in detail by elicitation procedures.

Despite the reservations of some early researchers, more recently there seems to be a general consensus that elicited imitation, when used correctly, provides a window into the child's competence for language (Bernstein Ratner, 2000). As a result, sentence repetition is considered a reliable diagnostic tool and is used as an expressive language measure both clinically and in research (Bishop, Bishop, Bright, & James, 1999; Conti-Ramsden, Botting, & Faragher, 2001; Dalal & Loeb, 2005; Redmond, 2005).

Examples of research outcomes support the findings that sentence repetition has been found to be related to expressive grammatical skills in typically developing children (Newcomer & Hammill, 1997) and children with SLI (Conti-Ramsden et al., 2001). Conti-Ramsden et al.'s study (2001) investigated which clinical assessments out of non-word repetition, tense-marking ability and sentence repetition act as psycholinguistic markers for SLI in children aged 11 who were originally identified as having SLI at age 7. The Recalling Sentences Subtest of the CELF-R (Semel, Wiig, & Secord, 1994) was used to assess the participants' sentence repetition abilities, and their responses were scored in relation to the number of errors made in each sentence. The outcomes of the study revealed sentence repetition to be the most useful marker of SLI.

3.8 WHAT DOES SENTENCE IMITATION REALLY MEASURE?

While it is widely accepted that sentence repetition is not purely a measure of expressive syntactic ability, consensus as to the particular abilities being tapped by sentence repetition has not been reached. Some researchers emphasise the role of short-term memory in sentence repetition, whereas others highlight the involvement of language processing abilities.

3.8.1 SHORT-TERM MEMORY

Research relating to the contribution of short-term memory to sentence repetition has focused on the correlations that have been found between sentence repetition and short-term memory (Willis & Gathercole, 2001) in typically developing children (Alloway, Gathercole, Willis, & Adams, 2004; Bishop et al., 1999), as well as in children with difficulties such as SLI (Bishop et al., 1999; Botting & Conti-Ramsden, 2001) and with Downs Syndrome (Laws, 1998).

While different models of verbal working memory exist (Cowan, 1997; Just & Carpenter, 1992; King & Just, 1991), the majority of investigations within the paediatric population are based upon the working memory model originally proposed by Baddeley and Hitch (1974) and later extended by Baddeley (2000) (Figure 3.1). Within the original model, short-term memory is seen to comprise a central executive supplemented by two sub-systems: the visuo-spatial sketchpad and the phonological loop. The central executive is thought to be a flexible multi-functional system responsible for the control and regulation of cognitive processes, the retrieval of information from other memory systems, shifting between tasks or retrieval strategies (Baddeley, 1996), and selective attention or inhibition (Baddeley, Emslie, Kolodny, & Duncan, 1998).

The central executive controls the two supplementary slave systems, which are specialised for temporary storage and manipulation of material in specific domains. The visuo-spatial sketchpad processes and maintains visuo-spatial information, while the phonological loop holds speech-based information. The phonological loop is composed of a short-term phonological store subject to rapid decay and a sub-vocal

rehearsal process that acts to refresh and maintain phonological information in the store for a brief period. Serial recall tasks such as digit recall, real-word and non-word repetition, and sentence repetition are thought to test the capacities of the central executive and phonological loop and therefore phonological short-term memory (Gathercole & Baddeley, 1996; Pickering & Gathercole, 2001; Towse, Hitch, & Hutton, 1998).

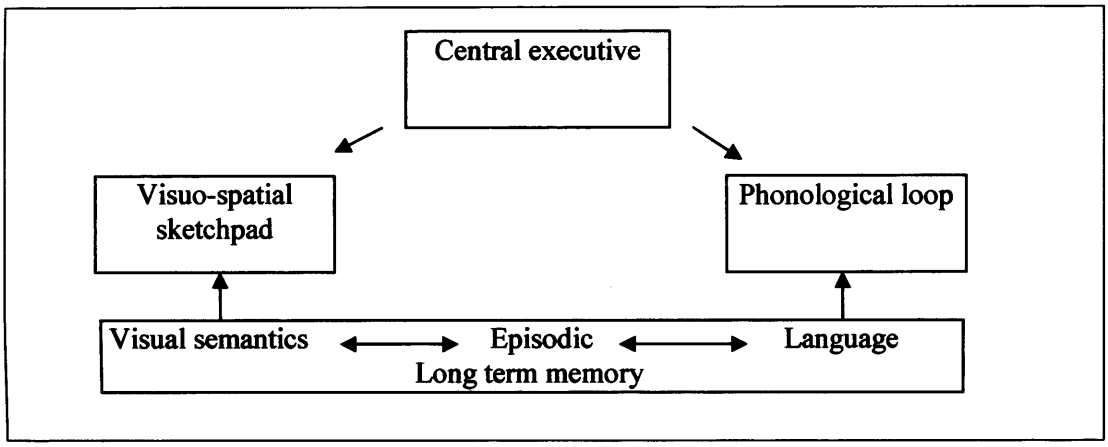

Figure 3.1 Extended working memory model (Baddeley, 2000)

Based on this model, Willis and Gathercole (2001) aimed to determine the extent to which phonological short-term storage contributes to sentence repetition and comprehension in 30 typically developing children aged 4 and 5 years (mean age 4.6 years). The main focus of their study involved manipulating the phonological memory load in sentences by varying word length: 'short' sentences contained nouns of one syllable, and 'long' sentences contained nouns of two or three syllables but the same number of words as the short sentences. Adjective length was also manipulated where possible. Four 'short' and four 'long' sentences of each syntactic type were constructed. Four line drawings were constructed for each sentence, with one drawing corresponding to the precise sentence meaning and three lexical or semantic-based foils. The participants were required to repeat each sentence and then point to a picture they believed corresponded to the meaning of the sentence.

The results of this study revealed a significant effect of sentence length (based on the number of syllables) on sentence repetition but not on sentence comprehension, thus suggesting that increasing sentence length by increasing word length does not affect the ability of 4- and 5-year olds to comprehend sentences, but does affect their ability

to repeat sentences: they are significantly more able to repeat sentences containing shorter rather than longer words.

These results were supported by their second study (Willis & Gathercole, 2001). In this study they assessed the sentence repetition and comprehension abilities of 61 4- and 5-year olds (mean age 5.2 years) who were divided into two groups according to whether they obtained relatively high or low scores on two measures of phonological memory – auditory digit span (Gathercole, 1995) and non-word repetition (Gathercole & Baddeley, 1996). In this experiment, the children in the high short-term memory group were more able to repeat sentences than children in the low short-term memory group, but they did not differ significantly in their ability to understand the sentences.

Based on the findings of the above studies, Willis and Gathercole (2001) concluded that sentence repetition "is strongly supported by access to temporary representations of the phonological form of the sentence held in short-term memory, and to a lesser extent to the stored products of syntactic and conceptual analysis of the sentence structure" (p.361). In contrast, comprehension is more strongly constrained by the child's ability to process sentences at the syntactic and conceptual levels.

A major weakness in Willis and Gathercole's studies is their less-than-rigorous assessment of the effect of length on sentence repetition. Firstly, as they themselves point out, in both experiments the difference in the number of syllables contained in the short and long sentences was only moderate. Long sentences contained an average of 10.8 syllables and short sentence an average of 7.8. This reflects a difference of 41%, compared with experiments contrasting word length in list recall, where the difference in syllables is between 200% and 400%.

Furthermore, while they investigated the effect of length on sentence repetition by manipulating the syllable load of single words, they failed to investigate the effect of varying the number of words in a sentence. This is an important distinction to make, as it may be that varying the load of single words yields different results from varying the load at a sentence level by adding more words, due to differences in single-word versus sentence-level processing (see Chapter 4, Section 4.4.).

Willis and Gathercole's broad quantitative method of scoring also provides limited information regarding the effect of manipulating length on sentence repetition. They awarded one point for accurate repetition of the whole sentence and zero if the repetition was not 100%. This provides no indication of where in the sentence errors may have occurred, and hence which components of a sentence are most vulnerable to this kind of increase in processing load. In order to reveal this, more detailed analyses of children's sentence repetitions are required, where each word in a sentence is scored.

3.8.2 LANGUAGE PROCESSING

Evidence that language processing is involved in sentence repetition lies in findings that people with no identified speech or language problems have an ability to repeat words in meaningful sentences that greatly exceeds their repetition ability in conventional memory-span assessments using sequences containing unrelated digits, letters or words (Willis & Gathercole, 2001). This also holds true for adults with neuropsychological impairments corresponding to the phonological loop (Baddeley, 2000; Martin, Lesch, & Bartha, 1999).

Baddeley (2000) explained these findings in terms of the function of the episodic buffer, the additional component in his extended working memory model (Figure 3.1). The episodic buffer is thought to be a limited-capacity, temporary storage system controlled by the central executive. It is assumed to be capable of storing information in a multi-dimensional code and thus provides a temporary interface between the slave systems and long-term memory. In sentence repetition, information from the phonological loop, about the verbatim forms of the words and their order is integrated in the episodic buffer with information from the language processing system about linguistic aspects, such as syntax and semantics.

Some researchers take an extreme view of sentence repetition as reflecting the language processing system alone (Potter & Lombardi, 1998; Prelock & Panagos, 1989). In contrast to Willis and Gathercole (2001), Potter and Lombardi (1998), whose research involves adults, do not believe that memory plays a significant role in adults' sentence recall. From their earlier studies, they asserted that a "sentence is regenerated in immediate recall from a representation of its meaning, using recently activated words"

(Potter & Lombardi, 1990, p.633), and that the surface syntax of the to-be-recalled sentence is regenerated using normal mechanisms of sentence production, as opposed to being directly represented in memory (Lombardi & Potter, 1992). They later put forward syntactic priming as an additional factor contributing to sentence recall: "there is no explicit memory for the surface structure of a perceived sentence, although there is an implicit memory in the form of a trace of the most recently processed structure of a given type; this implicit memory is manifested as syntactic priming when the subject attempts to regenerate a sentence of that type from its meaning" (1998, p.267).

A major difference between Potter and Lombardi's and Willis and Gathercole's (2001) work is the population under study, namely adults versus children. Among other things, this involved different methodologies. For example, in Potter and Lombardi's studies, the participants repeated target sentences they had read, whereas the participants in Willis and Gathercole's studies repeated sentences they had heard. In addition, it is possible that there are differences in the sentence repetition abilities of children and adults based on the relative contributions of short-term memory and linguistic knowledge: in children, phonological memory and linguistic knowledge increase during development, whereas adults have a number of additional abilities that may assist them, including a larger knowledge base and a faster processing speed.

McCarthy and Warrington (1987) adopted a more integrated approach to sentence repetition. They proposed that "although under most circumstances the language processor operates on-line without recourse to buffer storage, phonological memory representations may be consulted to enable backtracking and possible re-analysis of spoken language under conditions where on-line comprehension is not possible" (as cited in Willis and Gathercole, 2001, p.350). This is in line with Martin and colleagues (Hanten & Martin, 2000; Martin et al., 1999) who put forward a multiple systems model of short-term memory (from their work primarily with adults). They propose that phonological, lexical and semantic knowledge representations are activated during processing, and pass on activation to more temporary phonological and semantic storage buffers. In line with this 'integrated' view, Conti-Ramsden and Botting (2001) assert that sentence repetition not only involves short-term memory but taps something of the language knowledge base of the child.

There has also been some evidence to suggest that different sentence structures may influence performance on sentence repetition tasks. In Willis and Gathercole's studies discussed in Section 3.8.1 above, they also compared the participants' performance on different types of syntactic structures from the Test for Reception of Grammar (TROG) (Bishop, 1982). This was based on findings that links between phonological memory and sentence processing are highly specific to sentence structures and particularly to complex and lengthy constructions (Mann, Shankweiler, & Smith, 1984; McCarthy & Warrington, 1987). The results of their studies showed syntactic type to affect both sentence repetition and sentence comprehension.

Finally, the potential role of linguistic comprehension in sentence repetition has been highlighted in a study conducted by Marshall and Nation (2003), where the sentence recall abilities of 21 children (mean age 10.1 years) with reading comprehension at least one year below their chronological age were compared to a group of 20 typically developing children. Results showed that the performance of the poor comprehenders was significantly poorer than the controls on the Recalling Subtest of the CELF-R3^{UK} (Semel, Wiig, & Secord, 2000). There was also a difference in the types of errors made by the two groups. Marshall and Nation call for further investigations of this group to be carried out, as they caution that their study used a standardised assessment where length and syntactic complexity are not well controlled.

3.8.3 IMPLICATIONS FOR RESEARCH

Despite the differences in methodologies and models of the interaction of short-term memory and language processing, the evidence clearly shows that if we use sentence imitation to assess children's expressive syntactic abilities, we need to consider how short-term memory and language processing abilities affect sentence imitation performance.

3.9 THE SUITABILITY OF AVAILABLE STANDARDISED SENTENCE REPETITION TASKS

As this review has established sentence repetition to be a potentially informative method of assessing the sentence-level abilities of children with speech disorders, it is

appropriate to explore the suitability of using existing standardised sentence repetition assessments with these children. Table 3.1 presents an outline of some of the currently available standardised assessments in the UK.

Table 3.1 Standardised sentence imitation assessments

Name	**Recalling Sentences in Context Subtest of the CELF-P** (Wiig, Secord, & Semel, 1992)
Description	18 sentences, three to ten words in length. Standardised on children between the ages of 3 and 6.11.
Administration	Child listens to a story and repeats sentences s/he heard within the story in response to a question. For example, the examiner says "Robert told Jimmy 'You won't grow tall if you don't eat'", and then asks "What did Robert say?".
Scoring	Each word changed, added or omitted is counted as an error. Reversed words are counted as two errors.
Comments	The challenges of this task include: understanding the story and questions, and not knowing which sentence is to be repeated until each question is asked.
Name	**Sentence Imitation Subtest of the TOLD-P:3** (Newcomer & Hammill, 1997)
Description	30 sentences containing between five and 12 words. Standardised on children between the ages of 4 and 8.11.
Administration	The child repeats each sentence immediately after hearing it.
Scoring	One point is awarded for the correct imitation of the complete sentence. Only word stems are considered.
Comments	Children with short-term memory difficulties may not obtain a score high enough to be meaningfully analysed, as the shortest sentence contains five words.
Name	**Expressive Component of the Northwestern Syntax Screening Test (NSST)** (Lee, 1971)
Description	20 picture pairs which may differ in function and form. The length of sentences ranges from three to seven words. Standardised on children between the ages of 3 and 7.11.
Administration	The examiner describes two pictures while pointing to the corresponding pictures, for example 'This is their wagon'; 'This is her wagon'. The child is then required to repeat the sentences and point to the pictures.
Scoring	One point is awarded for the correct imitation of each complete sentence.
Comments	The test is standardised on an American sample. In addition, although the syntactic structure being tested has been primed, by the time the child attempts to produce the second sentence s/he may produce an original syntactic structure while maintaining the meaning of the picture. In this case the child will score zero for imitating the sentence.

Name	**Carrow Elicited Language Inventory (CELI)** (Carrow, 1974)
Description	52 utterances, ranging from two to ten words. Standardised on children between the ages of 3 and 7.11.
Administration	The child repeats each utterance immediately after hearing it.
Scoring	Each word is scored and analysed for the type of error made, including substitutions, omissions, additions, transpositions and reversals.
Comments	Standardised on an American sample. In addition, 11 of the sentences are in the question form, which clinical experience has shown sometimes elicits an answer from the child instead of its repetition.

As Table 3.1 shows, only the subtests of the CELF-P and the TOLD-P:3 have been standardised on a UK sample, and on the TOLD-P:3 and the NSST scoring is all-or-nothing. In addition to the individual shortcomings of each one of these assessments, none of the assessments consider the issues associated with assessing children with speech disorders. There is no evidence of phonology or phonotactics being considered, to control for the possibility that children may avoid phonemes they perceive to be difficult. In addition, the only mention of the issue of intelligibility in children with speech disorders is in the CELI which states that "if the child has a severe articulation problem, analysis of his grammatical errors will be almost impossible" (Carrow, 1974, p.17). Hence, these sentence imitation tasks, like the assessment methods considered in Section 3.6, do not overcome the problems associated with assessing children who have IPD.

The shortfalls of the above assessments have highlighted a number of important points for the purposes of this research. Firstly, to be maximally informative about the sentence-level abilities of children with speech disorders, developmentally simple phonology and phonotactics should be used. Secondly, the scoring of each word is essential. Thirdly, it is important the length of the task be increased incrementally from short sentences to longer sentences.

3.10 CONCLUSION

This chapter has attempted to clarify the continuum of variability and inconsistency in the speech production of typically developing children and those with speech disorders. It has provided evidence that some children with speech disorders manifest characteristics of atypical inconsistency. The challenges of assessing the sentence-

level abilities of these children have been outlined, and the potential of sentence repetition in overcoming these challenges has been explored.

It has been established that sentence imitation is a more suitable method for assessing children with severe speech disorders than other common assessments, because of the control it provides over target structures to be elicited. Existing sentence imitation tasks are not suitable for assessing the sentence-level abilities of children with severe speech disorders as they make no attempt, in structure of targets or scoring methods, to minimise the potential impact of the speech disorder on sentence-level performance.

As a result, this thesis uses a novel sentence repetition task, designed to minimise the possibility that speech difficulties will mask sentence repetition capability in children with severe speech disorders. As will be seen, it recognises the need to:

(i) use developmentally simple phonology and phonotactics;
(ii) score each word to be maximally informative;
(iii) increase the length of target sentences incrementally.

Having designed a novel sentence imitation task, it will be important to evaluate whether it is an efficient and reliable method of assessing expressive syntax in children generally, and specifically in children with severe speech difficulties for whom this task is designed.

CHAPTER 4

SINGLE-WORD PHONOLOGY AND SENTENCE PRODUCTION

4.1 INTRODUCTION

As stated in Chapter 1, one of the key questions of this thesis is concerned with how speech difficulties relate to sentence production. One of the effects of the separateness of speech and language disorders (Chapter 2) is that there is currently no theoretical framework for investigating the relationship between these two linguistic domains. This chapter attempts to establish an appropriate theoretical framework for looking at speech disorders in relation to sentence production. This is done within the constraints of a dearth of literature on this topic, particularly regarding the developmental population.

4.2 MODELS OF SINGLE-WORD AND SENTENCE PRODUCTION

As highlighted in Chapter 2, speech disorders have been investigated primarily within the context of single words. In order to investigate the relationship between speech difficulties and sentence production, it is crucial first to consider current models and evidence of how single words and sentences are produced, and the relationship between them, in typical development. This provides foundations for exploring the relationship between speech disorders and sentence production in children.

4.2.1 DEVELOPMENTAL MODELS

Psycholinguistic models of single-word processing have existed within the paediatric literature since the early 1970s and the model proposed by Stackhouse and Wells (1997) is currently a commonly used model among SLTs (Chapter 1, Section 1.3.5). Although the model was constructed as a framework for identifying underlying deficits associated with single-word processing, the description of the model does include references to sentence production: in addition to the lexical representation containing semantic and phonological representations and the motor programme, Stackhouse and Wells assert that the lexical representation also contains grammatical

information, such as whether the word is a noun or a verb (for example, 'mouse' is a noun), and whether it has irregular forms (for example 'mouse' becomes 'mice' in the plural).

They go on to state that during the output stage of 'motor planning', motor programmes for each word are retrieved, and the gestural targets are assembled in the correct sequence in real time, "taking account of contextual requirements that will influence the eventual production...(including) the rhythmic and intonation patterns selected and the grammatical structure" (p.165). Despite these references to sentence production, it is clear that this model was constructed primarily as a model of single-word production, and sentence production is not within its scope. Further detail regarding grammatical processing in sentence production is not given, and difficulties occurring at a sentence level cannot be analysed in terms of this model.

As there are presently no published models of sentence production in children, we turn to the adult literature.

4.2.2 ADULT MODELS

The majority of studies relating to speech processing in adults have been based on the production of single words (Dell, 1988; Dell et al., 1997; Foygel & Dell, 2000). However, Levelt and colleagues (Bock & Levelt, 1994; Levelt, 1989; Levelt et al., 1999) have developed a model in which both single words and sentence production are accounted for.

The model outlined in this section is based on Levelt et al.'s single-word production model, with expansion of the grammatical encoding stage of processing as proposed by Bock and Levelt (1994) when applying the model to sentence production. The 1999 model is presented graphically in Figure 4.1.

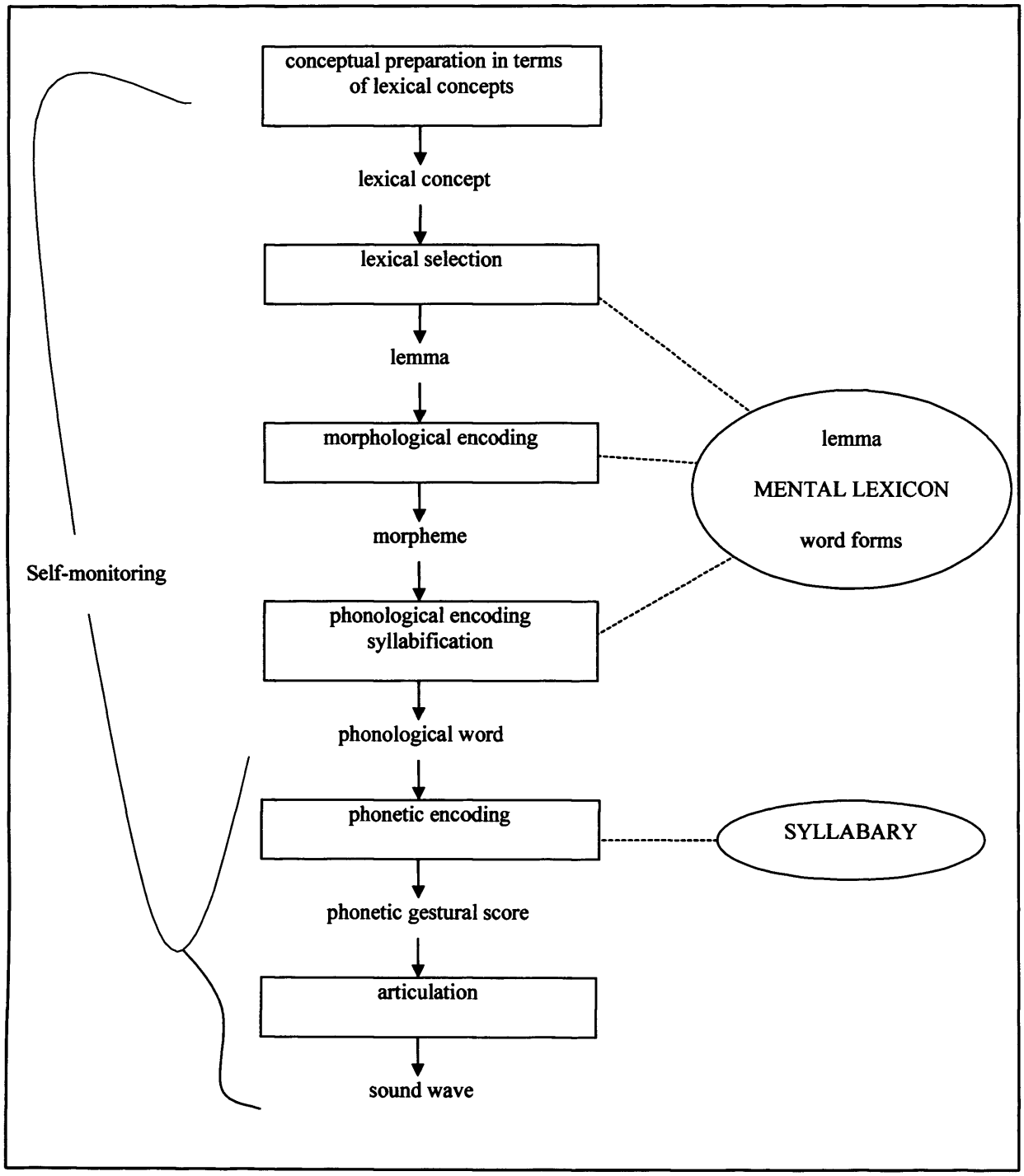

Figure 4.1 Model of single-word production according to Levelt, Roelofs and Meyer (1999)

The model represents speech production as a staged process from conceptual preparation to the initiation of articulation and contains four levels of processing: conceptual preparation, lexical selection, the morphological and phonological encoding of a word in its prosodic context, and phonetic encoding.

The model may be described as a feed-forward activation-spreading network, where each stage of the production process receives a certain input from the preceding stage and produces a certain kind of output. It is based on work by Roelofs (1996; 1997), who exemplified the basic assumptions of Levelt et al.'s theory in a computational model covering the stages from lexical selection to syllabary access (at the stage of phonetic encoding). The word-form encoding part of the model is called WEAVER (Word-form Encoding by Activation and VERification) and the full model, including lemma selection (described below), is called WEAVER ++.

Conceptual preparation

As depicted in Figure 4.1, the first stage in the process of speech production in the Levelt et al. model is termed 'conceptual preparation'. No input is specified, but it has as its output the activation of lexical concepts. As this stage of processing is not central to this thesis, it will not be elaborated.

Lexical selection

During lexical selection, a lemma is retrieved from the mental lexicon. A lemma is a lexical item which is not specified for phonological form, but is specified semantically and syntactically (Levelt, 1992): it contains information regarding the item's meaning or sense (the concept that goes with the word) – for example, the lemma 'dog' is categorised as a count noun – and its syntax is available in order to create the appropriate syntactic environment for the word, for example 'carry' is a transitive verb with two argument positions.

It is significant to note that Levelt and colleagues (Bock & Levelt, 1994; Levelt et al., 1999) do not make a distinction between the selection or encoding (described below) of content and function words.

Although not depicted in Levelt et al.'s 1999 model in Figure 4.1, Bock and Levelt (1994) outline this level of processing in more detail with regard to the production of utterances. They refer to 'grammatical encoding' as the selection of appropriate lexical concepts and the assembly of a syntactic framework. There are two sets of processes involved in grammatical encoding: functional and positional.

Functional encoding involves two steps. The first is the selection of suitable lexical concepts and lemmas. The second is 'function assignment', which involves the assignment of syntactic relations or grammatical functions such as 'nominative-subject and dative-object' (p.947). Positional processing then fixes the order of elements in an utterance. It begins with 'constituent assembly', where a hierarchy for phrasal constituents that manages the order of word production is created. The second step relates to 'inflection' and involves the generation of fine-grained details at the lowest level of the created hierarchy, including information about number and tense.

Phonological encoding

The next level of processing, as represented in Figure 4.1, involves morphological and phonological encoding and begins with the retrieval of the word's phonological shape from the mental lexicon. Levelt et al. (1999) propose that three kinds of information relating to the word are activated: the word's morphological make-up, its metrical shape and its segmental make-up. Table 4.1 outlines the information activated for the word *escorting*:

Table 4.1 Phonological information activated for *escorting*

Morphological make-up:	• two morphemes: *escort* and *ing*.
Metrical shape:	• *escort* - iambic, disyllabic and stress final • *ing* - monosyllabic, unstressed and cannot be an independent word.
Segmental make-up:	• 'spell out' for *escort* is /ɛ/ /s/ /k/ /ɔ/ /r/ /t/ • 'spell out' for *ing* is /ɪ/ /ŋ/ • the order of the segments is specified

Dell and colleagues (Dell, 1988; Dell et al., 1997) propose that during phonological encoding, 'fillers' (phonemes or clusters of phonemes) are inserted into phonological 'frames', which represent the structure of the word regarding the number of syllables and their stress pattern and the sequence of consonants and vowels within each syllable. Hence, word forms are retrieved as sub-lexical and sub-syllabic units as opposed to unanalysed wholes.

In contrast to Dell and colleagues (Dell, 1988; Dell et al., 1997), Levelt et al. (1999) propose that 'syllabification' of a word is not stored in the mental lexicon. It is a later process at the interface between phonological and phonetic encoding. Universal rules

of syllabification, as well as language-specific rules, are applied to create maximally pronounceable syllables.

There are no pre-specified syllable templates and each syllable's internal structure is generated online depending on the word's phonological environment, which can transcend lexical word boundaries. For example, when producing the word *escorting*, the middle syllable will be pronounced /skɔ/, whereas the syllable /skɔt/ will be pronounced when producing the word *escort.* This is also true in connected speech, where syllable boundaries often differ from a single word's canonical syllabification (Cholin, Schiller, & Levelt, 2004). For example, the word *predict* would be syllabified as */pre-dict/* when produced in isolation, but when the pronoun *it* is added, it becomes */pre-dic-tit/.* This is termed cliticisation. Hence, the output of phonological encoding is the 'phonological word' or 'prosodic word', which may be smaller or larger than the lexical word.

Phonetic encoding

Although speech processing does not end with phonetic encoding (Figure 4.1), it is the final level of processing that Levelt and colleagues elaborate. During phonetic encoding, the fairly abstract, syllabified phonological words are incrementally translated into articulatory-motor programmes. It is assumed that typical adult speakers have access to a repository of syllable gestures, called the 'mental syllabary' (Levelt, 1992), which contains articulatory scores for at least high-frequency syllables of the language (Cholin et al., 2004). Levelt et al. (1999) state that their theory has "an only partial account of phonetic encoding" (p.5). For example, while they acknowledge the existence of a mechanism for the generation of low-frequency or new syllables, they state that this mechanism is still to be modelled in detail in the framework of WEAVER ++ (Cholin et al., 2004).

Articulation

Although the final stage, 'articulation', is briefly mentioned, Levelt et al state that the functioning of this system is beyond their theory. This system consists of the musculature machinery that controls the lungs, larynx and vocal tract, and a neural system that controls the execution of abstract gestural scores (Levelt 1989).

The Levelt et al. (1999) model relates to the spontaneous generation of utterances and does not explicitly specify the processes involved in sentence imitation. It does not include 'input', which is a necessary component of sentence repetition, and while the mental lexicon is clearly represented in the model, there is no elaboration regarding the long-term store of semantic and syntactic knowledge. However, once the speaker has drawn on his/her recognition of the utterance from the long-term store, we can assume that the production of an utterance follows the same sequence of processing from morphological encoding onwards.

4.3 APPLYING AN ADULT MODEL OF SENTENCE PRODUCTION TO CHILDREN

The motivation for using this model of sentence production as a theoretical framework in this research is twofold. Firstly, as stated above, there are no models of sentence production within the paediatric literature. Secondly, since the participants in the research are between the ages of 4 and 6.1 years, it is expected that they have acquired a significant vocabulary and use complex syntactic structures. In other words, their language systems should be quite established, and their sentence processing system should be akin to the adult system in fundamental respects. Notwithstanding this, it is important to highlight issues that should be considered when applying this adult model of sentence production to children, especially when they are experiencing difficulties.

Paediatric models of single-word processing, such as those proposed by Stackhouse and Wells (1997) and Dodd and McCormack (1995), include processing components related to development. For example, in the Stackhouse and Wells (1997) model, motor programming is used to form new motor programmes (specification of articulatory gestures for the accurate pronunciation of words) for words or sound combinations that have not been produced before. This is in contrast to the adult system in which, according to Levelt and colleagues (Levelt, 1992; Levelt et al., 1999); the speaker has access to a repository of gestural scores for the frequently used syllables of the language, coined 'mental syllabary', and very rarely produces a new syllable.

As already stated above, Levelt et al.'s model is a feed-forward model, where the relationship between each stage of the model is such that each stage receives input from the stage before and produces a certain kind of output. A deficit occurring at any level will limit input to subsequent levels, resulting in production that is less than accurate. Developmental models also contain this phenomenon of feed-forward. However, within the developing system, connections between the different stages or levels are more crucial than in adults because new connections are continually constructed online and then are stored and consolidated within the course of development. This is exemplified in the Stackhouse and Wells (1997) model, which delineates the different levels of input and emphasises their role in the developing system: a deficit in phonological recognition, for example, could influence the establishment of adequate phonological representations, which would in turn affect speech production.

Closely related to this is the issue of feedback. Levelt and colleagues (Levelt, 1989; Levelt et al., 1999) describe the process of 'self-monitoring', where a speaker monitors his/her own overt and internal speech. Through this process, errors can be detected with respect to meaning or 'well-formedness' and the speaker can make adjustments accordingly. Self-monitoring within adult speech production assumes an established system against which the speaker's overt or internal speech can be adjusted, which is not the case for the developing system of a child.

An alternative approach to the notion of feedback is proposed by Dell and colleagues (Dell, 1988; Dell et al., 1997) in their interactive model of word retrieval (Figure 4.2). This connectionist model combines the two steps of lexical and phonological encoding with an interactive activation retrieval mechanism. As depicted in Figure 4.2, lexical knowledge is embedded in a network of three layers: the semantic layer (which represents the concept of the word) is connected by bidirectional excitatory connections to the word or lemma, which is in turn connected to the phoneme layer in the same way. Activation occurs both top-down and bottom-up. Feed-forward cascading activation occurs when top-down activation from the semantic-to-word layer continues down into the phoneme layer. Positive feedback results from bottom-up activation of the semantic layer, which gets input from the phoneme layer via the

word units. Therefore, deficits at one level may have an impact on 'earlier' as well as 'later' levels of processing.

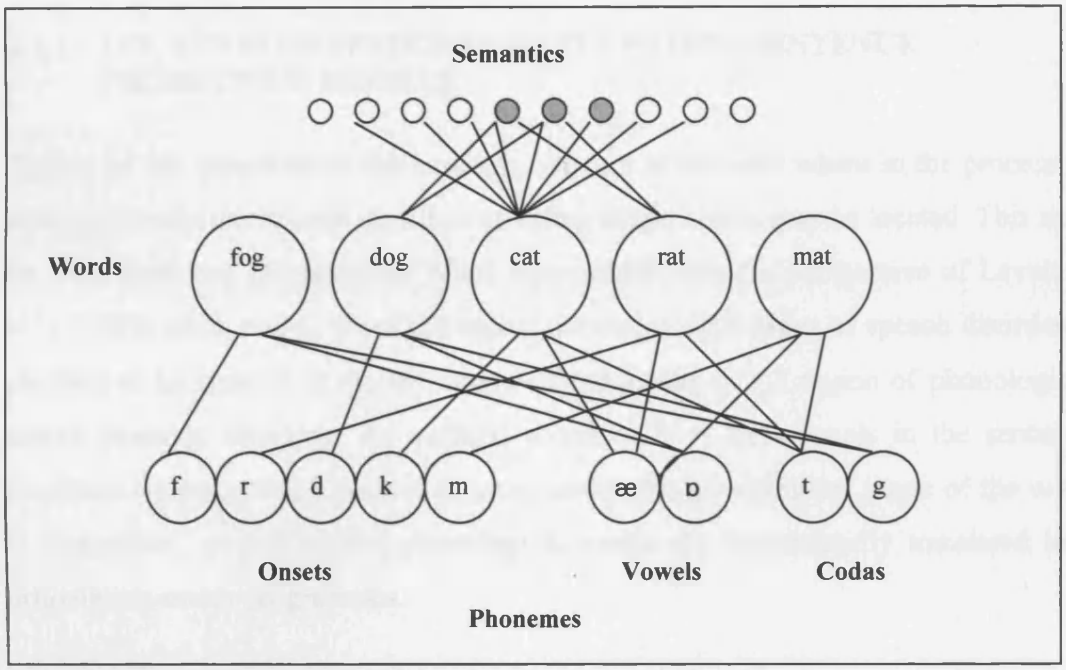

Figure 4.2 Lexical network for interactive two-step model of naming. Common semantic features of *cat*, *dog*, and *rat* are grey (Dell et al., 1997)

Developmental speech production models such as those proposed by Stackhouse and Wells (1997) and Dodd and McCormack (1995) do not explicitly define feedback, nor its role in development. However, it is implicit in them that children are constantly exposed to their own output, which then provides input to their processing system. This may in turn contribute to the development of the components of the processing system. Therefore, in contrast to Levelt et al's (1999) model, but in line with Dell and colleagues (Dell, 1988; Dell et al., 1997), it could be that within a developing system the functioning and development of each level of processing may be significantly affected by the processing taking place both before and after it in the processing chain.

4.4 SPEECH DEFICITS AND SENTENCE PRODUCTION

4.4.1 LOCATION OF SPEECH DEFICITS WITHIN SENTENCE PRODUCTION MODELS

In light of the objectives of this research, we turn to consider where in the process of sentence production speech disorders affecting single words may be located. This may be done from two perspectives. When approached from the perspective of Levelt et al.'s (1999) adult model, we might expect the output difficulties of speech disordered children to be situated at the late stages of processing in the region of phonological and/or phonetic encoding. As outlined above, it is at these levels in the sentence production process that Levelt et al. propose that the phonological shape of the word is formulated, and syllabified phonological words are incrementally translated into articulatory-motor programmes.

Alternatively, we could start from the hypothesised deficits of single-word speech difficulties (as discussed in Chapter 1, Section 1.3.5) and consider where in the sentence processing chain these may be located. This is difficult, partly because of the different terminology, varying amount of detail and different cut-offs used in grouping processes together. For example, while a phonological encoding deficit on Levelt et al.'s (1999) model would incorporate difficulties at either the motor programme or motor planning levels of processing on Stackhouse and Wells' (1997) model, it would incorporate difficulties only with phonological planning in Dodd and McCormack's (1995) analysis. Furthermore, the cognitive-linguistic deficit proposed by Dodd and colleagues to underlie CPD cannot be located in Levelt et al.'s model.

4.4.2 PREDICTIONS FOR SENTENCE LEVEL PERFORMANCE

Notwithstanding the difficulties in locating single-word speech difficulties within the sentence processing chain, some predictions regarding the sentence-level performance of children with speech difficulties can still be made.

According to Levelt et al.'s (1999) model, based on the principle of feed-forward, difficulties at the levels of phonological or phonetic encoding will not affect syntactic (or semantic) aspects of the sentence as these components would have already been formulated. The same should be true for children who experience difficulties at these late stages of speech processing: they should show no difficulties at earlier stages of processing and hence, their syntactic construction should not be affected.

Predictions regarding the sentence-level performance of children with speech difficulties can also be made when the unit or level of phonological planning in sentence production is considered. While Levelt and colleagues (Bock & Levelt, 1994; Cholin et al., 2004; Levelt, 1992; Levelt et al., 1999) do not clearly define the level or unit of planning involved in sentence production, their description of speech production suggests that it is at the 'word' level, and not the sentence level, that speech planning takes place, and it is the prosodic or phonological word (defined in Section 4.2.2 above) that is the unit of planning. If this is the case, then for children with planning difficulties *only* at the level of the prosodic word, increasing or decreasing the load of production at the level of the sentence - by varying the number of words - should not affect the sentence production of these children any more than the production of typically developing children. On the other hand, it would be predicted that increasing the load at the level of the phonological word, for example in terms of the number of syllables in a word, may affect their sentence performance more than it would affect children with typical development.

Support for this prediction is found in developmental studies that have investigated the effect of increasing syllable load on sentence repetition in atypically developing children. In Panagos and Prelock's (1982) study, discussed in Chapter 2, Section 2.3.2, ten children who were classed as having both language disorders and 'articulation deficits' (p.172) repeated sentences eight words in length but varying in syllable structure. They found that 27% more syntactic errors were made on sentences with greater syllable complexity. In addition to the methodological limitations of this study already discussed in Section 2.3.2, which include the absence of a comparison group of typically developing children, a further limitation relates to the lack of detail regarding the specific syntactic components that were affected by increasing the syllable complexity.

Willis and Gathercole's (2001) study, discussed in Chapter 3, Section 3.8.1, investigated the sentence repetition abilities of 30 typically developing children aged 4 and 5 years, where the number of syllables in words was manipulated in an attempt to determine the role of phonological short-term memory in sentence repetition. They found that the children were significantly more able to repeat sentences with words containing fewer rather than more syllables. This implies that manipulating syllable load at the word level will have an effect on the sentence production of typically developing children at some point. However, as with Panagos and Prelock's (1982) study, the broad method of scoring makes it impossible to know *how* the sentence production of these typically developing children was affected: it could be that they were still able to mark syntactic components, but were unable to preserve the number of syllables in longer words (to be referred to as syllable integrity). This would suggest difficulties with phonological planning at the word level. Alternatively, specific syntactic components of the sentences may have been omitted.

It is interesting to note that Willis and Gathercole (2001) refer to sentence length in terms of the number of syllables. While this is one way of measuring sentence length, they do not distinguish between varying production load at the word level - in terms of the number of syllables in a word - and the sentence level, in terms of the number of words in a sentence. In fact, a review of the literature found no studies that have differentiated between manipulating load at the sentence and word level. In light of the discussions above, it is possible that varying the load in these two different ways may have different effects on the sentence production of children with speech disorders. This would have implications for models of sentence processing.

Overall, findings from the above studies suggest that increasing the production load at the word level affects the sentence production of both typically and atypically developing children. However, the processing mechanisms responsible for this effect in relation to adult models of sentence production, and the specific overt consequences on the sentence production of either group of children, remain unclear.

4.5 CONCLUSION

Until now, a systematic investigation of the relationship between speech disorders and sentence production has not been carried out. Limitations in adult sentence production models and how speech planning fits in, together with different views of the underlying deficits of speech disordered children, mean that we have no clear theoretical framework for considering this relationship. However, it is possible to investigate the relationship empirically – the goal of this study – and return to models and hypothesised deficits in light of the findings. Investigation may provide insight into the following issues:

- Whether difficulties hypothesised to occur at the level of phonological-phonetic encoding are associated with sentence-level problems in children.
- Whether manipulating the production load at different levels of processing, namely the word or sentence levels, will have varying effects on the sentence production of children with typical and atypical development, and what these effects will be.

PART II

PHASE 1 INVESTIGATIONS:

SENTENCE IMITATION ABILITIES

CHAPTER 5

METHODOLOGY

5.1 RESEARCH DESIGN

As concluded in Chapter 3, Section 3.10, this thesis uses a Sentence Imitation Task to assess the sentence-level abilities of children with CPD and IPD. To validate the task and place the performance of children with CPD and IPD in context, children with typical development were also included. In addition, a group of children with SLI were included, to compare the performance of the CPD and IPD groups with that of children known to have sentence-level difficulties.

The research design that was adopted in this study was a quasi-experimental design. The independent variables relating to the Sentence Imitation Task were: (i) the three syntactic categories: content words, function words, inflections; (ii) complexity; and (iii) length. The dependent variable was the percentage morphemes correct.

5.2 QUESTIONS

This study compares the sentence imitation performance of children with CPD and IPD to those with SLI and typical development (TD).

Specific questions were:

- Can the sentence imitation performance of children with typical development be differentiated from children with speech disorders and those with SLI, with regard to:
  - their overall scores on the three measures of syntactic performance (content words, function words and inflections)?
  - the effect on performance of manipulating the variables of length and complexity?
- Can the sentence imitation performance of children with speech disorders be differentiated according to the type of speech disorder, namely CPD or IPD?

- How does the sentence imitation performance of children with speech disorders compare with the performance of children with SLI?

5.3 PARTICIPANTS

5.3.1 RECRUITMENT

Participants with speech disorders or SLI were recruited through: (i) the Nuffield Hearing and Speech Centre in the Royal Throat, Nose and Ear Hospital; (ii) Redbridge Clinics and Mainstream Services; and (iii) Camden and Islington Clinics and Mainstream Services. General recruitment criteria were given to SLTs, who were asked to refer potential participants. The criteria were conveyed to SLTs primarily during face-to-face contact at team meetings at each site. In some cases, inclusion criteria were discussed with SLTs on the telephone. This was always followed up with written information.

For children with speech disorders, SLTs were asked to refer children who: (i) seemed to have a speech disorder; (ii) appeared to have age-appropriate receptive language skills; (iii) were between 4 and 7 years of age; (iv) came from English first-language home environments; (v) appeared to have average general cognitive ability; and (vi) did not appear to have any other communication or motor difficulties such as Autistic Spectrum Disorder, Attention Deficit Disorder or Cerebral Palsy.

For children with SLI, SLTs were asked to refer children who fulfilled criteria (ii)-(iv) above, but had expressive language as their primary difficulty and no significant speech difficulties.

Once potential participants were identified by the SLTs, they discussed the possibility of participation in the study with the children's parents or guardians. Standard project information sheets and consent forms were given out to the parents/guardians, together with a stamped addressed envelope. Once the parents/guardians had returned a signed consent form to the researcher, the researcher contacted them to thank them for their co-operation and to make the necessary arrangements for their child to be seen for a more detailed assessment as to his/her suitability for the study. When a

child was to be seen in his/her school, arrangements were made with the school by telephone.

Participants with typical language development were recruited through: (i) the schools which the children with speech disorders or SLI attended; and (ii) schools in the surrounding areas. Once a child with a speech disorder or SLI had been seen, his/her teacher was asked whether it would be possible to assess some of the children with typical language development in the class. In the case where participants with typical language development were recruited from surrounding schools, the head teacher was contacted and informed of the study and the recruitment criteria for inclusion for children with typical language development. Potential participants were those children who: (i) were between the ages of 4 and 7 years; (ii) appeared to have age-appropriate receptive and expressive language abilities; (iii) did not appear to have any communication or motor difficulties; and (iv) came from English first-language home environments.

Project information sheets for children with typical language development, as well as consent forms and stamped addressed envelopes, were given out to parents of all the children who were considered suitable candidates. Once the parents/guardians had returned a signed consent form to the researcher, the researcher contacted the teacher and made arrangements to assess the children during school hours.

5.3.2 INCLUSION CRITERIA

A more detailed assessment was then carried out to check each child's suitability and assign suitable children to speech subgroups for inclusion in the study.

To be included, each child's performance was required to meet the following general criteria:

- Receptive language ability: This was measured using the Test of Auditory Comprehension of Language (TACL-3)(Carrow-Woolfolk, 1999). All participants were required to obtain a composite score of above 85, which is within one standard deviation of the mean (standard score mean of 100 with a standard deviation of 15).

- Non-verbal ability: Initially two subtests of the Weschler Preschool and Primary Scale of Intelligence-Revised (WPPSI-Ruk)(Wechsler, 1990) were chosen. These were the Picture Completion Subtest and the Block Design Subtest. These subtests were chosen as they are highly correlated with the full-scale score of non-verbal ability (LoBello, 1991). However, the Block Design Subtest, which requires the child to analyse and physically reproduce patterns with two-coloured blocks, requires motor skills for the physical reproduction of patterns and it has been found that 'general motor' difficulties can be associated with certain types of speech disorders (Bradford & Dodd, 1994). The Picture Completion Subtest was therefore used to assess non-verbal ability. On this subtest, all participants were required to obtain a scaled score of 7 or above, which is within one standard deviation of the mean (scaled score mean of 10 with a standard deviation of 3).
- Oro-motor ability: All children participating in the study were required to obtain a standard score of 7 or above, which is within one standard deviation of the mean (scaled score mean of 10 with a standard deviation of 3) on each of the three components of the Oro-motor Screening Subtest of the DEAP: isolated movements, sequential movements and DDK.

In addition, specific criteria relating to each group of participants were as follows:

For the speech disordered groups of children:

- Nature of speech difficulty: Participants were required to have a speech disorder as opposed to a speech delay, where all phonological processes are developmental. In this study, a child with disordered speech had to use at least two processes that are not developmental (Bradford & Dodd, 1994; Dodd, 1995). They could be classified as having either (a) CPD, if at least two atypical phonological processes are applied consistently; or (b) IPD, where atypical errors occurred with no observable pattern and no noted articulatory groping on volitional phoneme production (Bradford & Dodd, 1994). The Phonology and Inconsistency Subtests of the DEAP (Dodd et al., 2002) were used to identify the children with speech disorders and assign them to the CPD and IPD groups. Children obtaining an inconsistency percentage of 40% or above on the DEAP are

classified as having IPD. Those with an inconsistency percentage below 40% are considered to have CPD.

For the SLI children:

- Expressive language difficulties: as referred by SLTs.
- Speech development: Participants were required to have age-appropriate speech development or speech delay (Bradford & Dodd, 1994; Dodd, 1995) as measured on the Phonology Subtest of the DEAP.

A summary of the criteria for group assignment is as follows:

Table 5.1 Criteria for group classification

	Receptive (TACL-3)	**Non-verbal** (WIPPS-Ruk Subtest: Picture Completion)	**Oro-motor** (DEAP Subtest: Oro-motor screening)	**Speech** (DEAP Subtests: Inconsistency & Phonology)	**Expressive** (SLT/teacher report)
	quotient	**scaled score**	**ave. std score**		**difficulties**
CPD	≥85	≥7	≥7	• ≥ 2 atypical processes • inconsistency <40%*	
IPD	≥85	≥7	≥7	• ≥ 2 atypical processes • Inconsistency >40%*	
SLI	≥85	≥7	≥7	Normal or delayed	Yes
TD	≥85	≥7	≥7	Normal or delayed	No

* where an inconsistency score fell between 36% and 44% – borderline IPD – a further qualitative analysis of the child's productions was carried out. If there was evidence of multiple error forms in the same context, the child was placed in the IPD group. Otherwise the child was placed in the CPD group.

5.3.3 DESCRIPTION OF PARTICIPANTS

Using the above criteria, 74 participants were selected. These broke down into 14 children with CPD, 14 with IPD, 13 with SLI and 33 with typical development (TD). Table 5.2 presents the numbers and genders of participants in each group together with the means and ranges of their age, receptive language ability and non-verbal screening ability.

Table 5.2 Profile of participants

	N	Gender		Age (months)		Receptive language (quotient)		Non-verbal screen (scaled score)	
		M	F	Mean	Range	Mean	Range	Mean	Range
CPD	14	12	2	61.1	48-73	108.4	91-128	12.5	8-17
IPD	14	11	3	61.9	48-71	100.6	85-124	11.3	8-16
SLI	13	10	3	56.5	48-72	100.9	85-124	11.9	8-14
TD	33	19	14	58.1	48-75	108.9	91-128	12.3	8-14

5.3.4 MATCHING

One-way analysis of variance tests found no significant differences between the four groups of participants on the three matching variables of age, receptive language and non-verbal ability.

5.4 PROCEDURE

Children were seen either at the speech clinic (site of referral) or in school, during school hours. Each session took place in a quiet room with minimal background noise. Each child was assessed for approximately 50 minutes, ideally within one session. If a child became fatigued the session was immediately terminated and the remainder of the assessment was completed during a second session that took place within one week of the first. The order of presentation was kept the same for all children. The outcomes of a pilot study (to be discussed in Section 5.8.4) revealed the following order of presentation to be the most effective in terms of motivating the children and maintaining their attention and co-operation:

- Inconsistency Subtest of the DEAP (first administration)
- Vocabulary Subtest of the TACL-3
- Grammatical Morpheme Subtest of the TACL-3
- Inconsistency Subtest of the DEAP (second administration)
- Phonology Subtest of the DEAP
- Sentence Imitation Task (experimental task)
- Elaborated Subtest of the TACL-3

- Oro-motor Subtest of the DEAP
- Picture Completion Subtest of the WPPSI-Ruk
- Inconsistency Subtest of the DEAP (third administration)

Standardised assessments were carried out according to procedures as specified in each test manual. The procedure for the administration of the Sentence Imitation Task is described in Section 5.8.3. Each child was rewarded with a sticker at the end of the session. The child's parents, teacher and/or SLT were sent a summary report of his/her performance, depending on prior arrangement with the parents.

5.5 RECORDING

All sessions were recorded using a digitial video camera (SONYTVR30E) with a stereo uni-directional clip-on electret condenser microphone (Sony ECM-TS125). The microphone was clipped onto the child's clothing approximately six centimetres below his/her chin. Panasonic mini digital video cassettes (Ay-DVM83PQ: 83 minutes) for professionals were used.

5.6 RESPONSES ON TASKS

Responses on the TACL-3 and WIPPSI-Ruk subtests were recorded online during the session, while transcription of responses on the DEAP subtests (Phonology, Inconsistency and Oro-motor), as well as the Sentence Imitation Task, was carried out from recorded material.

5.7 DATA CAPTURE AND SCORING

In order to facilitate the transcription and scoring of speech data, session recordings were edited, saving only the recordings of tasks themselves. These edited 'clips' were then transferred onto CD-ROM. The process of editing and transferring the data was as follows:

- The digital video camera was connected to a desktop computer via a FireWire/i.LINK. Video clips were captured onto the computer in AVI format

using a digital video editing programme, Adobe Premiere version 6.0. The Adobe Premier version 6.0 settings were: Standard PAL video (4:3 interlaced); 32kHz (12/16 bit) audio.

- The conversion engine TMPGEnc version 2.5 was used to convert the edited video clips from the AVI format to an MPEG format for ease of storage.
- MPEG files were then 'burned' onto a CD-ROM (Sony CD-R 700MB) using the Nero 5 Burning Rom CD-ROM-burning software. Each CD-ROM contained two children's data.

The speech data from the Inconsistency and Phonology Subtests and the Sentence Imitation Task were then transcribed phonetically and scored by the researcher (an SLT). Transcription was aided by the use of a video analysis tool: DHCS Videolab. This tool allows 'playback loops' of varying duration to be set up, so extremely short excerpts can be listened to repeatedly in order to facilitate more accurate transcription. To determine inter-rater reliability, the speech data of two randomly selected children from each speech-disordered group were then independently transcribed and scored by a final-year SLT student. The sentence imitation data from five randomly selected participants were independently transcribed and scored by a linguist with phonetics training.

5.8 EXPERIMENTAL TASK: SENTENCE IMITATION

5.8.1 SELECTION OF STIMULI

The aim of this task was to evaluate the syntactic abilities of children with speech disorders through sentence imitation. Therefore, stimuli were designed to minimise the effects that variables other than syntactic ability could have on their performance. The following variables were considered:

SEMANTICS

Word frequency and familiarity

Words used were familiar to the participants to ensure that the task did not become a non-word repetition task. Non-word repetition can produce different results from real-word repetition (Gathercole & Baddeley, 1996). Stimulus words were taken from:

- The vocabulary checklist section of the MacArthur Communicative Developmental Inventory (Fenson, 1993), from both the 'Words and Gestures', and 'Words and Sentences' forms. These inventories were designed for use with children between the ages of 8 and 16 months, and 16 and 30 months, respectively.
- The 'early' and 'very early acquired' words (nouns and verbs) from the rated age-of-acquisition matched lists from 'An Object and Action Naming Battery' (Druks & Masterson, 2000).

Semantic concepts

The stimuli were constructed in such a way that they conveyed familiar, though not totally predictable, situations, such as 'Sammy saw his toy in the shop.' This was done to reduce the role of semantic complexity on performance, so that the role of length and syntactic complexity were more apparent.

PHONOLOGY

The primary objective of this task was to assess the participants' sentence-level production. Therefore, all variables that might increase speech production difficulty at a word level were controlled. These included:

Word length

The length of the nouns included in the task was either one syllable or two syllables with initial stress. This is most typical of English nouns (Stoel-Gammon, 1998). The length of the verbs was either one syllable or two syllables to indicate tense. The length of adjectives was either one or two syllables, and all prepositions contained one syllable apart from *under* with two syllables.

Phonotactic structure and phoneme range

Phonotactic structures were kept as developmentally simple as possible, with nouns having one of the following vowel/consonant phonotactic structures: VC / CV / CVCV / CVC / CVCVC. These phonotactic structures were also used wherever possible in relation to verbs and adjectives. This meant that, in general, consonant clusters were avoided. In four instances where consonant clusters were used, only the earliest developing clusters were included, such as post-vocalic nasals followed by a stop (Grunwell, 1981). Words containing these clusters included those words ending in the morpheme *n't*, as well as *found*, *want*, and *Monday*. Later developing phonemes, such as affricates, were not included.

Phonological forms

Morphemes are the most basic syntactic elements of utterances and performance on this task was determined primarily by the marking of morphemes. The objective, therefore, was to make morpheme distinctions as salient as possible by placing them in contexts where they are less liable to 'blurring' by assimilation, for example avoiding noun plurals ending in 's' followed by a word starting with 's'.

5.8.2 EXPERIMENTAL VARIABLES

SYNTAX

Sixty-one stimuli were constructed for this task: ten imperatives, five questions and forty-six statements. These stimuli were constructed according to a graded developmental syntactic hierarchy, as outlined on the LARSP (Crystal, 1982). Stimuli were spread across the LARSP stages as follows:

Table 5.3 Syntactic breakdown of stimuli (LARSP)

Stage	Clauses	Phrases	Words
II (1.6-2.0yrs)	13	27	10
III (2.0-2.6yrs)	21	48	15
IV (2.6-3.0yrs)	20	5	5
V (3.0-3.6yrs)	5	6	0
VI (3.6-4.6yrs)	1	0	0
Total	60	86	30

As shown in Table 5.3, the syntactic level of the stimuli ranged from an age equivalent of 18 months to 3.6 years, with one clause, a passive clause falling into Stage VI, acquired between 3.6 and 4.6 years of age. Thus, it would be expected that children from 4 years of age would experience no difficulties understanding and imitating these stimuli.

Syntactic-semantic clarification

Morphemes within the stimuli were classified into the three broad syntactic categories of content words, function words and inflections. Almost all the words contained in the Sentence Imitation Task can be clearly classified into a syntactic category. Content words included nouns, verbs, adjectives and adverbs. Function words included prepositions, pronouns, auxillaries, copulars, determiners, conjunctions and subordinates. Inflections included verb suffixes such as third person singular agreement; past tense markers; present tense continuous markers; contracted 'n't', and plurals.

In some cases, however, classification was less clear. For example, 'her' is syntactically classified as a pronoun. However, depending on the position in a sentence it may act as a determiner, as in the phrase 'in her book'. Syntactic components that were affected by this included:

- Determiners: these were divided into possessive determiners, for example 'in *my* book' and non-possessive determiners, for example 'in *the* book'.
- Pronouns: these were divided into possessive pronouns, for example 'mine', and non-possessive pronouns, for example 'he'.

COMPLEXITY

As syntactic complexity has been found to affect sentence imitation performance (Panagos & Prelock, 1982), this variable was manipulated: the task contained 51 stimuli that were simple in construction with no embedded or co-ordinated clauses, for example 'A cat was under the bus', and 10 that were complex constructions with an embedded verb phrase or sentence, for example 'We can't see if the shop is open'. The complex constructions were placed in sentences ranging from six to nine words

and there were 18 simple constructions of similar length. This allowed a comparison of performance on simple (n=18) and complex (n=10) utterances to be made.

LENGTH OF UTTERANCES

As length affects the linguistic load of an utterance, it was essential that this experimental variable be manipulated to determine its effect on performance. In this study, this variable was measured in terms of the number of words in a sentence.

The stimuli were made up of between two and nine words. In order to determine the effect of sentence length on performance, stimuli were classified according to the number of words they contained, as either short or long utterances. Length was investigated categorically by dividing stimuli into short and long utterances. A comparison of performance on short versus long utterances could then be made: 28 stimuli were considered short in length, containing from two to four words, and 28 were considered to be long utterances, containing from six to nine words.

Table 5.4 Breakdown of stimuli by length

Number of words	Number of stimuli
2-4	28
5	5
6-9	28

The full set of stimuli is presented in Appendix 1.

5.8.3 ADMINISTRATION

ORDER

Two one-word practice trials were included at the start of the task to ensure that the child understood what was expected from him/her. The stimuli were presented in a fixed order: the 51 simply constructed stimuli were presented in ascending order from two-word to nine-word utterances. Thereafter, the set of 10 complex stimuli, with six to nine words, were presented in ascending order.

DELIVERY

It is acknowledged that recorded speech is the ideal method of delivery to ensure consistency of delivery. However, due to the age of the participants and length of the task, all efforts were made to maintain the child's motivation, attention and participation in the task. For this reason stimuli were presented live by the researcher. While stimuli were not presented with a neutral tone, the researcher practised beforehand in order to ensure that the presentation of stimuli was kept as constant as possible. A bias for or against children with different speech disorders was prevented because at the time of testing the researcher did not know into which group the child's speech would be classified, since the Inconsistency Subtest had only been administered twice prior to the administration of the Sentence Imitation Task, which meant that the inconsistency score had not been calculated.

SCORING

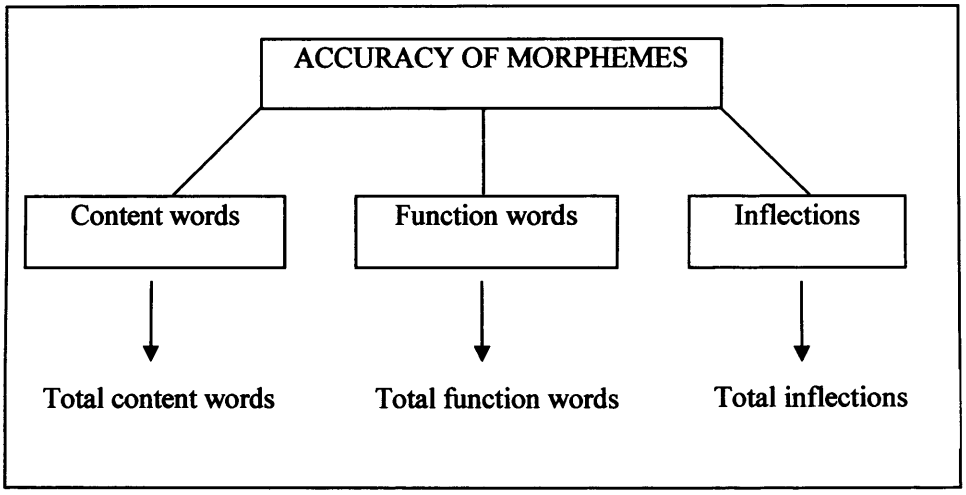

Figure 5.1 Breakdown of scoring sheet

As reflected in Figure 5.1, the scoring of morphemes was divided into three syntactic categories: content words, function words and inflections. Each content word, function word and inflection in each stimulus was scored as correct or incorrect. One point was awarded for each morpheme produced correctly. Scores across stimuli were then summed to give the total content word, function word and inflection scores. All

totals were represented as a percentage of the total target morphemes included in this task.

As mentioned previously, the speech production of children with severe speech difficulties can lead to the distortion of morphemes and hence provides a challenge to the scorer when assessing the accuracy of production in relation to the target morphemes. A scoring system was devised that would allow for the speech intelligibility issues of these children and reflect their syntactic ability as far as possible. The morphemes produced by each child were analysed and scored in the following way:

Content and function words

In order to be credited for the production of a morpheme, a child's production had to fulfil one of the following minimum requirements:

- The presence of the correct[3] consonant/s and the correct (or similar[4]) vowel, for example [pei] for *face*, [mau] for *mouse*.
- The presence of the syllable shape of the target word, with either the correct (or similar) vowel, for example [dɛk] for *get*; [hʊs] for *shoes*; or all correct consonants, for example /wʌs/ for *was*.
- The presence of the correct initial consonant with interference from a word preceding or following it, for example [huʃ shuz] for *her shoes*.

Inflections

The marking of inflections, which contain only one or two phonemes, may be challenging for a child who has difficulty producing particular consonants, such as /s/.

3 Correct: consonants that were produced accurately or where a clear relationship was evident between the child's sound system (as determined by performance on the Phonology and Inconsistency Subtests of the DEAP) and the target, for example [ɪt] for *is* produced consistently would suggest that the process of stopping and devoicing is operating in the child's system and therefore this production of *is* would be marked as correct.

4 A similar vowel is one which maintains the same length and is judged to be within the same quadrant of the vowel space as the target vowel.

Therefore, the child was credited for the production of the inflection if there was evidence of:

- The presence of a consonant in some form, for example /hɔdəd/ for *horses*.

In the case of irregular past tense verbs were past tense is marked by the vowel, the child was credited for marking the verb and marking of the past tense, for example [eit].

ANALYSIS

Scores on the Sentence Imitation Task were converted to percentages (to one decimal place) due to unequal numbers of instances in each syntactic category and at each level of stimulus length.

The scores of the TD group of children were analysed descriptively first and then compared to the three other groups of children, CPD, IPD and SLI, using non-parametric analyses. Mixed analyses of variance procedures were carried out when comparing the performance of the CPD, IPD and SLI groups.

5.8.4 PILOTING

The design and procedure of the study, as described above, was developed following a pilot study on ten children with typical development, and two children with speech disorders who fulfilled the criteria for inclusion in the study.

The following elements were not part of the original design of the study, but were added or adjusted based on the outcomes of the pilot study:

- Additional stimuli: As one of the children with a speech disorder and all the children with typical development who participated in the pilot study performed at ceiling on the Sentence Imitation Task, a decision was taken to add a set of ten sentences containing complex syntactic constructions to the task. This allowed for a comparison to be made between the children's performance on simply constructed sentences and sentences containing complex syntactic constructions

as noted above. Hence the effect of complexity on performance could be determined.

- Order of tasks: A number of different options were trialled in the pilot study relating to the order of presentation. It was felt that the final order of administration (detailed in Section 5.4) was the most successful in maintaining the children's interest and focus.

- Order of stimuli on the Sentence Imitation Task: Initially, stimuli of different lengths were presented in a random order. The children with speech disorders soon became discouraged when they were not able to imitate stimuli presented early in the task. Therefore, the order of stimuli was rearranged so that they progressed from least to most challenging: from two-word utterances to simple nine-word utterances, followed by complex six- to nine-word utterances.

- Location: The first six children with typical development were assessed in a 'quiet' area of their classroom. Upon listening to the recordings it became clear that the background noise level in the classroom interfered with the clarity of recording – an essential requirement for the recording of speech data. It was therefore decided that all sessions would be carried out in a separate room with only the researcher, child and parent or teacher present.

- Number of sessions: In most instances the children who took part in the pilot study remained focused and motivated to carry out all the tasks in one session lasting approximately 50 minutes. However, where a child showed signs of fatigue or lack of motivation to continue carrying out the tasks, the session was terminated. A second session took place within a week and the remaining tasks were carried out. This 'modus operandi' was adopted throughout the study.

CHAPTER 6

RESULTS

6.1 OVERVIEW OF PRESENTATION

Before presenting the main results of the study, reliability of the data is considered. The results of the TD group are presented and compared to those of the other groups. Then the analyses of the experimental groups are presented: as the primary aim of the study is to compare the two speech disordered groups of children, an analysis of their data alone is presented before a further analysis compares them to the SLI group.

6.2 INTER-RATER RELIABILITY

Inter-rater reliability was considered on the following data:

INCONSISTENCY

A Cohen's Kappa (Cohen, 1960) was used to determine the level of agreement (corrected for chance) between the two raters on each of the 25 items in the Inconsistency Subtest of the DEAP. This was carried out for two randomly selected participants from each of the two speech disordered groups. A value of 0.72 was obtained, which is considered to be a good level of agreement (Fleiss, 1981) between the two raters.

PHONOLOGICAL ACCURACY

The phonological accuracy scores of four participants, two randomly selected from each speech disordered group, were compared. This was done for the percentage consonants correct (PCC) and percentage vowels correct (PVC). Due to the small numbers, correlations were not carried out. However, as shown in Table 6.1, there was high agreement between the raters for both PCC and PVC scores at different levels of accuracy.

Table 6.1 Phonological accuracy scores for four children: two from each speech disordered group

	PCC		PVC	
	Rater 1	**Rater 2**	**Rater 1**	**Rater 2**
E23	35.9%	44%	86%	82%
E26	61.6%	62%	96%	94.7%
E27	80.7%	87.1%	97.4%	96.1%
E34	55.4%	63%	93.4%	90.7%

SENTENCE IMITATION

Pearson's *r* correlations were determined for raters' scoring of content words, function words and inflections on each of the 61 sentences in this task for five randomly selected participants: two from each speech disordered group and one from the group of children with SLI. Results showed the mean agreement between the two raters for content words to be $r(59)=.876$ ($p<.01$) with a range of .82 to .92; for function words to be $r(59)=.77$ ($p<.01$) with a range of .74 to .81; and for inflections to be $r(59)=.788$ ($p<.01$) with a range of .75 to .84.

6.3 TD GROUP

The first question this study was designed to address is:

Can the sentence imitation performance of children with typical development be differentiated from children with speech disorders and those with SLI , with regard to:

- *their overall scores on the three measures of syntactic performance (content words, function words and inflections)?*
- *the effect on performance of manipulating the variables of length and complexity?*

6.3.1 DESCRIPTIVE RESULTS

Table 6.2 presents descriptive statistics for the 33 TD children.

Table 6.2 TD group performance on the Sentence Imitation Task

	Content words	Function words	Inflections
Mean	99.9%	99.6%	99.3%
Std deviation (SD)	.31	.66	1.3
Range	98.7-100%	96.9-100%	94.9-100%
Skewness	-2.18	-2.4	-1.7

Table 6.2 shows that the TD Group's means were above 99% for all three syntactic categories. Hence, these results show that children with typical development completed the Sentence Imitation Task with no or little difficulty. Also, as they scored at or almost at ceiling overall, their performance could not have been affected by the manipulation of the experimental variables of complexity and length.

The standard deviations and ranges for all three categories were extremely small and their distributions were negatively skewed. Based on these ceiling effects, it is clear that the design of the Sentence Imitation Task dictates that the closer to 'typical' the population group attempting this task is, the more negatively skewed its distribution will be.

6.3.2 TD GROUP COMPARED WITH SLI AND SPEECH DISORDERED GROUPS

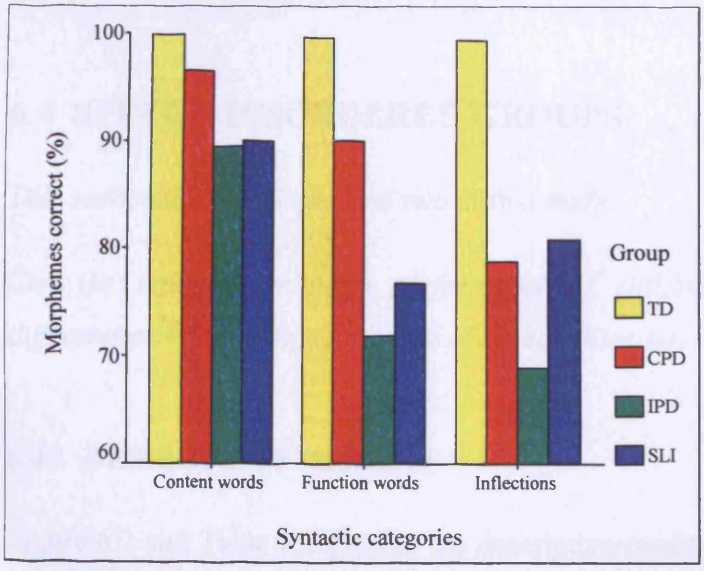

Figure 6.1 Sentence imitation performance of all groups

The results of the TD group were compared to those of the children with SLI and speech disorders. Figure 6.1 shows that the TD group obtained the highest mean scores for all three syntactic categories. As the scores obtained by the CPD group were the most similar to the TD group for content and function words, a comparison of the two groups' performance on these two categories was carried out. Similarly, since the inflection score obtained by the SLI group was most similar to the TD group score, a comparison of these two scores was carried out. As assumptions were not met for parametric analyses to be carried out, Mann-Whitney tests were used.

The Mann-Whitney tests revealed significant differences between the TD group and the CPD group on content words ($U=54$ $p<0.001$) and function words ($U=37$ $p<0.001$) and between the TD group and the SLI group on inflections ($U=8.5$ $p<0.001$).

6.3.3 SUMMARY

The TD group's results and comparisons with the other groups show that the sentence imitation performance of children with typical development can be differentiated from children with speech disorders and those with SLI, with regard to their overall scores on content words, function words and inflections, since they perform significantly better than the other three groups on all three measures. Based on these results, the TD group was excluded from further analyses.

6.4 SPEECH DISORDERED GROUPS

This section addresses question two of this study:

Can the sentence imitation performance of children with speech disorders be differentiated according to the type of speech disorder, CPD or IPD?

6.4.1 DESCRIPTIVE RESULTS

Figure 6.2 and Table 6.3 present the descriptive results for the CPD (n=14) and IPD (n=14) groups.

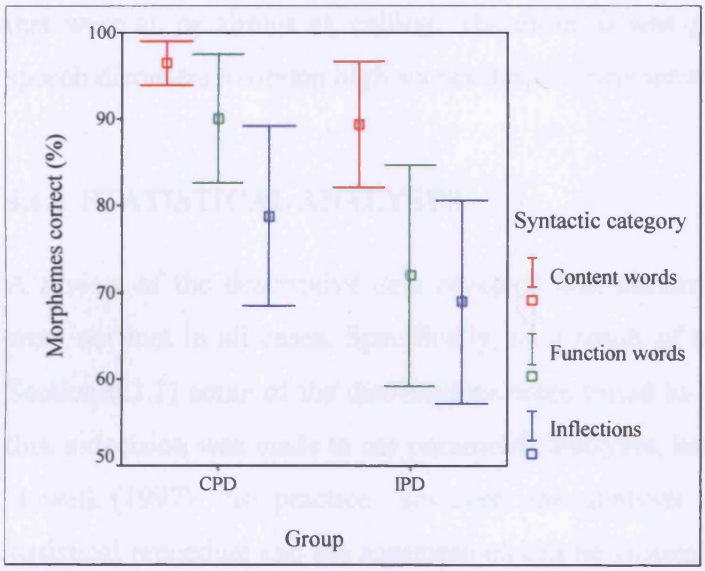

Figure 6.2 Percentage morphemes correct by syntactic category: CPD and IPD

Table 6.3 Performance on Sentence Imitation Task: CPD & IPD

	Content words		Function words		Inflections	
	CPD	**IPD**	**CPD**	**IPD**	**CPD**	**IPD**
Mean	96.5%	89.4%	90	71.9%	78.8%	68.9%
SD	4.4	12.6	12.8	22.1	18	20.31
Range	85.4-100%	58-100%	49.7-100%	29.6-98.7%	35.9-100%	23.1-97.4%

Figure 6.2 and Table 6.3 show that the CPD group obtained extremely high scores (means 78.8%-96.5%) on all three syntactic categories, and its means and medians were higher than those obtained by the IPD group. Both groups had the smallest range of scores for content words. The IPD group had an extremely wide range of scores for function words (29.6%-98.7%). This issue of heterogeneity within the IPD group is addressed in the investigations in Phase 2, where single case studies are carried out. In this study, the performances of children with IPD were analysed as a group.

Both the CPD and IPD group's scores were most wide-ranging for inflections (CPD=35.9%-100%; IPD=23.1%-97.4%). The wide range evident for the CPD group for function words in Table 6.3 (49.7%-100%) is deceptive as the score 49.7% is an outlier. The child who obtained this score was extremely shy and withdrawn during the assessment, and his score quite obviously did not reflect his expressive language potential demonstrated by his spontaneous productions during the session. Excluding this outlier the range is 82.4%-100%. Some children in both groups obtained scores

that were at, or almost at, ceiling. Therefore, it was possible for children with IPD speech disorders to obtain high scores despite their inconsistencies.

6.4.2 STATISTICAL ANALYSES

A review of the descriptive data revealed that assumptions for parametric analyses were not met in all cases. Specifically, as a result of task construction (discussed in Section 6.3.1) some of the distributions were found to be negatively skewed. Despite this, a decision was made to use parametric analyses, based on the case put forward by Howell (1997): "in practice, however, the analysis of variance is a very robust statistical procedure and the assumptions can be violated with relatively minor effects. This is especially true for the normality assumption... in general, if the populations can be assumed to be symmetrical or at least symmetrical in shape e.g. all negatively skewed, and if the largest variance is no more than four times the smallest, the analysis of variance is most likely to be valid". The performance of the CPD and IPD groups was compared on the three experimental variables: syntax, complexity and length.

SYNTAX

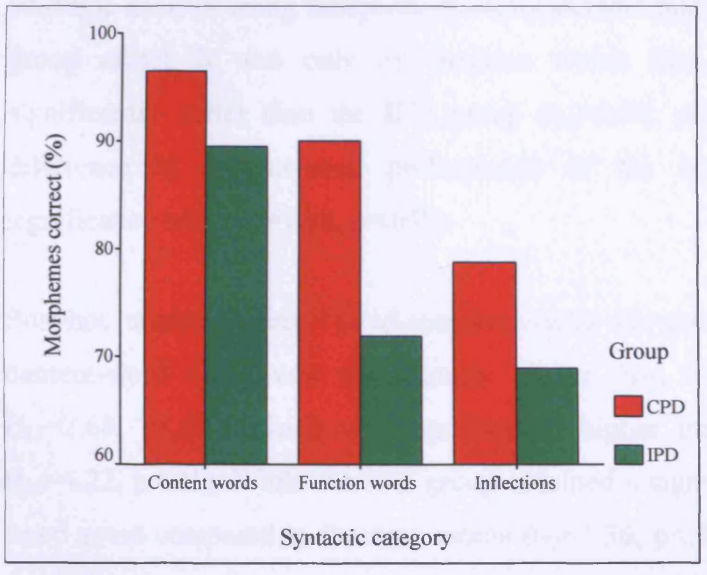

Figure 6.3 Percentage morphemes correct by syntactic category: CPD and IPD

A two-factor mixed ANOVA was used. The between factor was the group with two levels (CPD, IPD) and the within factor was the syntactic category with three levels (content words, function words, inflections). Both main effects were significant (group: $F_{1,26}$=4.42, p<.05 and syntactic category: $F_{1,26}$=54.231, p<.001). Their interaction was also significant ($F_{2,52}$=3.39, p<.05). The interaction effect is illustrated in Figure 6.4.

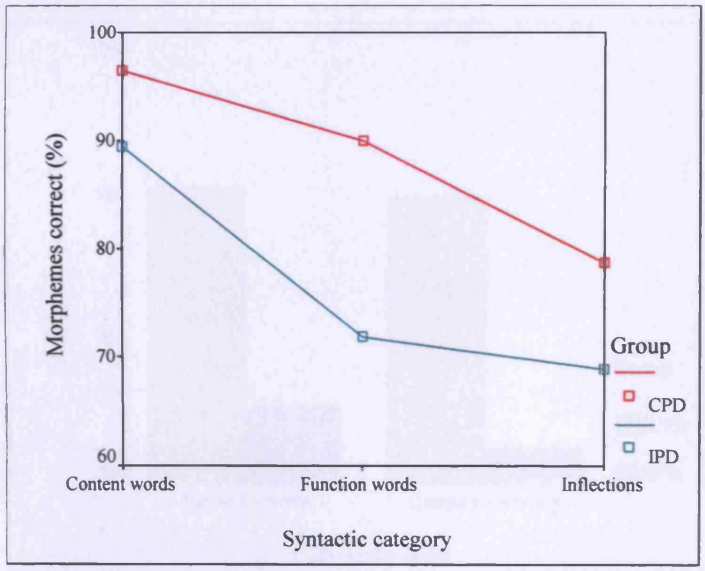

Figure 6.4 Interaction between group performance and syntactic category for CPD and IPD groups

Post hoc analysis using Independent *t*-tests showed that although there was an overall group effect, it was only on function words that the CPD group performed significantly better than the IPD group (t_{26}=2.65, p<0.05). It was noted that the difference in content-word performance of the two groups was approaching significance with (t_{26}=1.98, p=.059).

Post-hoc analysis using Paired-samples *t*-tests showed that the CPD group's mean content-word score was significantly higher than its mean function-word score (t_{13}=2.68, p<.05), which was significantly higher than its mean inflection score (t_{13}=4.22, p<.01). While the IPD group obtained a significantly higher mean content-word score compared to function words (t_{13}=5.36, p<.01), the difference between its mean function-word and inflection score was not significant.

These results show that the performance of the CPD group is significantly better than the IPD group overall. Inflections are most vulnerable for the CPD group, followed by function words and then content words. Inflections and function words are equally vulnerable for the IPD group.

COMPLEXITY

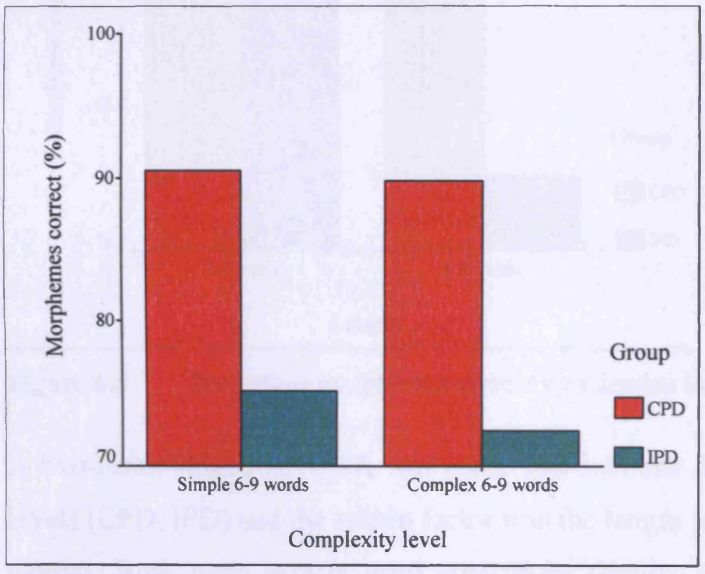

Figure 6.5 Percentage morphemes correct by complexity level: CPD and IPD

A two-factor mixed ANOVA was used. The between factor was the group with two levels (CPD, IPD) and the within factor was the complexity with two levels (6-9 words simple, 6-9 words complex). Only the main effect of group was significant ($F_{1,26}$= 5.52, p<.05). The interaction effect was not significant.

Post hoc analysis using Independent *t*-tests showed that the CPD group of children obtained significantly higher scores on both the simple stimuli (t_{26}= 2.34, p<.01) and complex stimuli (t_{26}= 2.29, p<.01).

Thus, while manipulating the variable of complexity did not significantly affect the performance of either group of speech disordered children, the CPD group performed significantly better than the IPD group in both cases.

LENGTH

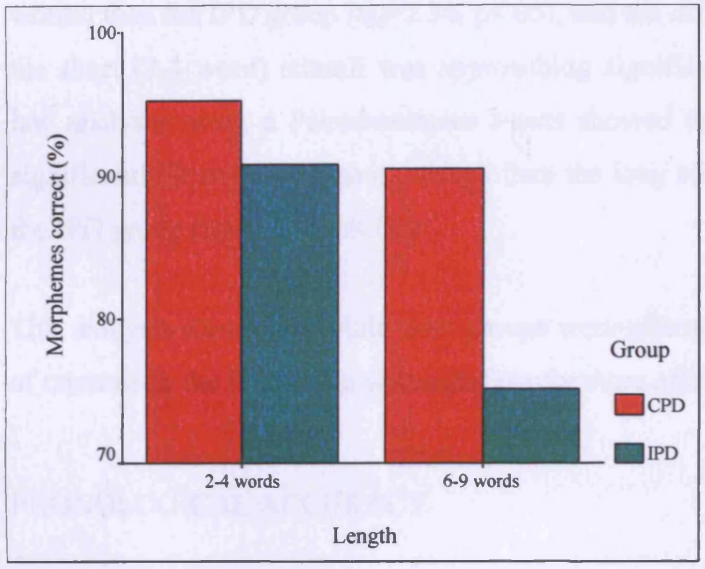

Figure 6.6 Percentage morphemes correct by stimulus length: CPD and IPD

A two-factor mixed ANOVA was used. The between factor was the group with two levels (CPD, IPD) and the within factor was the length with two levels (2-4 words, 6-9 words). Both main effects were significant (group: $F_{1,26}$=5.73, p<.05 and length: $F_{1,26}$= 15.48, p<.01). Their interaction was also significant ($F_{1,26}$= 4.36, p<.05). The interaction effect is illustrated in Figure 6.7.

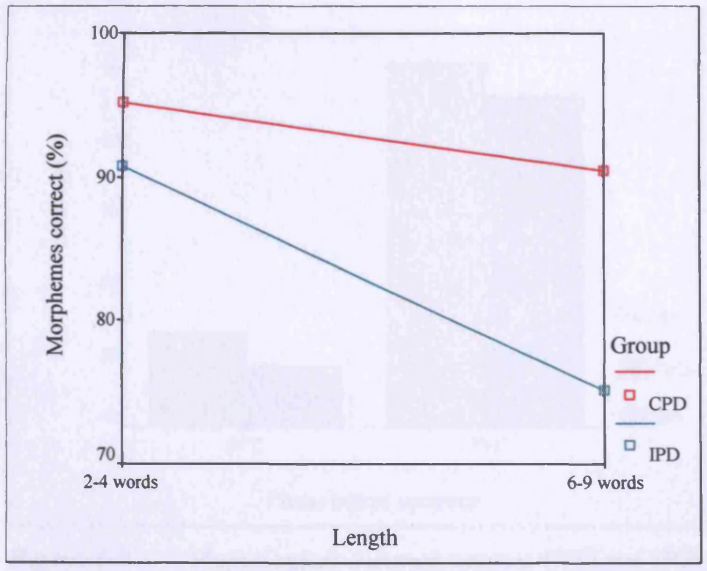

Figure 6.7 Interaction between group performance and stimulus length for CPD and IPD groups

The interaction suggests that length had a much stronger effect on the IPD group. This was confirmed by post hoc analyses. Post hoc analysis using Independent *t*-tests showed that the CPD group was significantly better able to imitate longer stimuli (6-9 words) than the IPD group (t_{26}=2.34, p<.05), and the difference between the scores for the short (2-4 word) stimuli was approaching significance (t_{26}=2.037, p=.052). Post hoc analyses using a Paired-samples *t*-tests showed that the CPD group performed significantly better on the short stimuli than the long stimuli (t_{13}=-2.88, p<.05), as did the IPD group (t_{13}= -3.18, p<.01).

This analysis shows that while both groups were affected by an increase in the length of utterances, the IPD group was significantly more affected.

PHONOLOGICAL ACCURACY

It is possible that the performance of the IPD children is simply due to poor phonological accuracy scores compared with those of the CPD children. If they realise fewer phoneme targets correctly, this could have repercussions on their realisation of target morphemes. To address this possibility, the phonological accuracy of the two groups was compared in terms of PCC and PVC. Figure 6.8 shows the PCC and PVC scores for the two groups.

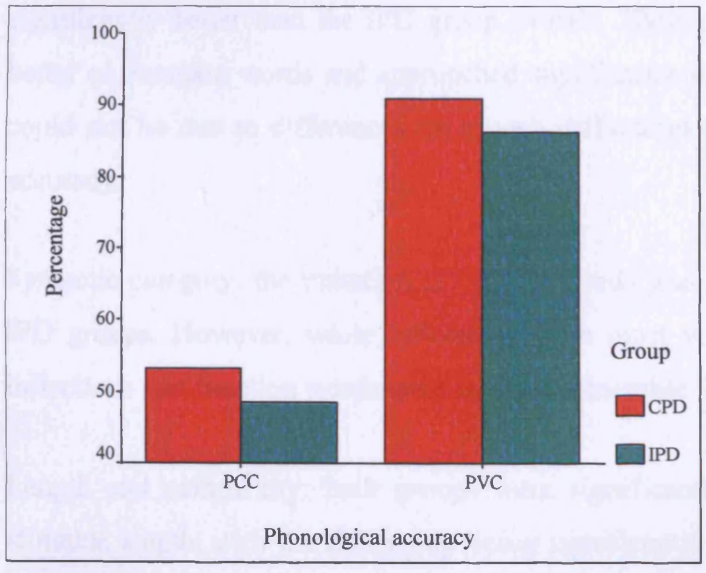

Figure 6.8 Phonological accuracy scores: CPD and IPD groups

A two-factor mixed ANOVA was used. The between factor was the group with two levels (CPD, IPD) and the within factor was the phoneme type with two levels (PCC, PVC). Only the main effect of phoneme type was significant ($F_{1,26}$= 250.19, p<.001). There was no interaction effect.

Post hoc analysis using Paired samples *t*-tests showed that the PVC score was significantly higher than the PCC score for both the CPD (t_{13}=-9.06, p=.001) and IPD (t_{13}=-15.96, p=.001) groups.

Therefore, while both groups obtained significantly higher PVC than PCC scores, their scores were not significantly different. Hence, the differences found between the two groups on the Sentence Imitation Task could not be attributed to phonological accuracy. The possible effects of speech difficulties will be addressed again in Chapter 8.

6.4.3 SUMMARY

A summary of results comparing the performance of the CPD and IPD groups is as follows:

Comparison of CPD and IPD groups: the performance of the CPD group was significantly better than the IPD group overall. Their performance was significantly better on function words and approached significance on content words. Differences could not be due to differences on speech difficulties as measured by phonological accuracy.

Syntactic category: the imitation of content words was highest for both the CPD and IPD groups. However, while inflections were most vulnerable for the CPD group, inflections and function words were equally vulnerable for the IPD group.

Length and complexity: both groups were significantly affected by an increase in stimulus length, with the IPD group being significantly more affected. Neither group was significantly affected by the manipulation of complexity.

6.5 COMPARISON OF SPEECH DISORDERED GROUPS AND SLI GROUP

This section addresses the third question of this study:

How does the sentence imitation performance of children with speech disorders compare with the performance of children with SLI?

Having compared the performance of the two speech disordered groups, the analyses in this section focus on the performance of these groups *relative* to the SLI group.

6.5.1 DESCRIPTIVE RESULTS

Figure 6.9 and Table 6.4 present the descriptive results for the SLI group (n=13) and the speech disordered groups (n=14 in each group).

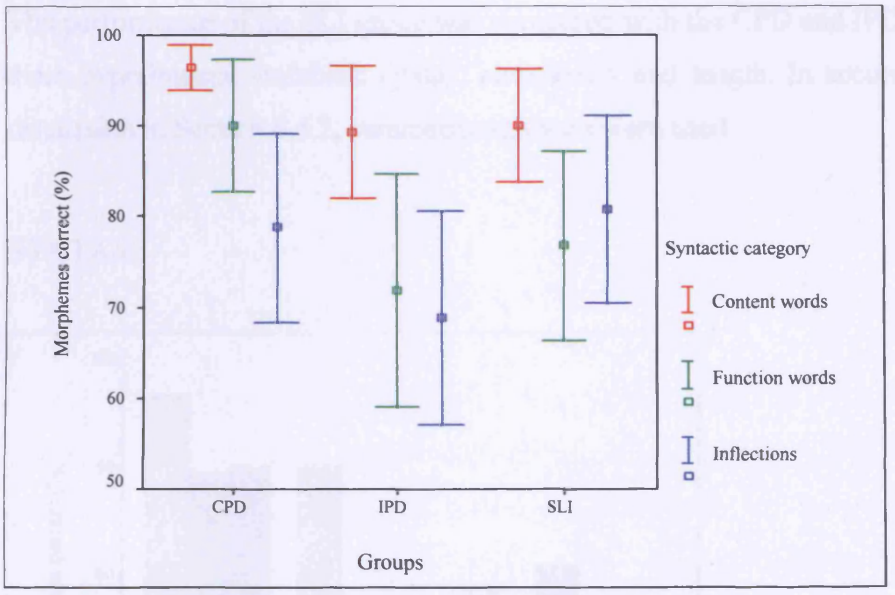

Figure 6.9 Percentage morphemes correct by syntactic category: CPD, IPD and SLI

Table 6.4 Performance on Sentence Imitation Task: CPD, IPD and SLI

	Content words			Function words			Inflections		
	CPD	IPD	SLI	CPD	IPD	SLI	CPD	IPD	SLI
Mean	96.5%	89.4%	90%	90%	71.9%	76.8%	78.8%	68.9%	80.8%
SD	4.4	12.6	10.4	12.8	22.1	17.4	18	20.3	17.0
Range	85.4-100%	58-100%	65-99%	49.7-100%	29.6-98.7%	34.6-97.4%	29.6-98.7%	35.9-100%	23.1-97.4%

The SLI group scored lower than the CPD group and higher than the IPD group for content and function words, while their mean inflection score was higher than both groups.

Like the two speech disordered groups, the SLI group obtained the smallest range of scores for content words. Like the IPD group, wide ranges of scores were obtained for function words and inflections.

The SLI group performed slightly better on inflections than function words. This is a different pattern from the speech disordered groups, where inflections were at least as vulnerable as function words (IPD group) or more vulnerable than functions words (CPD group).

6.5.2 STATISTICAL ANALYSES

The performance of the SLI group was compared with the CPD and IPD groups on the three experimental variables: syntax, complexity and length. In accordance with the discussion in Section 6.4.2, parametric analyses were used.

SYNTAX

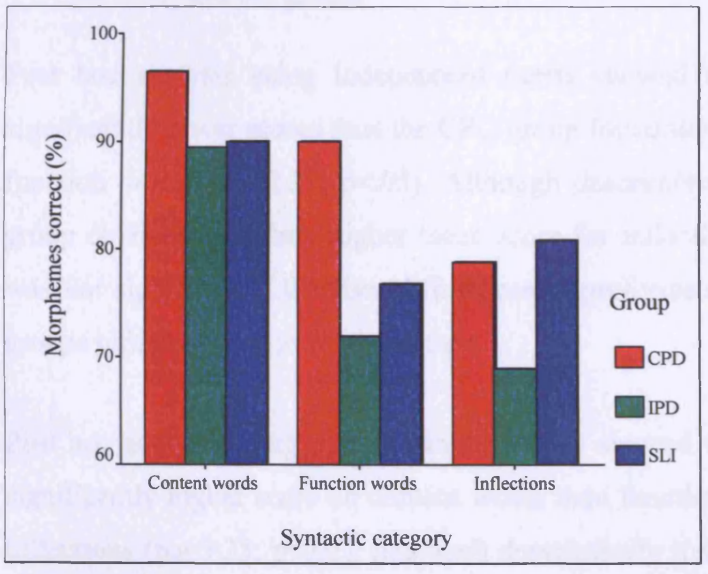

Figure 6.10 Percentage morphemes correct by syntactic category: CPD, IPD and SLI

A two-factor mixed ANOVA was used. The between factor was the group with three levels (CPD, IPD, SLI) and the within factor was the syntactic category with three levels (content words, function words, inflections). The main effect of syntactic category was significant ($F_{1,38}$=63.22, p<.001), as was the interaction effect ($F_{4,38}$ =4.62, p<.01). The main effect of group was not significant. This could be due to the fact that the mean scores of the SLI group were between the CPD and IPD groups' content and function word scores, as well as the general variability in the IPD and SLI groups' scores. The interaction effect is illustrated in Figure 6.11.

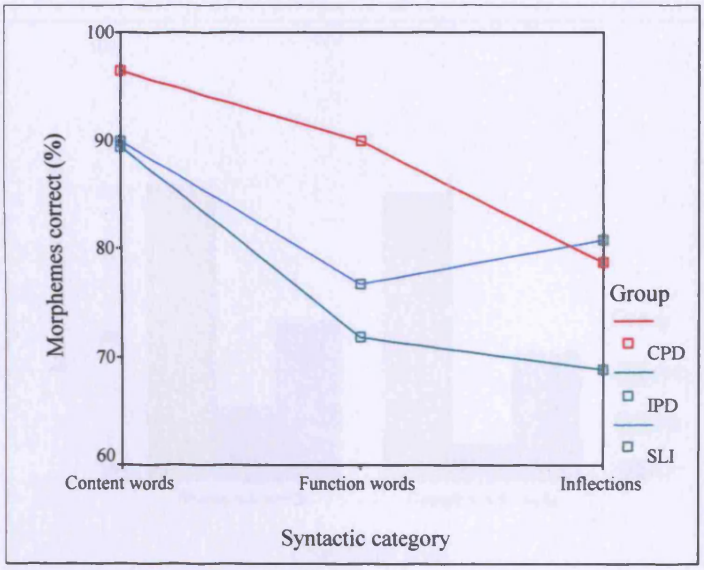

Figure 6.11 Interaction between group performance and syntactic category for CPD, IPD and SLI groups

Post hoc analysis using Independent *t*-tests showed that the SLI group obtained significantly lower scores than the CPD group for content words (t_{25}=2.12, p<.05) and function words (t_{25}=2.27, p<.05). Although descriptively it was noted that the SLI group obtained a slightly higher mean score for inflections than the CPD group, this was not significant. Likewise, differences in performance between the IPD and SLI groups turned out not to be significant.

Post hoc analysis using Paired-samples *t*-tests showed that the SLI group obtained a significantly higher score on content words than function words (t_{12}=4.53, p<.01) and inflections (t_{12}=3.25, p<.01). Although descriptively it was shown that the SLI group scored slightly better on inflections than function words, this was not found to be significant.

These results therefore show that overall, the performance of the SLI group was most similar to the performance of the IPD group. The SLI group performed worse than the CPD group on content and function words. The three groups could not be differentiated based on their inflection scores. This could be due to the fact that all three groups obtained relatively low scores for inflections, with significant variability within each group.

COMPLEXITY

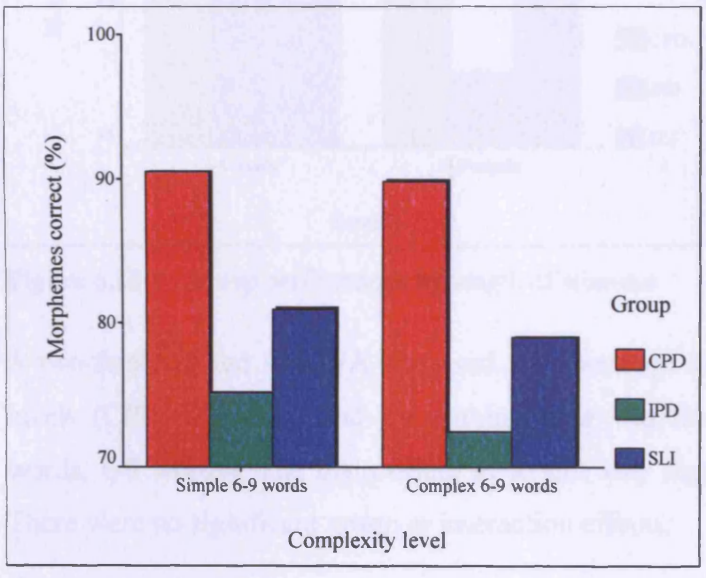

Figure 6.12 Percentage morphemes correct by complexity level: CPD, IPD and SLI

A two-factor mixed ANOVA was used. The between factor was group with three levels (CPD, IPD, SLI) and the within factor was complexity with two levels (simple, complex). There were no significant main or interaction effects. While descriptively the SLI group obtained slightly higher scores than the IPD group and lower scores than the CPD group, these were not statistically significant.

These results suggest that the SLI group did not perform significantly differently from either the CPD or IPD groups on simple or complex stimuli.

LENGTH

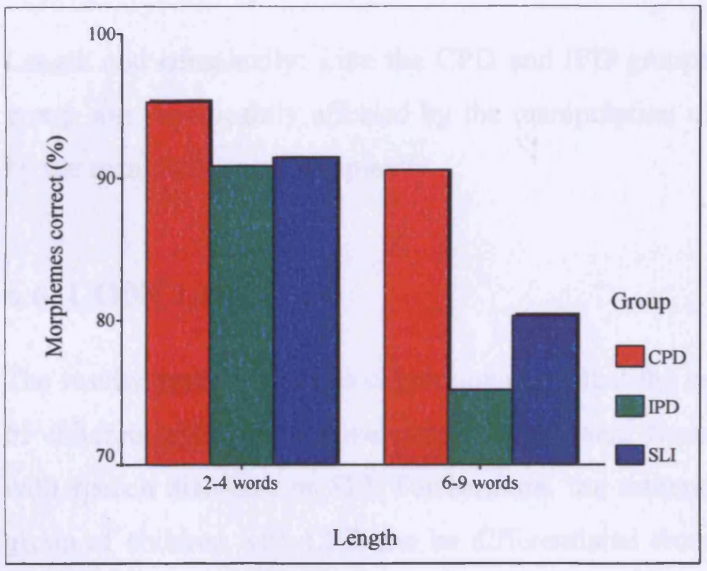

Figure 6.13 Group performance by length of stimulus

A two-factor mixed ANOVA was used. The between factor was the group with three levels (CPD, IPD, SLI) and the within factor was the length with two levels (2-4 words, 6-9 words). The main effect of length was significant ($F_{1,37}$=20.11, p<.001). There were no significant group or interaction effects.

Post hoc analysis using a Paired-samples *t*-test showed that, like the CPD and IPD groups (see Figure 6.6), the SLI group was significantly affected by an increase in stimulus length (t_{11}=-3.41, p<.01).

6.5.3 SUMMARY

A summary of the results comparing the performance of the SLI group with the CPD and IPD groups is as follows:

Comparison of SLI and speech disordered groups: The performance of the SLI group did not differ significantly from the performance of the IPD group on any of the three syntactic categories. The CPD group performed significantly better than the SLI group on content words and function words.

Syntactic category: Like both groups, the SLI group obtained significantly higher content-word scores than function-word and inflection scores. Like the IPD group, however, their scores for function words and inflections did not differ significantly.

Length and complexity: Like the CPD and IPD groups, the performance of the SLI group was significantly affected by the manipulation of length, but was not affected by the manipulation of complexity.

6.6 CONCLUSIONS

The results presented in this chapter revealed that the sentence imitation performance of children with typical development is different from the performance of children with speech disorders or SLI. Furthermore, the sentence imitation performance of a group of children with CPD can be differentiated from the performance of children with IPD, particularly on function words.

Lastly, the scores of a group of children with SLI are most similar to those of children with IPD, and differ from a group of children with CPD on content and function words. Based on this outcome, it could be assumed that the SLI and IPD groups of children have the same profile of difficulties. This paves the way for an analysis of their errors which is the focus of the next chapter.

CHAPTER 7

ANALYSIS OF ERRORS

7.1 INTRODUCTION

As the results presented in Chapter 6 revealed, the TD children and those with CPD made very few errors, and their performance profiles were different from each other and the IPD and SLI groups. Therefore, an in-depth analysis of the few errors made by these children would not be meaningful. It was apparent, however, that children in the TD group only produced errors consisting of whole-word substitutions from the same grammatical category (defined below in Section 7.2), and children in the CPD group only produced whole-word sound substitutions (defined below in Section 7.2) and whole-word substitutions from the same grammatical category.

Children in the IPD and SLI groups made far more errors and their scores were comparable, especially for content and function words. As stated in Chapter 6, if the comparison of these two groups is based on their accuracy scores, it could be assumed that they have the same profile of difficulties. Consequently, this chapter examines whether these two groups can be distinguished by their errors, if not their accuracy scores. A comparison of their errors was carried out with respect to the range of error types, and the mean percentage of each error type as a proportion of the total errors made.

7.2 DEFINITION OF ERROR TYPES

A review of the sentence imitation data resulted in the identification of the following error categories:

- Whole-word substitution from the same grammatical category (Wsub): when a target whole word is substituted by a word that belongs to the same grammatical category as the target word, such as [gɜl] for 'lady'. Although the morpheme was marked correct for the purposes of scoring in Chapter 6, it was also recorded as a whole-word substitution error for the purposes of this error analysis.

- Whole-word substitution from a different grammatical category (Wsubdif): when a target word is substituted by a word that belongs to a different grammatical category, such as 'the water made black shoes dirty' where 'black' has replaced 'her' in the sentence 'the water made her shoes dirty'.
- Sound substitution (Ssub): when the number of target syllables is produced but sounds in syllables bear no relation to sounds in target morphemes, and they do not pass the criteria (as stipulated in Chapter 5, Section 5.8.3) for crediting a child for the morpheme, for example [ʊ hʌhʌ kəu] where [hʌhʌ] has replaced 'on your' in 'put on your coat'.
- Unmatched syllables (Usyl): when the number of target syllables is not maintained (either too few or too many) and it is not possible to 'match' the syllables produced to the target morphemes, such as [jæb gæm] for 'there is the man'. Here it is uncertain which target syllable [jæb] corresponds to. It is possible that unmatched syllables are a combination of omissions (see below) and sound substitutions.
- Omission (Om): when all syllables produced can be matched to target morphemes and it is clear that a target morpheme has been omitted, for example [kɪti ʌgʌ bʌk] for 'the cat was under the bus'. Here, 'the' and 'was' were omitted.
- Distortion (Dist): this occurs when a child's production is too distorted or unintelligible to be transcribed.

Note: /ə/ for /ðə/ substitutions were not marked as sound or whole-word substitution errors. This is because it is extremely difficult to determine whether a /ə/ has been produced due to difficulty with the production of the more difficult phoneme /ð/, or whether it is in fact a whole-word substitution.

7.3 COMBINED CONTENT- AND FUNCTION-WORD ERRORS: IPD AND SLI

Figure 7.1 presents a breakdown of the types of combined content- and function-word errors associated with each group. These are presented as the mean percentage of each group's total errors in relation to the content- and function-word targets.

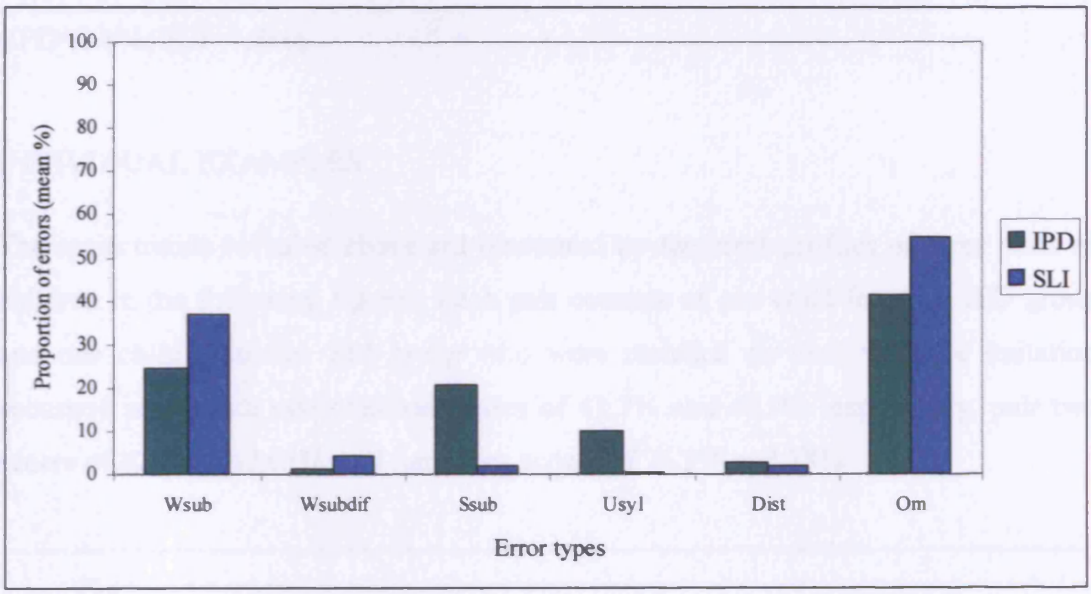

Figure 7.1 Error types as a percentage of total errors on combined content- and function-word targets: IPD and SLI

The results in Figure 7.1 reveal differences between the two groups in relation to all error categories apart from distortions. Omissions and whole-word substitutions from the same grammatical category made up the majority of errors in the SLI group (Om=54.9%; Wsub=36.8%) and represent higher proportions of their errors compared with the IPD group (Om=41.3%; Wsub=24.4%). The differences in these proportions were not significant. Although making up only 4.1% of the SLI group's errors, the proportion of whole-word substitutions from a different grammatical category was also higher for the SLI group than for the IPD group. A Mann-Whitney test found this difference to be significant ($U=27.5$, $p<.002$)[5].

[5] The nature of these analyses was essentially exploratory, so it was policy to investigate only differences that appeared substantial. However, as there were implicitly six comparisons possible, a Bonferroni correction was applied to yield a significance level of .008.

The IPD group's errors were spread across omissions (41.3%), whole-word substitutions from the same grammatical category (24.4%), sound substitutions (20.6%) and unmatched syllables (10.1%). Their errors contained substantially higher proportions of sound substitutions (IPD=20.6%; SLI = 1.9%) and unmatched syllables (IPD = 10.1%; SLI = 0.4%) than the SLI group. Mann-Whitney tests found the difference between the sound substitutions to be significant (U=5, p<.001) and the difference between unmatched syllables to be marginal as a result of the Bonferroni correction (U=45, p=.01). Distortions made up less than 3% of either group's errors (IPD=2.6%; SLI=1.8%).

INDIVIDUAL EXAMPLES

The main trends revealed above are illustrated by the error profiles of three pairs of children in the following figures. Each pair consists of one child from the IPD group and one child from the SLI group who were matched on their sentence imitation accuracy score. Pair one obtained scores of 41.7% and 47.9% respectively, pair two scores of 62.8% and 63%, and pair three scores of 76.9% and 78%.

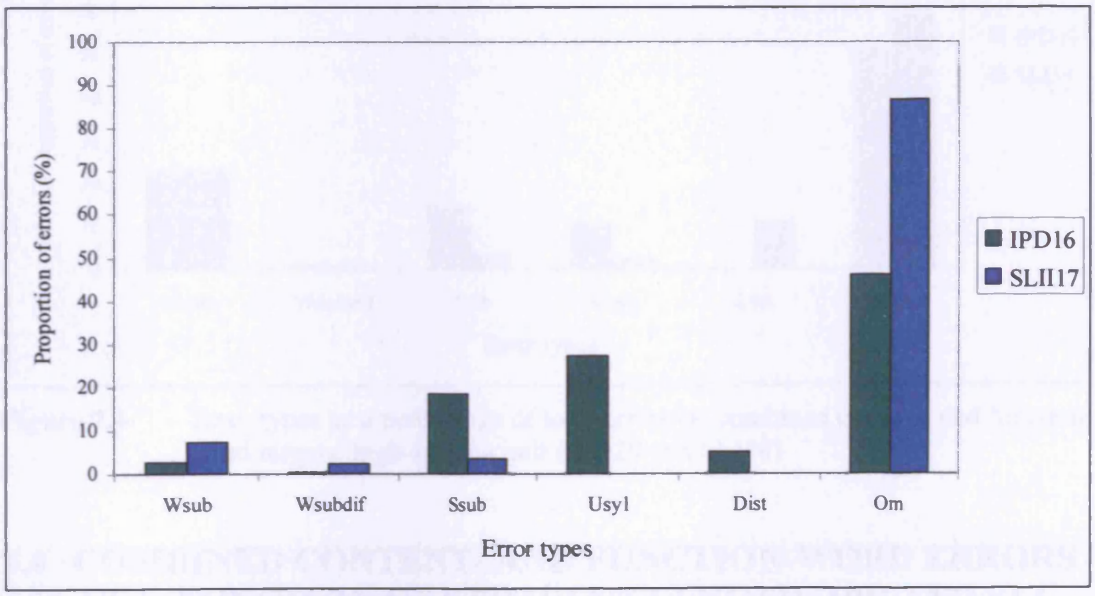

Figure 7.2 Error types as a percentage of total errors on combined content- and function-word targets: low-scoring pair (IPD16 and SLI17)

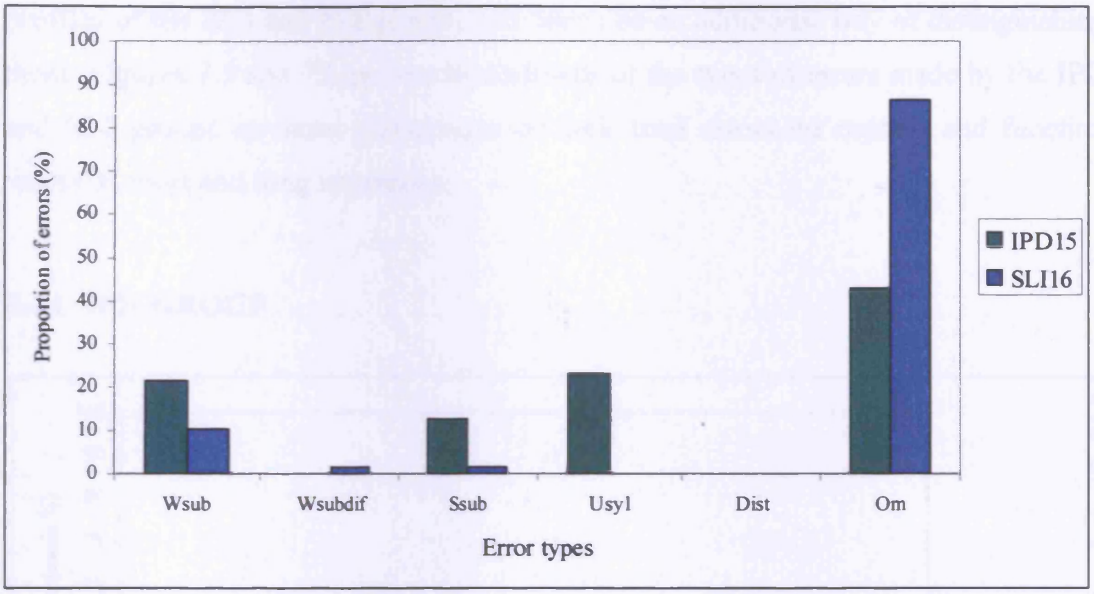

Figure 7.3 Error types as a percentage of total errors on combined content- and function-word targets: mid-scoring pair (IPD15 and SLI16)

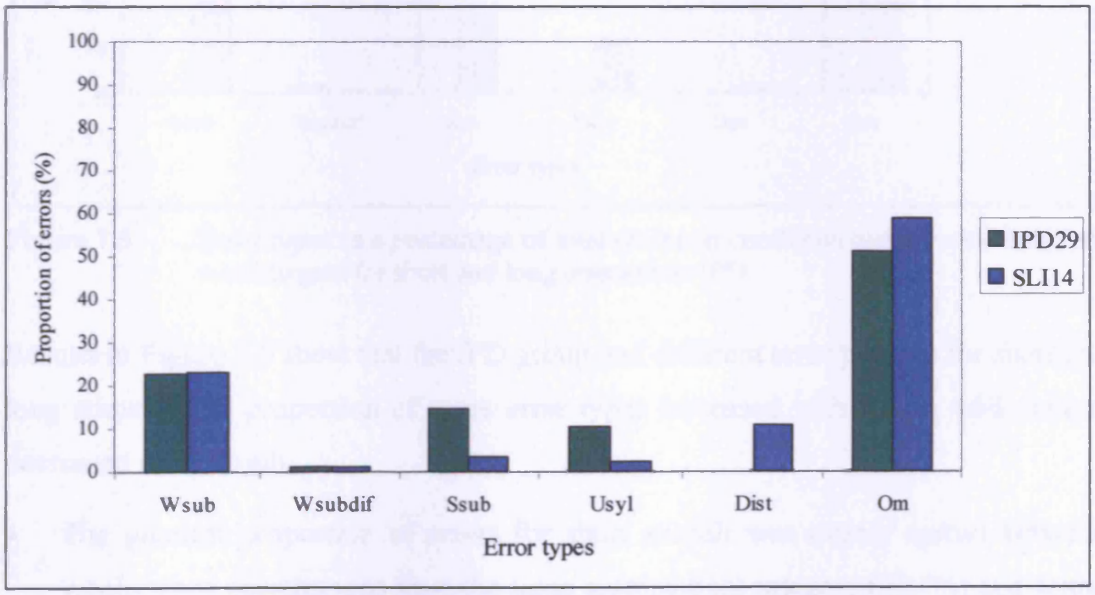

Figure 7.4 Error types as a percentage of total errors on combined content- and function-word targets: high-scoring pair (IPD29 and SLI14)

7.4 COMBINED CONTENT- AND FUNCTION-WORD ERRORS AS A FUNCTION OF STIMULUS LENGTH: IPD AND SLI

As discovered from the quantitative analysis of results for this study (Chapter 6, Section 6.5.2), sentence length had a significant effect on the performance of all groups. This section explores the possibility that stimulus length may affect the error

profiles of the IPD and SLI groups, and hence be an additional way of distinguishing them. Figures 7.5 and 7.6 present breakdowns of the types of errors made by the IPD and SLI groups as mean percentages of their total errors on content and function words in short and long utterances.

7.4.1 IPD GROUP

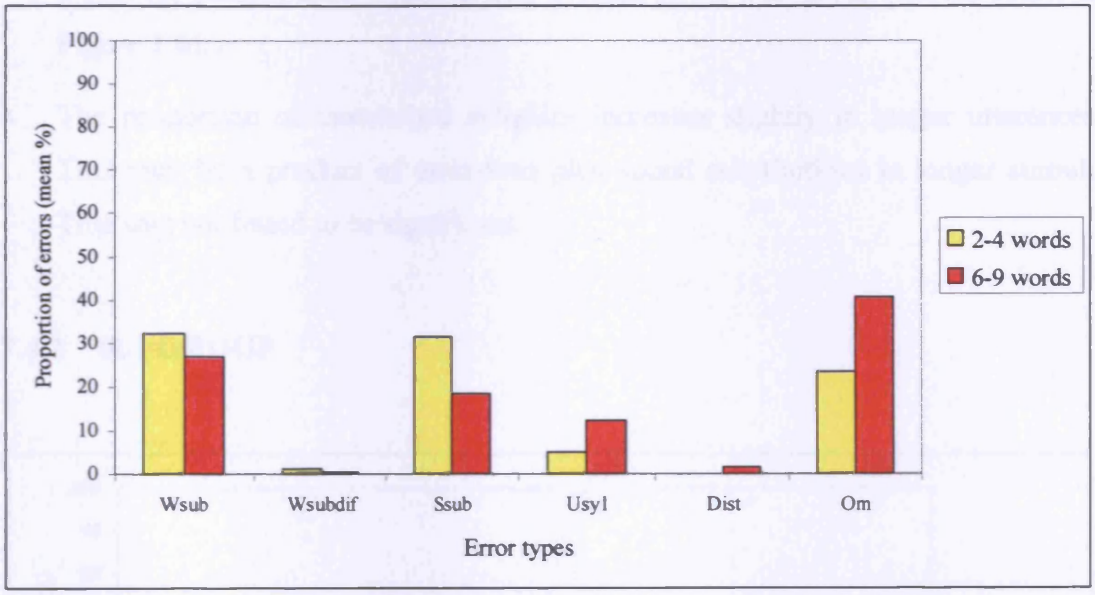

Figure 7.5 Error types as a percentage of total errors on combined content- and function-word targets for short and long utterances: IPD

Results in Figure 7.5 show that the IPD group had different error patterns for short and long stimuli. The proportion of some error types increased with length while others decreased with length:

- The greatest proportion of errors for short stimuli was evenly spread between whole-word substitutions from the same grammatical category (32.4%) and sound substitutions (31.4%). Omissions formed the next highest proportion of errors at this level (23.2%), followed by unmatched syllables (4.9%). The proportion of sound substitutions and whole-word substitutions from the same grammatical category decreased for long stimuli and the proportion of omissions increased to form the highest proportion of errors (40.6%). A Wilcoxon Sign Ranks Test found the difference in the proportion of omissions to be significant (Z=-2.315,

p=.002)[6]. This suggests that as stimuli increased in length it generally became more difficult for children in the IPD group to attempt the production of target morphemes. This is linked to the observation of a decrease in the proportions of sound substitutions and whole-word substitutions from the same grammatical category when longer utterances were attempted.

- The significant increase in the proportion of omissions as the stimuli get longer is a general phenomenon which is also evident in the SLI group (shown below in Figure 7.6).
- The proportion of unmatched syllables increases slightly in longer utterances. This may be a product of omissions plus sound substitutions in longer stimuli. This was not found to be significant.

7.4.2 SLI GROUP

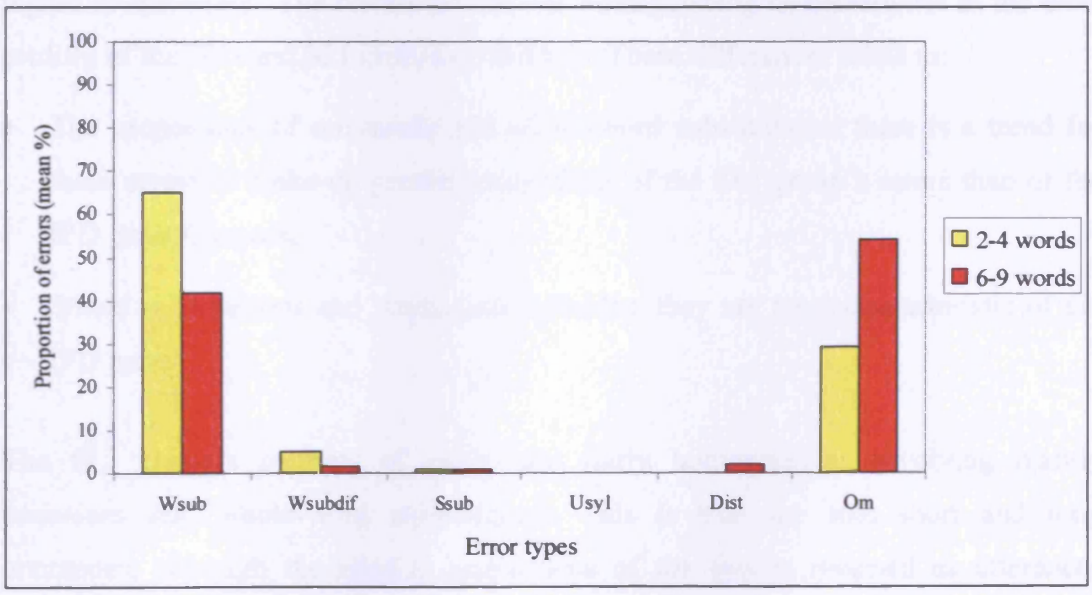

Figure 7.6 Error types as a percentage of total errors on combined content- and function-word targets for short and long utterances: SLI

The results in Figure 7.6 show relatively similar profiles of errors made by the SLI group for short versus long stimuli. The greatest differences relate to the decrease in the proportion of whole-word substitutions from the same grammatical category in the

6 In line with the previous analysis of six comparisons, a Bonferroni correction was applied to yield a significance level of .008.

production of longer stimuli, and an increase in the proportion of omissions. A Wilcoxon Signed Rank Test found the difference in the proportions of omissions to be significant ($Z=-3.040$, $p=.002$)[7].

Although they made up only a small proportion of the SLI group's errors, there was a slight decrease in the proportion of whole-word substitutions from a different grammatical category in long utterances. This difference was not found to be significant. There were no unmatched syllables at either level and a tiny proportion of distortions in long utterances (1.8%). Sound substitutions made up less than 1% of the errors at either level.

7.5 SUMMARY

The results presented thus far reveal that, unlike the TD and CPD groups, the IPD group makes some errors of the sort children with SLI make. This is most evident with regard to omissions. The results also reveal distinguishing characteristics in the error profiles of the IPD and SLI groups of children. These differences relate to:

- The proportions of omissions and whole-word substitutions: there is a trend for these errors to make-up greater proportions of the SLI group's errors than of the IPD group's errors.
- Sound substitutions and unmatched syllables: they are more characteristic of the IPD group.

The SLI group's patterns of errors are fairly homogeneous, involving mainly omissions and whole-word substitutions. This is true for both short and long utterances, although the relative proportions of the two is reversed as utterances become longer. The error profile of the IPD group, on the other hand, is more varied, and the proportions of errors for short and long utterances were slightly different.

7 In line with the previous analysis of six comparisons, a Bonferroni correction was applied to yield a significance level of .008.

7.6 CONCLUSIONS OF PHASE 1

Overall, the outcomes of this phase of investigation go some way in answering the key thesis questions:

- *Can children with different types of speech disorders be differentiated according to their sentence-level performance?*

  The outcomes of this study revealed that the sentence imitation performance of the CPD and IPD groups were differentiated, particularly in relation to function words.

- *Is there a more-than-chance co-occurrence of sentence-level difficulties in children with different types of speech disorders?*

  The outcomes of this study suggest that children with CPD are no more likely to experience sentence-level difficulties than typically developing children. Of the children in the IPD group, six out of eight (43%) experienced sentence-level difficulties. This figure is discussed in relation to co-occurrence in Chapter 14, Section 14.6

- *What is the relationship between speech disorders and sentence production?*

  The outcomes of this phase of investigation provided limited conclusions regarding the relationship between speech disorders and language. For the CPD group, their speech disorder appears to have no significant effect on sentence production since their performance was comparable with the TD group. The heterogeneity of the IPD group (Chapter 6, Section 6.4.1), however, together with their profile of errors that suggests some similarities and some differences in comparison with the SLI group, warrants further investigation to determine the relationship between IPD and sentence-level abilities in more detail. This will be the focus of the second set of investigations in this thesis (Phase 2).

- *Is sentence imitation an efficient, effective and reliable method of assessing expressive syntax in children with severe speech difficulties?*

  Since Phase 2 investigations also use sentence imitation as a method of assessing expressive syntactic abilities, this question will be addressed in the discussion in Chapter 14.

PART III:

PHASE 2 INVESTIGATIONS:

UNDERLYING DIFFICULTIES

CHAPTER 8

INTRODUCTION TO PHASE 2 AND SINGLE-WORD SPEECH PRODUCTION AND SENTENCE IMITATION

8.1 INTRODUCTION TO PHASE 2

The second set of investigations in this thesis further explore the relationship between speech disorders and sentence-level ability in those children whose sentence-level abilities warrant further investigation, namely those with IPD or SLI. The investigations focus on answering the following three questions:

- Can the heterogeneity of sentence imitation performance in children with IPD be explained by the severity of their difficulties with single-word speech production alone? This will be determined by analysing the single-word speech production abilities of children with IPD in terms of inconsistency (type and degree) and accuracy, and relating these abilities to their corresponding sentence imitation scores. This investigation will be presented in this chapter.
- Are there other factors associated with sentence processing which contribute to the heterogeneity observed? Investigation of this issue required the construction of a number of novel tasks exploring a range of psycholinguistic abilities contributing to sentence processing. The methodology and results of this investigation will be presented in Chapters 9 and 10 respectively. Chapter 11 presents two single-case studies that explore the validity of the outcomes of Chapter 10.
- Where problems relating to sentence processing are identified in children with IPD, are they similar to difficulties associated with children with SLI? Specifically:
  - What problems do children with SLI show on the purposefully constructed tasks assessing abilities associated with sentence processing?
  - Are their profiles of ability similar to, or different from, children with IPD who show sentence imitation difficulties?

Chapter 12 contains the results obtained by children with SLI on the purposefully constructed tasks. A comparison of these results with those obtained by children with IPD who exhibit sentence imitation difficulties will be presented in Chapter 13.

As function words proved to be the category that distinguished the SLI and IPD groups from the TD and CPD groups in Phase 1, the majority of the investigations in Phase 2 focus on this grammatical category.

8.2 SINGLE WORD SPEECH PRODUCTION AND SENTENCE IMITATION PERFORMANCE

Phase 1 investigated the sentence imitation abilities of children with IPD and CPD. Within the IPD group there was a wide range of sentence imitation ability, reflected particularly in function word scores (Chapter 6, Section 6.4.1). The aim of this chapter is to explore the first possible source of heterogeneity in this group. Since we know that all the children have a speech disorder at a single-word level, it is possible that the type and/or degree of speech difficulty at a single-word level is responsible for the varied sentence imitation performance. In order to evaluate this possibility, the sentence imitation results of five children with IPD are presented, and their single-word speech production abilities are analysed in terms of the degree and type of inconsistency, as well as accuracy, to see if these can account for their performance on sentence imitation.

8.3 PARTICIPANTS

The participants in this study were two girls and three boys with IPD who did not participate in Phase 1. They were recruited in the same way as the children who participated in Phase 1 (Chapter 5, Section 5.3.1). Like the participants of Phase 1, they were required to obtain a composite score of 85 or above on the TACL-3, a scaled score of 7 or above on the WPPSI-RUK, and a scaled score of 7 or above on each of the three components of the Oro-motor Screening Subtest of the DEAP (isolated movements, sequential movements and DDK) (Chapter 5, Section 5.3.2).

Table 8.1 presents a description of the five participants in this investigation.

Table 8.1 Profile of participants

	Gender	Age	Receptive language	Non-verbal screen	Oro-motor screen			Sp. disorder
		months	quotient	scaled score	standard score			DEAP subtest
					DDK	IM	SM	Inconsistency
AA	M	57	102	12	7	12	9	56%
BH	M	60	102	11	11	7	8	52%
RF	F	57	113	13	11	9	12	48%
PJ	F	55	100	12	10	11	10	40%
RG	M	57	102	12	9	9	8	56%

The ages of the participants ranged from 55 to 60 months. All five participants obtained at least average scores on the non-verbal and oro-motor screening tests, as well as the receptive language assessment. The range of inconsistency was small (40-56%).

8.4 METHODOLOGY

The same basic procedure as was used in Phase 1 was followed here. The order of task presentation was as follows:

- Inconsistency Subtest of the DEAP (first administration)
- Vocabulary Subtest of the TACL-3
- Grammatical Morpheme Subtest of the TACL-3
- Inconsistency Subtest of the DEAP (second administration)
- Sentence Imitation Task (experimental task)
- Elaborated Subtest of the TACL-3
- Oro-motor Subtest of the DEAP
- Picture Completion Subtest of the WPPSI-Ruk
- Inconsistency Subtest of the DEAP (third administration)
- Phonology Subtest of the DEAP

The same recording, data capture and scoring procedures as were used in Phase 1 in relation to the above tasks, were employed in this study.

8.5 RESULTS

8.5.1 INTER-RATER RELIABILITY

The speech data were transcribed phonetically and scored by the researcher (an SLT). Data from three randomly selected children with IPD were independently transcribed and scored by a final-year Speech and Language Therapy student. The inter-rater reliability results were as follows:

INCONSISTENCY

Cohen's Kappa (Cohen, 1960) was used to determine the level of agreement (corrected for chance) between the two raters on each of the 25 items in the Inconsistency Subtest of the DEAP. A good level (Fleiss, 1981) of agreement (0.6) was obtained between the two raters.

PHONOLOGICAL ACCURACY

Due to the small numbers, correlations could not be carried out on PCC and PVC. However, as shown in Table 8.2, there was high agreement between the raters for both PCC and PVC scores at different levels of accuracy.

Table 8.2 Phonological accuracy scores for three children with IPD

	PCC		PVC	
	Rater A	**Rater B**	**Rater A**	**Rater B**
1	48.5%	39%	89.2%	85%
2	43.2%	41%	93.2%	89.2%
3	44.9%	43%	76.1%	74%

SENTENCE IMITATION

Data from the Sentence Imitation Task were transcribed phonetically and scored by the researcher. Data from two randomly selected participants were transcribed and

scored independently by a linguist. As mentioned in the introduction to Phase 2, the function-word category was the focus of this phase of investigations. Therefore, the raters' scorings of function words on each of the 61 sentences in this task were compared for each child, using a Pearson's *r* correlation. Results showed the mean agreement between the two raters to be r(59)=.785 (p<.01)(Child A: r(59)=.797; Child B: r(59)=.774 p<.01).

8.5.2 SENTENCE IMITATION TASK

Figure 8.1 presents each child's total function-word score, as well as the mean total function-word score of the TD group from Phase 1. These results replicate the findings of Phase 1 in two ways. Firstly, all the children with IPD obtained significantly lower scores than the mean of the TD group. This was confirmed by a Modified *t*-test (Crawford & Howell, 1998), which found the highest score obtained by a child with IPD, 96.8% obtained by BH, to be significantly lower than the mean of the TD group (t = -4.18, p<.001).

Secondly, the heterogeneity of performance in Phase 1 was replicated, inasmuch as the five IPD participants obtained varied results. Two participants, BH and RF, obtained extremely high scores (96.8% and 93%), while AA obtained an extremely low score (28.5%) compared with the TD group mean (99.6%). The fourth and fifth participants (PJ and RG) obtained notably lower scores than BH and RF but higher than AA (70.9% and 41.8%).

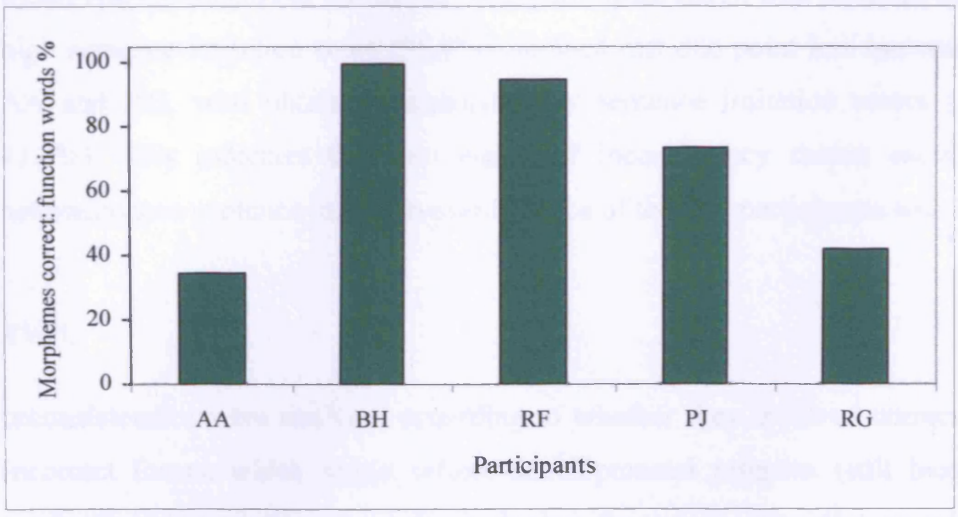

Figure 8.1 Percentage morphemes correct on function word targets: IPD participants

Having established that there is heterogeneity in the sentence imitation performance of the above five children, the specific question that is addressed in this chapter is:

Can the heterogeneity of children with IPD on sentence imitation be explained by the severity of their problems with single- word speech production alone?

In answering this question, a comparison was carried out of the five participants' speech inconsistency (degree, type and errors) and accuracy (phoneme and prosodic levels) at a single-word level, as measured by the Inconsistency Subtest of the DEAP, to see if there were any parallels with their sentence imitation scores.

8.5.3 INCONSISTENCY

DEGREE

Table 8.3 Comparison of degree of inconsistency

	SIT score	Inconsistency Subtest of the DEAP	
		Raw score	Degree of inconsistency
AA	28.5%	14/25	56%
BH	96.8%	13/25	52%
RF	93%	12/35	48%
PJ	70.9%	10/25	40%
RG	41.8%	14/25	56%

As shown in Table 8.3, the degree of inconsistency did not vary significantly across the five participants. Their raw scores for inconsistency ranged from 10 to 14 on the Inconsistency Subtest of the DEAP. One participant (BH), who obtained an extremely high sentence imitation score (96.8%), showed just one point less inconsistency than AA and RG, who obtained extremely low sentence imitation scores (28.5% and 41.8%). This indicates that the degree of inconsistency cannot account for the heterogeneous sentence imitation performance of the five participants with IPD.

TYPE

Inconsistencies were analysed according to whether they involved correct as well as incorrect forms, which might reflect developmental progress (still inconsistent in production, but moving towards producing the words correctly) or whether they

involved all incorrect forms, which might reflect speech delay or disorder. Results are shown in Table 8.4.

Table 8.4 Comparison of type of inconsistency

	SIT	Total inconsistency		Inconsistent incorrect		Inconsistent correct	
	%	Total	%	Total	%	Total	%
AA	28.5%	14/25	56%	11/14	78.6%	3/14	21.4%
BH	96.8%	13/25	52%	10/13	76.9%	2/13	15.4%
RF	93%	12/25	48%	12/12	100%	0/12	0%
PJ	70.9%	10/25	40%	9/10	90%	1/10	10%
RG	41.8%	14/25	56%	14/14	100%	0/14	0%

Table 8.4 shows that the pattern of inconsistency of all five participants was characterised by a high percentage of inconsistent incorrect realisations of the target, for example *elephant* realised as [ʌlət] [ʌnjəʔət] [ɛləʔənt]. The inconsistent productions of RF, who obtained a high sentence imitation score (93%), contained a higher percentage of inconsistent incorrect productions (100%) than the productions of AA, who obtained the lowest sentence imitation score (78.6%). Thus, the type of inconsistency cannot account for the heterogeneity of sentence imitation performance of the five participants.

ERRORS

An analysis was carried out to determine whether the errors were phonologically developmental or deviant. A phonologically developmental error would be if a child produced an item differently on at least two out of three occasions, and at least one of his/her productions was a phonologically developmental error, for example [bwɪdʒ] [bɪdz] [bɪdz], where the first production contains a developmental error.

A deviant error would be if a child produced an item differently on at least two occasions, and at least one of his/her productions was atypical or deviant (Dodd et al., 2002). All the errors produced by the five children, apart from two produced by BH, were found to be deviant. Examples of this deviance are: [dʌ] [dʌw] [dʌbʌ] for *bridge,* and [tændɪwu] [kæθəwu] [vʌnkwɛ] for *kangaroo*. In both examples all three productions contained deviant errors as opposed to developmental errors.

The two inconsistent developmental errors produced by BH were [kæŋgəwu] [kæŋəɹu] [kæŋgəwu], where the first and last productions contained developmental processes.

Thus, the five participants could not be distinguished by the type of errors they produced within inconsistent productions on the Inconsistency Subtest of the DEAP. By implication, their sentence imitation performance could not be due to the type of inconsistent errors produced.

8.5.4 ACCURACY

PHONEME LEVEL

The phonological accuracy scores of the four participants, as measured on the Phonological Subtest of the DEAP, are presented in Table 8.5 in terms of PCC and PVC.

Table 8.5 Comparison of speech accuracy scores

	SIT score	PCC	PVC
AA	28.5%	46.4%	85.5%
BH	96.8%	48.5%	89.2%
RF	93%	44.9%	76.1%
PJ	70.9%	43.2%	93.2%
RG	41.8%	32.1%	81.3%

As shown, the PCC scores of four participants were similar (range: 43.2-48.5%), while RG obtained a somewhat lower PCC score (32.1%). It is interesting to note that RF, who obtained 93% for the production of function words on the Sentence Imitation Task, obtained the lowest PVC score (76.1%) and the third lowest PPC score (44.9%). Hence, the varied sentence imitation performance of the five participants cannot be due to their phoneme-level accuracy scores: their number of errors when imitating function words cannot be due to their problems in producing target phonemes.

PROSODIC LEVEL

An analysis of the two-, three- and four-syllable words on the Inconsistency Subtest of the DEAP was carried out to determine syllable integrity: whether the number of syllables in each word had been maintained. Table 8.6 shows the few items where syllable integrity was not maintained.

Table 8.6 Items where syllable integrity was not maintained

	SIT score	Syllable integrity: number of syllables in words	
		Three	Four
AA	28.5%	[ɛfənt] for *elephant* [pɛlʌ] for *umbrella*	[hʌskɒpə] for *helicopter*
PJ	70.9%		[hipi haid] for *slippery slide*
RG	41.8%	[ʌ:jən] for *elephant* [dʌmvu] for *kangaroo* [daintɔ] for *dinosaur*	

The three participants who experienced the most difficulty on the Sentence Imitation Task also experienced some difficulty with syllable integrity. AA experienced difficulty maintaining the number of syllables in three- and four-syllable words. PJ only experienced difficulty on one four-syllable word, and RG experienced difficulty with three three-syllable words.

Thus, syllable integrity is the only category which may distinguish the two high-scoring participants on sentence imitation (BH and RF) from the three (AA, PJ and RG) who obtained lower scores on the Sentence Imitation Task. However, the data are very limited and it is questionable whether syllable integrity alone can account for such heterogeneity in sentence imitation performance.

8.6 CONCLUSION

In light of the comparisons presented, it may be concluded that, overall, single-word speech production abilities do not account for the heterogeneous abilities of the ipd participants on sentence imitation, reflected in function-word scores. This necessitates the consideration of other possible explanations, which will be explored in Chapter 9.

CHAPTER 9

SENTENCE PROCESSING-RELATED ABILITIES OF CHILDREN WITH IPD: METHODOLOGY

9.1 INTRODUCTION

The findings of the previous chapter established that the heterogeneity of sentence imitation performance of children with IPD is not due to single word speech production difficulties alone. Therefore, the focus of the investigation shifts beyond the single word to the sentence level.

The broad question that will be addressed in this and the next chapter is:

Can the heterogeneity of sentence imitation performance be explained by abilities associated with sentence processing?

The specific questions that will be addressed are:

(i) Are there difficulties in processing sentence input, and specifically in recognising function words appropriate to sentence contexts? One possibility is that some of the children with IPD do not even know, on an input level, what function words are required. One way of looking at this is to determine whether these children can judge function word errors of the sort they are producing.

(ii) Are there phonological memory difficulties? Evidence from Phase 1 raises this possibility because length effects were found on the sentence imitation performance of the group of children with IPD. One way of looking at this is to assess these children's phonological working memory abilities as measured by digit span and word span.

(iii) Are there difficulties due to production 'overload'? It is possible that some children with IPD know the function words required, but omit them in sentences due to production overload. This may be investigated by:

- reducing the production load in relation to the structure and number of words to be produced, to determine whether these children's ability to produce

function words then approximates the ability of children with typical development.

- varying the production load in terms of the number of content-word syllables and the number of words in sentences to determine the effect that this has on production.

In order to address these questions, four novel tasks were constructed and trialled on 34 typically developing children, before being administered to children with IPD. These tasks will be referred to as 'sentence processing-related tasks' as they include the assessment of phonological working memory in addition to some input and output sentence processing skills. This chapter describes the participants, the four tasks, as well as the session procedure and data capture and analysis.

9.2 PARTICIPANTS

The participants in this study were made up of two groups:

- The same five children with IPD presented in the previous chapter
- A group of 34 children with typical development (TD2)[8]

As none of the tasks constructed for the purposes of this study were standardised, it was imperative that they were first administered to children who were considered to be developing typically, to ensure that each new task was appropriate for children above the age of 4 years with regard to the cognitive demands and level of ability required. Teachers were informed of the same recruitment criteria for children with typical development as those used in Phase 1 (Chapter 5, Section 5.3.2). Parents from four schools – two state and two private schools – in different areas gave consent for their children to participate in the study. These children were expected to perform at or almost at ceiling on all the tasks constructed, apart from the phonological working memory tasks, where the aim was to determine the level that children with typical

8 The typically developing children in TD2 were not the same children as those who participated in Phase 1.

development would achieve. The performance of each child with IPD was compared to the performance of typically developing children.

The TD2 group comprised 34 children, 28 males and 6 females, aged 47 to 59 (mean = 53.3 months). The mean age of this group is lower than the ages of the five children with IPD, who ranged from 55 to 60 months.

9.3 TASKS

In order to address the three questions outlined in Section 9.1 above, four tasks were constructed. Two out of the four tasks focus on the investigation of function words exclusively.

9.3.1 SENTENCE JUDGEMENT TASK

Aim: To determine whether there is a difficulty in processing sentence input, and specifically in recognising function words appropriate to sentence contexts.

Question: Can the participants detect function-word omissions or sound substitutions in sentences?

Activity: This task took the form of a Sentence Judgment Task in a computer game format. Two cats appear on the screen sequentially and 'speak'. The child is required to decide which cat is 'speaking properly' and push the button on the keyboard corresponding to the cat chosen. This program was designed by Dr Mike Coleman, Experiments Officer in the Department of Human Communication Science, University College London.

Test stimuli were recorded with the researcher's voice using a Sony electric condenser stereo microphone with a 90-degree setting. The sound clips were edited using Goldwave Digital Audio Editor v.4 and they were then inserted into the software developed by Dr Mike Coleman.

Stimuli

Content

The function words included in this task were:

- auxiliaries/copulas: is, are, was, were, will, won't; can, can't
- determiners: a, the, his, her
- prepositions: (i) spatial – in, on, under; (ii) arbitrary, dependent on the head noun or verb – for, at, to

The objective was to have different types of function words represented in the task, rather than having an equal number of examples of each of the categories above.

Types of errors

As omissions constituted a significant proportion of both the SLI and IPD groups' errors, and sound substitutions constituted a significant proportion of the IPD group's errors, both error types were 'fed' back to children in this task. Two trial pairs were created for each function word targeted. One trial pair contained a correctly produced sentence and one where the function word was omitted, for example 'the glass full' vs 'the glass is full'. The second trial pair contained a correctly produced sentence and one where the function word was substituted by a nonsense syllable, for example 'the apple's [hə] the tree' vs 'the apple's in the tree'.

The task consisted of 20 trials where the function word was omitted and 20 trials where the function word was substituted.

Variables considered

- Length of words: kept to one or two syllables in order to reduce memory load.
- Length of sentences: kept as short as possible so as not to stress memory load. Most sentences consisted of three or four words and none exceeded six words. The idea was not for the child to hold both sentences in mind and then compare them,

but rather to listen to each production and decide if it was correct. If a child does have to compare the two sentences to make the judgement, and fails at the task, it indicates that the child's input skills are not as robust as they should be.

- Semantics: In order to ensure that the participants would be familiar with the words used, almost all words were taken from The MacArthur Communicative Development Inventory (Fenson, 1993).
- Phonology: This was not an issue as the child was not required to say anything and hence phonological complexity would not affect his/her answer.

The full set of stimuli is presented in Appendix 2.

Procedure

The task was explained to the child while showing him/her the two cats on the screen. The following instruction was given: 'These two cats are learning to speak English. They are both going to try and say some sentences. You need to decide which cat is talking properly.'

Three practice trials followed. In the first trial one cat produced a nonsense word and the other a real word: [fædʒət] versus 'chocolate'. The second trial consisted of a correctly produced sentence versus one where the copula is omitted: 'I happy' versus 'I am happy'. The third trial consisted of a correctly produced sentence versus one where a nonsense syllable was substituted for the copula: 'I ha happy' versus 'I am happy'.

The whole keyboard was covered, apart from the 'z' and 'm' which were situated under illustrations of an orange and blue cat respectively. The child was required to push the key corresponding to the coloured cat that 'spoke properly'. Each time the child pushed either the 'z' or 'm' an activity occurred on the computer screen: one cat ate fish when chosen, and the other cat drank milk. A character called 'Charlie' was introduced to the child after the third trial. The character entertained the child by moving around the screen while making funny noises and pulling funny faces.

If it was evident that the child was still unsure of the requirements of the task by not obtaining a score of three for the trial items presented, an additional two trial pairs were presented. These items were [plɪʃtɪʃ] versus 'kitchen', and [ʃlɛktəpɒk] versus 'elephant'.

Once it was established that the child understood the requirements of the task, the test items were presented. 'Charlie' appeared after every five trials. After 25 trial pairs had been presented, the child was given a break (by carrying out another activity). The remaining 15 trials were then presented.

Correct sentences were randomly allocated to either the orange or blue cat (first or second presentation). The stimuli pairs were presented in a different random order for each child.

Scoring

One point was given for each correctly identified sentence. A maximum of 40 could be scored.

9.3.2 PHONOLOGICAL WORKING MEMORY

Aim: To determine whether there are phonological working memory difficulties as measured by digit-span and word-span.

Question: Do children with IPD have phonological working memory difficulties compared with children with typical development?

THE CHALLENGE OF ASSESSING PHONOLOGICAL WORKING MEMORY IN CHILDREN WITH SPEECH DISORDERS

All currently available phonological working memory tasks require a verbal response, often in the form of recall (Gathercole & Baddeley, 1996; Pickering & Gathercole, 2001). This can be difficult for some children with severe speech disorders and the validity of the assessment may be affected: the words may contain difficult phonology such as clusters and affricates, and the child may anticipate the difficulty with

production and refuse to attempt the task. In some cases, a child may attempt to imitate what s/he has heard, but his/her production may be so unintelligible that it is impossible to score, or it may be intelligible but scored as incorrect due to production difficulties. Hence, children with speech difficulties may obtain poor scores on phonological working memory tasks due to difficulties not related to working memory.

The challenge in assessing the phonological working memory abilities of children with speech disorders is therefore to do so in a way that minimises the potential stress on a child and, as far as possible, eliminates problems due to speech production difficulties. One way of addressing this challenge is to use an assessment that avoids the production of speech altogether. A picture-pointing task was developed, which required the child to point to pictures in response to words produced by the researcher. The task was piloted on five children with typical development, but the results showed that it was not a satisfactory test of phonological working memory. Therefore a different task – a recall task adapted from standardised digit and word recall tasks – was developed, successfully piloted and used instead. Both tasks are described below.

METHOD ONE: PICTURE-POINTING TASK

Stimuli

These were four sets of pictures, each set containing four pictures. They were made with Boardmaker version 5.1.10. The following factors were taken into consideration when choosing the words represented by the target pictures:

Semantics

The words all appeared on The MacArthur Communicative Development Inventory: Words and Sentences (2.6 years and below). Each set of pictures represented words from a mix of semantic categories: clothes, food, animals, transport and furniture.

Phonology

The words depicted in the first set of four pictures were one syllable in length and contained no clusters or affricates.

- The words depicted in the second set of pictures were one syllable in length but contained clusters.
- The third set of pictures depicted two-syllable words without clusters or affricates.
- The fourth set of pictures depicted words containing two syllables with affricates.

This graded hierarchy of difficulty was used in order to determine whether phonological complexity affected performance. It was acknowledged that this task taps more than pure memory, as the child is required to point to a picture in response to the presentation of a word. It is more difficult to listen, look and point at the same time, than just to listen and speak. Therefore, performance was expected to be affected.

Procedure

The first set of pictures was laid down in front of the child in a line in random order. The child was asked to point to each picture in response to the label produced by the researcher. Once it was established that the child knew all the pictures, the researcher said the names of two pictures. The child was required to point to the pictures in the order they were announced. Four trials of two-word recall pictures were presented. If the child pointed correctly in three out of four trials, the researcher proceeded to the next level, namely four trials of three-word recall pictures. This progressed until the child pointed correctly in only one or two trials.

At this level the researcher presented the second set of pictures and began the recall task at the level below the one at which trials with the first set of pictures were halted. This was done in order to determine whether recall was affected by an increase in phonological complexity. If the child succeeded at this level with the second set of pictures, the next level was attempted. If the child failed at this level, the third set of pictures was presented, starting at the previous level. Breakdown was where two or fewer trials were carried out correctly. This procedure was continued until all four sets of pictures had been used.

Words were presented with roughly equal stress and with roughly equal time between each word.

Scoring

One point was awarded for each picture pointed to correctly within each sequence. Credit was given for pictures that were not tested in levels below the child's established level of competence.

Results

The method was trialled on five 4-year olds considered to have typical development.

- All five children were able to name all the pictures used.
- Four out of the five children repeated the words out loud in response to their presentation by the researcher.
- All the children found it more difficult to point to the pictures than to repeat the words. On many occasions, the child would repeat the words correctly while pointing to different pictures at the same time. Alternatively, when taking the time to point to pictures, they often pointed to pictures in a random order and named them.
- As a result of the difficulties described, three out of the five children became frustrated and lost interest in the task quite quickly.

This pilot therefore showed that a picture-pointing task was too challenging for children of 4 years of age who were considered to have typical development. The results obtained could not be considered reliable or an accurate reflection of the phonological working memory abilities of these children. An alternative methodology was required.

METHOD TWO: RECALL TASK

Two measures were used: digit span and real-word recall.

Digit recall stimuli

Digit recall was used as it is the conventional measure of short-term memory (Gathercole & Pickering, 2000). It is the least dependent on linguistic knowledge and

would therefore be the easiest type of repetition for children of this age. In accommodating the participants' speech difficulties, it was decided to use only digits that contain a single syllable and avoid late developing phonemes (Shriberg & Kwiatkowski, 1994b).

As pointed out above, a major difficulty in using a repetition task with children with speech disorders is the unintelligibility of their speech: they may attempt to repeat something, but their production may be too far from the target to determine which target word they are attempting. As target words can often be distinguished based on vowel production, care was taken to use digits that have different vowels. The digits used in the task were: *one, two, four, eight, nine,* and *ten.* A full set of items is presented in Appendix 3.

Procedure

Two trials at each length were presented. For each trial, the child was required to repeat the digits in the correct order. If the child accurately repeated both trials, the researcher progressed to the next level. If the child only succeeded on one trial, a third trial was presented at the same level. If the child repeated this trial correctly, the researcher proceeded to the next level. If the child was not able to correctly repeat items on the third trial, then the level below was taken to be the threshold of ability. In other words, successful completion of a level in order to attempt the next level required the correct production of two out of three trials.

Scoring

The child's level of ability was taken to be the highest level at which s/he was able to repeat two out of three trials.

Real-word recall stimuli

Although it has become conventional to use non-word repetition as a measure of phonological working memory (Pickering & Gathercole, 2001), a decision was made

to use real words. This was based on the following:

- The familiarity and automaticity of real words facilitates production more easily than non-words, which require new motor patterns to be formed. Therefore, the use of real words may encourage participation in children with speech difficulties.
- Although real words do include a semantic element, they are different enough from the Sentence Imitation Task inasmuch as they do not include syntax, to be assessing memory in a different way.

The words consisted of single syllables and contained no clusters or affricates. Semantically simple words from The MacArthur Communicative Development Inventory: Words and Sentences (2.6 years and below) were used. The following categories of words were included: transport, body parts, animals, food, and household items. Each trial consisted of words from different categories. A full set real-word items is presented in Appendix 3.

Procedure and scoring

The same procedure and scoring method were followed as for the digit recall task.

9.3.3 SENTENCE COMPLETION TASK

Aim: To determine whether decreasing the output load in terms of the sheer number of words facilitates the expression of function-word knowledge.

Question: Does the ability of children with IPD to produce function words approximate the TD2 group, when the output load is reduced in terms of the number of words to be produced, and only the first word produced is scored?

Stimuli

There were 25 function words targeted. These represented all the function word categories included in the Sentence Imitation Task. They were:

- determiners: a, the, his, her, their

- auxiliaries/copulas: will, won't, can't, is, are
- prepositions: on, under, at, to, for
- subordinate conjunction: if

Seventeen sets of three or four pictures were used, each picture associated with a short stimulus sentence. The full set of stimuli is presented in Appendix 4.

Procedure

The following instruction was given to the child: 'I am going to show you some pictures and tell you about them. When I get stuck you must help me.'

Two trial sets of two pictures each were presented to the child. The researcher pointed to the first two pictures sequentially – the first of a dog and the second of a cat – and said 'This is a dog. This....' The child was required to complete the sentence by saying 'is a cat'. If the child did not produce the function word *is* the researcher modelled the correct answer and gave the child the instruction 'You must say *is a cat*' while emphasising *is*. The researcher then proceeded to the second set of trial pictures – the first of a boy smiling and the second of a boy with a sad face – and said 'The boy is happy. The boy .....'.

The child was then shown the seventeen sets of pictures in turn. Nine of the sets contained three pictures, for example 'Go *to* the shop' – 'Stop *at* the light' – 'Go *to* the park'. Eight of the sets contained four pictures, where a pair of contrasting function words was targeted, for example 'We *can* eat chocolate' – 'We *can't* eat bees' – 'We *can* eat cake' – 'We *can't* eat shoes'. For each set, the researcher described the first two pictures. Either the first or the second picture description contained the same syntactic structure (and in some cases the target function word) as the target picture/s. This provided the child with a model to follow in their own production relating to the target pictures. For the following one or two picture/s, the researcher began the description, but became silent just before the function word was to be produced. The child was required to complete the description. The function word was always the first word to be produced by the child. For example: picture 1 = 'Hit the ball to the girl'; picture 2 = 'Take the ball from the dog'; picture 3 = 'Throw the

ball ....'. Here, the child was required to complete the sentence by saying 'to the boy', in which *to* was the target.

Responses were recorded using a Sony TVR-30 digital video recorder. Transcription and scoring were carried out by the researcher. A proportion of the data was also transcribed and scored by a linguist.

Scoring

Only the function word targeted in each stimulus picture was scored. A point was given for each function word produced correctly. These were added to give a total score out of a maximum 25 points. This score was converted to a percentage.

9.3.4 SENTENCE IMITATION WITH VARIABLE LOAD (SIVL) TASK

Aim: To determine the impact of the number of content-word syllables and the number of words on sentence imitation.

Question: Does an increase in output load at the word level or the sentence level affect the production of content and function words on a sentence imitation task?

Stimuli

This SIVL Task consisted of 30 sentences ranging from four to eight words in length. (Four words is the level at which even the most severely speech-disordered children in Phase 1 attempted to repeat the utterances). Fifteen sentences were phonologically simple (PS) sentences containing one-syllable nouns, verbs and adjectives, and the other 15 were phonologically loaded (PL) sentences containing nouns, verbs and adjectives of two and three syllables. Three sentences of each type (six sentences) were presented at each of the five sentence length levels (four, five, six, seven and eight words). Only syntactically simple sentences were used in order to restrict the variables that could affect performance. Table 9.2 gives a breakdown of the stimuli.

Table 9.1 Breakdown of SIVL Task

Sentence length	Number of PS sentences	Number of PL sentences
4 words	3	3
5 words	3	3
6 words	3	3
7 words	3	3
8 words	3	3
Total content words	51	51
Total function words	39	39

Function words included

An equal number of function words was included in each set of sentences: the 15 phonologically simple sentences and the 15 phonologically loaded sentences each contained 39 function words. The function words included were:

- determiners: a, the, his, her, our, my, your
- auxiliaries/copulas: will, can, be, is, cannot, hasn't
- prepositions: to, at, in, on, with, inside
- pronouns: he, me

Syllable load of words

In the phonologically simple sentences, each content word contained only one syllable. In the phonologically loaded sentences, the content words ranged from one to three syllables. There were three function words which contained two syllables. These were 'cannot', 'inside' and 'hasn't'. The total number of syllables in each of the phonologically simple sentences ranged from four to eight, while the number of syllables in each of the phonologically loaded sentences ranged from seven to thirteen.

Variables considered

- Semantics: Phonologically simple and loaded sentences were matched as far as possible, both semantically and syntactically, as well as for the number of words. Semantic absurdity was incorporated into some of the sentences to keep the attention of the child, for example 'A monkey can open the window' and 'A bear can shut the door'.

- Phonology/phonotactics: These were kept as simple as possible. In particular, there were no affricates and the only clusters were those containing the nasal /n/ followed by a stop /b/k/t/. When placed before the /b/ or /k/ the nasal would be assimilated to /mb/ and /ŋk/. Inclusion of the 'late eight' phonemes (/s, z, l, r, ʃ, ʒ, θ, ð/) as described by Shriberg and Kwiatkowski (1994b) was kept to a minimum. For example, /θ/ was included on only two occasions: in 'Samantha' and 'Jonathan'. The contracted negative was added to the auxiliary in two sentences to ensure that the auxiliary was required in order to be syntactically well-formed: 'He hasn't forgotten his noisy dinosaur at home' and 'He hasn't got his loud bear at home'. If there were no contracted negative 'n't', then the sentence would be grammatical without the auxiliary: 'He got his loud bear at home'.

A full set of stimuli is presented in Appendix 5.

Procedure

The following instruction was given to the child: 'This is a 'copy cat' game. You must copy exactly what I say'. Two trial stimuli were then presented. The first trial contained one word, 'dog', and the second contained two words, 'funny man'. Once it had been established that the child understood the requirements of the task, the test stimuli were presented.

The stimuli were presented by the live voice of the researcher in order to maintain the child's attention and participation as far as possible. Sentences were presented in increasing length, from four words to eight words. The presentation of the phonologically loaded and the phonologically simple sentences was random within the order of increasing sentence length.

A clown-building toy was used as a motivation to maintain the child's attention. After every two sentences the child attempted to imitate, s/he was allowed to put a coloured wooden peg on one of five sticks in order to build a clown.

Responses were recorded on a Sony TVR30 digital video recorder with a mini dv 83 minutes professional tape. The child's responses were then transcribed and scored independently by the researcher and a linguist, as above.

Scoring

Sentence imitation scores

One point was awarded for each content and function word produced. With one exception, the same criteria were used here for crediting the production of a content or function word as were used for the Sentence Imitation Task in Phase 1 (Chapter 5, Section 5.8.3). The only exception was that whole-word substitutions from the same category were marked as an error here. This was based on the findings from Phase 1, where whole-word substitutions were not penalised in scoring, but were noted and found to be an important category of error in terms of group distinctions.

The total content- and function-word scores in the simple condition (single-syllable content words) and the loaded condition (multi-syllabic content words) were converted to percentages and compared. The same conversion and comparison was carried out for the total content and function word scores for short sentences (four to five words) and long sentences (seven to eight words).

Error analysis

Content- and function-word errors were analysed according to the following categories, defined in Chapter 7, Section 7.1: omissions (Om), sound substitutions (Ssub), distortions (Dist), whole-word substitution from the same grammatical category (Wsub), and whole-word substitution from a different grammatical category (Wsubdif), and unmatched syllables (Usyl).

In addition, the production of multi-syllabic content words for which a child was credited in the loaded condition were analysed to determine whether any of the syllables had been omitted. This was termed syllable integrity (Chapter 4, Section 4.4). For example, while a child was credited for the production [mɛmbə] for *remember*, his/her omission of the first syllable [ri] was recorded.

9.4 GENERAL METHODOLOGY

9.4.1 SESSION PROCEDURE

The tasks were carried out under the same conditions as those reported in Phase 1. The order of task presentation was as follows:

- Sentence Judgement Task (first 25 items)
- SIVL Task
- Recall Task (digits and words)
- Sentence Completion Task
- Sentence Imitation Task (administered to the 34 typically developing children only)
- Sentence Judgement Task (last 15 items)

9.4.2 RECORDING AND DATA CAPTURE

This study used the same procedures as those used in Phase 1 to record the sessions, edit the sessions to save only the tasks themselves, and transcribe the children's utterances.

9.4.3 ANALYSIS

There is currently debate as to the best method of comparing an individual's scores to those of a group (Crawford, Garthwaite, Howell, & Gray, 2004; Crawford & Howell, 1998; Mycroft, Mitchell, & Kay, 2002). A review of the methods proposed led to the adoption of Crawford and Howell's (1998) use of Modified *t*-tests (ANOVAS with revised F-criteria). This choice was largely based on reluctance to consider each individual as representative of a notional group, as advocated by Mycroft et al (2002).

CHAPTER 10

SENTENCE PROCESSING-RELATED ABILITIES OF CHILDREN WITH IPD: RESULTS

10.1 OVERVIEW OF PRESENTATION

This chapter presents the results of the TD2 group of children, followed by those of the five participants with IPD on the four purposefully constructed tasks outlined in the previous chapter.

10.2 INTER-RATER RELIABILITY

The sentence imitation data from the SIVL Task were transcribed phonetically and scored by the researcher. Data from two randomly selected participants with IPD were transcribed and scored independently by a linguist. As mentioned in Chapter 9, Section 9.3.4, the imitation of both content and function words was analysed for this task. Therefore, the raters' scores for content and function words on each of the 30 sentences in this task were compared for the two participants using a Pearson's *r* correlation.

Results showed the mean agreement between the two raters for content words to be $r(28)=.952$ ($p<.01$) (Child A: $r(28)=.977$; Child B: $r(28)=.922$). A mean agreement of $r(28)=.885$ ($p<.01$) was obtained for function word scores (Child A: $r(28)=.864$; Child B: $r(28)=.907$).

10.3 TD2 GROUP

The results obtained by TD2 group are presented in Table 10.1.

Table 10.1 Results of TD2 group

Task	Mean	Range	Std deviation
Sentence Imitation	98.7%	96.2 -100%	.76
Sentence Judgement	89.4%	67.5 -100%	8.4
Recall – digits	4	3-5	.76
Recall – words	3.8	3-5	.73
Sentence Completion	91.6%	80 -100%	5.2
SIVL:			
Simple content words	97.8%	90-100%	2.8
Simple function words	98.9%	92.5-100%	2.1
Loaded content words	97.8%	88-100%	3.1
Loaded function words	98.2%	90-100%	2.2
Short-sentence content words	99%	94.4-100%	1.8
Short-sentence function words	99.3%	94.4-100%	1.8
Long-sentence content words	97%	87-100%	3.8
Long-sentence function words	98.1%	88.6-100%	2.6

As Table 10.1 shows, the TD2 group obtained extremely high scores on the Sentence Imitation, Judgement and Completion Tasks. Their close-to-ceiling score on the Sentence Imitation Task (mean=98.7%, SD=.76) is in line with the TD group's results in Phase 1.

As children were choosing between just two sentences on the Sentence Judgement Task, the chance of making the correct choice was 50% (20 out of 40). A Binomial Test was used to determine the lowest score that is unlikely to occur by chance. This was found to be a score of 27 (67.5%), $p<.05$. All the children demonstrated abilities significantly above chance on this task ($\geq$ 67.5%).

On the SIVL Task, Paired-samples *t*-tests revealed no differences between the scores on simple versus loaded sentences (content words: $t_{(33)}=.245$, $p>.05$; function words: $t_{(33)}=1.501$, $p>.05$). For short and long sentences, however, Paired-samples *t*-tests found the scores obtained for content and function words to be significant (content words: $t_{(33)}=3.47$, $p<.01$; function words: $t_{(33)}=2.48$, $p<.01$). These results are not surprising, as increasing sentence length is bound to have an effect on the performance of all children if pushed far enough. The fact that the group obtained such high scores in both conditions (content words: short=99%, long=97%; function words:

short=99.3%, long=98.1%) suggests that the abilities of these typically developing children were not stretched very much by this task, although slightly more by the longer sentences than by the shorter ones.

On the Recall Task these children recalled a range of three to five digits and words, with a mean of 4 for digits and 3.8 for words. The digit-span mean was slightly higher than the means obtained by Gathercole (1995) in her assessment of the phonological working memory abilities in groups of children with mean ages of 4.1 years (2.9) and 5.3 years (3.5).

Although the constructed tasks were not standardised, the TD2 group showed a high level of ability with a limited range of scores. This shows that these tasks generate scores at, or almost at, ceiling and failure to achieve high scores is not a function of the task construction. This formed a strong basis for determining whether children with IPD fell out of the 'normal' range and, if so, how far below they were. This was measured in standard deviations (SD) or by Modified *t*-tests (Crawford & Howell, 1998). A colour-coded scheme is used to indicate this in a summary table at the end of the analysis of each IPD child's performance:

Green: where a non-significant difference between the child and the TD2 group was obtained. This was reflected by scores being less than 1.5 SD from the mean of the TD2 group, or by non-significant Modified *t*-test results.

Red: where a significant difference between the child and the TD2 group was obtained. This was reflected by scores being equal to or greater than 1.5 SD from the mean of the TD2 group, or by significant Modified *t*-test results.

A cut-off of 1.5 SD was used as a compromise between the cut-off of 2 SD specified by the World Health Organisation (1993) and the 1.25 SD cut-off used by some researchers such as Shriberg and Austin (1998) and Tomblin et al. (1997).

10.4 PARTICIPANTS WITH IPD

The results of the two participants who obtained extremely high scores for the production of function words on the Sentence Imitation Task (Chapter 8, Section 8.5.2) will be presented first. Thereafter, the results of the three participants who did not perform as well on the Sentence Imitation Task will be presented. The performance of all these children will be compared with that of the TD2 group.

10.4.1 HIGH-SCORING PARTICIPANTS

Of the children with IPD, BH's and RF's scores on the Sentence Imitation Task approximated the TD2 group's scores most closely. Both BH's and RF's function-word scores were above 90% and BH's score (96.8%) was within the range of the TD2 group (96.2-100%). Hence, it is clear that even when speech is severely impaired and highly inconsistent, this need not affect sentence imitation performance if allowances are made for speech difficulties when scoring.

Table 10.2 shows their scores on the four novel tasks aimed at assessing their sentence processing-related abilities, as well as the mean, range and standard deviations of the TD2 group.

Table 10.2 Results of high-scoring participants compared with typically developing children

Task	BH	RF	TD2 group (n=34)		
			Mean	Range	SD
Sentence Judgement	82.5%	90%	89.4%	67.5-100%	8.4
Recall – digits	3	4	4	3-5	.76
Recall – words	4	4	3.8	3-5	.73
Sentence Completion	84%	92%	91.6%	80-100%	5.2
SIVL:					
Simple content words	100%	88.9%	97.8%	90-100%	2.8
Simple function words	100%	100%	98.9%	92.5-100%	2.1
Loaded content words	97.8%	97.8%	97.8%	88-100%	3.1
Loaded function words	100%	100%	98.2%	90-100%	2.2
Short-sentence content words	100%	100%	99%	94.4-100%	1.8
Short-sentence function words	100%	100%	99.3%	94.4-100%	1.8
Long-sentence content words	98%	90%	97%	87-100%	3.8
Long-sentence function words	100%	100%	98.1%	88.6-100%	2.6

This table shows that BH and RF both obtained scores significantly above chance on the Sentence Judgement Task, and above 83% on the Sentence Completion Task.

Their scores on the SIVL Task were at or close to ceiling in the simple and loaded conditions. A qualitative analysis of the multi-syllabic content words included in the loaded condition found one instance where RF omitted one of the syllables in a multi-syllabic word, [pʊf] for *purple.* There were no significant differences in BH and RF's scores when imitating short versus long sentences. In nearly all cases their scores on this task were higher than the TD2 group's means.

RF was able to recall four digits and four words, while BH was able to recall three digits and four words.

BH's and RF's performance profiles are illustrated in Figure 10.1, which shows that their scores are not significantly different from the TD2 group's scores across the board (within 1.5 SD of the mean of the TD2 group's scores). In fact, they were all within 1 SD of the TD2 group's means. As BH and RF do not show any sentence-processing difficulties relative to the TD2 group, no further analysis of their results is necessary.

	SJ	Recall		SC	SIVL							
		Digits	Words		Simple		Loaded		Short		Long	
					C	F	C	F	C	F	C	F
BH												
RF												

Key:

Green: non-significant difference between participant and TD2 group reflected by scores being less than 1.5 SD from the mean of the TD2 group, or by a non-significant Modified *t*-test result.

Red: significant difference between participant and TD2 group, reflected by scores being equal to or greater than 1.5 SD from the mean of the TD2 group, or by a significant Modified *t*-test result.

Figure 10.1 BH's and RF's profiles in relation to the TD2 group

10.4.2 LOW-SCORING PARTICIPANTS

PARTICIPANT AA

AA obtained the lowest score for function-word production on the Sentence Imitation Task (28.5%). Table 10.3 shows his performance on the four novel tasks aimed at assessing his sentence processing-related abilities, as well as the TD2 group's mean, range and standard deviations. It reflects AA's significant difficulties in most areas. These scores are statistically analysed and illustrated under their respective headings.

Table 10.3 Results of AA compared with typically developing children

Task	AA	TD2 group (n=34)		
		Mean	Range	SD
Sentence Judgement	70%	89.4%	67.5-100%	8.4
Recall – digits	2	4	3-5	.76
Recall – words	3	3.8	3-5	.73
Sentence Completion	20%	91.6%	80-100%	5.2
SIVL:				
Simple content words	82%	97.8%	90-100%	2.8
Simple function words	10%	98.9%	92.5-100%	2.1
Loaded content words	54%	97.8%	88-100%	3.1
Loaded function words	12.5%	98.2%	90-100%	2.2
Short-sentence content words	72.2%	99%	94.4-100%	1.8
Short-sentence function words	22.2%	99.3%	94.4-100%	1.8
Long-sentence content words	58.7%	97%	87-100%	3.8
Long-sentence function words	11.4%	98.1%	88.6-100%	2.6

Sentence Judgement Task

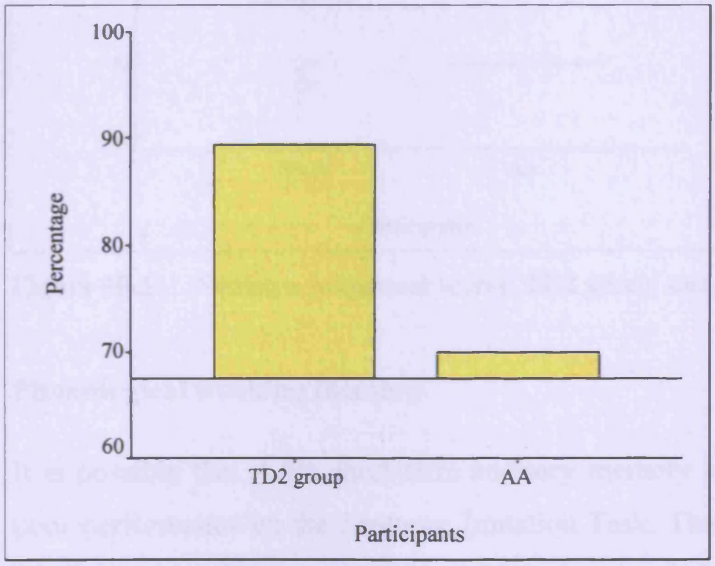

Figure 10.2 Sentence judgement scores: TD2 group and AA

The horizontal line, in this and subsequent sentence judgement diagrams, indicates the level of result that has to be achieved (67.5%) to be significantly above chance ($p<.05$).

The bar diagram in Figure 10.2 illustrates that AA's score (70%) is significantly above chance (50%), which may suggest that he does not have input difficulties relating to the appropriateness of function words in the context of sentences. However, his score is only marginally above the *significant* level above chance (67.5%). In addition it is inconsistent with his performance on the other tasks. In light of this it could be that a Type I error occurred here. This is supported by a follow-up of AA's abilities, reported in Chapter 11.

When comparing AA with typically developing children, the box plot in Figure 10.3 shows that, even though AA achieved a score significantly above chance, his score is only comparable with two outliers of the TD2 group. His score is still 2.3 SD below the mean of the TD2 group.

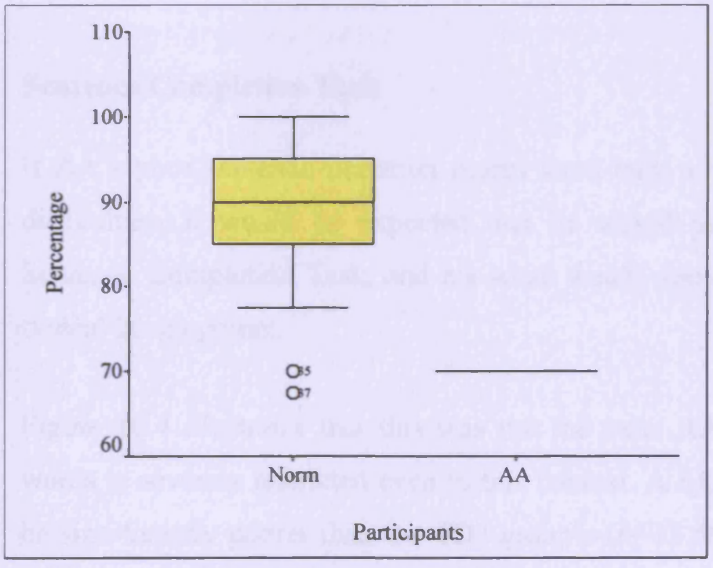

Figure 10.3 Sentence judgement scores: TD2 group, showing outliers, and AA

Phonological working memory

It is possible that AA's short-term auditory memory abilities are contributing to his poor performance on the Sentence Imitation Task. There was some indication of this when his score for the production of function words in short utterances (two to four

words: 54.1%) on the Sentence Imitation Task was compared with his function word score in long utterances (six to nine words: 19.7%). A Chi-squared analysis of the number correct found a significant difference between these two scores, indicating that AA's performance was significantly affected by length on this task (X^2=12.85, df=1, p<.001). Table 10.4 shows AA's and the TD2 group's scores on the Recall Task.

Table 10.4 Phonological working memory: AA and TD2 group's scores on the Recall Task

Recall Task: digits				**Recall Task: words**			
AA	**TD2**			**AA**	**TD2**		
	Mean	Range	SD		Mean	Range	SD
2	4	3-5	.76	3	3.8	3-5	.73

As this table shows, AA's digit span (2) was below the range of the TD2 group and more than 2 SD from its mean. His word span (3) was at the lowest end of the range of the TD2 group but was within 1.5 SD of the group's mean. These results suggest some difficulty with phonological working memory, though less so for words than for digits.

Sentence Completion Task

If AA's poor sentence imitation scores were only a result of his speech production difficulties, it would be expected that he would perform extremely well on the Sentence Completion Task, and his score would approximate those of children with typical development.

Figure 10.4 illustrates that this was not the case. AA's ability to produce function words is severely restricted even in this context. A Modified *t*-test found his score to be significantly poorer than the TD2 group's (*t*=-13.565, p<.001). Thus, it is evident that AA has a genuine expressive difficulty with function words, not related to speech production overload.

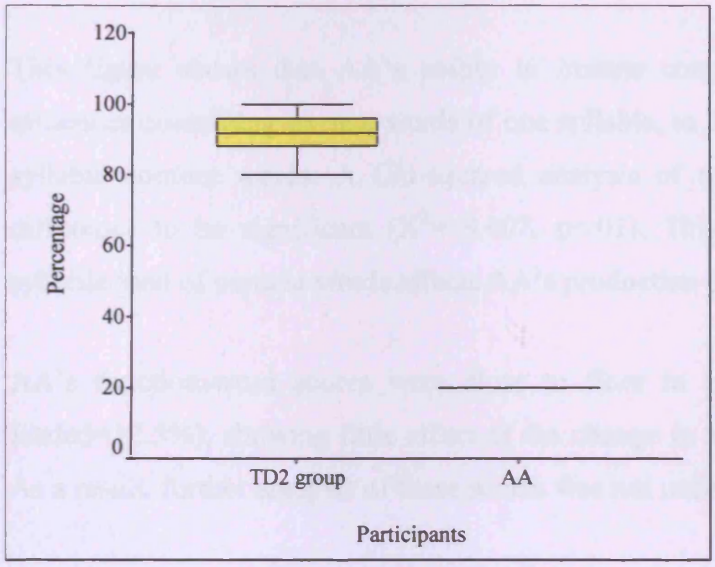

Figure 10.4 Sentence completion scores: TD2 group and AA

SIVL Task

Syllable load

Figure 10.5 shows AA's performance on content and function words in phonologically simple (with single-syllable content words) and loaded (with multi-syllabic content words) conditions.

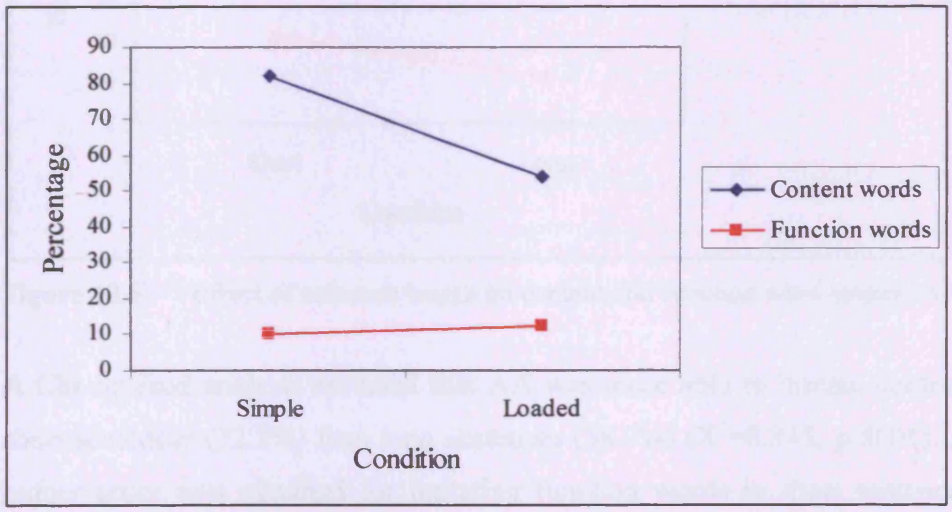

Figure 10.5 Effect of content-word syllable load on content and function word targets: AA

This figure shows that AA's ability to imitate content words fell from 82% in sentences containing content words of one syllable, to 54% in those containing multi-syllabic content words. A Chi-squared analysis of the number correct found this difference to be significant (X^2= 9.007, p<.01). This suggests that increasing the syllable load of content words affects AA's production of content words in sentences.

AA's function-word scores were close to floor in both conditions (simple=10%, loaded=12.5%), showing little effect of the change in syllable load of content words. As a result, further analysis of these scores was not undertaken.

Sentence length

The results AA obtained for imitating content and function words in short (four to five word) and long (seven to eight word) utterances are presented in Figure 10.6.

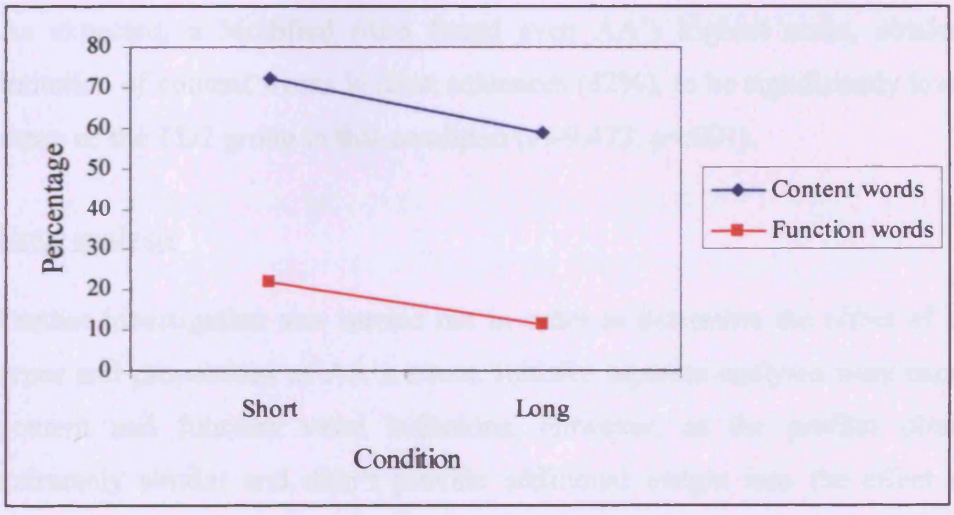

Figure 10.6 Effect of sentence length on content and function word targets: AA

A Chi-squared analysis revealed that AA was more able to imitate content words in short sentences (72.2%) than long sentences (58.7%) (X^2=8.343, p<0.01). Although a higher score was obtained for imitating function words in short sentences (22.2%) than in long sentences (11.4%), the difference was not significant. It may be that AA's function word scores are too low to be meaningfully analysed.

Overall, AA's poor scores reflect his severe difficulty with sentence imitation. His performance is adversely affected by both aspects of output load: increasing the number of syllables in content words, and the number of words in a sentence. This load effect was more clear in his imitation of content words than function words, where he obtained extremely low scores even when imitating short sentences containing content words of one syllable.

Comparison with typically developing children

The effect of load on AA's performance can be compared with the effect of load on the performance of the TD2 group. Unlike AA, the manipulation of content-word syllable load had no effect on the group's scores. However, just as with AA, increasing sentence length had a significant effect on their scores, despite the fact that they achieved scores almost at ceiling even in long sentences (as outlined in Section 10.3 above).

As expected, a Modified *t*-test found even AA's highest score, obtained for the imitation of content words in short sentences (82%), to be significantly lower than the mean of the TD2 group in that condition ($t=-9.473$, $p<.001$).

Error analysis

Further investigation was carried out in order to determine the effect of load on the types and proportions of AA's errors. Initially separate analyses were carried out for content and function word imitations. However, as the profiles obtained were extremely similar and didn't provide additional insight into the effect of load on imitation within sentences, combined analyses of content- and function-word errors were carried out for all IPD participants. AA's combined content- and function-word errors, in simple vs loaded sentences, and short vs long sentences, are presented below.

Content-word syllable load

The types and proportions of AA's errors, in the simple and loaded conditions, are presented in Figure 10.7.

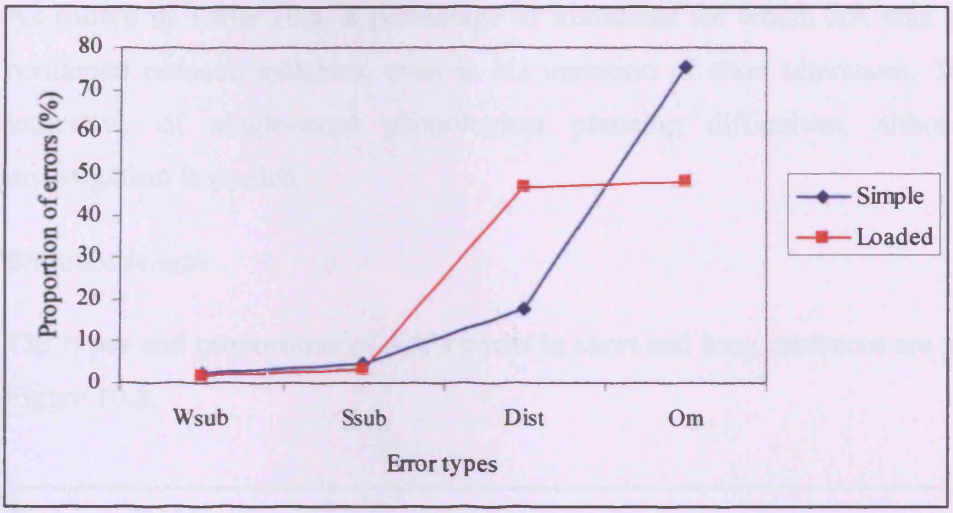

Figure 10.7 Combined content- and function-word error analysis: simple and loaded conditions

As Figure 10.7 shows, AA's imitations contained the same types of errors in both conditions. The greatest proportion of AA's errors in both conditions was made up of omissions and distortions. While AA tended mostly to omit content or function words in the simple condition (75.6%), his productions became more distorted in the loaded condition (46.6%), which prevented any further analysis of his errors. An example of this in stimuli of six words is:

Simple condition: 'Our game will make a noise'; Response: [ʌθ geim nɔiz].

Loaded condition: 'Our video can record the movie'; Response: [*distortion* u i].

AA's errors in both simple and loaded conditions, also consisted of small proportions (less than 5%) of whole-word substitutions from the same grammatical category and sound substitutions.

With regard to syllable integrity, Table 10.5 presents a breakdown of the extent to which AA produced multi-syllabic content words with a reduced number of syllables, in short and long utterances.

Table 10.5 Percentage syllables reduced as a proportion of AA's correct score

	% syllables reduced as proportion of correct score
Short utterances	15.4%
Long utterances	7.4%

As shown in Table 10.5, a percentage of imitations for which AA was given credit contained reduced syllables, even in his imitation of short utterances. This may be indicative of single-word phonological planning difficulties, although further investigation is needed.

Sentence length

The types and proportions of AA's errors in short and long sentences are presented in Figure 10.8.

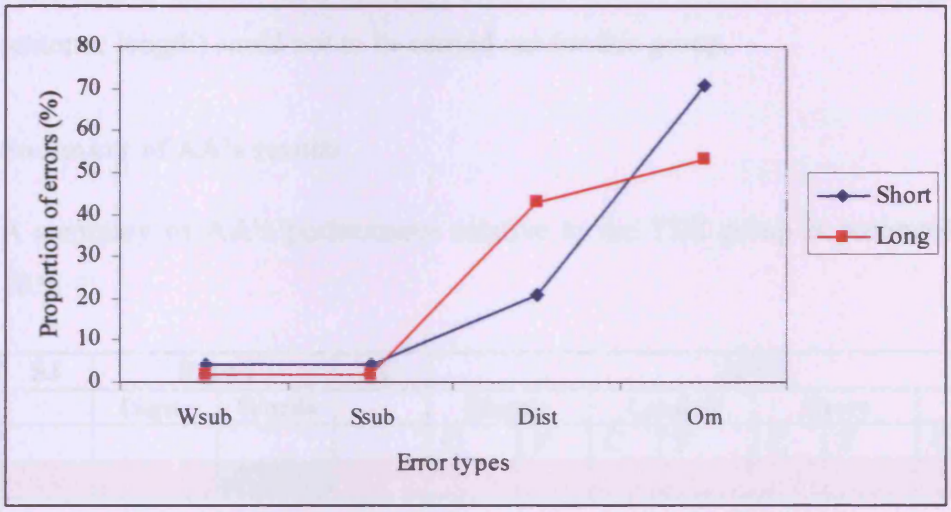

Figure 10.8 Combined content- and function-word error analysis: short and long sentences

As Figure 10.8 shows, the types and proportions of AA's errors here mirror his profile in response to increasing the content-word syllable load. Omissions and distortions make up the largest proportion of AA's errors in both conditions, and an increase in sentence length results in an increased proportion of distortions (short: 20.8%; long: 43.1%). Small proportions of whole-word substitutions from the same grammatical category and sound substitutions were also recorded (less than 5%) in both conditions.

The above results indicate that an increase in load – either in terms of content-word syllable load or the number of words in a sentence – mainly causes AA's production of sentence components to become distorted, thus making it difficult to identify words or other types of errors in his sentence productions. His difficulty at a single-word level is evident in his reduction of syllables even when imitating short sentences.

Comparison with typically developing children

The above patterns of errors in response to increasing output load can be contrasted with the few errors made by children in the TD2 group. Only two error types were recorded for this group. In total, 82 whole-word substitutions from the same grammatical category and 34 omissions were recorded across the whole group of 34 TD2 children. Ten instances of syllable reduction were noted across the group in relation to the following words: *forgotten*, *Amanda*, *pancake*, *cannot*, *computer*. Due to the few errors recorded, as well as their random distribution, meaningful comparisons of the effect of load (either in relation to content-word syllable load or sentence length) could not to be carried out for this group.

Summary of AA's results

A summary of AA's performance relative to the TD2 group is presented in Figure 10.9.

SJ	Recall		SC	SIVL							
	Digits	Words		Simple		Loaded		Short		Long	
				C	F	C	F	C	F	C	F

Key:
Green: non-significant difference between participant and TD2 group reflected by scores being less than 1.5 SD from the mean of the TD2 group, or by a non-significant Modified *t*-test result.
Red: significant difference between participant and TD2 group, reflected by scores being equal to or greater than 1.5 SD from the mean of the TD2 group, or by a significant Modified *t*-test result.

Figure 10.9 AA's profile in relation to the TD2 group

As this figure shows, AA experienced difficulty on all the sentence processing-related tasks compared with the TD2 group, except for word recall, where he achieved a span within 1.5 SD of the mean of the TD2 group.

His results may also be viewed in relation to the three questions posed at the start of Chapter 9:

(i) Abilities at an input level: AA's ability to recognise function words appropriate to sentence contexts is slightly above the level of chance but still poor relative to typically developing children.

(ii) Phonological working memory skills: AA shows weakness in this area.

(iii) Effect of load on production: AA has a genuine difficulty producing function words, irrespective of the context in which they are produced. In addition, his difficulty with imitating sentences is exacerbated by increased load, both when the number of syllables in words is increased, and when the number of words in the sentence is increased. This is more apparent with content words, as his function word scores are almost at floor in most conditions. Any increase in output load causes AA's sentences to become increasingly distorted. Of the content words AA was credited for, he produced a proportion of the multi-syllabic words with a reduced number of syllables.

These results provide sufficient evidence to assert that AA's poor sentence imitation performance is not due to the severity of his single-word speech difficulties alone, but also reflects difficulties he is experiencing across all levels of sentence processing assessed.

PARTICIPANT RG

RG obtained the second lowest score for the production of function words on the Sentence Imitation Task (41.8%). Table 10.6 shows his performance on the four novel tasks aimed at assessing his sentence processing-related abilities, as well as the mean, range and standard deviations of the TD2 group.

Table 10.6 Results of RG compared with typically developing children

Task	RG	TD2 group (n=34)		
		Mean	Range	SD
Sentence Judgement	45%	89.4%	67.5-100%	8.4
Recall – digits	4	4	3-5	.76
Recall – words	4	3.8	3-5	.73
Sentence Completion	52%	91.6%	80-100%	5.2
SIVL:				
Simple content words	76%	97.8%	90-100%	2.8
Simple function words	32.5%	98.9%	92.5-100%	2.1
Loaded content words	68%	97.8%	88-100%	3.1
Loaded function words	27.5%	98.2%	90-100%	2.2
Short-sentence content words	75%	99%	94.4-100%	1.8
Short-sentence function words	55.6%	99.3%	94.4-100%	1.8
Long-sentence content words	67.4%	97%	87-100%	3.8
Long-sentence function words	25%	98.1%	88.6-100%	2.6

Table 10.6 reflects RG's significant difficulties in most areas assessed. These scores are statistically analysed and illustrated under their respective headings.

Sentence Judgement Task

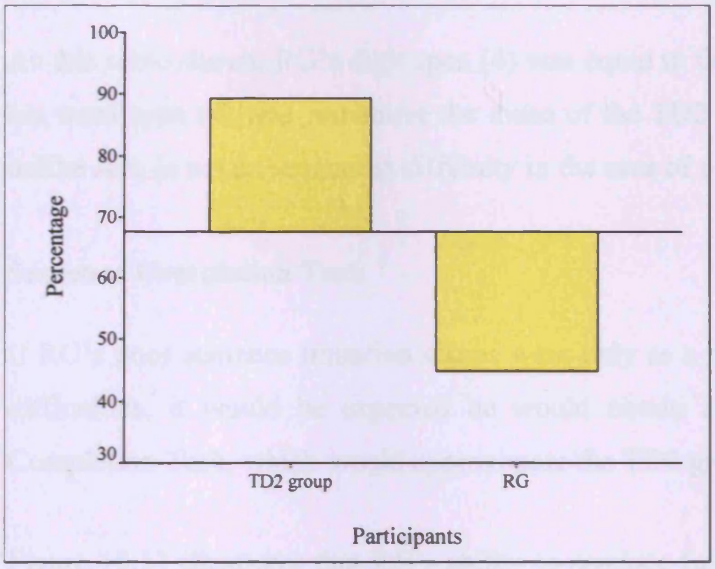

Figure 10.10 Sentence judgement scores: TD2 group and RG

As shown in Figure 10.10, RG's score of 45% is not significantly above chance (67.5%). His score is also 5.28 SD below the mean of the TD2 group. This suggests that RG has significant input difficulties, in that he is not sure about the appropriateness of function words in the context of sentences.

Phonological working memory

It is possible that RG's short-term auditory memory abilities are contributing to his poor performance on the Sentence Imitation Task. There was some indication of this when his score for the production of function words in short utterances (two to four words: 64.9%) on the Sentence Imitation Task was compared with his function word score in long utterances (six to nine words: 37.9%). A Chi-squared analysis found a significant difference between these two scores, indicating that his performance was significantly affected by length on this task (X^2=6.923, df=1, p<.01).

Table 10.7 compares RG's and the TD2 group's scores on the Recall Task.

Table 10.7 Phonological working memory: RG and TD2 group scores on the Recall Task

Recall Task: digits				Recall Task: words			
RG	TD2			RG	TD2		
	Mean	Range	SD		Mean	Range	SD
4	4	3-5	.76	4	3.8	3-5	.73

As this table shows, RG's digit span (4) was equal to the mean of the TD2 group and his word span (4) was just above the mean of the TD2 group. This suggests that RG, unlike AA, is not experiencing difficulty in the area of phonological working memory.

Sentence Completion Task

If RG's poor sentence imitation scores were only as a result of his speech production difficulties, it would be expected he would obtain a high score on the Sentence Completion Task, which would approximate the TD2 group's scores.

Figure 10.11 illustrates that RG's ability to produce function words is restricted even in this context. A Modified *t*-test revealed a significant difference between RG's performance and that of the TD2 group (t=-7.506, p<.001). Thus, it is evident that RG has a genuine expressive difficulty with function words, not related to speech production overload.

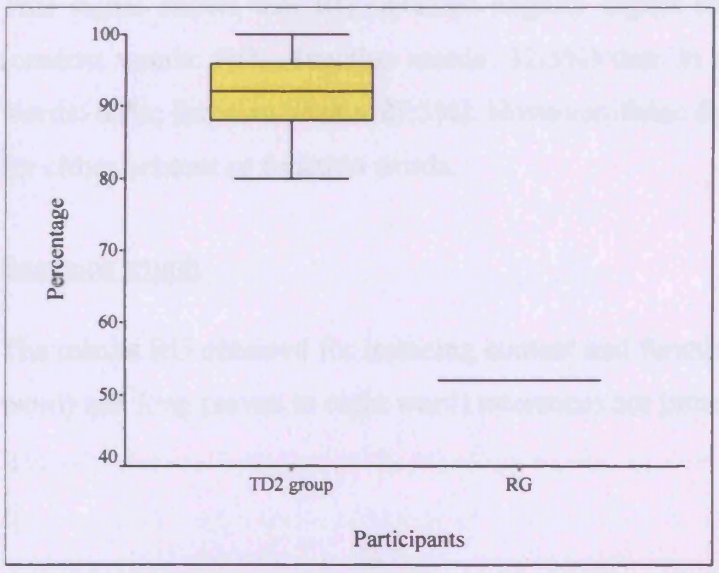

Figure 10.11 Sentence completion scores: TD2 group and RG

SIVL Task

Content-word syllable load

Figure 10.12 shows RG's performance on content and function words in phonologically simple (with single-syllable content words) and loaded (with multi-syllabic content words) conditions.

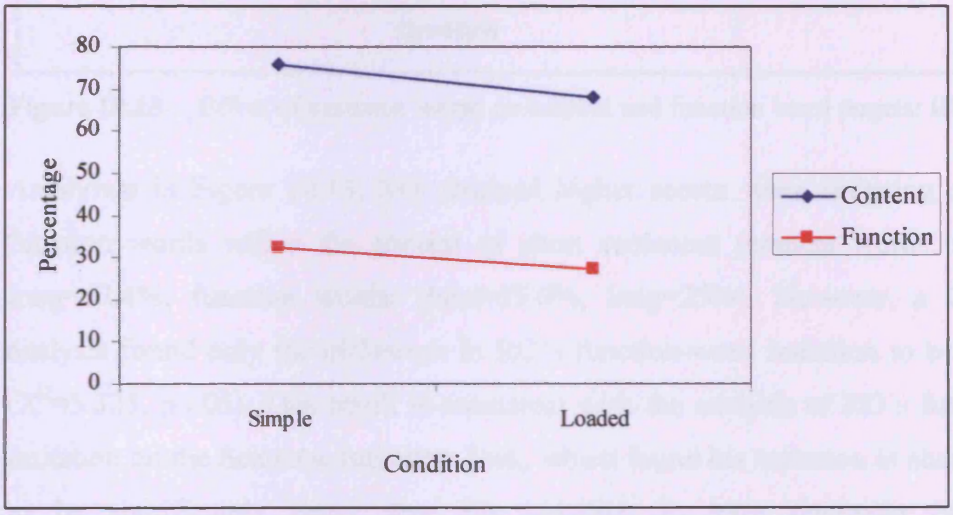

Figure 10.12 Effects of content-word syllable load on content and function word targets: RG

This figure shows that RG obtained slightly higher scores in the simple condition (content words: 76%; function words: 32.5%) than in the loaded condition (content words: 68%; function words: 27.5%). However, these differences were not significant for either content or function words.

Sentence length

The results RG obtained for imitating content and function words in short (four to five word) and long (seven to eight word) utterances are presented in Figure 10.13.

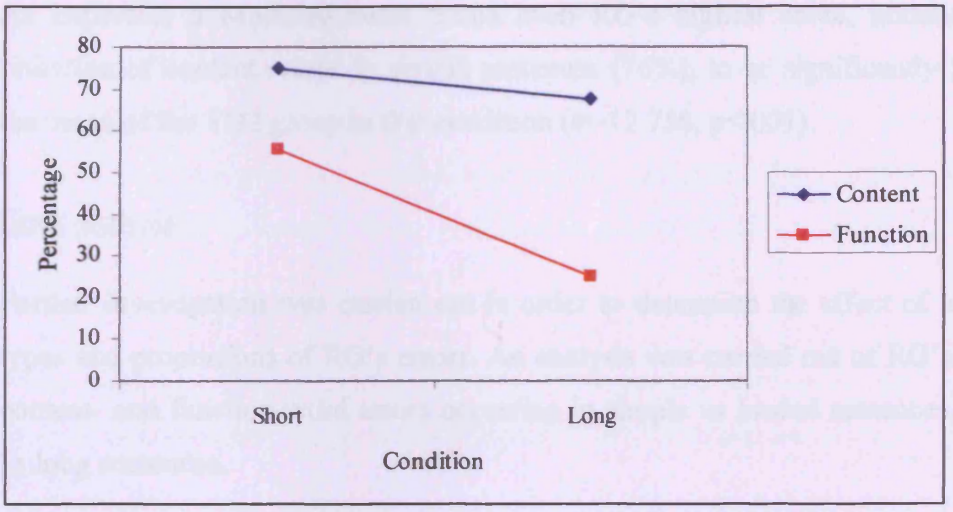

Figure 10.13 Effect of sentence length on content and function word targets: RG

As shown in Figure 10.13, RG obtained higher scores when imitating content and function words within the context of short sentences (content words: short=75%, long=67.4%; function words: short=55.6%, long=25%). However, a Chi-squared analysis found only the difference in RG's function-word imitation to be significant (X^2=5.325, p<.05). This result is consistent with the analysis of RG's function-word imitation on the Sentence Imitation Task, which found his imitation in short sentences to be significantly better than his imitation in long sentences (see Section 'Phonological working memory' above).

In summary, RG's imitation of function words in sentences is significantly affected by an increased load in terms of sentence length. Although there is some suggestion of his performance being affected by increasing the number of syllables in words, this is not statistically significant.

Comparison with typically developing children

The effect of load on RG's performance can be compared with the effect of load on the performance of the TD2 group. Unlike RG, the manipulation of content-word syllable load had no effect on the group's scores, which were almost at ceiling for both content and function words in both conditions. Like RG, increasing sentence length had a significant effect on the group's scores, despite the fact that they achieved scores almost at ceiling even in long sentences (as outlined in Section 10.3 above).

As expected, a Modified *t*-test found even RG's highest score, obtained for the imitation of content words in simple sentences (76%), to be significantly lower than the mean of the TD2 group in that condition (t=-12.758, p<.001).

Error analysis

Further investigation was carried out in order to determine the effect of load on the types and proportions of RG's errors. An analysis was carried out of RG's combined content- and function-word errors occurring in simple vs loaded sentences, and short vs long sentences.

Content-word syllable load

The types and proportions of RG's errors in the simple and loaded conditions are presented in Figure 10.14.

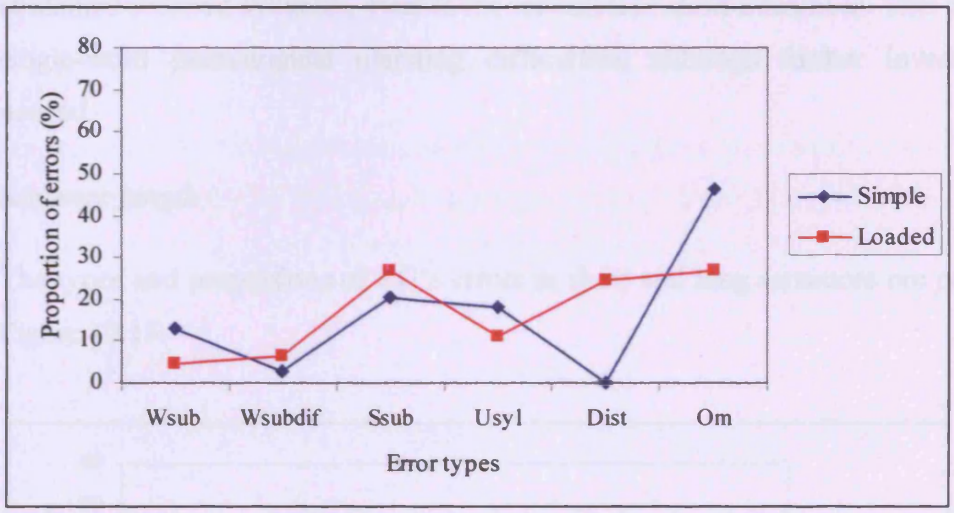

Figure 10.14 Combined content- and function-word error analysis: simple and loaded conditions

As Figure 10.14 shows, like AA, the types of errors RG made in both conditions were similar, but their proportions differed. For example, while by far the largest proportion of errors in the simple condition was made up of omissions (46.2%), the majority of errors in the loaded condition was more evenly spread among omissions, sound substitutions and distortions (26.7% for omissions and sound substitutions, 24.4% distortions). The only difference between the types of errors recorded in the two conditions was the absence of distortions in the simple condition.

Similar proportions of errors in both conditions were made up of sound substitutions (simple=20.5%; loaded=26.7%), and unmatched syllables (simple=17.9%; loaded=11.1%). Small proportions of errors were made up of whole-word substitutions from the same grammatical category (simple=12.8%; loaded=4.4%), and whole word substitutions from a different grammatical category (simple=2.6%; loaded=6.7%).

With regard to syllable integrity, Table 10.8 presents a breakdown of the proportion of multi-syllabic content words that RG produced with a reduced number of syllables.

Table 10.8 Percentage syllables reduced as a proportion of RG's correct score

	% syllables reduced as proportion of correct score
Short utterances	14.8%
Long utterances	12.9%

As with AA, a percentage of content-word imitations for which RG was given credit contained reduced syllables, even in his imitation of short utterances. This may reflect single-word phonological planning difficulties, although further investigation is needed.

Sentence length

The types and proportions of RG's errors in short and long sentences are presented in Figure 10.15.

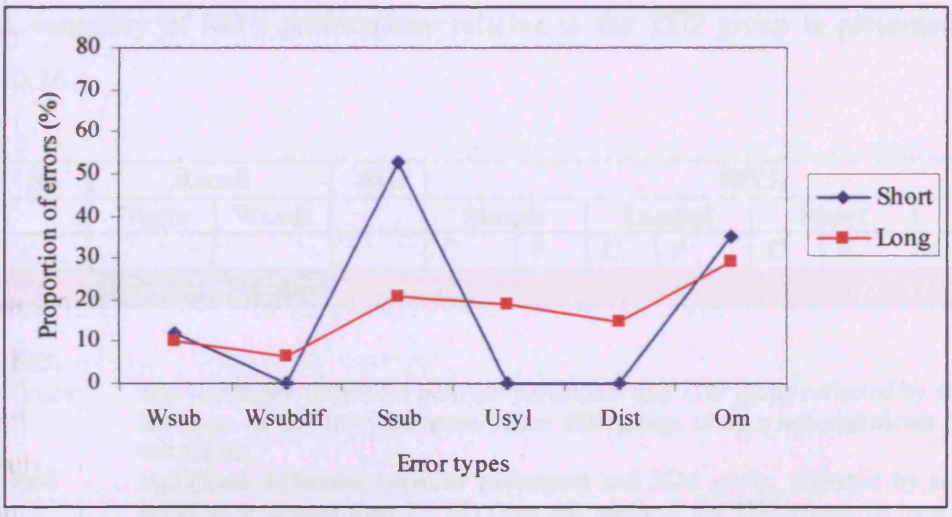

Figure 10.15 Combined content- and function-word error analysis: short and long sentences

As shown in Figure 10.15, the types and proportions of errors in RG's imitation of short and long sentences differ. In short sentences, the majority of RG's errors consisted of sound substitutions (52.9%), followed by omissions (35.3%) and a small proportion of whole-word substitutions from the same grammatical category (11.8%).

In contrast, a greater variety of errors is evident in his imitation of long sentences. While 29.2% of his errors were made up of omissions, approximately equal proportions of unmatched syllables (18.8%) and sound substitutions (20.8%) were recorded. Small proportions of whole-word substitutions from the same (10.4%) and different (6.3%) categories were also recorded.

These results show that while an increase in load does result in an increased proportion of distortions, as with AA, distortions do not dominate RG's error profile in conditions of increased load. It is therefore easier to determine the nature of his other errors.

Comparison with typically developing children

As with AA, the above patterns of errors in response to increasing output load are in stark contrast with the few errors made by children in the TD2 group, who made too few errors to be analysed (see Section 'Error analysis' in AA's results above).

Summary of RG's results

A summary of RG's performance relative to the TD2 group is presented in Figure 10.16.

SJ	Recall		SC	SIVL							
	Digits	Words		Simple		Loaded		Short		Long	
				C	F	C	F	C	F	C	F

Key:
Green: non-significant difference between participant and TD2 group reflected by scores being less than 1.5 SD from the mean of the TD2 group, or by a non-significant Modified *t*-test result.
Red: significant difference between participant and TD2 group, reflected by scores being equal to or greater than 1.5 SD from the mean of the TD2 group, or by a significant Modified *t*-test result.

Figure 10.16 RG's profile in relation to the TD2 group

As the summary figure shows, RG experienced difficulty on all the sentence processing-related tasks compared with the TD2 group, except for digit and word recall, where his scores were within 1.5 SD of the mean of the TD2 group.

His results are also viewed in relation to the three questions posed at the start of Chapter 9:

(i) Abilities at an input level: RG is experiencing difficulty recognising function words appropriate to sentence contexts.

(ii) Phonological working memory skills: RG does not show weakness in this area.

(iii) Effect of load on production: RG has a genuine difficulty producing function words, irrespective of the context in which they are assessed. Increased content-word syllable load does show some effect on his content- and function-word imitation, but this is not significant. It results in some distortions and a decreased proportion of omissions. His imitation of function words is significantly affected by an increase in sentence length, which is associated with increased proportions of both unmatched syllables and distortions. RG reduced the number of syllables in a proportion of multi-syllabic content words, even in short utterances.

These results provide sufficient evidence to assert that RG's poor sentence imitation performance is not due to the severity of his single-word speech difficulties alone, but also reflects the difficulties he is experiencing at nearly all levels of sentence processing assessed.

PARTICIPANT PJ

PJ was the third child with IPD who experienced sentence imitation difficulties relative to the TD2 group of typically developing children. Her score of 70.9% for the imitation of function words on the Sentence Imitation Task was higher than the scores obtained by AA (28.5%) and RG (41.8%). Her performance on the four novel tasks is presented in Table 10.9, together with the TD2 group's mean, range and standard deviation.

Table 10.9 Results of PJ compared with typically developing children

Task	PJ	TD2 group (n=34)		
		Mean	Range	SD
Sentence Judgement	50%	89.4%	67.5-100%	8.4
Recall – digits	3	4	3-5	.76
Recall – words	2	3.8	3-5	.73
Sentence Completion	68%	91.6%	80-100%	5.2
SIVL:				
Simple content words	70%	97.8%	90-100%	2.8
Simple function words	55%	98.9%	92.5-100%	2.1
Loaded content words	68%	97.8%	88-100%	3.1
Loaded function words	67.5%	98.2%	90-100%	2.2
Short-sentence content words	86.1%	99%	94.4-100%	1.8
Short-sentence function words	88.9%	99.3%	94.4-100%	1.8
Long-sentence content words	56.5%	97%	87-100%	3.8
Long-sentence function words	45.5%	98.1%	88.6-100%	2.6

Table 10.9 reflects PJ's significant difficulties in most areas assessed. These scores are statistically analysed and illustrated under their respective headings.

Sentence Judgement Task

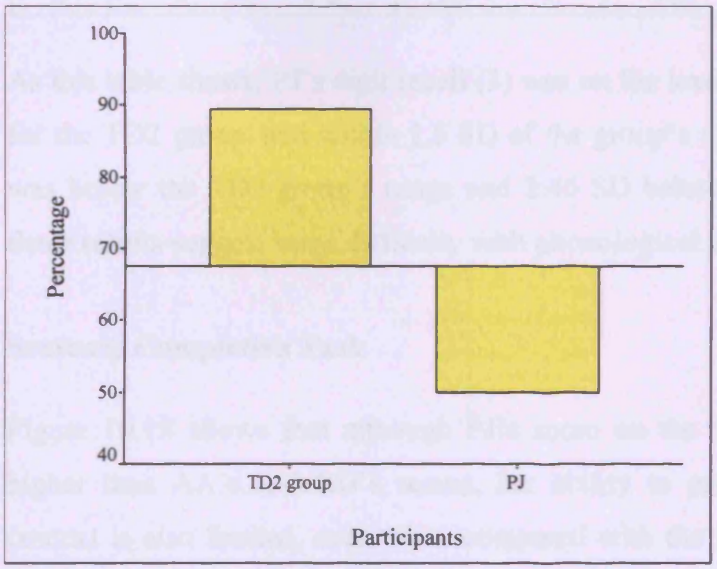

Figure 10.17 Sentence judgement: TD2 group and PJ

As shown in Figure 10.17, PJ's result on the Sentence Judgement Task suggests that she is experiencing significant input difficulty regarding the appropriateness of function words within the context of sentences, compared with children with typical development. Indeed, her score of 50% is exactly at the level of chance (well below

the significant level above chance of 67.5%), and is 4.69 SD below the mean of the TD2 group.

Phonological working memory

As with AA and RG, it is possible that PJ's short-term auditory memory abilities are contributing to her performance on the Sentence Imitation Task. There was some indication of this when her score for the production of function words in short utterances (two to four words: 91.9%) on the Sentence Imitation Task was compared to her function-word score in long utterances (six to nine words: 57.6%). These scores were found to be significantly different (Fisher's Exact test, p=.001), indicating that her performance was significantly affected by length on this task. Table 10.10 compares PJ's and the TD2 group's scores on the Recall Task.

Table 10.10 Phonological working memory: PJ and TD2 group scores on the Recall Task

Recall Task: digits				**Recall Task: words**			
PJ	**TD2**			**PJ**	**TD2**		
	Mean	Range	SD		Mean	Range	SD
3	4	3-5	.76	2	3.8	3-5	.73

As this table shows, PJ's digit recall (3) was on the lowest limit of the range of scores for the TD2 group, and within 1.5 SD of the group's mean. Her word span score (2) was below the TD2 group's range and 2.46 SD below the group's mean. Together, these results suggest some difficulty with phonological working memory.

Sentence Completion Task

Figure 10.18 shows that although PJ's score on the Sentence Completion Task is higher than AA's and RG's scores, her ability to produce function words in this context is also limited, even when compared with the lowest-scoring children in the TD2 group. A Modified *t*-test confirmed this observation (t=-4.471, p<.001). Thus, as with AA and RG, PJ has a genuine expressive difficulty with function words, not related to speech production overload.

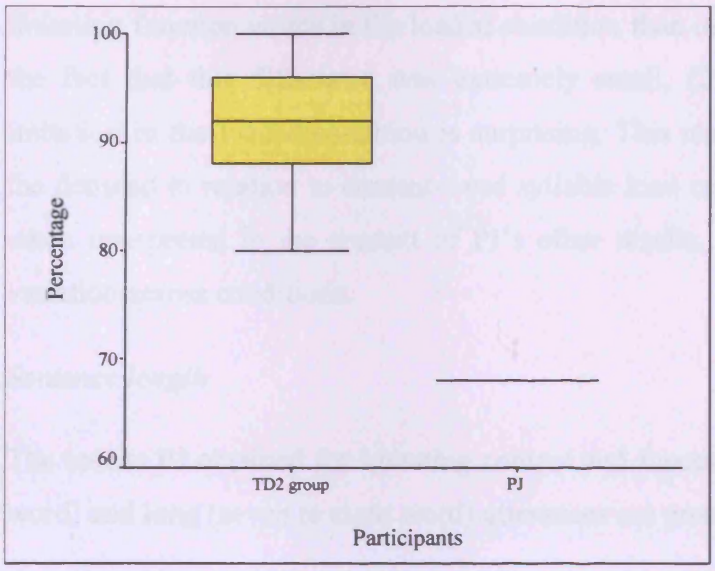

Figure 10.18 Sentence completion scores: TD2 group and PJ

SIVL Task

Content-word syllable load

Figure 10.19 shows PJ's performance on content and function words in phonologically simple (with single-syllable content words) and loaded (with multi-syllabic content words) conditions.

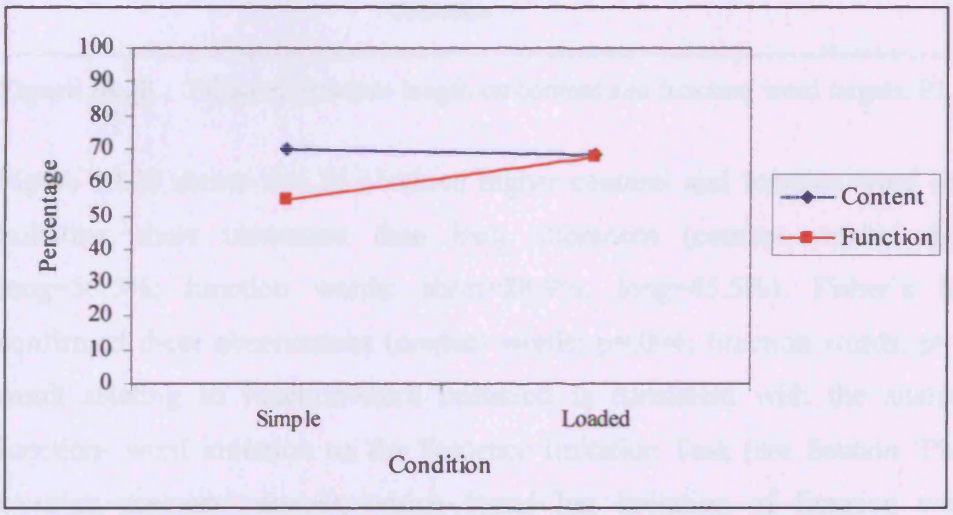

Figure 10.19 Effect of content-word syllable load on content and function word targets: PJ

As this figure shows, PJ obtained a slightly higher score when imitating content words in the simple condition (70%) than in the loaded condition (68%), although this difference was not significant. Unlike AA and RG, PJ obtained a higher score when

imitating function words in the loaded condition than in the simple condition. Despite the fact that this difference was extremely small, (2%), her slight preference for imitation in the loaded condition is surprising. This result may imply that increasing the demand in relation to content-word syllable load can be overcome. Alternatively, when interpreted in the context of PJ's other results, it may simply reflect normal variation across conditions.

Sentence length

The results PJ obtained for imitating content and function words in short (four to five word) and long (seven to eight word) utterances are presented in Figure 10.20.

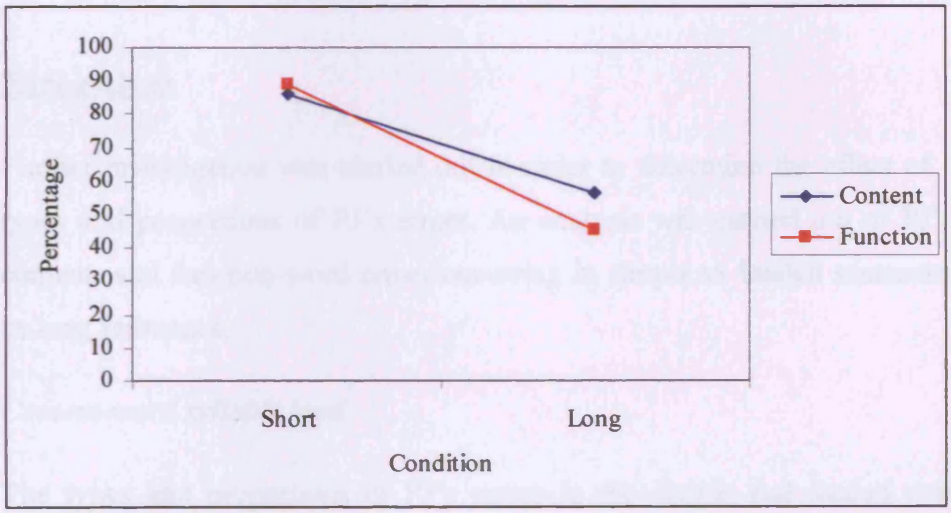

Figure 10.20 Effect of sentence length on content and function word targets: PJ

Figure 10.20 shows that PJ obtained higher content- and function-word scores when imitating short utterances than long utterances (content words: short=86.1%, long=56.5%; function words: short=88.9%, long=45.5%). Fisher's Exact tests confirmed these observations (content words: p=.004; function words: p=.002). The result relating to function-word imitation is consistent with the analysis of her function- word imitation on the Sentence Imitation Task (see Section 'Phonological working memory' above), which found her imitation of function words to be significantly better in short sentences than long sentences.

Overall, PJ's relatively mild sentence imitation difficulties are significantly affected by an increase in sentence length, but not an increase in content-word syllable load.

Comparison with typically developing children

The effect of load on PJ's performance was more similar to the effect of load on the performance of the TD2 group than was the case with AA or RG. As with PJ, the manipulation of content-word syllable load had no effect on the group's scores, while increasing sentence length did have a significant effect on the group's scores (see Section 10.3).

Despite this similarity in performance profile, as well as the fact that PJ obtained higher scores than AA and RG, a Modified *t*-test still found even PJ's highest score, obtained for the imitation of function words in short sentences (88.9%), to be significantly lower than the TD2 group's mean in that condition ($t=-2.101$, $p<.05$).

Error analysis

Further investigation was carried out in order to determine the effect of load on the types and proportions of PJ's errors. An analysis was carried out of PJ's combined content- and function-word errors occurring in simple vs loaded sentences, and short vs long sentences.

Content-word syllable load

The types and proportions of PJ's errors in the simple and loaded conditions are presented in Figure 10.21.

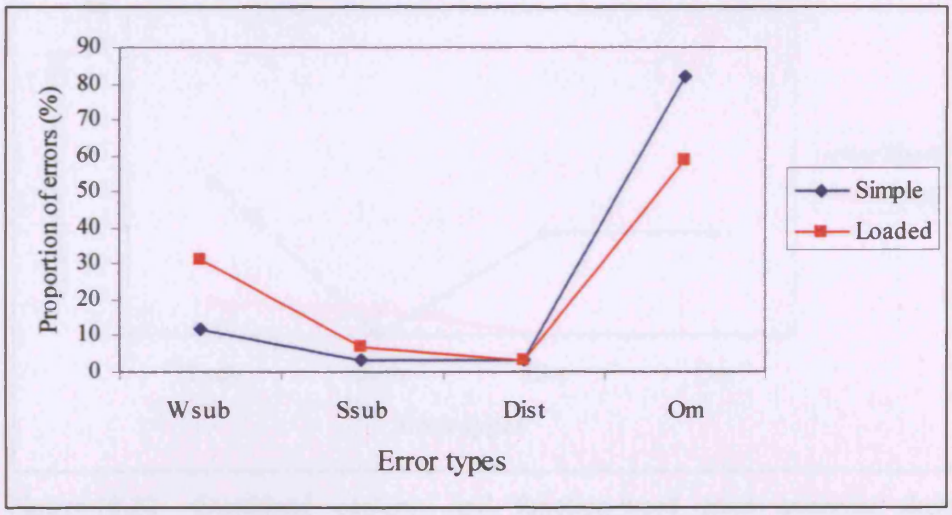

Figure 10.21 Combined content- and function-word error analysis: simple and loaded conditions

Figure 10.21 shows that, like AA and RG, PJ made similar types of errors in both conditions, although the proportions differed. The proportion of omissions dropped from 81.8% in the simple condition to 58.6% in the loaded condition, and the proportion of whole-word substitutions from the same grammatical category rose from 12.1% to 31%. Extremely small but similar proportions of sound substitutions (simple=3%, loaded=6.9%) and distortions (simple=3%, loaded=3.4%) were recorded.

With regard to syllable integrity, Table 10.11 presents a breakdown of the extent to which PJ produced multi-syllabic content words with reduced syllables.

Table 10.11 Percentage syllables reduced as a proportion of PJ's correct score

	% syllables reduced as proportion of correct score
Short utterances	6.5%
Long utterances	3.8%

As with AA and RG, though at a lower proportion than them, PJ reduced a percentage of multi-syllabic content words for which she was credited. This may suggest some single word phonological planning difficulties. As the data is limited, further research is required to verify this.

Sentence length

Figure 10.22 shows the types and proportions of PJ's errors in short and long sentences.

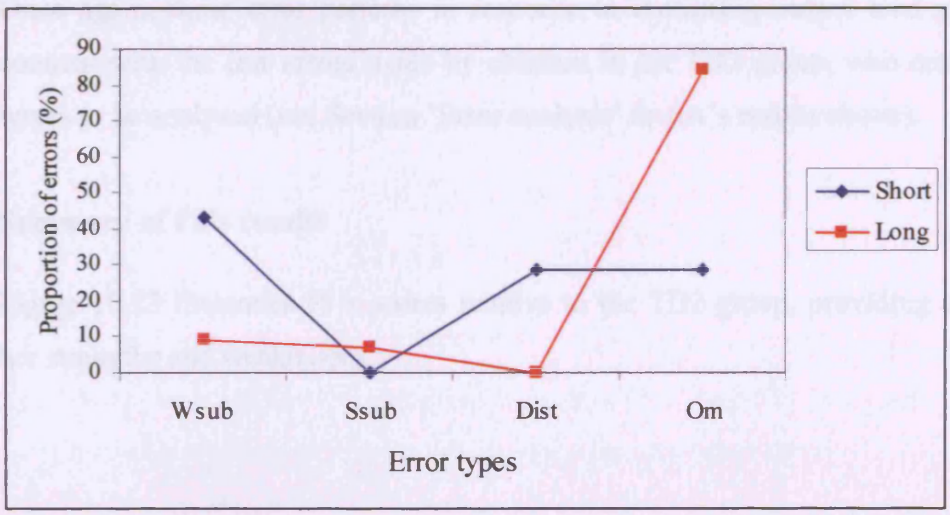

Figure 10.22 Combined content- and function-word error analysis: short and long sentences

Figure 10.22 shows that PJ obtained slightly different error profiles when imitating short and long sentences. The greatest proportion of her errors in short sentences were whole-word substitutions from the same grammatical category (42.9%). The remainder of her errors in short sentences were equally spread between distortions (28.6%) and omissions (28.6%).

An increase in sentence length resulted in a dramatic increase in the proportion of omissions (84.1%). Extremely small proportions of whole-word substitutions from the same grammatical category (9.1%) and sound substitutions (6.8%) were also recorded in this condition.

Analysis of PJ's error profiles reveals that PJ seems to have had different strategies for dealing with the two types of load increase. When load was increased by manipulating content-word syllable load in words, PJ responded by making up her own words that still made sense within the context of the sentence, for example: Target: 'The elephant cannot walk in the garden'; Response: [ə mʌmi kan wɔk ɪn ə gadən]. When load was increased by manipulating sentence length, PJ's response was to omit sentence elements, for example: Target: 'Kim came out to kiss the boy'; Response: [keim ki ə bɔi].

Comparison with typically developing children

Once again, these error patterns in response to increasing output load are in stark contrast with the few errors made by children in the TD2 group, who made too few errors to be analysed (see Section 'Error analysis' in AA's results above).

Summary of PJ's results

Figure 10.23 illustrates PJ's scores relative to the TD2 group, providing a profile of her strengths and weaknesses.

SJ	Recall		SC	SIVL							
	Digits	Words		Simple		Loaded		Short		Long	
				C	F	C	F	C	F	C	F

Key:
Green: non-significant difference between participant and TD2 group reflected by scores being less than 1.5 SD from the mean of the TD2 group, or by a non-significant Modified *t*-test result.
Red: significant difference between participant and TD2 group, reflected by scores being equal to or greater than 1.5 SD from the mean of the TD2 group, or by a significant Modified *t*-test result.

Figure 10.23 PJ's profile in relation to the TD2 group

As the summary figure shows, PJ experienced difficulty on all the sentence processing-tasks compared with the TD2 group, except for digit span recall, where her score was within 1.5 SD of the mean of the group.

PJ's results may be viewed in relation to the three questions posed at the beginning of Chapter 9:

(i) Abilities at an input level: PJ's results show that she is experiencing significant difficulty recognising function words appropriate to sentence contexts.

(ii) Phonological working memory skills: There is evidence to suggest that PJ is experiencing some difficulty in this area.

(iii) Effect of load on production: PJ's results indicate that she has difficulty with the production of function words, irrespective of the context in which they are assessed. While her quantitative scores for the imitation of content and function words are not affected by changes in content-word syllable load, she does reduce a proportion of multi-syllabic content words even in short utterances. PJ's performance is affected by an increase in sentence length. She responds differently to the manipulation of different types of load – she tends to produce a greater proportion of whole-word substitutions from the same grammatical category in response to increased content-word syllable load, and omits more sentence elements when the length of the sentence increases.

Despite performing generally better than AA and RG on the Sentence Imitation Task, there is sufficient evidence to assert that, as with AA and RG, PJ's sentence imitation

performance is not only due to her speech difficulties. She is also experiencing difficulties across most levels of sentence processing assessed.

10.5 OVERALL SUMMARY AND CONCLUSION

The aim of the Phase 2 study was to determine whether the heterogeneity of sentence imitation performance in children with IPD could be explained by specific abilities relating to sentence processing. Investigation of five children with IPD revealed that they could be divided into two groups:

The two children who obtained extremely high sentence imitation scores (96.8% and 93%), which were comparable with the TD2 group, did not experience any difficulties on the sentence processing-related tasks constructed for the purpose of this study. The three children with IPD who obtained poorer scores on the Sentence Imitation Task (AA=28.5%, RG=41.8%, PJ=70.9%) experienced difficulties on nearly all sentence processing-related tasks administered.

While RG and PJ showed significant weaknesses in their sentence judgement abilities, AA obtained a score above the significant level of chance but lower than the lowest-scoring typically developing child.

AA and PJ's phonological working memory scores reflect their weakness in this area, while RG's scores were in line with those of the TD2 group.

The results obtained in relation to output load showed that all three participants experienced difficulties with function word production, even when the output load was reduced, as was the case in the Sentence Completion Task. AA experienced the most severe difficulties on this task.

Increasing the output load in relation to the number of syllables in words significantly affected AA's imitation of content and function words, while RG's content- and function-word imitation was affected, but not significantly so. In both cases an increased syllable load resulted in increased proportions of distortions. PJ's content- and function-word imitation was not affected by an increase content-word syllable

load, although she responded to the increased output load by producing a higher proportion of whole- word substitutions from the same grammatical category.

An increase in sentence length significantly affected the performance of all three children with IPD in some way. While AA's and PJ's imitations of both content and function words were significantly affected, RG's imitation of function words only was significantly affected. His imitation of content words, though affected, was not significantly so. While AA's imitations became largely distorted in long utterances, PJ tended to omit more sentence elements, and RG's errors contained greater proportions of unmatched syllables and distortions.

Increasing sentence length was shown to have an effect on imitation performance for the typically developing children in the TD2 group. However, the extremely high scores obtained by the TD2 group in both conditions (98.1% and 97.4%) suggest that length had an effect for this group only when imitating the longest sentences. Indeed, in a task such as this, there is a point at which length would eventually start affecting the performance of any typically developing child. The significantly poorer scores obtained by the children with IPD reflects that length has a more dramatic effect for these children, affecting them at 'shorter' lengths.

The types of errors occurring in the imitations of the three participants with IPD can be viewed in relation to the results obtained in Phase 1. AA obtained the lowest sentence imitation score of all the participants in the two phases of study and his productions consisted largely of distortions. RG's profile of errors is similar to the children with IPD in Phase 1, in that unmatched syllables and sound substitutions feature prominently. PJ's profile of errors appears more similar to the group of children with SLI in Phase 1, inasmuch as whole-word substitutions and omissions formed the majority of their errors. PJ's errors contained only relatively small proportions of sound substitutions and distortions. This will be explored further in Chapter 13, which explores the similarities and differences between children with IPD and those with SLI.

Where Chapter 8 established that sentence imitation heterogeneity among children with IPD could not be explained only by speech problems in the production of

individual words, the findings of this chapter suggest that sentence processing-related abilities appear to be implicated: heterogeneity in sentence processing-related abilities contributes to the heterogeneity observed in the sentence imitation performance of children with IPD. To try to verify this, we can look at how the sentence imitation and processing abilities of children with IPD change, or do not change, over time as their IPD speech problems change or do not change. This will also provide insight into whether speech difficulties and sentence difficulties are independent, suggesting co-morbidity, or whether they are related. These issues will be addressed in the next chapter.

CHAPTER 11

FOLLOW-UP OF TWO CHILDREN WITH IPD

11.1 INTRODUCTION

From the results so far, it can be inferred that the poor performance of some children with IPD on sentence imitation, relative to typically developing children, is due not only to their speech disorder, but to a combination of single-word speech difficulties (IPD) and difficulties relating to sentence processing.

One way of verifying this inference is to reassess a child who was originally found to have co-occurring IPD and sentence processing-related difficulties, and who shows no change in consistency of speech at a later stage. If the child's sentence imitation performance at the first assessment was due merely to severe inconsistency of speech then, when there is no improvement in speech abilities from the first (T1) to the second assessment (T2), no significant improvement in sentence imitation performance would be expected. On the other hand, if the child's performance was due to co-occurring IPD and sentence processing-related difficulties, improvements in sentence imitation and processing-related abilities could occur irrespective of his/her unchanged speech abilities.

Another way of verifying this inference is to reassess a child who was originally found to have co-occurring IPD and sentence processing-related difficulties, at a time when his/her speech disorder has improved and is no longer considered inconsistent. If the child's original sentence imitation performance was due merely to severe inconsistency of speech, then his/her performance should approximate typically developing children or children with CPD at the second assessment. On the other hand, if the child's performance was due to co-occurring IPD and sentence processing-related difficulties, results on the sentence imitation and processing-related tasks could still reflect difficulties at the second assessment (unless the cause(s) of the sentence processing-related problems had somehow also been removed with an improvement in speech consistency).

This chapter presents follow-up studies of two children, AA and PJ, presented in Chapters 8 and 10, six months after their original assessments. The chapter explores whether changes have occurred over time in their speech, their sentence imitation and their sentence processing-related abilities.

11.2 METHODOLOGY

11.2.1 PARTICIPANTS

AA, a male, was 4.9 years of age at T1 and 5.3 years of age at T2. At T1, he presented with average receptive language (quotient=102 on the TACL-3) and non-verbal abilities (scaled score=12 on Picture Completion Subtest of the WPSSI-RUK), and no oro-motor difficulties (standard scores above 7 on the Oro-motor Screening Subtest of the DEAP).

AA's speech disorder was assessed to be inconsistent (56%) at T1 and he obtained a score of 20.8% for imitating function words on the Sentence Imitation Task. Assessment results reflected his difficulties on almost all the tasks administered: Sentence Completion, SIVL and Recall for digits. It was concluded that at T1 AA was experiencing severe expressive syntactic difficulties due to co-occurring IPD and sentence processing-related difficulties.

PJ, a female, was 4.7 years of age at T1 and 5.1 years of age at T2. At T1, she too presented with average receptive language (quotient=100 on the TACL-3) and non-verbal abilities (scaled score=12 on Picture Completion Subtest of the WPSSI-RUK), and no oro-motor difficulties (standard scores above 7 on the Oro-motor Screening Subtest of the DEAP).

At T1 PJ's speech disorder was on the limit of the IPD classification (40%) and she achieved a score of 70.9% for imitating function words on the Sentence Imitation Task. Assessment results reflected her difficulty on almost all the sentence processing related tasks administered: Sentence Judgement, Sentence Completion, SIVL and Recall for words. It was concluded at T1 that PJ's mild expressive syntactic difficulties were due to co-occurring IPD and sentence processing-related difficulties.

Both AA and PJ had received less than five sessions of speech therapy between T1 and T2.

11.2.2 PROCEDURE

The same administration, data collection and scoring procedures as those employed at T1 were used at T2. The following tasks were re-administered:

- Inconsistency Subtest of the DEAP
- Phonology Subtest of the DEAP
- Sentence Imitation Task
- Sentence Judgement Task
- Sentence Completion Task
- Sentence Imitation with Variable Load (SIVL) Task
- Recall Task (digits and words)

As AA and PJ obtained at least average scores for receptive language, non-verbal and oro-motor screenings, and also because standardised assessments should not be re-administered within a six month period, their abilities in these areas were not re-assessed at T2.

11.3 RESULTS

The reliability of the data is first considered. Thereafter, the follow-up of AA's performance will be presented, followed by PJ's results. Comparisons with typically developing children are made where appropriate.

11.3.1 INTER-RATER RELIABILITY

AA's and PJ's speech data at T2 were independently transcribed and scored by the researcher and a Speech and Language Therapy student. Their sentence imitations were independently transcribed and scored by the researcher and a second rater, who was a linguist training to be a SLT. Inter-rater reliability was calculated for:

INCONSISTENCY

A Cohen's Kappa (Cohen, 1960) was used to determine the level of agreement (corrected for chance) between the two raters on each of the 25 items in the Inconsistency Subtest of the DEAP. This was carried out for AA and PJ. A value of 0.6 was obtained for AA's data, which is considered to be a good level of agreement (Fleiss, 1981). A fair level of agreement was obtained for PJ's data (.482).

PHONOLOGICAL ACCURACY

The phonological accuracy scores for AA and PJ, as scored by both raters at T2, are presented in Table 11.1. As with the phonological accuracy data presented in Chapter 8, Table 8.2, correlations could not be carried out on PCC and PVC due to the small numbers. However, as shown in Table 11.1, there was high agreement between the raters for both the PCC and PVC scores.

Table 11.1 Phonological accuracy scores for AA and PJ

	PCC		PVC	
	Rater 1	**Rater 2**	**Rater 1**	**Rater 2**
AA	48%	41.3%	88%	84.1%
PJ	55%	58%	97.3%	94%

SENTENCE IMITATION TASK

The raters' scorings of function words on each one of the 61 sentences in this task were compared for each child using a Pearson's *r* correlation. Results show the mean agreement between the two raters to be $r(59)=.766$ ($p<.01$) (AA: $r(59)=.752$; PJ: $r(59)=.781$, $p<.01$).

SIVL TASK

The raters' scoring of content and function words on each one of the 30 sentences in this task were compared for AA's and PJ's data at T2 using a Pearson's *r* correlation. The mean agreement between the two raters for content words was $r(28) =.885$, ($p<.01$) (AA: $r(28)=.849$; PJ: $r(28)=.922$). A mean agreement of $r(28) =.822$, ($p<.01$) was obtained for function word scores (AA: $r(28)=.788$; PJ: $r(28)=.856$).

11.3.2 PARTICIPANT AA

SINGLE-WORD SPEECH ABILITIES

The patterns of AA's speech inconsistency, as measured on the Inconsistency Subtest of the DEAP, are presented in Table 11.2.

Table 11.2 Inconsistency scores over time: AA

Inconsistency	**T1**		**T2**	
Degree	56%		52%	
Type	**Incon. incorrect**	**Incon. correct**	**Incon. incorrect**	**Incon. correct**
	11/14 (78.6%)	3/14 (21.4%)	10/13 (76.9%)	3 /13 (23%)
Errors	All deviant		All deviant	

The results in Table 11.2 show that the degree and pattern of AA's inconsistencies were very similar from T1 to T2. He was still considered to have IPD at T2. Almost all inconsistencies were in the category of inconsistent incorrect, and within this category all his errors were deviant, for example *bridge* [blɪd] [blɪʔ] [blɪdθ].

Table 11.3 presents AA's phonological accuracy scores, as measured on the Phonological and Inconsistency Subtests of the DEAP at T1 and T2.

Table 11.3 Phonological accuracy scores over time: AA

	PCC		**PVC**	
Phoneme level	**T1**	**T2**	**T1**	**T2**
	46.4%	48%	85.5%	88%
Prosodic level: syllable integrity	**T1**		**T2**	
	[ɛfənt] for *elephant* [pɛlʌ] for *umbrella* [hʌskɒpə] for *helicopter*		[ʌpkɒptə] for *helicopter*	

The results in Table 11.3 do show negligible improvements in AA's phonological accuracy scores from T1 to T2. There was evidence of some improvement in AA's syllable integrity performance, in that at T2 only one word was reduced compared with T1, where three words were reduced. However, as mentioned in Chapter 10, Section 10.4.2, interpretation of this result is limited, given such limited data.

Overall, the speech results presented show no significant change in the profile of AA's speech abilities from T1 to T2. Thus, any changes in AA's sentence imitation and processing-related performance cannot be attributed to his speech disorder. The following section presents AA's results that showed some change from T1 to T2.

TASKS REFLECTING SOME CHANGE OVER TIME

Unlike AA's speech, changes were evident in his performance in all other areas.

Sentence Imitation Task

AA was able to imitate 28.5% of the function words on the Sentence Imitation Task at T1 and 42.4% of the function words at T2. A Chi-squared analysis found this improvement to be significant (X^2=6.694, p=.01).

This significant improvement in AA's sentence imitation performance, in the absence of change in his speech abilities, supports the claim that his sentence imitation performance is not a function of speech abilities alone.

Sentence Judgement Task

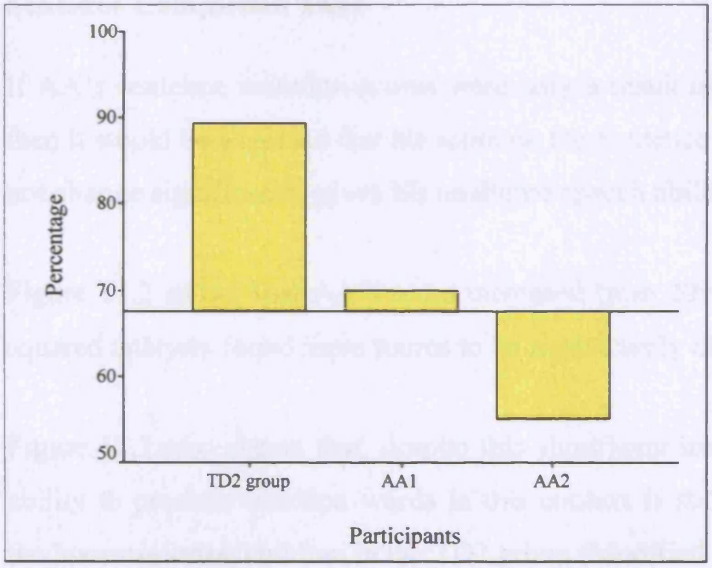

Figure 11.1 Sentence judgement scores: TD2 group and AA (T1 & T2)

The results in Figure 11.1 show that AA obtained a poorer score on this task at T2 than at T1. This result implies that over time AA has developed difficulties in his ability to judge the appropriateness of function words within the context of sentences. Alternatively, AA's result at T2 may support the suggestion in Chapter 10, Section 10.4.2, that his score at T1 may be the product of a Type I error. Based on this interpretation, it is questionable whether AA's skills in this area have indeed changed significantly from T1 to T2, despite the results in Figure 11.1 implying this.

Phonological working memory

Table 11.4 shows AA's phonological working memory results at T1 and T2, together with the TD2 group's mean, range and standard deviation.

Table 11.4 Phonological working memory: AA (T1 & T2) and TD2 group scores on the Recall Task

Recall Task: digits					Recall Task: words				
AAT1	AAT2	TD2 group			AAT1	AAT2	TD2 group		
		Mean	Range	SD			Mean	Range	SD
2	3	4	3-5	.76	3	3	3.8	3-5	.73

Results in Table 11.4 show that AA's digit recall has improved from T1 (2) to T2 (3), so that both his digit and word span at T2 are within the range of the TD2 group.

Sentence Completion Task

If AA's sentence imitation scores were only a result of his speech difficulties at T1, then it would be expected that his score on the Sentence Completion Task at T2 would not change significantly given his unaltered speech abilities.

Figure 11.2 shows that AA's score increased from 20% at T1 to 52% at T2. A Chi-squared analysis found these scores to be significantly different (X^2=5.556, p<.01).

Figure 11.2 also shows that, despite this significant improvement in his score, AA's ability to produce function words in this context is still limited compared with even the lowest-scoring children in the TD2 group (Modified *t*-test: *t*=-7.506, p<.001).

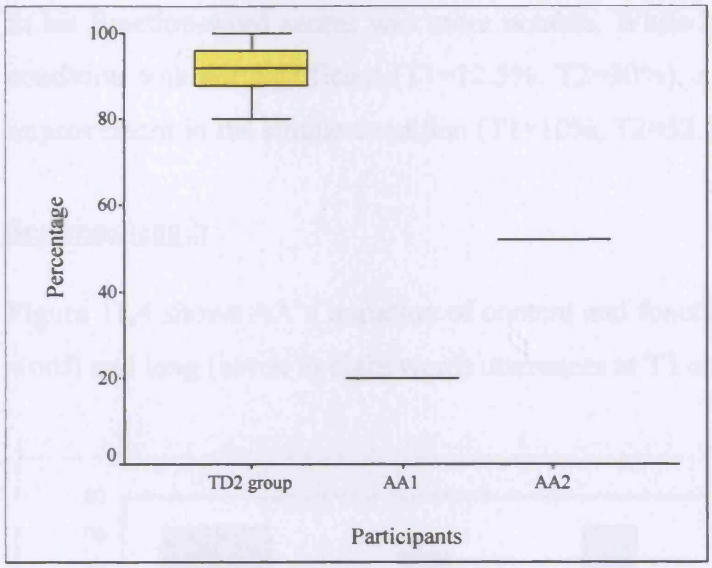

Figure 11.2 Sentence completion scores: TD2 group and AA (T1 & T2)

SIVL Task

Content-word syllable load

Figure 11.3 shows AA's imitation of content and function words in phonologically simple (with single-syllable content words) and loaded (with multi-syllabic content words) conditions at T1 and T2.

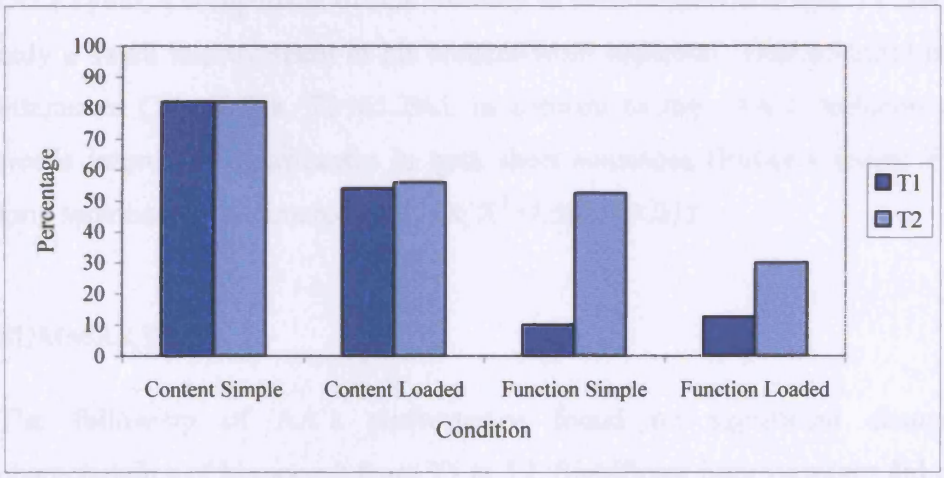

Figure 11.3 Effect of content-word syllable load on content and function word targets: AA (T1 & T2)

A comparison of AA's results in each condition reveals no difference in his content-word imitation in the simple condition across T1 and T2 (T1=82%, T2=82%), and a negligible difference in the loaded condition (T1=54%, T2=56%). The improvement

in his function-word scores was more notable. While his improvement in the loaded condition was not significant (T1=12.5%, T2=30%), a Fisher's Exact test found his improvement in the simple condition (T1=10%, T2=52.5%) to be significant (P=.001).

Sentence length

Figure 11.4 shows AA's imitation of content and function words in short (four to five word) and long (seven to eight word) utterances at T1 and T2.

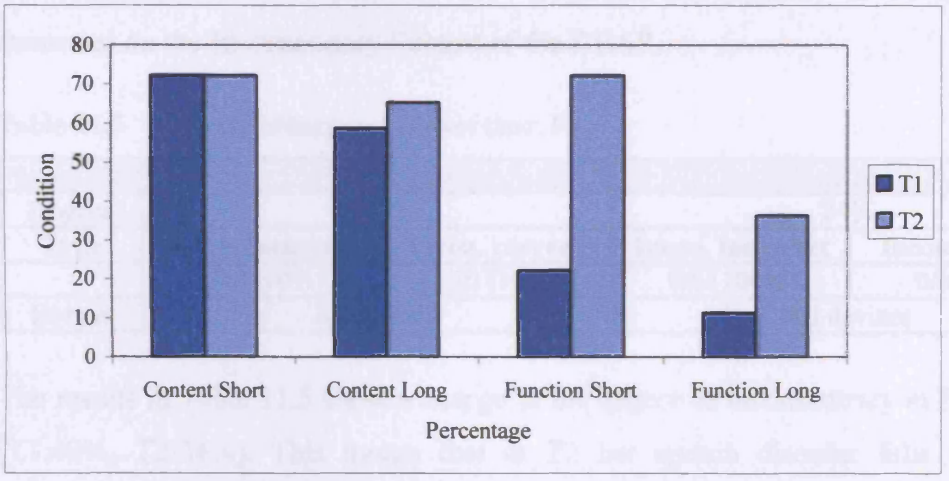

Figure 11.4 Effect of sentence length on content and function word targets: AA (T1 & T2)

Once again, a comparison of AA's results in each condition across T1 and T2 reveals only a small improvement in his content-word imitation. This occurred only in long utterances (T1=58.7%, T2=65.2%). In contrast to this, AA's imitation of function words improved significantly in both short sentences (Fisher's Exact: P=.007) and long sentences (Chi-squared analysis: X^2=7.568, p<.01).

SUMMARY

The follow-up of AA's performance found no significant changes in the characteristics of his speech from T1 to T2. Significant improvements did occur in his sentence imitation performance, as well as on some of the other tasks: sentence completion, digit recall and function-word imitation on the SIVL Task.

This supports the inference that poor sentence imitation performance is not merely a function of his speech disorder but of co-occurring sentence-level difficulties, and that these skills can develop independently of single-word abilities.

11.3.3 PARTICIPANT PJ

SINGLE-WORD SPEECH ABILITIES

Table 11.5 presents the patterns of PJ's speech inconsistency at T1 and T2, as measured on the Inconsistency Subtest of the DEAP.

Table 11.5 Inconsistency scores over time: PJ

	T1		T2	
Degree	40%		24%	
Type	**Incon. incorrect**	**Incon. correct**	**Incon. incorrect**	**Incon. correct**
	9/10 (90%)	1/10 (10%)	6/6 (100%)	0/6 (0%)
Errors	All deviant		All deviant	

The results in Table 11.5 show a change in the degree of inconsistency in PJ's speech (T1:40%, T2:24%). This means that at T2 her speech disorder falls within the category of CPD as opposed to IPD at T1. The type of inconsistencies at T1 and T2 were very similar, with almost all being inconsistent incorrect and all falling in the category of deviant.

Table 11.6 presents PJ's phonological accuracy scores, as measured on the Phonological and Inconsistency Subtests of the DEAP at T1 and T2.

Table 11.6 Phonological accuracy scores over time

	PCC		PVC	
Phoneme level	**T1**	**T2**	**T1**	**T2**
	43.2%	55%	93.2%	97.3%
Prosodic level: syllable integrity	**T1**		**T2**	
	[hɪpi haid] for *slippery slide*		All intact	

The slight improvement in PJ's phonological accuracy scores from T1 to T2 was not found to be significant. At a prosodic level, one word was reduced at T1, while the syllable integrity of all words produced at T2 was maintained. Hence, the only

significant change in PJ's speech abilities from T1 to T2 is the reduction in inconsistency.

If PJ's sentence imitation difficulties at T1 were due merely to the inconsistent nature of her speech disorder, then her abilities should approximate the abilities of typically developing children, or at least children with CPD, at T2. The remainder of this section explores whether changes have occurred in PJ's sentence imitation and processing-related abilities and, if so, whether they can be linked to the change in her speech inconsistency. Discussion of PJ's results is therefore divided into her performance on tasks that showed no significant change between T1 and T2, and those that did.

TASKS SHOWING NO SIGNIFICANT CHANGE OVER TIME

Sentence Judgement Task

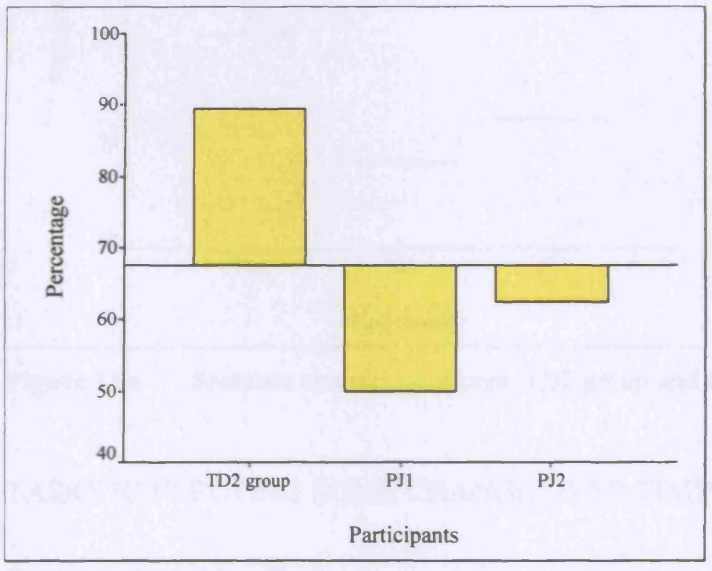

Figure 11.5 Sentence judgement scores: TD2 group and PJ (T1 & T2)

As depicted in Figure 11.5, PJ's score at T2 (62.5%) is still below the significant level above chance, suggesting that – despite her improved speech abilities – she is still experiencing significant input difficulty regarding the appropriateness of function words within the context of sentences, when compared with typically developing children. Her score of 62.5% is now approaching the level significantly above chance (67.5%) but is 3.2 SD below the mean of the TD2 group, compared to 4.69 SD at T1.

Sentence Completion Task

It would be expected that if PJ's sentence imitation scores were only a result of the degree of inconsistency of her speech disorder – which has improved from T1 to T2 – then her score on the Sentence Completion Task at T2 would approximate the TD2 group's scores.

Figure 11.6 shows that PJ's score increased by only one point at T2: T1=17 (68%); T2=18 (72%). Hence, her ability to produce function words in this context is still limited compared with even the lowest-scoring children in the TD2 group, as confirmed by a Modified *t*-test (t=-3.715, p<.001).

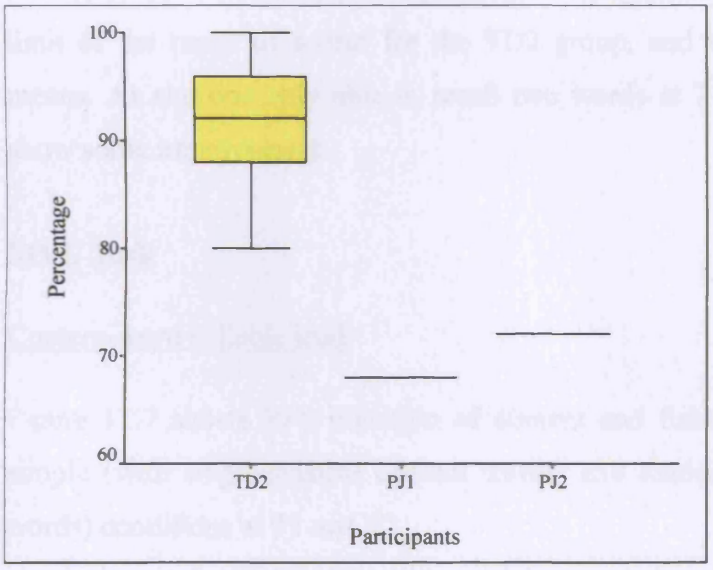

Figure 11.6 Sentence completion scores: TD2 group and PJ (T1 & T2)

TASKS REFLECTING SOME CHANGE OVER TIME

Sentence Imitation Task

PJ was able to imitate 70.9% of the function words on the Sentence Imitation Task at T1 and 84.4% of the function words at T2. A Chi-squared analysis found this improvement to be significant (X^2=8.882, p<.01). Her score is still below the range of the TD2 group's scores (96.2-100%) and more than two standard deviations below its mean (98.7%).

This indicates that despite the reduction in inconsistency of PJ's speech from T1 to T2, and the fact that her sentence imitation has improved over the time period, she is still experiencing some mild expressive language difficulties at T2.

Phonological working memory

Table 11.7 Phonological working memory: PJ (T1 & T2) and TD2 group scores on the Recall Task

Recall Task: digits					Recall Task: words				
PJT1	PJT2	TD2 group			PJT1	PJT2	TD2 group		
		Mean	Range	SD			Mean	Range	SD
3	3	4	3-5	.76	2	3	3.8	3-5	.73

As shown in Table 11.7, PJ's digit (3) and word (3) recall at T2 were on the lowest limit of the range of scores for the TD2 group, and within 1.5 SD of the group's means. As she was only able to recall two words at T1, her word recall at T2 does show some improvement.

SIVL Task

Content-word syllable load

Figure 11.7 shows PJ's imitation of content and function words in phonologically simple (with single-syllable content words) and loaded (with multi-syllabic content words) conditions at T1 and T2.

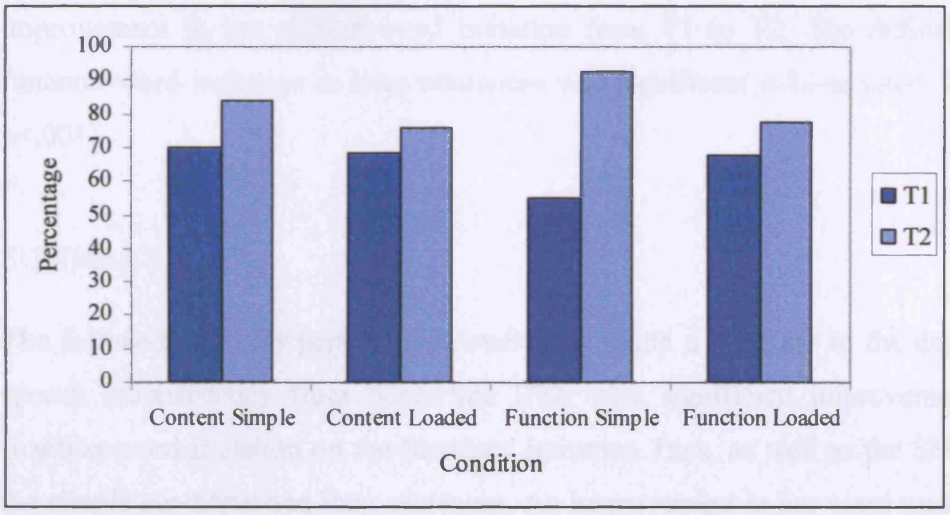

Figure 11.7 Effect of content-word syllable load on content and function word targets: PJ (T1 & T2)

A comparison of PJ's results in both simple and loaded conditions revealed non-significant improvements in her content-word imitation from T1 to T2 (simple: T1=70%, T2=84%; loaded: T1=68%, T2=76%). While PJ's function-word imitation was only slightly improved in the loaded condition, a Fisher's Exact test found her improvement in the simple condition to be significant (P=.001).

Sentence length

Figure 11.8 shows PJ's imitation of content and function words in short (four to five word) and long (seven to eight word) utterances at T1 and T2.

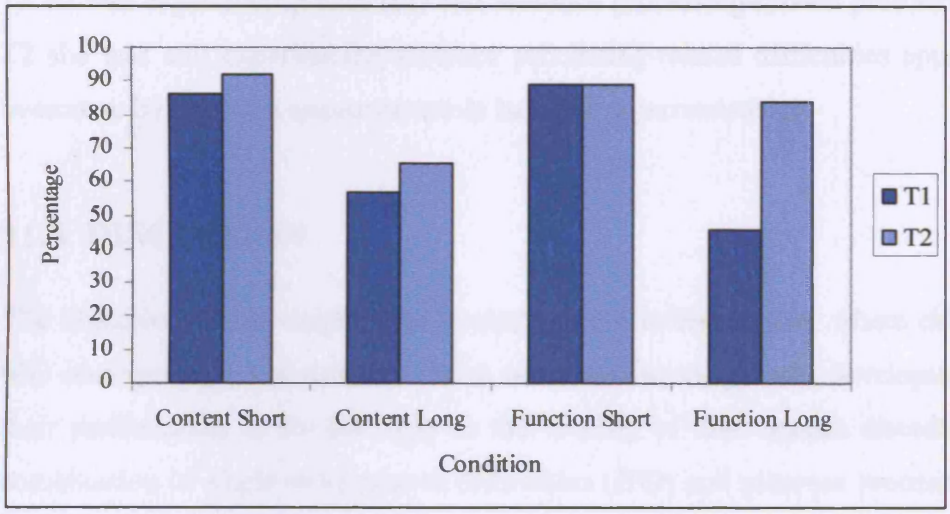

Figure 11.8 Effect of sentence length on content and function word targets: PJ (T1 & T2)

Once again, a comparison of PJ's results in each condition revealed only a small improvement in her content-word imitation from T1 to T2. The difference in her function-word imitation in long utterances was significant (Chi-squared: X^2=14.393, p<.001).

SUMMARY

The follow-up of PJ's performance over time found a decrease in the degree of her speech inconsistency from borderline IPD, with significant improvements in her function-word imitation on the Sentence Imitation Task, as well as the SIVL Task in the simple condition and long sentences. An improvement in her word recall was also noted.

Not all PJ's scores improved over time. No significant change occurred in her sentence judgement and sentence completion abilities, nor her digit span recall or content-word imitation on the SIVL Task. If PJ's sentence imitation difficulties were due merely to her speech inconsistency at T1, then – given the improvement in inconsistency – not only should her sentence imitation have improved at T2, but she should not have been experiencing so many of these sentence processing-related difficulties outside of the range of typically developing children at T2. But at T2 she still experiences mild sentence imitation difficulties relative to typically developing children and has problems on the Sentence Judgement, Sentence Completion and SIVL Tasks. This scenario therefore does give some support to the inference that at T1 PJ was experiencing both IPD and sentence processing-related problems, while at T2 she was still experiencing sentence processing-related difficulties apparently not overcome by the overt improvement in her speech inconsistency.

11.4 DISCUSSION

The objective of this chapter was to evaluate the inference that, where children with IPD score poorly on sentence imitation tasks relative to typically developing children, their performance is not due only to the severity of their speech disorder, but to a combination of single-word speech difficulties (IPD) and sentence processing-related difficulties.

The case of AA is strong. While there was no improvement in AA's speech abilities from T1 to T2, his sentence imitation and some sentence processing-related abilities showed significant improvement. Therefore, his speech abilities alone could not account for his severe expressive syntactic difficulties at T1, which suggests a co-morbid relationship between these two difficulties as opposed to a causal one.

It remains unclear as to whether AA is an isolated case of dissociation between speech disorder and sentence-level abilities. Further studies tracking the development of children with co-occurring IPD and sentence processing-related difficulties are required to verify or disprove this.

The case of PJ is less clear. Improvements in her speech, sentence imitation and sentence processing-related abilities did occur from T1 to T2. However, none of her abilities approximated those of typically developing children or those with CPD at T2. Furthermore, at T2 she still experienced sentence judgement, sentence completion and other difficulties. This suggests that her speech inconsistency could not be solely responsible for her difficulties at T1. However, the precise relationship between her speech disorder and her overt production difficulties remains unclear. This also raises the issue regarding what underlies borderline IPD and whether children with this type of difficulty are more at risk of having mild SLI. In order to address these issues more, longitudinal data is required.

CHAPTER 12

SENTENCE PROCESSING-RELATED ABILITIES OF CHILDREN WITH SLI

12.1 INTRODUCTION

The findings of the study carried out in Phase 1 established that both the IPD and SLI groups were significantly different from the groups of children with typical development and those with CPD on a sentence imitation task. The only significant differences between the content- and function-word production of the IPD and SLI groups were the types and proportions of errors made. This raised the question whether the different overt error patterns of the IPD and SLI groups represented the same or different underlying difficulties.

Findings reported in Chapters 8 and 10 of this phase of investigation, established that children with IPD who scored poorly on a sentence imitation task also experienced difficulties on sentence processing-related tasks, and that their difficulties in sentence imitation do not simply reflect the effects of their speech production constraints, but indicate other difficulties with sentence processing.

These findings therefore point to the possibility that some IPD children have an additional impairment in sentence processing that may be the same as that observed in children with SLI. In order to explore this possibility further, the four novel sentence processing-related tasks were administered to five children with SLI. Their results are presented in this chapter, and compared to the TD2 group of 34 typically developing children (Chapter 10, Section 10.3), where appropriate. The following chapter compares their performance with the performance of the IPD children who had undertaken these tasks.

The same three questions as those posed in relation to the skills of children with IPD in Chapter 9, Section 9.1 are addressed here:

(i) Are there difficulties in processing sentence input, and specifically in recognising function words appropriate to sentence contexts?

(ii) Are there phonological memory difficulties?

(iii) Are there difficulties due to production 'overload'?

12.2 METHODOLOGY

12.2.1 PARTICIPANTS

As the children with SLI did not present with any speech difficulties, apart from isolated delayed phonological processes such as gliding of /r/, the Inconsistency, Phonology and Oro-motor Screening Subtests of the DEAP were not administered. Their profiles are presented in Table 12.1.

Table 12.1 Profile of children with SLI

	Gender	Age	Receptive language	Non-verbal
		months	quotient	scaled score
CL	M	59	100	8
CM	F	62	106	12
CH	F	62	89	9
KA	M	61	87	7
CK	F	62	96	10

As shown in Table 12.1, the ages of the children ranged from 59 to 62 months, and all had non-verbal scores within one standard deviation of the mean, as specified in Chapter 5, Section 5.3.2. Three of the participants (CL, CM and CK) had average receptive language abilities while the other two (CH and KA) demonstrated skills just below the average range (89; 87) as measured on the TACL-3. They still fulfilled the criteria regarding receptive language ability as specified in Phase 1 (above 85) (Chapter 5, Section 5.3.2).

12.2.2 PROCEDURE

The same administration, recording, data capture and scoring procedures relating to the tasks used in the previous two chapters, were employed in this study.

12.2.3 ANALYSIS OF DATA

The minimal assumption is that the children with SLI come from the same group and therefore their data should be analysed as a group. However, due to the small number of participants (n=5), as well as the detection of some variation within their performance, the participants with SLI were approached as single case studies. Unlike the children with IPD, whose results were presented sequentially, children with SLI are not the focus of investigation in this thesis and therefore their results are presented together under each task heading.

12.3 RESULTS

12.3.1 INTER-RATER RELIABILITY

As with investigations of the children with IPD in Chapters 8 and 10, the sentence imitation data from the Sentence Imitation Task and the SIVL Task were transcribed phonetically and scored by the researcher. Data from two randomly selected participants with SLI were independently transcribed and scored by a linguist. The inter-rater reliability for each task was as follows:

SENTENCE IMITATION TASK

The raters' scoring of function words on each of the 61 sentences in this task were compared for each child using a Pearson's *r* correlation. Results show the mean agreement between the two raters to be $r(59)=.815$ ($p<.01$) (Child A: $r(59)=.843$; Child B: $r(59)=.787$).

SIVL TASK

The raters' scoring of content and function words on each one of the 30 sentences in this task were compared for the two SLI children with using a Pearson's *r* correlation. Results show the mean agreement between the two raters for content words to be r(28) =.949 (p<.01) (Child A: r(28)=.977; Child B: r(28)=.922). A mean agreement of r(28) =.849 (p<.01) was obtained for function-word scores (Child A: r(28)=.806; Child B: r(28)=.892).

12.3.2 SENTENCE IMITATION TASK

The function-word scores of the five children on the Sentence Imitation Task are presented in Figure 12.1, together with the average of the TD2 group.

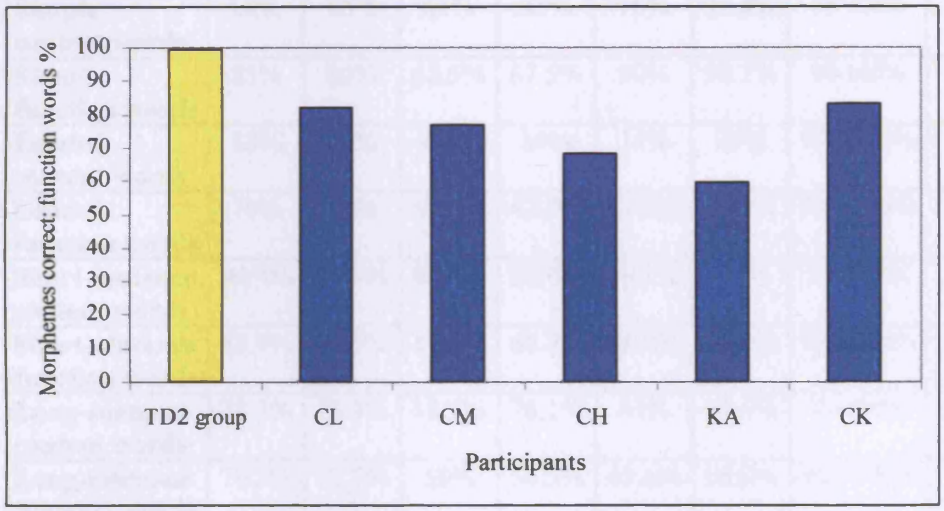

Figure 12.1 Sentence imitation scores: SLI participants

A Modified *t*-test found the highest score obtained by a child with SLI (83.5% obtained by CK) to be significantly lower than the mean of the TD2 group, *t*=-24.402, p<.001. Thus, by implication, all the participants showed sentence-level difficulties relative to the TD2 group.

12.3.3 RESULTS ON SENTENCE PROCESSING-RELATED TASKS

The performance of these children on the sentence processing-related tasks is presented in Table 12.2, together with the TD2 group's mean, range and standard deviation.

Table 12.2 Results of SLI children compared with typically developing children

	CL	CM	CH	KA	CK	TD2 group		
						Mean	Range	SD
Sentence Judgement	52.5%	85%	47.5%	60%	45%	89.4%	67.5-100%	8.4
Recall – digits	4	4	3	3	4	4	3-5	.76
Recall – words	3	3	3	3	4	3.8	3-5	.73
Sentence Completion	52%	60%	52%	48%	52%	91.6%	80-100%	5.2
SIVL:								
Simple content words	88%	86%	64%	82%	76%	97.8%	88-100%	3.1
Simple function words	85%	80%	62.5%	67.5%	80%	98.2%	90-100%	2.2
Loaded content words	88%	82%	66%	80%	74%	99%	94.4-100%	1.8
Loaded function words	70%	70%	57.5%	47.5%	67.5%	99.3%	94.4-100%	1.8
Short-sentence content words	94.4%	88.9%	66.7%	80.6%	86.1%	97%	87-100%	3.8
Short-sentence function words	88.9%	88.9%	83.3%	66.7%	88.9%	98.1%	88.6-100%	2.6
Long-sentence content words	78.3%	73.9%	58.7%	76.1%	63%	97.8%	90-100%	2.8
Long-sentence function words	70.5%	72.7%	50%	54.5%	63.6%	98.9%	92.5-100%	2.1

The results in Table 12.2 confirm the similarity of all the children with SLI, and the contrast between them and the TD2 group. The only exception to this was CM, whose sentence judgement ability was in line with the TD2 group's.

The results in Table 12.2 are statistically analysed and illustrated under their respective headings.

Sentence Judgement Task

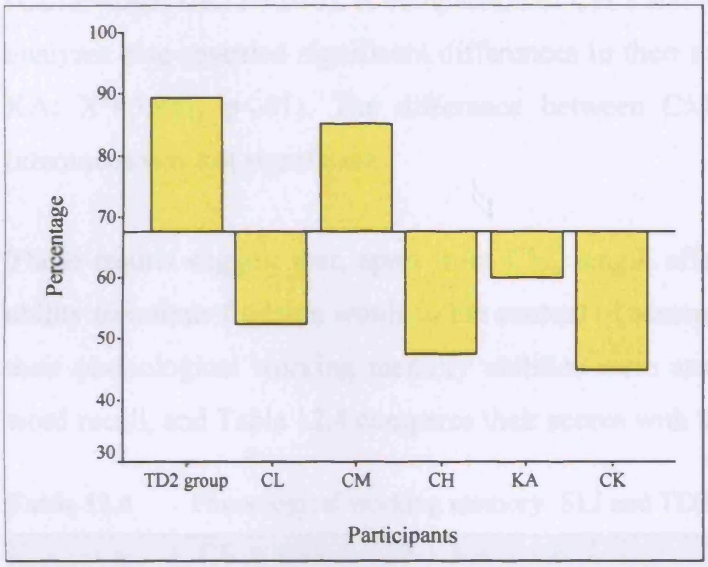

Figure 12.2 Sentence judgement: TD2 group and SLI participants

As shown in Figure 12.2, four out of five of the children with SLI obtained scores below the significant level above chance (67.5%). Their scores ranged between 3.5 SD (KA) and 5.28 SD (CK) below the mean of the TD2 group. Only one participant's score, CM's, was significantly above chance and within 1.5 SD of the TD2 group. These results suggest that all the participants with SLI, apart from CM, are experiencing difficulties in recognising the appropriateness of function words in the context of sentences.

Phonological working memory

Table 12.3 contains the SLI participants' scores for the production of function words in short utterances (two to four words) on the Sentence Imitation Task, compared with their function-word scores in long utterances (six to nine words).

Table 12.3 Function-word scores on the Sentence Imitation Task

	2-4 words	6-9 words
CL	97.3%	80.3%
CM	91.9%	77.3%
CH	86.5%	62.1%
KA	83.8%	60.6%
CK	98.8%	76.7%

A comparison of CL's and CK's scores using Fisher's Exact tests revealed significant differences in their imitation scores within the context of short and long utterances (CL: P=.009; CK: P=.016). A comparison of CH's and KA's scores using Chi-squared analyses also revealed significant differences in their scores (CH: X^2=6.818, p<.001; KA: X^2=5.947, p<.01). The difference between CM's scores in short and long utterances was not significant.

These results suggest that, apart from CM, length affected all the SLI participants' ability to imitate function words in the context of sentences. As with the IPD children, their phonological working memory abilities were assessed in relation to digit and word recall, and Table 12.4 compares their scores with the TD2 group's.

Table 12.4 Phonological working memory: SLI and TD2 group scores on the Recall Task

	CL	CM	CH	KA	CK	TD2		
						Mean	Range	SD
Digits	4	4	3	3	4	4	3-5	.76
Words	3	3	3	3	4	3.8	3-5	.73

As shown in Table 12.4, three children (CL, CM and CK) achieved a digit-span level equal to the mean (and median) of the TD2 group, while two children had a digit span within 1.5 SD of the TD2 group mean. For word span, only CK achieved a span equal to the TD2 group's mean, but all the participants achieved a span within 1.5 SD of the group's mean.

Overall these results show an inconsistent picture of the participants' short-term auditory memory abilities. Apart from CM, length was found to affect their imitation performance in the context of sentences. However, their digit- and word-span scores, as they were tested here, appear not to support their sentence imitation results.

Sentence Completion Task

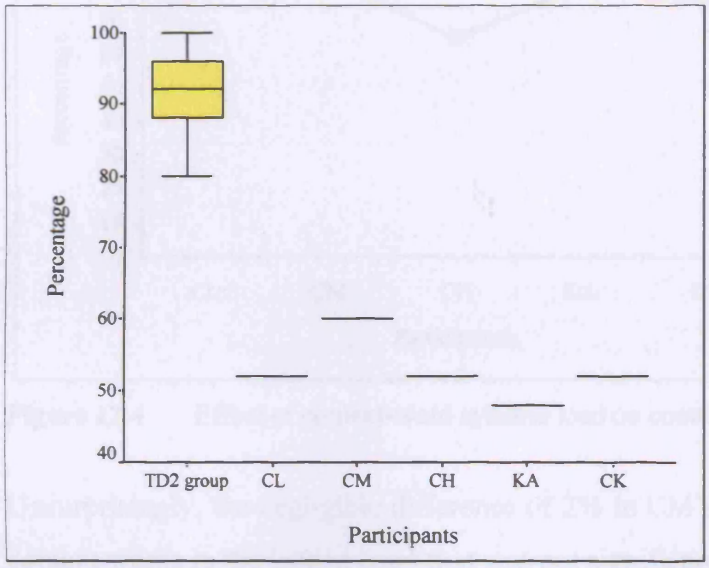

Figure 12.3 Sentence completion scores: TD2 group and SLI participants

As Figure 12.3 shows, each child's ability to produce function words in this context was limited compared with even the lowest-scoring children in the TD2 group. A Modified *t*-test found the highest score obtained by a child with SLI (60% obtained by CM), to be significantly lower than the mean of the TD2 group (t =-5.989, p<.001).

SIVL TASK

Content-word syllable load

Figures 12.4 and 12.5 show each child's performance for content and function words in phonologically simple (with single-syllable content words) and loaded (with multi-syllabic content words) conditions.

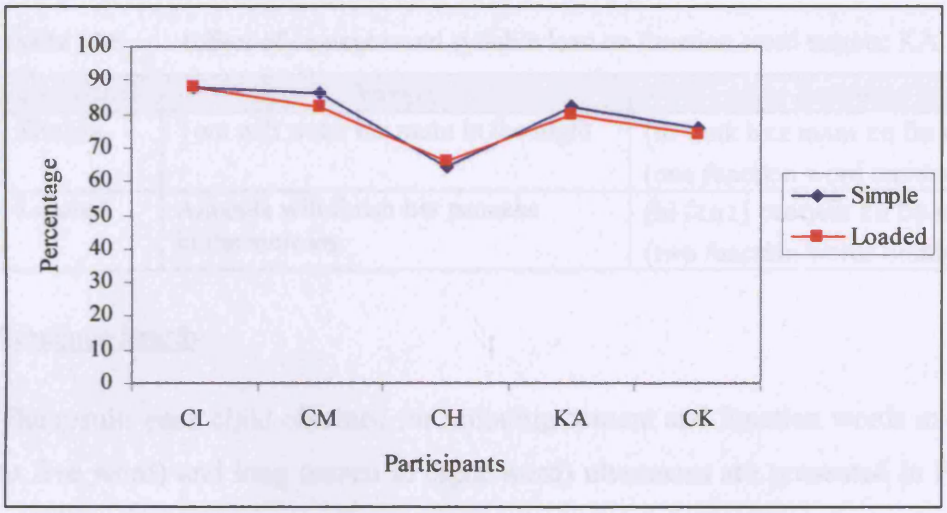

Figure 12.4 Effect of content-word syllable load on content word targets: SLI participants

Unsurprisingly, the negligible difference of 2% in CM's, KA's and CK's imitation of content words in the loaded condition was not significant.

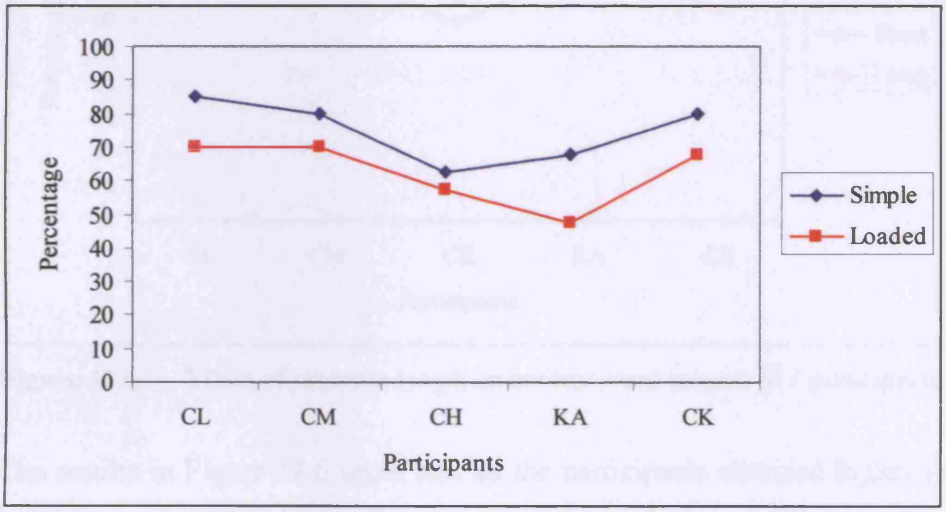

Figure 12.5 Effect of content-word syllable load on function word targets: SLI participants

As Figure 12.5 shows, all the participants obtained higher scores for the imitation of function words in simple sentences than in loaded sentences (CL=85% vs 70%; CM=80% vs 70%; CH=62.5% vs 57.5%; KA=67.5% vs 47.5%; CK=80% vs 67.5%). However, none of these differences were significant. The difference in scores obtained by KA was approaching significance (X^2=3.274, p=.07). An example of KA's imitation illustrates this effect:

Table 12.5 Effect of content-word syllable load on function word targets: KA

Condition	Target	Response
Simple	Tom will wake his mum in the night	[hi weik hɪz mʌm ɪn ðə nait] (one function word omitted)
Loaded	Amanda will finish her pancake in the morning	[hi fɪnɪʃ pæŋeik ɪn ðə mɔnɪŋ] (two function words omitted)

Sentence length

The results each child obtained for imitating content and function words in short (four to five word) and long (seven to eight word) utterances are presented in Figure 12.6 and Figure 12.7.

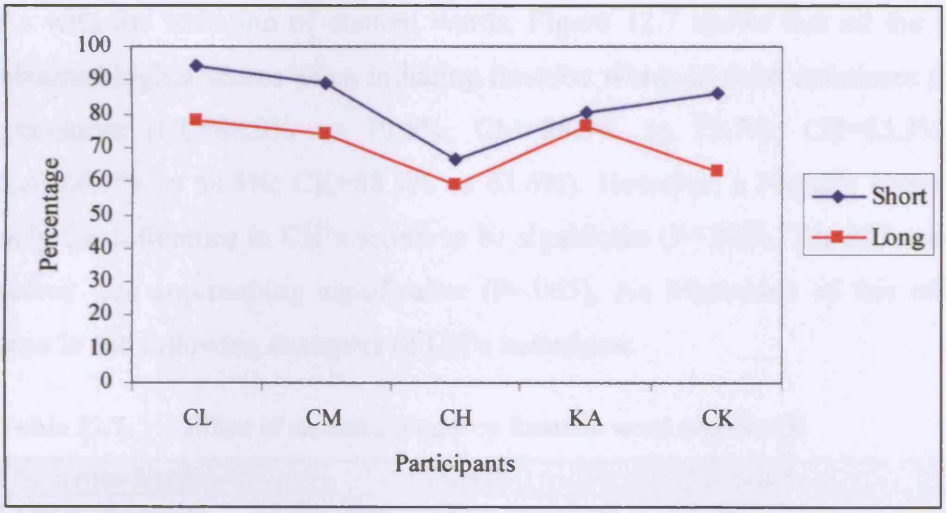

Figure 12.6 Effect of sentence length on content word targets: SLI participants

The results in Figure 12.6 show that all the participants obtained higher scores when imitating content words in short utterances than in long utterances (CL=94.4% vs 78.3%; CM=88.9% vs 73.9%; CH=66.7% vs 58.7%; KA=80.6% vs 76.1%; CK=86.1% vs 63%). However, statistical analyses found only the differences for CL and CK to be just significant (CL: Fisher's Exact test, P=.05; CK: Chi-squared analysis, X^2=5.474, p<.01). An example of CK's imitations illustrates this effect:

Table 12.6 Effect of sentence length on content word targets: CK

Sentence length	Target	Response
Short (4 words)	Be happy on holiday	[bi hæpi ɒn hɒlidei]
Long (7 words)	The lady carried Simon to the computer	[ðə leidi saimɪn tu ðə kɒmputə]

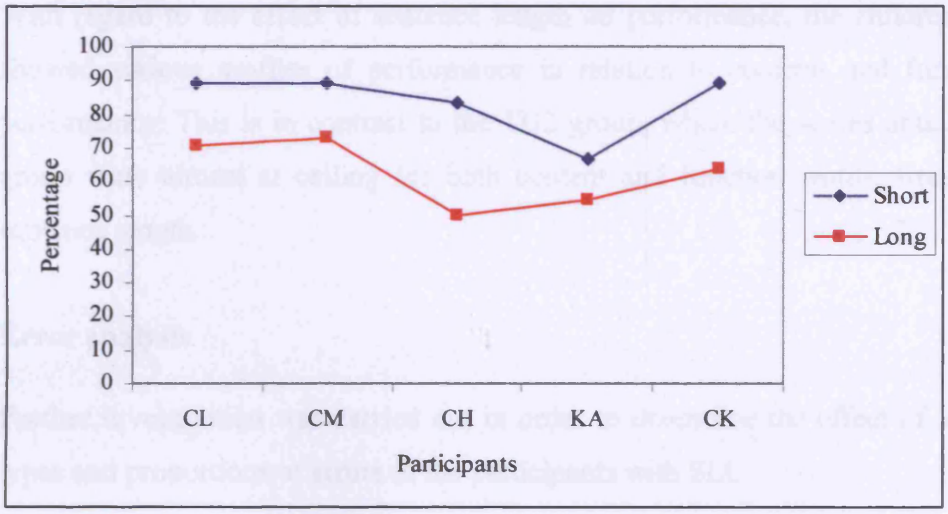

Figure 12.7 Effect of sentence length on function word targets: SLI participants

As with the imitation of content words, Figure 12.7 shows that all the participants obtained higher scores when imitating function words in short utterances than in long utterances (CL=88.9% vs 70.5%; CM=88.9% vs 72.7%; CH=83.3% vs 50%; KA=66.7% vs 54.5%; CK=88.9% vs 63.6%). However, a Fisher's Exact test found only the difference in CH's scores to be significant (P=.022). The difference in CK's scores was approaching significance (P=.065). An illustration of this effect can be seen in the following examples of CH's imitations:

Table 12.7 Effect of sentence length on function word targets: CH

Sentence Length	Target	Response
Short (4 words)	Take your medicine tomorrow	[teik jɔ mɛdɪsɪn tumɒɹəʊ]
Long (7 words)	The man took Tom to the door	[ðə tɒm teik ðə dɔ] (one function word omitted)

Comparison with typically developing children

These results may be viewed in light of the profile of responses obtained from the TD2 group. In terms of content-word syllable load, all the participants with SLI obtained similar profiles to the TD2 group in relation to imitation of content words, in that negligible differences were found between their scores obtained in the two conditions. Unlike the TD2 group, differences were noted in relation to each child's function-word scores, although these were not statistically significant.

With regard to the effect of sentence length on performance, the children with SLI showed various profiles of performance in relation to content- and function-word performance. This is in contrast to the TD2 group, where the scores obtained by the group were almost at ceiling for both content and function words, irrespective of sentence length.

Error analysis

Further investigation was carried out in order to determine the effect of load on the types and proportions of errors of the participants with SLI.

A comparison of each child's combined content- and function-word errors occurring in simple vs loaded conditions and short vs long conditions, was carried out. For individual graphs and detailed analysis of each child's error profiles, see Appendix 6 and Appendix 7.

An analysis of these children's error profiles suggests that, overall, similar types of errors were recorded in all conditions (short and long utterances, simple and loaded utterances). The types of errors mainly consisted of whole-word substitutions (from the same and different grammatical categories) and omissions. In terms of content-word syllable load, very small proportions of sound substitutions, distortions and unmatched syllables were evident in both conditions in some of the children's profiles. With regard to increasing sentence length, small proportions of sound substitutions were recorded for all the children, except CL. In only one case (KA) were small proportions of distortions and unmatched syllables recorded. In nearly all cases an increase in sentence length led to increased proportions of whole-word substitutions or omissions. These findings are consistent with those in Phase 1, where omissions and whole-word substitutions made up the vast majority of the SLI group's errors, with minute proportions of other types of errors (Chapter 7, Section 7.2).

In terms of syllable integrity, Table 12.8 presents a breakdown of the proportion of multi-syllabic content words that the children with SLI produced with a reduced number of syllables.

Table 12.8 Percentage syllables reduced as a proportion of each child's correct score

Length	% syllables reduced as proportion of correct score				
	CL	CM	CH	KA	CK
Short utterances	0%	3.1%	0%	3.4%	0%
Long utterances	2.8%	2.9%	7.4%	8.6%	3.4%
Total utterances	2.3%	2.9%	3.1%	6.2%	1.3%

The results in Table 12.8 show that overall, KA reduced the greatest proportion of multi-syllabic words (6.2%) of all the SLI children, none of whom reduced more than 3.1% of their multi-syllabic words produced. This finding could be related to the fact that KA was the only one who was identified as having primary SLI with some phonological delay. Only two out of the five participants, CM and KA, reduced any multi-syllabic words in short utterances

Comparison with typically developing children

Once again, the above patterns of errors in response to increasing output load can be contrasted with the errors made by children in the TD2 group, which were too few to be analysed (Chapter 10, Section 10.4.2, subsection 'Error analysis' in AA's results).

12.4 SUMMARY AND CONCLUSION

Figure 12.8 represents a summary of each of the five children's scores relative to the TD2 group, profiling their strengths and weaknesses.

	SJ	Recall		SC	SIVL							
		Digits	Words		Simple		Loaded		Short		Long	
					C	F	C	F	C	F	C	F
CL												
CM												
CH												
KA												
CK												

Key:
Green: non-significant difference between participant and TD2 group reflected by scores being less than 1.5 SD from the mean of the TD2 group, or by a non-significant Modified *t*-test result.
Red: significant difference between participant and TD2 group, reflected by scores being equal to or greater than 1.5 SD from the mean of the TD2 group, or by a significant Modified *t*-test result.

Figure 12.8 Profile of SLI participants in relation to the TD2 group

As the summary figure shows, apart from the phonological working memory recall scores and CM's score on the Sentence Judgement Task, all the children with SLI experienced difficulties across the tasks.

The results obtained by the children with SLI can be related back to the three questions posed at the beginning of this chapter:

(i) Abilities at an input level: Apart from CM, all the children are experiencing difficulty recognising function words appropriate to sentence contexts.

(ii) Phonological working memory skills: All the children have digit and word recall within 1.5 SD of the TD2 group mean. Three of the children (CL, CM and CK) have digit recall equal to the mean of the TD2 group, and CK has word recall equal to the mean of the TD2 group. It should be noted that there is a difference in age between these children (59-62 months) and the average age of the children in the TD2 group (mean = 53.3, range 47-59 months). This may account for the fact that the digit- and word-span performance of these children, apart from CK's, were not greater than 1.5 SD below the mean of the TD2 group. This, together with the fact that the range of scores on these tasks is extremely small (3-5), leads to the postulation that further investigation of the phonological working memory skills of these children might reveal clearer weaknesses for all the SLI participants. This issue is discussed further in Chapter 14, Section 14.9.1.

(iii) Effect of load on production: All five children have difficulty with the production of function words, irrespective of the context in which they are assessed. An increase in content-word syllable load was found to affect all the participants' production of function words, although not significantly so. Increased sentence length significantly affected two participants' (CL's and CK's) imitation of content words, and one participant's (CH's) imitation of function words.

With regard to error analysis, overall, similar types and patterns of errors were produced by the participants, irrespective of the output load. Their errors consisted mainly of omissions and whole-word substitutions from the same and different categories.

Although patterns of performance were not considered in depth, it is interesting to note that the participants did not show consistent patterns of performance across tasks, apart from CM. Her sentence imitation was not affected by sentence length and she obtained the highest receptive language, sentence judgement and sentence completion scores.

The results presented above show that, although there was heterogeneity in performance of the participants with SLI, these children all experienced comparable difficulties with most aspects of sentence processing assessed, which may contribute to their observed sentence imitation difficulties. These results are as one would expect of children with SLI on these types of tasks and paves the way for comparison with the difficulties observed in the children with IPD.

CHAPTER 13

COMPARISON BETWEEN IPD AND SLI

13.1 INTRODUCTION

The results thus far show that the children with IPD who scored poorly on the Sentence Imitation Task, and the children with SLI, experienced some difficulties on the sentence processing-related tasks, relative to the TD2 group and the two children with IPD who obtained extremely high scores on the Sentence Imitation Task. (Chapter 10 and Chapter 12). This chapter presents a comparison of these IPD and SLI participants' performance on the sentence processing-related tasks in order to determine whether there are any characteristics in their profiles that distinguish them from one another.

The broad question that will be addressed in this chapter is:

Are the difficulties of children with IPD who score poorly on sentence imitation the same as those of children with SLI?

Data from the three children with IPD who were presented as single cases in Chapter 10 are used here (AA, RG, PJ). AA's data at T2 (AA2), presented in Chapter 11, are also included, as at T2 his speech was still characterised as IPD and the improvement in his sentence imitation skills allowed for a more discriminating analysis of his abilities. The data from these children are compared with the data from the five children with SLI (CL, CM, CH, KA and CK) presented in Chapter 12. Performance characteristics are grouped according to those that are similar (overlap across the IPD and SLI participants) and those that distinguish the participants with IPD and SLI.

13.2 OVERLAP

13.2.1 SENTENCE JUDGEMENT TASK

As shown in Figure 13.1 and statistically confirmed in earlier discussions of their results, all the participants except AA at T1 (AA1) and CM obtained scores below the

significant level above chance (67.5%), reflecting difficulties in judging the appropriateness of function words in the context of sentences. As pointed out in Chapter 11 (Section 11.3.2), AA's score at T1, which was still more than 1.5 SD below the mean of the TD2 group, could well be a rogue result/Type I error. It was only CM's score that was within 1.5 SD of the TD2 group's mean.

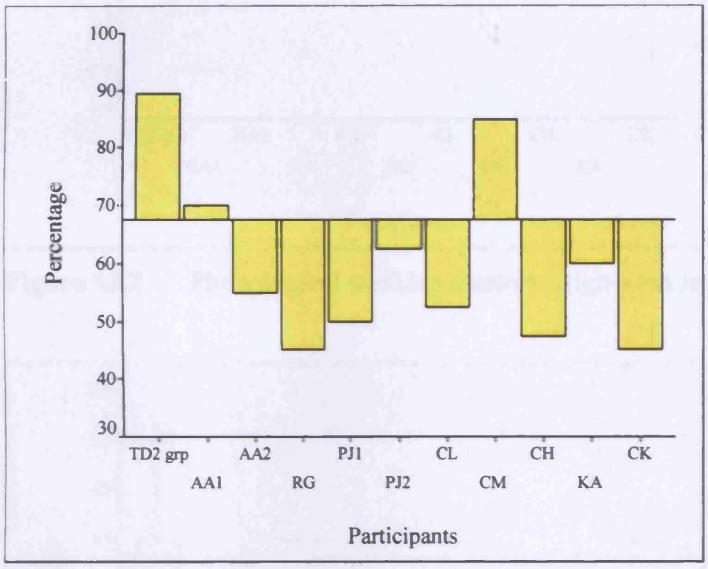

Figure 13.1 Sentence judgement: IPD, SLI and TD2 group

13.2.2 PHONOLOGICAL WORKING MEMORY

Varied results were obtained for the participants identified as having IPD or SLI. As is evident from the digit- and word-span results in Figures 13.2 and 13.3, AA1 and PJ showed the greatest weakness in phonological working memory of all nine participants. However RG, one of the children with IPD, obtained digit- and word-span scores comparable to the typically developing children. Three of the children with SLI (CL, CM and CK), obtained digit-span scores comparable to the mean of the TD2 group, while only CK achieved this in relation to word span. The remainder of the scores obtained by the participants with SLI were on the lowest limit of the TD2 group range.

These results reflect overlap with regard to phonological working memory, inasmuch as they suggest a mix of weakness and strength among children with each type of disorder.

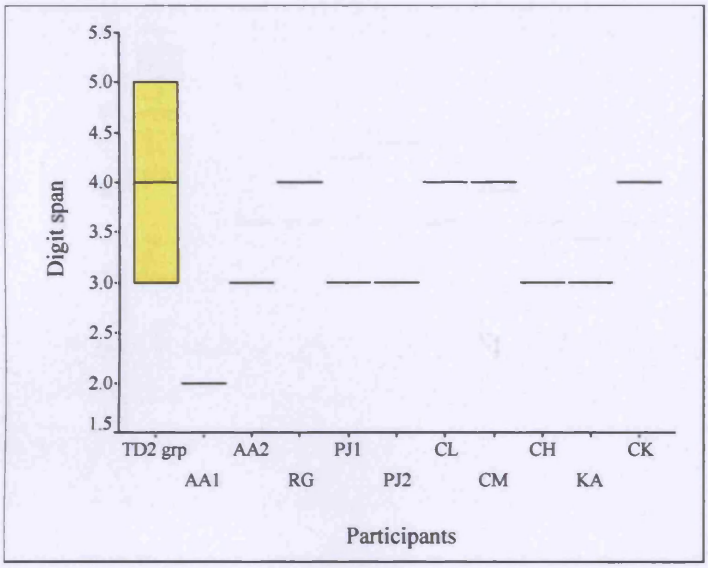

Figure 13.2 Phonological working memory: digit-span recall for IPD, SLI and TD2 group

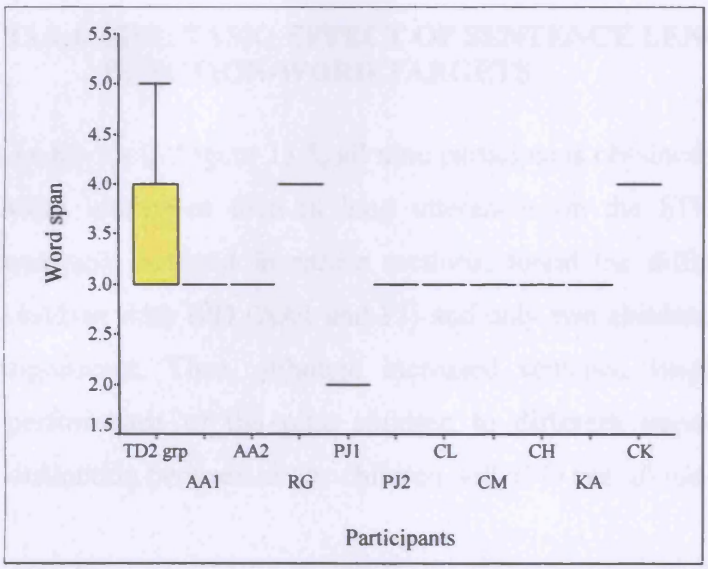

Figure 13.3 Phonological working memory: word-span recall for IPD, SLI and TD2 group

13.2.3 SENTENCE COMPLETION TASK

As shown in Figure 13.4, and statistically confirmed in earlier presentations of results, all the participants showed difficulty producing function words on this task, compared with the TD2 group. AA1 showed the greatest difficulty and PJ the least, with the abilities of RG, AA2 and the children with SLI falling somewhere between these two scores. Therefore, the children with IPD and SLI cannot be distinguished based on their performance on this task. All the participants seemed to have a genuine difficulty with the generation of function words even when production load was minimised.

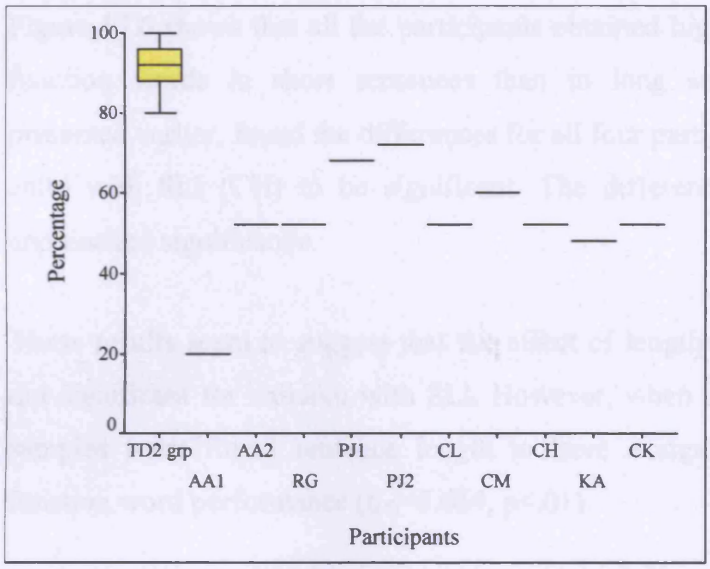

Figure 13.4 Sentence completion scores: TD2 group, IPD and SLI

13.2.4 SIVL TASK: EFFECT OF SENTENCE LENGTH ON CONTENT- AND FUNCTION-WORD TARGETS

As shown in Figure 13.5, all nine participants obtained higher content-word scores in short utterances than in long utterances on the SIVL Task. However, statistical analyses, outlined in earlier sections, found the difference in scores for only two children with IPD (AA1 and PJ) and only two children with SLI (CL and CK) to be significant. Thus, although increased sentence length affected the content-word performance of the nine children to different degrees, there was no pattern of distinction between all the children with IPD and all the children with SLI.

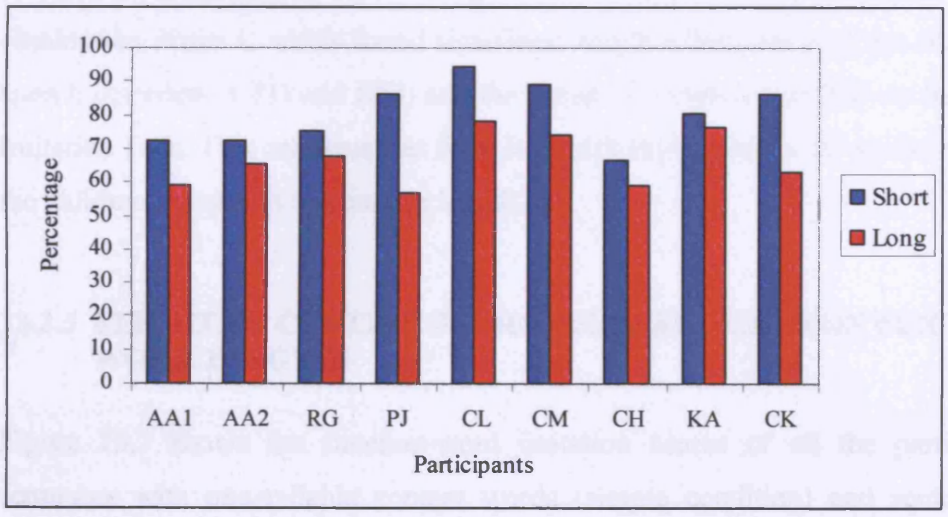

Figure 13.5 Effect of sentence length on content word targets: IPD and SLI

Figure 13.6 shows that all the participants obtained higher scores for the imitation of function words in short sentences than in long sentences. Statistical analyses, presented earlier, found the differences for all four participants with IPD and only one child with SLI (CH) to be significant. The difference in scores obtained by CK approached significance.

These results seem to suggest that the effect of length on function word imitation is not significant for children with SLI. However, when analysed as a group, a Paired-samples t-test found sentence length to have a significant effect on the group's function word performance ($t_{(4)}$=5.664, p<.01).

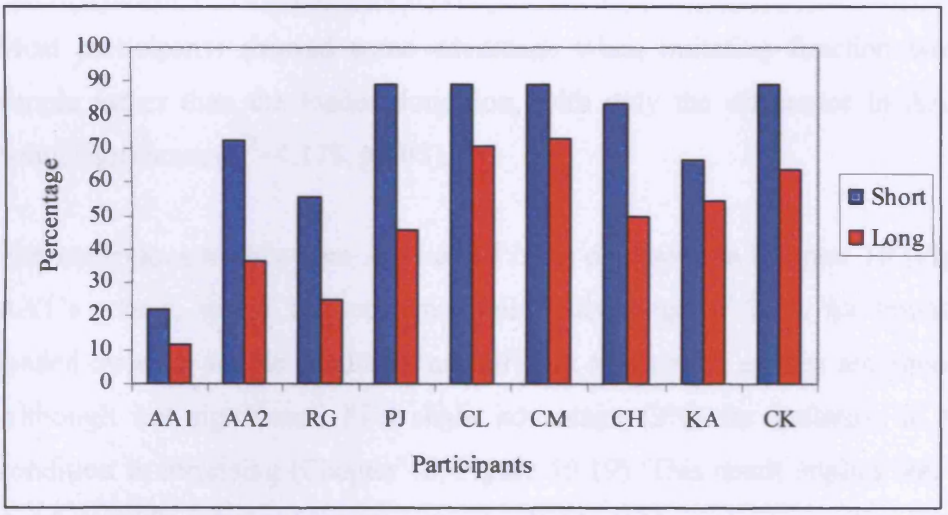

Figure 13.6 Effect of sentence length on function word targets: IPD and SLI

Overall, the results in relation to length on the SIVL Task are consistent with those obtained in Phase 1, which found significant length effects for both the children with speech disorders (CPD and IPD) and the group of children with SLI on the Sentence Imitation Task. This confirms that there is significant overlap in the performance of all the children in relation to sentence length.

13.2.5 EFFECT OF CONTENT-WORD SYLLABLE LOAD ON FUNCTION-WORD TARGETS

Figure 13.7 shows the function-word imitation scores of all the participants in sentences with one-syllable content words (simple condition) and sentences with multi-syllabic content words (loaded condition).

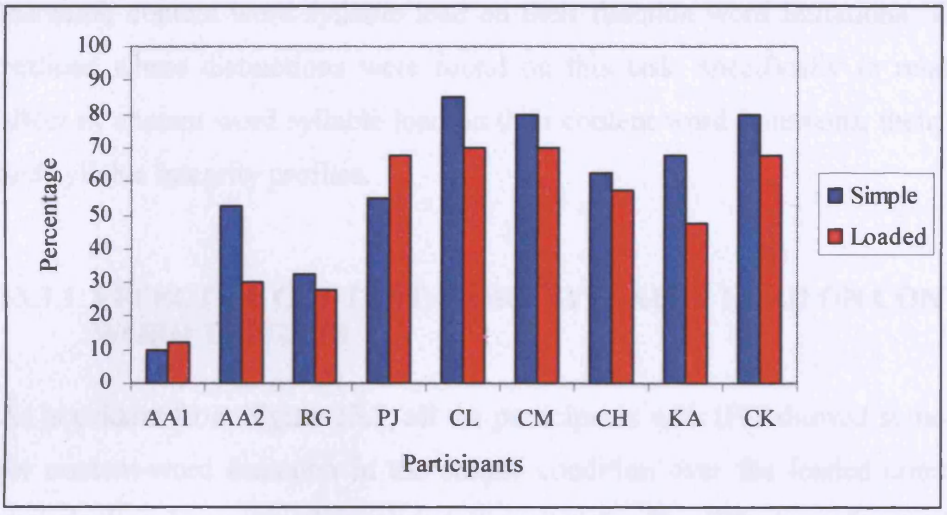

Figure 13.7 Effect of content-word syllable load on function word targets: IPD and SLI

Most participants showed some advantage when imitating function words in the simple rather than the loaded condition, with only the difference in AA2's scores being significant (X^2=4.178, p<.05).

The exceptions to this were AA1 and PJ. As discussed in Chapter 10 (Figure 10.5), AA1's scores, which showed a negligible advantage of 2.5% for imitation in the loaded over the simple condition, are difficult to interpret as they are almost at floor. Although not significant, PJ's slight advantage (2%) for imitation in the loaded condition is surprising (Chapter 10, Figure 10.19). This result implies that increasing the demand in relation to content-word syllable load can be overcome. Alternatively, if considered within the context of PJ's other results, it may simply reflect normal variation across conditions. This interpretation is supported by the fact that she obtained a higher score in the simple condition at T2 (Chapter 11, Figure 11.7), which is in line with the rest of the participants' profiles.

Thus, these results suggest that overall the IPD and SLI participants cannot be distinguished based on their function-word imitations in response to increasing content-word syllable load.

13.3 DISTINCTIONS

As outlined above, the performance of the participants with IPD and SLI on the SIVL task cannot be distinguished based on their responses to increasing sentence length or

increased content word syllable load on their function word imitations. This section outlines where distinctions were found on this task, specifically in relation to the effect of content word syllable load on their content word imitations, their error types and syllable integrity profiles.

13.3.1 EFFECT OF CONTENT-WORD SYLLABLE LOAD ON CONTENT WORD TARGETS

As is evident from Figure 13.8, all the participants with IPD showed some advantage for content-word imitation in the simple condition over the loaded condition, with statistical analyses in earlier sections showing that the differences for AA1 and AA2 were significant. Although not significant, RG's score in the simple condition was notably higher than his score in the loaded condition (8%).

The difference in PJ's scores (2%), however, was similar to the pattern of scores for the children with SLI, where negligible differences, if any, were found in content-word imitation between the simple and loaded conditions (Chapter 12, Figure 12.4). For one of the children with SLI (CH), the trend was reversed as she obtained a marginally higher score (2%) in the loaded condition.

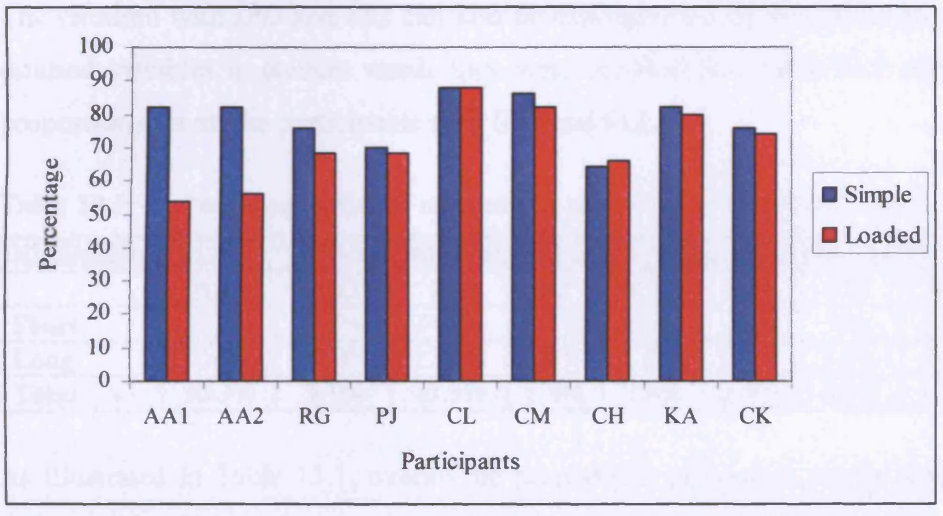

Figure 13.8 Effect of content-word syllable load on content word targets: IPD and SLI

Thus, the content word imitation performance of AA1, AA2 and RG distinguishes them from the children with SLI and PJ.

13.3.2 SIVL TASK: ERROR TYPES AND PROPORTIONS

In line with the findings from Phase 1, error analysis yields some differences between children with IPD and those with SLI. The errors associated with AA1, AA2 and RG included 'speech-related' errors, such as sound substitutions, unmatched syllables and distortions, in addition to omissions and proportions of whole-word substitutions from the same or different categories.

PJ's error profile, however, appears more similar to the profile of errors obtained by the children with SLI. The majority of her errors were omissions and whole-word substitutions, with very small proportions of distortions and sound substitutions (for details see Chapter 10, Figures 10.21 and 10.22). In line with this profile, the vast majority of the SLI children's errors were omissions and whole-word substitutions from the same and different grammatical categories. Small proportions of sound substitutions, distortions and unmatched syllables were recorded for some of the children in some conditions (individual profiles of errors are outlined in Appendix 6 and Appendix 7).

13.3.3 SIVL TASK: SYLLABLE INTEGRITY

The children with IPD and SLI can also be distinguished by the extent to which they omitted syllables in content words they were credited for. Table 13.1 outlines these proportions for all the participants with IPD and SLI.

Table 13.1 Percentage syllables reduced as a proportion of each child's correct score

Utterance	% syllables reduced as proportion of correct score								
	AA1	AA2	RG	PJ	CL	CM	CH	KA	CK
Short	15.4%	7.7%	14.8%	6.5%	0%	3.1%	0%	3.4%	0%
Long	7.4%	10.0%	12.9%	3.8%	2.8%	2.9%	7.4%	8.6%	3.4%
Total	10.3%	9.1%	13.9%	5.8%	2.3%	2.9%	3.1%	6.2%	1.3%

As illustrated in Table 13.1, overall the proportions of content words produced with reduced syllables were higher for children with IPD than for children with SLI (IPD: 5.8-10.3% versus SLI: 1.3-6.2%). The difference between the two types of children was particularly striking in short utterances where the children with IPD reduced between 6.5% and 15.4% of their content words, compared with the children with SLI where three out of the five of them did not produce any content words with reduced

syllables. The remaining two children with SLI reduced the number of content-word syllables in short utterances in less than 3.5% of their content-word productions.

13.4 SUMMARY

The comparison presented in this chapter has revealed both overlaps and distinctions in the performance characteristics of children identified as having IPD or SLI. The overlaps in performance were the following:

- All participants experienced difficulty with sentence completion and only one child with IPD (AA1) and one child with SLI (CM) obtained sentence judgement scores above chance.
- One child with IPD (RG) and one child with SLI (CK) showed no weakness in their phonological working memory relative to typically developing children. The remainder of the participants obtained scores largely at the lower limit of the TD2 group's range, with AA1 and PJ showing the greatest weaknesses on these tasks.
- On the SIVL Task, content- and function-word imitation was affected by the manipulation of sentence length to varying degrees for all participants, and there was a trend for function-word imitation to be more affected in the loaded condition than the simple condition.

The distinctions in performance were the following:

- On the SIVL Task, the content-word imitation of children with IPD seemed to be more affected by an increase in content-word syllable load than the performance of children with SLI, which was hardly affected.
- The imitations of the children with IPD, apart from PJ's, contained larger proportions of distortions, unmatched syllables and sound substitutions than the imitations of children with SLI. PJ's error profile appeared more similar to that of the children with SLI than to the profile of AA1, AA2 and RG.
- The children with IPD were more likely to reduce the number of syllables in content words than were the children with SLI. This was especially noticeable in short utterances, where the children with SLI very rarely reduced the number of syllables in any content words they produced.

13.5 DISCUSSION

The objective of this chapter was to determine whether the difficulties of children with IPD who have poor sentence imitation abilities are the same as the difficulties of children with SLI. The comparison carried out showed that the low-scoring IPD children and the children with SLI could not be differentiated by most of their sentence processing-related abilities. On the other hand, there were a few unique performance characteristics associated with the IPD children. Since these characteristics also contribute to the performance profile of children with IPD, the outcomes confirm that the overt performance of the low-scoring IPD children is due to a combination of language-based and speech-based difficulties.

The comparison of results unveils a number of significant issues relating to input processing, phonological working memory and the classification of difficulties.

13.5.1 INPUT: TACL VS SENTENCE JUDGEMENT TASK

It may seem incongruous that all the participants obtained receptive language scores at least within the average range on the TACL-3 (Tables 8.1 and 12.1) yet, apart from two children, one with IPD (AA1) and one with SLI (CM), they all scored poorly on the Sentence Judgement Task. However, a brief comparison of the scope and methods used in each assessment uncovers possible explanations for this apparent paradox.

The scope of knowledge assessed by the TACL-3 is broad compared with the Sentence Judgement Task. The Sentence Judgement Task was designed to focus exclusively on function-word knowledge, including prepositions, determiners and auxiliaries. The TACL-3, on the other hand, is made up of three subtests that assess a range of areas in relation to the understanding of language.

The first subtest, Word Class and Relations, assesses a child's knowledge of vocabulary and concepts. The second subtest, Grammatical Morphemes, focuses on assessing a child's knowledge of the meaning of morphemes such as prepositions; pronouns; noun inflections, including number (for example, 'child' versus 'children') and possessive case (for example, 'There is the grandfather's clock' vs 'There is the grandfather clock'); and verb inflections, including noun-verb agreement (for

example, 'The sheep drink water' vs 'The sheep drinks water') and tense (for example, 'The man painted the house' vs 'The man is painting the house'). The third subtest, Elaborated Sentences, tests the understanding of syntactically based word relations, elaborated phrase and sentence constructions, embedded sentences, and partially and completely conjoined sentences.

Hence, while a child may show average ability in her/his overall knowledge of the aspects of comprehension assessed in the three subtests of the TACL-3, s/he could still experience specific difficulties in relation to function words. Furthermore, an analysis of task items on the TACL-3 reveals that the assessment does not test a child's knowledge of determiners, it tests a limited number of auxiliaries, and the only preposition assessed in common with the Sentence Judgement Task is 'in'.

Where function words are assessed in the TACL-3, the nature and method of assessment is different from the Sentence Judgement Task. Firstly, the TACL-3 uses auditory input in connection with pictures to assess comprehension, whereas the Sentence Judgement Task is purely auditory. Secondly, in the TACL-3 the function word is always present and contrasted with other functions words with similar meanings. The child is required to recognise the word and know its meaning. For example, the preposition 'in' in the target sentence 'The cat is in the box' is presented with the target picture and distractors showing the cat behind and in front of the box. The Sentence Judgement Task, on the other hand, requires the child to be aware of whether the function word is present or absent and whether it is appropriate to the context or not. For example, the copular 'are' is omitted in 'The men happy', which is contrasted with 'The men are happy', and 'The people are noisy' is contrasted with a nonsense syllable in 'The people [pə] noisy'.

Thus, as the nature and scope of the assessments are different, it is feasible for a child to have specific difficulties in relation to the appropriateness of function words as assessed on the Sentence Judgement Task, and yet obtain an average score or above on the TACL-3. It may be that children find it easier to retrieve sufficient meaning to distinguish function-word targets from visual distractors, than to identify their form and where they should occur. This could be investigated more systematically in a future study.

13.5.2 PHONOLOGICAL WORKING MEMORY

The assessment of phonological working memory was one of the areas in which the abilities of children with IPD or SLI could not be distinguished. In addition, it was difficult to distinguish the performance of an individual child from the group of typically developing children in the individual case studies. As there is a growing body of evidence to support the notion that children with SLI have limitations in their capacity to process and store information (Gathercole & Baddeley, 1990; Montgomery, 1995, 2002), it is unlikely that the results are due to subject variables (discussed in Chapter 12, Section 12.4). Therefore, this lack of distinction could be due to the nature of the task and the scoring procedure used, which will be discussed further in Chapter 14, Section 14.9.1.

13.5.3 CLASSIFICATION OF DIFFICULTIES

Differentiating between language and speech-based difficulties

One of the differences between children identified with IPD and those identified with SLI is the types of errors they make. This echoes the findings from the group study in Phase 1. It also has practical implications in terms of differential diagnosis that will be discussed in Chapter 14.

Other distinguishing characteristics are the effect of increased content-word syllable load on the content word production of IPD children in sentence imitation, and the higher likelihood of children with IPD reducing content-word syllables (syllable integrity). This underlines the fact that children with IPD, unlike children with SLI, have a phonological difficulty at the level of single words. The implications of these differences will also be discussed in Chapter 14.

Inconsistency: Continuum of difficulty

One of the findings of this chapter is that of all the children with IPD, PJ's performance was more like the children with SLI than it was like the other IPD children. The performance of AA1, AA2 and RG could be distinguished from the children with SLI in relation to their content-word imitations in response to increased

content-word syllable load, their error profiles and the extent to which they reduced the number of syllables in content words attempted. In contrast to this, PJ's performance profile in these three areas was hardly distinguishable from the children with SLI.

It is possible that this outcome is related to the degree of inconsistency in PJ's speech. Support for this possibility is found in the following:

- PJ's speech inconsistency was the lowest of all the children with IPD, 40%, which is considered to be borderline for being classified as IPD according to Dodd (1995). It is possible that her 'borderline' status means that she is not experiencing phonological difficulties at a single-word level to the same extent as the other children with IPD. This could explain the fact that her content-word imitation was negligibly affected by increasing the number of syllables.
- PJ's 'borderline status' could also explain the finding that she reduced fewer multi-syllabic content words than AA1, AA2 and RG. KA, who was noted to have a phonological delay, showed the highest proportion of syllables reduced out of the children with SLI (6.2%, which is within the range of the IPD children: 5.8-13.9%). This confirms that phonological difficulties are not discrete but rather exist on a continuum from 'speech delay' to CPD to IPD. Based on this, it would be predicted that as PJ's speech became more consistent from T1 (40%) to T2 (24%), the proportion of syllables she reduced at T2 would be also be lower.

Overall, while PJ's results show that the inconsistency in her speech was severe enough for her to be identified as a child with IPD, her speech disorder did not feature prominently in her sentence production profile. This may indicate that the lower the degree of inconsistency in a child with co-occurring speech and sentence processing-related difficulties, the less distinguishable his/her profile will be from children with SLI. In order to verify and extend these limited findings, further research is required to compare the performance of children with varying degrees of inconsistency in relation to a range of abilities.

PART IV:

DISCUSSION & CONCLUSIONS

CHAPTER 14
DISCUSSION

14.1 INTRODUCTION

As stated at the beginning of the thesis, the investigations carried out were both complementary and cumulative. Therefore, this chapter begins with a summary of the cumulative findings of the thesis. This is followed by a discussion of the key findings relating to sentence imitation and sentence processing in children with CPD and IPD. Possible explanations for the high co-occurrence of IPD and language difficulties are explored in relation to models of single-word and sentence processing. Clinical implications and proposals for future research are then considered, and the chapter ends with the conclusions of the thesis.

14.2 SUMMARY

This thesis examined the sentence-level abilities of children with different types of speech disorders. The following key questions were addressed:

- Can children with different types of speech disorders be differentiated according to their sentence-level performance?
- Is there a more-than-chance co-occurrence of sentence-level difficulties in children with different types of speech disorders?
- What is the relationship between speech disorders and sentence production?
- Is sentence imitation an efficient, effective and reliable method of assessing expressive syntax in children with severe speech difficulties?

The objective of the first phase of investigation was to investigate the relationship between speech and language difficulties, and more specifically whether they co-occur. A group study systematically compared the sentence imitation performance of typically developing (TD) children with that of groups of children who presented with speech disorders (CPD and IPD), and a group of children with SLI (Chapter 5 and

Chapter 6). A summary of the groups' sentence imitation scores for content words, function words and inflections are presented in Figure 14.1.

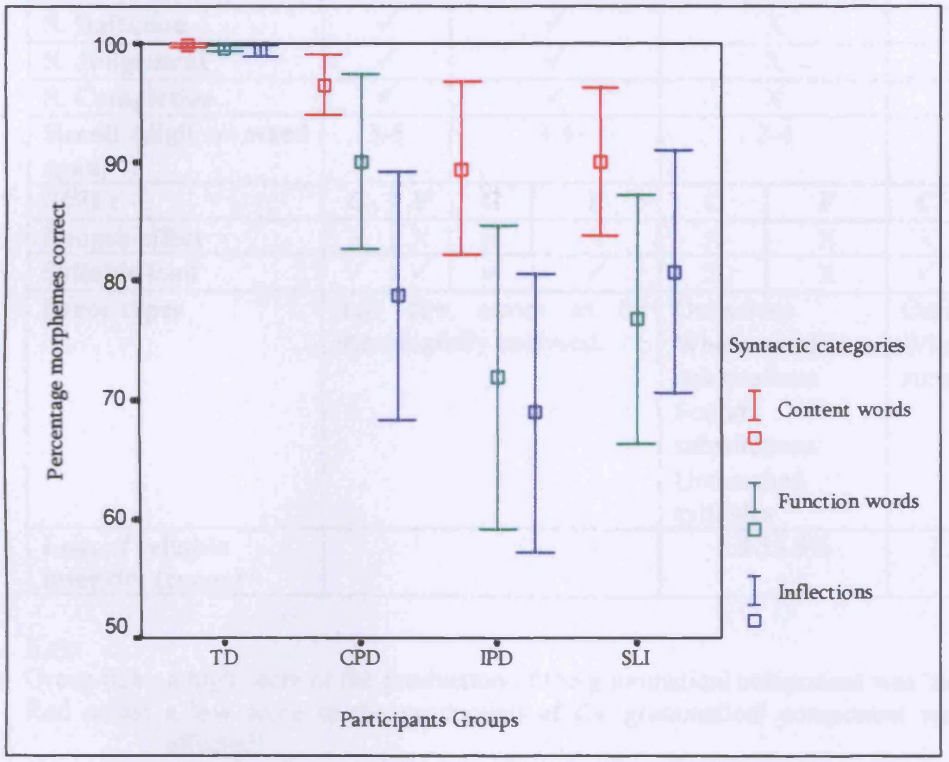

Figure 14.1 Summary of sentence imitation scores obtained in Phase 1

Scores in Figure 14.1 reflect that the TD group completed this task with ease. The CPD group did not experience sentence-level difficulties apart from the imitation of inflections. The performance of the CPD group was better than the performance of the IPD group, particularly for function-word imitation. Overall, the accuracy scores of the IPD group for content- and function-word imitation were most similar to those of the SLI group. These groups were, however, differentiated by the types and proportions of their errors (Chapter 7). Within the IPD group, children varied significantly in their performance across all three grammatical categories.

Phase 2 of the research took the form of single-case studies and focused on identifying the possible sources of heterogeneity in the performance of children with IPD. The performance of five children with IPD was compared to five children with SLI and a group of 34 typically developing children. A summary of the results of this phase of investigation is presented in Table 14.1.

Table 14.1 Summary of Phase 2 findings

Tasks	TD (n=34)		IPD				SLI (n=5)	
			High-scoring (n=2)		Low-scoring (n=3)			
S. Imitation	✓		✓		X		X	
S. Judgement	✓		✓		X		X	
S. Completion	✓		✓		X		X	
Recall (digit or word span)	3-5		3-4		2-4		3-4	
SIVL:	**C**	**F**	**C**	**F**	**C**	**F**	**C**	**F**
Length effect	X	X	X	X	X	X	X	X
Syllable load	✓	✓	✓	✓	X	X	✓	X
Error types	Too few errors to be meaningfully analysed.				Omissions Whole-word substitutions Sound substitutions Unmatched syllables		Omissions Whole-word substitutions	
Loss of syllable integrity (range)					5.8-13.9%		1.3-6.2%	

Key:
Green tick: a high score or the production of the grammatical component was 'not affected'
Red cross: a low score or the production of the grammatical component was 'negatively affected'
C: content words
F: function words

As shown on the table, two of the five children with IPD obtained scores on the Sentence Imitation Task comparable with typically developing children, and three obtained significantly lower scores. Since their speech characteristics could not account for the differences between the high- and low-scoring IPD children on the Sentence Imitation Task (Chapter 8), four novel tasks were constructed to assess the participants' abilities in relation to input processing, phonological working memory, and the manipulation of output load (Chapter 9).

The two high-scoring IPD children showed no sentence processing-related difficulties relative to children with typical development. Conversely, the three low-scoring IPD children experienced difficulties on the Sentence Judgement, Sentence Completion and SIVL Tasks. Their results on the Recall Task were less definitive, and possible explanations for this will be discussed in Section 14.9.1. From these results, it was inferred that the poor sentence imitation performance of the low-scoring children with IPD in Phase 1 and Phase 2 was due to difficulties in sentence processing as well as

speech (Chapter 10). This inference was partially supported in a follow-up study of two children with IPD (Chapter 11). Evidence was found to suggest dissociation of speech and language development in one participant, AA, while the outcomes for the second participant, PJ, were unclear.

As shown in Table 14.1, there was overlap in the processing abilities of low-scoring IPD children and children with SLI, in terms of their poor sentence judgement abilities and their phonological working memory scores. In addition, the effect of content-word syllable load on their function word production was similar, as shown by the results of the Sentence Completion and SIVL Tasks. The comparison also revealed some unique performance characteristics of children with IPD. These involved the effect of content-word syllable load on content word production, their error types and their syllable integrity scores (Chapter 13).

The key findings of Phase 1 and Phase 2 are discussed in the next section.

14.3 SENTENCE IMITATION PERFORMANCE OF CHILDREN WITH CPD AND IPD

While the TD group obtained sentence imitation scores at ceiling, overall, children with speech disorders obtained significantly lower scores on all three grammatical categories. This confirms the findings of previous research regarding the existence of co-occurring speech and language difficulties (Broomfield & Dodd, 2003, 2004a; Nathan, 2001; Shriberg & Austin, 1998).

Although the studies for this thesis included relatively small numbers of children, it is striking that overall (apart from one outlier on function-word imitation), children in the CPD group did not show sentence-level difficulties, at least with regard to the production of content and function words (the group's means were both above 90%). This finding supports previous research that shows that the majority of children with speech disorders do not have language difficulties (Broomfield & Dodd, 2004a; Shriberg & Austin, 1998).

While the performance of the CPD group was high for content and function words, the inflection results (mean: 78.76%; range: 35.9%-100%; standard deviation: 18.03) show that some children with CPD experienced difficulties imitating inflections. This result requires further consideration. Particular difficulties with inflections may be due to their prosodic and phonological/phonotactic characteristics, which differentiate them from content and function words:

- Content words always contain at least one stressed syllable.
- Function words on the Sentence Imitation Task consisted of just one syllable and this was most often unstressed, although this depended on the type of function word and its position in a sentence (Black & Chiat, 2003). This is illustrated in the sentence 'Are the boys hiding?' where the auxiliary *are* is stressed at the beginning of the sentence and takes the full form /a/, and the determiner *the* is not stressed.
- Inflections were mostly sub-syllabic, for example, the plural /z/ in the sentence 'We have cake at parties'.

Given these characteristics, children with speech difficulties are most able to demonstrate their knowledge of content words – where the production of the vowel is sufficient to credit the child with the production of the morpheme (see scoring in Chapter 5, Section 5.8.3) – and least able to demonstrate their knowledge of inflections, where crediting the morpheme was most often reliant on the production of a single consonant. This is illustrated by the analysis of inflection errors made by the children with CPD:

- The majority of their errors (70.68%) involved (i) the production of the later developing phonemes /s/ and /z/ as plurals, for example 'We have cake at *parties*', and as third person singular agreement marker, for example 'Tim *goes* in the house'; and (ii) clusters such as the contracted negative, illustrated in the sentence '*Don't* feed the horses'.
- Inflections that were produced more successfully by these participants included (i) the progressive inflection, for example 'Mummy is *giving* Peter cake' where *ing* is a whole syllable, which contains a vowel; (ii) past tense markers requiring alveolar stops and which do not involve clusters, such as *poured*; and (iii)

irregular past tense verbs, including *gave*, *sat*, *ate,* where the vowel indicates tense.

This distribution of errors indicates that the lower inflection scores of the CPD group may be primarily attributable to their speech difficulties, not linguistic knowledge. This has significant clinical implications for SLTs, when focusing on the word endings of children with CPD.

These findings need to be replicated on larger numbers of children. However, they do suggest a low probability of co-occurrence of CPD and sentence-level difficulties, probably no greater than the incidence in the general population. This finding is incongruent with the result of 45% for co-occurrence of CPD and language difficulties obtained by Broomfield and Dodd (2004a). The difference may be accounted for by the differing ages, assessments and cut-off criteria used in their study, compared with those in this thesis. The children included in Broomfield and Dodd's study ranged between the ages of 0 and 16 years. Their expressive language abilities were determined by a variety of assessments, depending on the age of the child, and a cut-off of 1SD was used to indicate the presence of a difficulty. In contrast to this, the children in this thesis represented a narrow age range (from 4 to 6 years). A consistent measure of expressive language assessment was used (Sentence Imitation Task), and a less stringent cut-off of 1.5 SD below the mean of the TD group indicated a difficulty.

The present research revealed that the children with speech disorders were not a homogeneous group: the performance of the CPD group was better than that of the IPD group, especially with respect to function words (function word mean: CPD=90.03%, IPD=71.92%). Therefore, on a broad level, when considered as a group, children with CPD and IPD can be differentiated by their sentence imitation performance. This finding may partially explain the variability in co-morbidity estimates obtained in Shriberg and Austin's (1998) review: it could be that language assessments were administered to groups of children made up of different proportions of children with CPD and IPD, differentially influencing the outcomes of each study.

The sentence imitation results in Phase 1 and Phase 2 revealed significant variability in the performance of children with IPD. The sentence imitation results of some of the

children (eight out of 14 in Phase 1 and two out of five in Phase 2) was comparable with those of typically developing children and children with CPD. These findings indicate that, despite their overall group scores being lower than children with CPD, children with IPD do not necessarily have sentence-level difficulties. The remaining six out of 14 children with IPD in Phase 1, and three out of five children in Phase 2, obtained low scores across all three grammatical categories. This heterogeneity in the performance of children with IPD could also contribute to the variable co-occurrence estimates relating to speech and language disorders (Shriberg & Austin, 1998). This finding highlights that while there is good reason to investigate subgroups hypothesised to have different underlying problems, it is important to consider each child and his/her abilities individually. This supports the single-case approach advocated by Stackhouse and Wells (1997).

14.4 SENTENCE IMITATION PERFORMANCE OF CHILDREN WITH IPD AND SLI

The sentence imitation performance of a group of children with SLI was also analysed in order to validate the Sentence Imitation Task, and to determine whether the difficulties experienced by children with SLI on sentence imitation are similar to those of children with speech disorders. The results of this group are also depicted on Figure 14.1.

In terms of overall scores, the sentence imitation performance of the SLI group was most similar to the group of children with IPD with regards to content- and function-word repetition. This outcome has significant clinical implications. If accuracy scores are considered in isolation, then children with SLI and IPD may be seen as belonging to the same group in terms of sentence-level difficulties, which has significant ramifications for intervention design and implementation.

However, a further analysis revealed that these groups could be differentiated by the types and proportions of their errors. The vast majority of the errors of the children with SLI consisted of omissions, with small proportions of whole-word substitutions from both the same and different grammatical categories. In contrast to this, a range of errors were associated with children with IPD. These included omissions, whole-word

substitutions, sound substitutions, unmatched syllables, and extremely small proportions of distortions. Hence, an analysis of errors may be used to assist in the differential diagnosis of these two groups of children. This will be discussed under Section 14.8.3 below.

14.5 SENTENCE PROCESSING-RELATED ABILITIES OF CHILDREN WITH IPD AND SLI

Of the five children with IPD who participated in Phase 2, two children who obtained high scores on the Sentence Imitation Task showed sentence processing-related abilities comparable with those of typically developing children. This finding confirms the statement above that, despite their overall group scores being lower than those of children with CPD, children with IPD do not necessarily have sentence imitation or sentence processing-related difficulties. In contrast to this, the three low-scoring IPD children on the Sentence Imitation Task experienced difficulties with sentence processing. With regard to the range of co-morbidity estimates obtained by Shriberg and Austin (1998), it is most likely the inclusion of children with this type of profile that contributed to the more-than-chance co-occurrence estimates.

The research revealed significant overlap in the sentence processing-related abilities of the three low-scoring children and five children with SLI, in terms of their poor sentence judgement abilities and their phonological working memory scores. In addition, the effect of changing output load on their function-word production was similar, as shown by the results of the Sentence Completion and SIVL Tasks. These results suggest that the low-scoring children with IPD have 'SLI-type' sentence processing-related difficulties, which contribute to their poor sentence imitation performance. The comparison also revealed some unique characteristics of their performance on the SIVL Task, which could be attributed to their IPD. These included the effect of content-word syllable load on content word production, their error types and their syllable integrity scores. From these results it was inferred that the poor sentence imitation performance of low-scoring children with IPD is due to co-occurring difficulties in both sentence processing and speech.

14.6 CO-OCCURRENCE

This research has confirmed that speech and language difficulties can exist in isolation. However, it also revealed varying degrees of co-occurring speech and language difficulties in children with CPD and IPD. While there was no evidence to suggest that children with CPD are more at risk for having sentence-level difficulties than children without speech disorders, a more-than-chance co-occurrence was found between IPD and sentence-level difficulties: of the 19 children with IPD assessed (14 in Phase 1 and five in Phase 2), nine had co-occurring sentence-level difficulties (47%). Overall, the co-occurrence of speech disorders and sentence-level difficulties was 28% (nine out of a total of 33 children (CPD and IPD) with speech disorders).

These estimates are slightly lower than those obtained by previous researchers: Broomfield and Dodd found a 66.7% (compared with 47% in this study) co-occurrence of IPD and language difficulties, and Shriberg and Austin (1998) established a range of 38-64% (compared with 28% in this study) for the co-morbidity of speech and expressive language difficulties. As stated above, the difference in estimates may be due to the inclusion of children of different ages, as well as the different assessments and cut-off criteria used in each study. Notwithstanding these differences, the results obtained in this thesis do confirm Broomfield and Dodd's (2004a) finding of a higher probability of co-occurring sentence-level difficulties in children with IPD than in those with CPD. Possible reasons for this finding are explored in the following section.

14.7 WHY ARE CHILDREN WITH IPD MORE AT RISK OF SENTENCE-LEVEL DIFFICULTIES?

Figure 14.2 represents modified versions of pertinent components of single-word and sentence-processing models discussed in this thesis (Levelt et al., 1999; Stackhouse & Wells, 1997). Possible sources for the higher probability of co-occurring sentence-level difficulties in children with IPD are identified numerically in this figure, and discussed below.

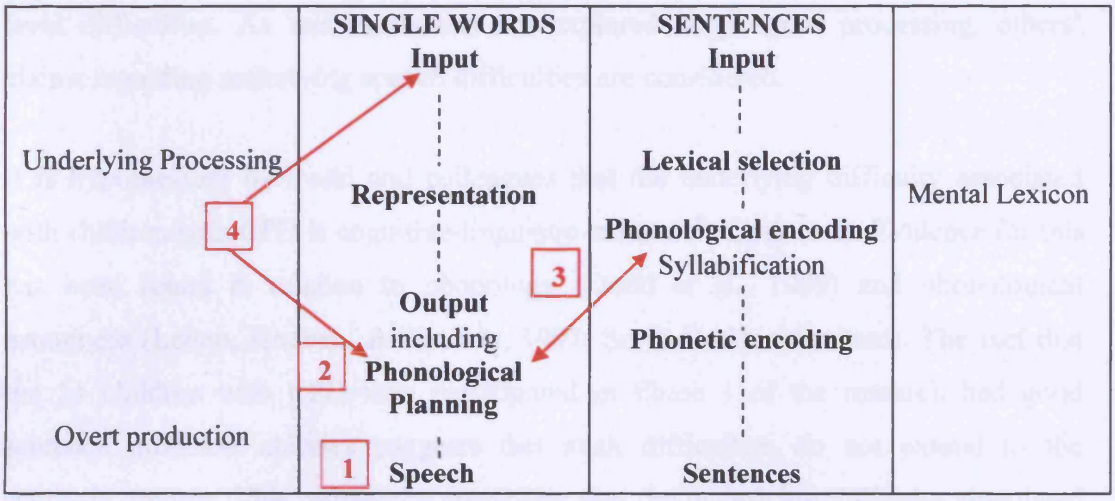

Figure 14.2 Simplified models of single-word and sentence processing, adapted from Stackhouse and Wells (1997) and Levelt et al. (1999)

14.7.1 SEVERITY OF SPEECH DISORDER (identified by the number '1' in Figure 14.2)

A plausible explanation, but one that can be discounted, is that children who have sentence-level difficulties are those with more severe speech difficulties. A comparison of phonological accuracy scores in Chapter 6 (Figure 6.8) showed that, overall, the speech of the IPD group was no less accurate than the speech of the CPD group as reflected by their PCC and PVC scores. Furthermore, a comparison of speech profiles in Chapter 8 showed that the high-scoring and low-scoring children with IPD in Phase 2 could not be differentiated by the characteristics of their speech disorder. Their profiles did not differ with respect to inconsistency (degree, type and errors) or accuracy (at the phoneme and prosodic levels). Therefore, the speech characteristics of IPD cannot account for the fact that some children with IPD were found to have co-occurring sentence-level difficulties while the sentence-level performance of others was comparable with that of typically developing children.

14.7.2 NATURE OF DIFFICULTIES UNDERLYING SPEECH

While the severity of speech difficulties cannot account for the higher risk of children with IPD having sentence-level difficulties, it could be the nature of the difficulties underlying their speech that differentiates children who do or don't have sentence-

level difficulties. As this thesis has not explored single-word processing, others' claims regarding underlying speech difficulties are considered.

It is hypothesised by Dodd and colleagues that the underlying difficulty associated with children with CPD is cognitive-linguistic in nature[9] (Chapter 1). Evidence for this has been found in relation to phonology (Dodd et al., 1989) and phonological awareness (Leitao, Hogben, & Fletcher, 1997; So & Dodd, submitted). The fact that the 14 children with CPD who participated in Phase 1 of the research had good sentence imitation abilities suggests that such difficulties do not extend to the syntactic domain. This refutes the possibility that the underlying difficulty associated with CPD, as Dodd and colleagues see it, determines whether a child will or won't sentence-level difficulties.

Dodd and colleagues further propose that the underlying difficulty associated with IPD is phonological planning (identified by the number '2' in Figure 14.2). Theoretically, would we expect that phonological planning problems would give rise to sentence-level difficulties? In terms of Levelt et al.'s (1999) feed-forward model of speech production depicted in Chapter 4, Figure 4.1, phonological planning is located in the vicinity of phonological-phonetic encoding (identified by the number '3' in Figure 14.2) – a process occurring late in the sentence production process, after the encoding of syntax has taken place during lexical selection. Therefore, phonological planning difficulties existing in isolation should not cause difficulties in sentence production. Furthermore, if it were the case that all children with IPD have phonological planning difficulties, and that this difficulty was responsible for overt sentence-level difficulties, we would expect all children with IPD to experience sentence-level difficulties. As the findings of this research showed that some children with IPD have sentence-level difficulties and others not (Chapter 10), their underlying speech processing difficulty cannot be responsible for the higher co-occurrence unless they are a homogenous group.

9 In line with the discussions in Chapter 1 and Chapter 4, the underlying nature of CPD, according to Dodd and colleagues, does not relate to online processing and therefore cannot be identified in Figure 14.2.

However, there is an instance where the research outcomes hint at the possibility of underlying speech processing difficulties contributing to overt syntactic performance. As discussed above, where children with IPD have co-occurring sentence processing-related difficulties related to sentence processing, increasing the load at the level of the phonological word – the level at which these children are alleged to be experiencing particular difficulty – sometimes had an impact on their production of content words. Evidence for this is found in an analysis of the errors of two of the low-scoring IPD children in the loaded condition on the SIVL Task. For both AA and RG, increasing the content-word syllable load resulted in increased proportions of distortions affecting syntax – an error more associated with IPD than SLI (Chapters 10, 12 and 13). This is illustrated by the following example:

Table 14.2 Example of sentence repetition in simple and loaded conditions: IPD child

Condition	Target	Response
Simple	The man wrote a note with a pen	[mæn wait nəʊ i pei]
Loaded	The teacher copied the letter with a pencil	[diə *distortion* di pɛmvu]

In these matched sentences, the child was able to maintain the semantics and syntax of the eight-word sentence in the simple condition and was credited for the production of the four content words. In the loaded condition, however, his production of both content and function words was largely distorted and he was credited for only two content words. As the difference in complexity between these sentences is phonological and not syntactic or semantic, it's likely that the child's difficulty with content words is a response to the increased content-word syllable load. This implies that for AA and RG, exaggerating their phonological planning difficulty at the level of the phonological word affects the production of content words to such a degree that it manifests in a syntactic deficit at the sentence level. Hence, their overt difficulty with the production of content words could be due partly to the underlying nature of their speech disorder.

The above scenario was not replicated for the third low-scoring child with IPD, PJ. In her case, increasing the content-word syllable load did not change the type or proportions of her errors, which were mainly omissions and whole-word substitutions, as with the children with SLI. The fact that PJ's speech inconsistency was borderline

for classification as IPD, could mean that she was not experiencing the same degree of phonological planning difficulty as AA and RG. This, together with the fact that she showed only mild sentence production difficulties, may go some way to explaining her different profile for content words.

BH, however, whose inconsistency score was almost as high as AA's and RG's, showed not difficulty relative to typically developing children when producing content words when the content-word syllable load was increased. One possible explanation for this might be found in Dell's model of interactive feedback, discussed in Chapter 4 (Dell, 1988; Dell et al., 1997). If the impact of feedback in such a model were affected by the robustness of the system, we might expect that a child with only one problem, for example BH with phonological planning problems but no syntax problems, would not experience sentence-level difficulties due to the feedback of his phonological planning problems on his robust sentence-processing system. But AA and RG, with deficits at both phonological planning and syntactic levels, would experience an effect of their phonological planning difficulties on their sentence-level syntax.

The theory cannot, however, explain why children with IPD should be more at risk of sentence-level difficulties than children with CPD, since the feedback does not seem to *cause* the sentence-level difficulties (if it did, all children with severe IPD should have sentence-level difficulties). It merely seems to exacerbate an existing difficulty, which must have a separate cause that IPD children are more at risk of than CPD children. The next section considers a final possibility for this.

14.7.3 INPUT PROCESSING

According to Dodd, Leahy and Hambly (1989), the overt patterns of IPD and CPD are not associated with difficulties at the level of input speech processing (Chapter 1). However, it is possible that inconsistency arises from different sources, so that children with IPD may not form a single group in terms of their underlying difficulties. It is possible that the children with IPD who have co-occurring sentence-level difficulties have subtle input processing difficulties not picked up in input tasks previously used, in addition to their phonological planning difficulties (identified by

the number '4' on Figure 14.2). Support for this possibility stems from two areas of research: the phonological theory of SLI; and research into infant speech perception.

The phonological theory of SLI

The impact of difficulties with input phonology on sentence processing is put forward under the umbrella of the phonological theory of SLI. Disruptions in syntactic development have been ascribed to impairments in speech processing (Joanisse & Seidenberg, 1998), where children with SLI have been found to have subtle impairments in:

(i) speech perception (Elliot, Hammer, & Scholl, 1990; Joanisse & Seidenberg, 2003; Stark & Heinz, 1996; Tallal, 1990); or

(ii) phonological processing (Chiat, 2001), where they may have reduced access to the phonological details within rhythmic structures required for the establishment of lexical forms and syntactic structures. That is, "particular syllables and/or vowels at the core of those syllables and/or consonants which flank these vowels will be unavailable or unstable in the child's perception, storage and/or retrieval of rhythmic chunks" (Chiat, 2001, p.124).

Hence, it may be that some children with IPD have input-processing difficulties that are affecting both their phonological and sentence processing, whereas their phonological planning difficulties seem to account for only some of their content-word production, as discussed above in Section 14.7. To verify or disprove this possibility, the single-word input-processing abilities of IPD children would need to be thoroughly and systematically investigated. For example, it would be predicted that low-scoring children with IPD, like AA and RG, would have difficulties on a word judgement task with relatively fine variations, compared with high-scoring IPD children. If correct, it would turn the question of why children with IPD are more at risk of having sentence-level difficulties, into why they are more at risk of speech input-processing problems.

Infant speech perception

There is an increasing emphasis on researching the link between infant speech perception and later language acquisition (Werker & Curtin, 2005). Over and above

the ability to discriminate phonetic differences, recent findings on infant sensitivities reveal that infants pay attention to contextual effects such as the speaker's rate (Eimas & Miller, 1992), co-articulatory cues (Curtin, Mintz, & Byrd, 2001) and stress (Johnson & Juscyk, 2001)(all cited in Werker & Curtin, 2005). Furthermore, infants learn to use different discriminatory features at different stages of their linguistic development (Werker & Curtin, 2005). The extent to which the acquisition of these early skills impacts upon later sentence processing is yet to be determined. Nonetheless, consideration of these recent findings on infant speech perception broadens our perspective on the possible origins of difficulties in children with SLI and maybe some children with IPD who have sentence level difficulties.

14.7.4 SUMMARY

This section has outlined how the higher probability of IPD co-occurring with sentence-level difficulties cannot be explained by overt characteristics of the speech disorder, nor current analyses of underlying difficulties associated with IPD and CPD. Two alternative possibilities have been raised: firstly, that the location of IPD's phonological planning difficulties within a connectionist sentence-processing model makes it susceptible to being influenced by, and influencing, the processing of syntax, and secondly, that some children with IPD have single-word input processing difficulties as well as difficulties with output processing. The two possibilities are not mutually exclusive.

14.8 CLINICAL IMPLICATIONS

The outcomes of this thesis have a number of significant clinical implications.

14.8.1 SENTENCE IMITATION TASK

The limitations associated with evaluating a child's expressive abilities solely on the basis of his/her performance on a sentence repetition task are acknowledged. Nevertheless, the Sentence Imitation Task proved extremely successful in the investigations carried out in this thesis. The nature of this success is demonstrated by the following outcomes.

Sentence Imitation Task as an effective tool for eliciting sentence output

It was noted that all children assessed, apart from two children who were suspected of having Dyspraxia (whose data were subsequently withdrawn from the study), attempted to imitate all the sentences on the Sentence Imitation Task. As discussed in Chapter 3, Section 3.5, children with speech difficulties may refuse to attempt speech production or avoid the production of words that contain phonemes they find difficult. In order to minimise this possibility, phonological variables (including word length, phonological structure and range) and phonological forms were controlled (Chapter 5, Section 5.8.1). It may be that controlling the phonological variables achieved the desired objective of generating a representative sample of sentence output where targets were clear.

Sentence Imitation Task as an effective tool in discriminating between children with and without difficulties

The Sentence Imitation Task proved effective in tapping important sentence-processing abilities, as evidenced by its discrimination between children known to have difficulties and those with intact sentence processing: in both the group study carried out in Phase 1 and the single-case studies carried out in Phase 2, children with SLI, who are known to have expressive language problems, experienced difficulties on the Sentence Imitation Task. Conversely, children with typical development obtained scores at ceiling on this task in both Phase 1 (n=33) and Phase 2 (n=34) of the investigations.

The discriminating power of the Sentence Imitation Task was also evidenced by its differentiation of the two groups of children with speech disorders, CPD and IPD, from each other and from children with typical development. Furthermore, it discriminated the skills of children within the IPD group: the Sentence Imitation Task yielded the same results regarding heterogeneity in children with IPD in both Phase 1 and Phase 2 of the investigations. In each phase, the IPD group was divided into those who were impaired on sentence imitation (Phase 1: six out of 14 children, Phase 2: three out of five children) and those whose sentence imitation was comparable with that of typically developing children (Phase 1: eight out of 14 children, Phase 2: two out of five children). Given the results relating to typically developing children and

those with SLI, it is unlikely that the differences revealed in relation to children with CPD and IPD are random. This, together with the fact that the different overt profiles are discriminated, suggests that the Sentence Imitation Task is informative about these children's sentence processing.

Sentence Imitation Task as a tool for revealing sentence-processing skills in relation to other tasks

In all cases, children with IPD or SLI who obtained low scores on the Sentence Imitation Task experienced difficulties on other tasks assessing their sentence processing skills, namely the Sentence Judgement, Sentence Completion and SIVL Tasks. This represents the most specific evidence that sentence imitation taps sentence processing abilities.

14.8.2 SENTENCE PROCESSING-RELATED TASKS

As discussed in Chapter 1, there are various psycholinguistic tasks designed to assess input and output processing at the single-word level. Until now, the same types of tasks have not been available to assess input and output processing at the sentence level. Use of the Sentence Judgement, Sentence Completion and SIVL Tasks developed for this thesis can inform SLTs of the level of deficit in language processing. Using these tasks in conjunction with single-word speech-processing assessments allows for a more accurate identification of the underlying deficits in children. In this way, problems with speech processing in single words and difficulties with sentence processing can be accurately diagnosed, and interventions targeting the different affected areas may be tailored to a child's specific difficulties. This will prevent a child with co-occurring difficulties being categorised as either SLI or speech-disordered, with only their most readily observed difficulty being treated.

14.8.3 ERROR ANALYSIS ON SENTENCE IMITATION AS A TOOL FOR DIFFERENTIAL DIAGNOSIS

Findings in this study showed that certain overt error patterns on sentence imitation were associated with certain underlying difficulties. These findings can be used in facilitating the accurate diagnosis of underlying difficulties that require intervention.

The underlying difficulties that were found to be associated with different overt error patterns of production are outlined in Table 14.3.

Table 14.3 Overt error patterns associated with underlying difficulties

Errors on sentence imitation	Underlying difficulty
• Errors relate to difficulty with individual phonemes. • Inflections affected the most.	Single-word speech-processing only: CPD or IPD[10]
• Errors consist largely of omissions of morphemes with some whole-word substitution from the same and different grammatical categories.	Sentence-processing difficulties only
• Errors consist of a combination of whole-word sound substitutions, unmatched syllables, omissions, distortions, some whole-word sound substitutions from the same or different grammatical categories. • Some difficulty in maintaining the number of syllables in multi-syllabic words.	Both speech-processing difficulties in single words and sentence-processing difficulties

Consideration of the associations depicted in Table 14.3 highlights the potential informativeness of the Sentence Imitation Task even when used in isolation. In practice, it would of course be important to complement this task with assessments at the single-word level where there are indications of problems, and possibly other sentence-level tasks. But sentence imitation is quick to administer and easy to score, and patterns of response can provide strong indications of underlying difficulties.

14.9 LIMITATIONS OF THE STUDY

Some methodological limitations of this research are identified and discussed in this section.

14.9.1 RECALL TASK

A purposefully constructed recall task was used to assess the phonological working memory abilities of the children who participated in Phase 2 of the research. Unlike the results obtained on the other purposefully constructed tasks, the results of this task did not discriminate between individuals with IPD or SLI and children with typical development. While it's possible that children with these difficulties do not have

[10] Crediting children with IPD for the production of a morpheme can be more difficult as their productions are not consistent and may be too far from the target to be recognised.

difficulties with phonological working memory, this is unlikely given previous research findings (Gathercole & Baddeley, 1990; Montgomery, 1995, 2002).

A possible reason for these findings is the method used to score the children's responses. In achieving the objective of determining the digit and word span of each child, a child was credited for the correct repetition of an entire sequence of digits or words heard, and her/his level of ability was taken to be the highest level at which s/he was able to repeat two out of three sequences. Investigations in Phase 2 found the range of the TD2 group to be between three and five words for both digit and word span. Given this narrow range, only those children with digit and word recall spans below three could be differentiated from typically developing children. Consequently, the single-case studies carried out in Phase 2 revealed that all the children with IPD or SLI, apart from two, were found to have digit and word recall within the lower limits of the TD2 group range.

While this method of scoring has been used in previous research comparing groups of typically developing children of pre-school age (Adams & Gathercole, 1995; Gathercole, 1995), an alternative method of scoring could have been employed that may have differentiated the children more successfully. By crediting a child with the repetition of each digit or real word within a sequence, a wider range of scores would be obtained, which might result in greater discrimination between children with different abilities.

14.9.2 EXCLUSION OF CHILDREN WITH CPD FROM PHASE 2

Phase 1 of the research included 14 children with CPD who generally obtained high scores on the Sentence Imitation Task. Due to this good performance, as well as the relative homogeneity of the group, the sentence processing- related abilities of children with CPD were not investigated in Phase 2. However, as the scores of the children in this group – particularly for function words and inflections – were not quite at ceiling, it would have been worthwhile to administer the purposefully constructed tasks of Phase 2 to these children.

Administration of the SIVL Task in Phase 2 yielded interesting results when sentence-level difficulties were found to co-occur with IPD. Specifically, while increasing the output load at the sentence level had similar effects on the performance of all the participants, increasing the content-word syllable load affected the production of both content and function words in IPD children with co-occurring sentence-level difficulties, while only the function-word imitation of SLI children was affected, and only for the group as a whole. It would be interesting to determine whether similar outcomes would result from administering this task to children with co-occurring CPD and sentence-level difficulties. As results in Phase 1 indicated a low incidence of CPD and co-occurring language difficulties, recruiting children with this type of profile would have been challenging. As children with this type of profile were not recruited for Phase 2, discussions regarding the interaction between speech disorders and sentence production when sentence-level difficulties co-occur with a speech disorder, are limited to children with IPD only.

14.9.3 THE MANIPULATION OF COMPLEXITY ON THE SENTENCE IMITATION TASK

The results from Phase 1 showed that the performance of the participants was not affected by the manipulation of syntactic complexity on the Sentence Imitation Task. This is in contrast to previous research, where sentence processing was found to be sensitive to sentence structure (Kamhi et al., 1984; Saffran & Martin, 1975; Willis & Gathercole, 2001). Alternatively, it could be that complexity only has an effect in longer sentences. In order to obtain more accurate evidence of the effect of the complexity of utterances on sentence imitation performance, a comparison of performance on simple and complex sentences of variable length is required.

14.10 FUTURE RESEARCH

The findings reported in this thesis yielded a number of issues and questions that require further investigation.

14.10.1 SINGLE-WORD PROCESSING AND SENTENCE PRODUCTION

This research has established that there is a relationship between speech disorders in single words and sentence production. Based on the findings of the investigations, proposals have been put forward regarding the nature of this relationship. However, these proposals are limited by current gaps in research.

Firstly, there are no comprehensive models of sentence processing in either the developmental or adult literature. While the research related to adult sentence production is more advanced, the current models used are mainly based on single-word research.

Secondly, while there have been evidence-based claims regarding where different problems arise in single-word processing, more research is required, especially with regard to how these proposed levels of deficit map onto levels of sentence processing.

Thirdly, this thesis raised the possibility that some children with IPD have deficits at more than one level of speech processing. In order to explore this possibility, single-word input-processing abilities of high- and low-scoring children with IPD would need to be thoroughly and systematically investigated. This would form part of an in-depth investigation of how single-word input and output processing relate to sentence profiles, with implications for mapping single-word models onto sentence models.

14.10.2 SYLLABLE INTEGRITY IN UTTERANCES

One of the outcomes of administering the SIVL Task was the identification of a trend in the sentence imitation production of children with co-occurring IPD and sentence-level difficulties: they reduced a proportion of the multi-syllabic words contained in the target utterances. This loss of syllable integrity in utterances with multi-syllabic content words might be viewed as a clinical marker for phonological planning difficulties in children with co-occurring speech and language difficulties. However, as the data in this research is limited, further research is required to verify this

possibility. In addition, it would be useful to compare the responses of these children to children with CPD and co-occurring sentence-level difficulties.

14.10.3 REPLICATION

The interpretation of results in this thesis is based on small participant numbers. As this research has significant theoretical and clinical implications, the need for replicating the studies with larger numbers of participants is emphasised. This is important to:

(i) replicate the findings relating to co-occurrence, and the relationship between sentence imitation and performance on sentence processing-related tasks.

(ii) verify identified trends, for example the effect of content-word syllable load increase on content word production in children with co-occurring single-word and sentence-level difficulties.

14.10.4 STANDARDISATION OF MEASURES

It would be useful to standardise the Sentence Imitation Task and the purposefully constructed sentence processing-related tasks (apart from the Recall Task). Including large numbers of children with speech difficulties or SLI, in addition to the standardisation sample of typically developing children, would make the tasks more informative assessment tools with children who are suspected of having difficulties with sentence production.

14.10.5 INTERVENTION

The results of this thesis raised the possibility that some content-word errors of children with co-occurring IPD and sentence-level difficulties are due to their single-word speech-processing difficulties rather than their sentence-processing difficulties. Intervention studies would verify this possibility by exploring the most efficient protocol for intervention. Is it more efficient to treat these children's difficulties from a single-word speech perspective first and only then focus on their sentence-level difficulties? Alternatively, if speech disorders and language develop independently, would it be more efficient to treat both the single-word and sentence-level difficulties

simultaneously? The final option would be to treat the sentence-level difficulties before the single-word speech difficulties. The outcomes of these studies would provide insight into how intervention at the single-word level does or does not affect the sentence level and vice versa, providing further evidence relevant to theories of the relationship between these two domains.

14.11 GENERAL SUMMARY AND CONCLUSIONS

The most significant findings of this thesis in relation to the key questions posed are:

Can children with different types of speech disorders be differentiated according to their sentence-level performance?

- As a group, children with IPD performed less well on sentence imitation than children with CPD.
- Children with IPD were more heterogeneous with regard to their sentence-level abilities than children with CPD.

Is there a more-than-chance co-occurrence of sentence-level difficulties in children with different types of speech disorders?

- Overall, this research found that just under one-third of children with speech disorders had co-occurring sentence level difficulties (9 out of 33).
- Children with CPD were no more at risk of having co-occurring sentence-level difficulties than children without speech disorders.
- Children with IPD were at a higher risk of having co-occurring sentence processing difficulties than children with CPD (47% co-occurrence rate).

What is the relationship between speech disorders and sentence production?

- Speech difficulties occurring in isolation affected intelligibility and were most evident in the production of inflections and least apparent in the production of content words.
- Significant sentence-level difficulties could not be accounted for by the classification or the severity of a speech disorder.

- Children with IPD who had significant sentence imitation difficulties exhibited sentence processing-related difficulties comparable with those of children with SLI.
- The sentence imitation abilities of children with co-occurring IPD and sentence-level difficulties could be distinguished from children with SLI only by the types and proportions of their sentence-level errors.
- When IPD and sentence-level difficulties co-occurred, a unique effect of IPD was evident in the production of content words in sentences containing multi-syllabic words.
- There was some, though limited, evidence for a dissociation between speech and language development.

Is sentence imitation an efficient, effective and reliable method of assessing expressive syntax in children with severe speech difficulties?

- Sentence imitation proved an effective method of assessing the expressive syntactic abilities of typically developing children and children with speech or expressive language difficulties;
- Sentence imitation performance may be used to distinguish children with speech-only difficulties from those with co-occurring sentence difficulties.

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APPENDIX 1

SENTENCE IMITATION TASK STIMULI

1. Sammy fell.
2. They go.
3. Look here.
4. Come down.
5. Show him.
6. Sally goes.
7. Big shoes.
8. Go inside.
9. The park.
10. At home.
11. Where is teddy?
12. Push him out.
13. Babies won't eat.
14. Pull it out.
15. Daddy poured water.
16. Daddy can cook.
17. Get the toys.
18. Bobby is naughty.
19. Mummy was eating.
20. On his bed.
21. Put on your coat.
22. His room is tiny.
23. What is Peter doing?
24. Take the food out.
25. Are the boys hiding?
26. Don't feed the horses.
27. This hat was mine.
28. Does a dog bite?
29. Tim goes in the house.
30. Can you sit on it?
31. We have cake at parties.
32. The bears will eat honey.
33. Mummy was giving Peter cake.
34. The cat ate a big mouse.
35. The water made her shoes dirty.
36. A cat was under the bus.
37. You can wash your face now.
38. I want to eat some food.
39. She can see the moon at night.
40. I give the bottle to the baby.
41. The boy hit a ball to me.
42. There are red houses in my book.
43. Sammy saw his toy in the shop.
44. He will go to big school on Monday.
45. We can't see if the shop is open.
46. Debbie gave a dummy to her new baby.
47. I like eating meat and peas for dinner.
48. The funny man put a dot on his nose.
49. The bird sat on her egg in the nest.
50. The girl won't see me in the dark room.
51. Daddy was reading his new book in our garden.
52. I know that you can sing.
53. He is the boy who fell.
54. I found the toy that I lost.
55. The people in the boat caught fish.
56. Tim saw the lady with the baby.
57. We can't see if the shop is open.
58. There is the man who paid for us.
59. The apple was eaten by the little bird.
60. I want you to kick the ball to me.
61. If we are good, Mummy will give us cake.

APPENDIX 2

SENTENCE JUDGEMENT TASK STIMULI

Trial pairs with function words substituted

1.	The ducks /hə/ swimming.	The ducks were swimming.
2.	Granny /hə/ swim.	Granny can't swim.
3.	The puppies are /hə/ the basket.	The puppies are in the basket.
4.	The boys /tu/ standing.	The boys are standing.
5.	She /pi/ sing.	She can sing.
6.	He read /pi/ book.	He read his book.
7.	Mummy found /pi/ bag.	Mummy found her bag.
8.	Bobby /hə/ naughty.	Bobby is naughty.
9.	Throw the ball /pi/ Billy.	Throw the ball to Billy.
10.	The puppy /hə/ jumping.	The puppy was jumping.
11.	The people /pə/ noisy.	The people are noisy.
12.	The girl's /həhə/ her mother.	The girl's next to her mother.
13.	Go /hə/ bed.	Go to bed.
14.	The baby /nɒt/ walk.	The baby won't walk.
15.	Mummy drives /pi/ car.	Mummy drives a car.
16.	The food's /hə/ the table.	The food's on the table.
17.	The baby /hə/ crying.	The baby is crying.
18.	Mummy looks /hə/ her keys.	Mummy looks for her keys.
19.	Look /hə/ me.	Look at me.
20.	The apple's /hə/ the tree.	The apple's under the tree.

Trial pairs with function words omitted

21.	The ball's the table.	The ball's under the table.
22.	The dog bite.	The dog can bite.
23.	The mice running.	The mice are running.
24.	The children laughing.	The children were laughing.
25.	Go the zoo.	Go to the zoo.
26.	Daddy ate carrot.	Daddy ate the carrot.
27.	Sally loves doll.	Sally loves her doll.
28.	The men happy.	The men are happy.
29.	The cat black.	The cat is black.
30.	Sing your Dad.	Sing to your Dad.
31.	Johnny lost toy.	Johnny lost his toy.
32.	Look the sky.	Look at the sky.
33.	The glass full.	The glass was full.
34.	He go.	He will go.
35.	The blanket's the bed.	The blanket's on the bed.
36.	The dog barking.	The dog is barking.
37.	The chair's the table.	The chair's next to the table.
38.	The children are the bus.	The children are in the bus.
39.	He looks his glasses.	He looks for his glasses.
40.	The baby walk.	The baby can't walk.

APPENDIX 3

RECALL TASK STIMULI

DIGIT STIMULI

Span	Digits
2	4 1
	2 8
	10 4
3	8 2 1
	9 10 4
	4 2 1
4	1 8 2 9
	10 4 8 2
	9 1 10 4
5	8 9 1 10 2
	4 10 2 1 9
	1 4 9 8 10

REAL-WORD STIMULI

Span	Words
2	car book
	pig arm
	cake hat
3	egg bird knee
	cup feet bird
	cow bus nose
4	car knee bird hat
	book pig hat cake
	bird car knee egg
5	pig arm feet cup book
	hat nose cake dog bus
	knee cow book egg cake

APPENDIX 4

SENTENCE COMPLETION TASK STIMULI

1	The boy is climbing	The girls are singing	The boys *are* swimming	The girl *is* running
2	She drank the water	He licked the ice-cream	He ate *a/the* carrot	
3	He is small	They are big	He *is* happy	They *are* sad
4	The ball is on the table	The ball is next to the TV	The ball is *in* the box	The ball is *under* the chair
5	He won't get wet	He get will wet	He *will* get dirty	He *won't* get dirty
6	We can eat chocolate	We can't eat bees	We *can* eat cake	We *can't* eat shoes
7	She tidies the toys	He wants a plane	He drives *a/the* car	
8	The pen is in his pocket	The pen is next to the paper	The pen is *on* the bed	
9	We sleep at home	We travel in a car	We learn *at* school	
10	Give the block to her	Give the book to him	Give the pen to *him*	Give the milk to *her*
11	He is looking at the boy	He is looking for his shoe	He is looking *at* the TV	He is looking *for* his ball
12	Go to the shop	Stop at the light	Go *to* the park	
13	The boys drink their juice	The girl washes her face	The boys put on *their* shirts	
14	He paints a picture for his Dad	He goes to the park with his dog	He paints a picture *for* his Mum	
15	We won't go to the shop if it is closed	We will go to the zoo if it is open	We won't go to the park *if* it is raining	
16	Hit the ball to the girl	Take the ball from the dog	Throw the ball *to* the boy	
17	The girl dries her face	The boy washes his hair	The lady combs *her* hair	The boy washes *his* face

APPENDIX 5

SENTENCE IMITATION WITH VARIABLE WORD LOAD (SIVL) TASK STIMULI

Sentence length	Content-word syllable load condition	
	Simple	**Loaded**
4 words	Tom is my Dad.	Samantha is my sister.
	Be good at home.	Be happy on holiday.
	Give me soap now.	Take your medicine tomorrow.
5 words	Tim made the shark white.	Simon coloured the kangaroo purple.
	Sam will guess the name.	Jonathan will remember the number.
	Dad bought a red toy.	Mummy saw a yellow balloon.
6 words	Our game will make a noise.	Our video can record the movie.
	A bear can shut the door.	A monkey can open the window.
	The goat will eat the key.	The alligator will eat the camera.
7 words	The dog can't go in the house.	The elephant cannot walk in the garden.
	Kim came out to kiss the boy.	Mummy went inside to cuddle the baby.
	The man took Tom to the door.	The lady carried Simon to the computer.
8 words	Dan will wake his Mum in the night.	Amanda will finish her pancake in the morning.
	He hasn't got his loud bear at home.	He hasn't forgotten his noisy dinosaur at home.
	The man wrote a note with a pen.	The teacher copied the letter with a pencil.

APPENDIX 6

COMBINED CONTENT- AND FUNCTION-WORD ERROR ANALYSIS FOR SLI PARTICIPANTS: SIMPLE VERSUS LOADED CONDITIONS

Participant CL

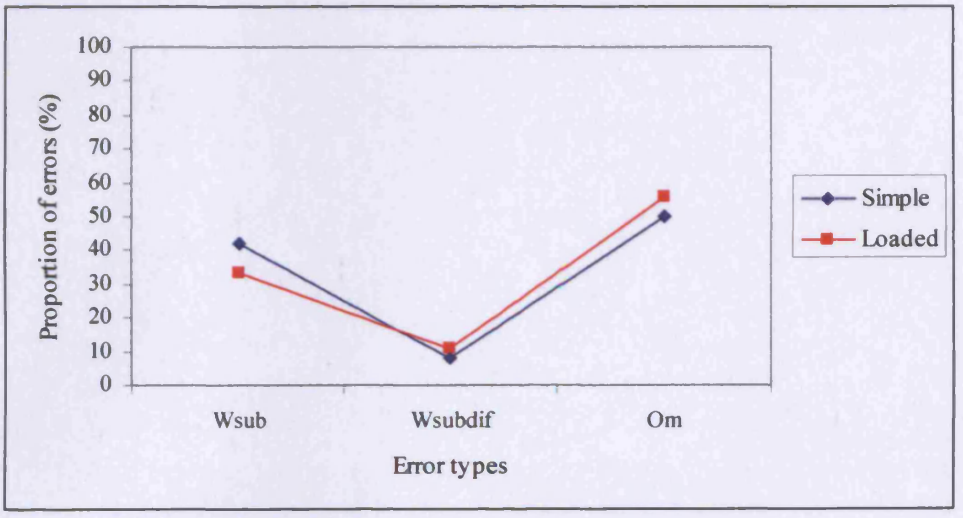

Figure A6.1 Combined content and function word analysis: simple versus loaded conditions: CL

Participant CM

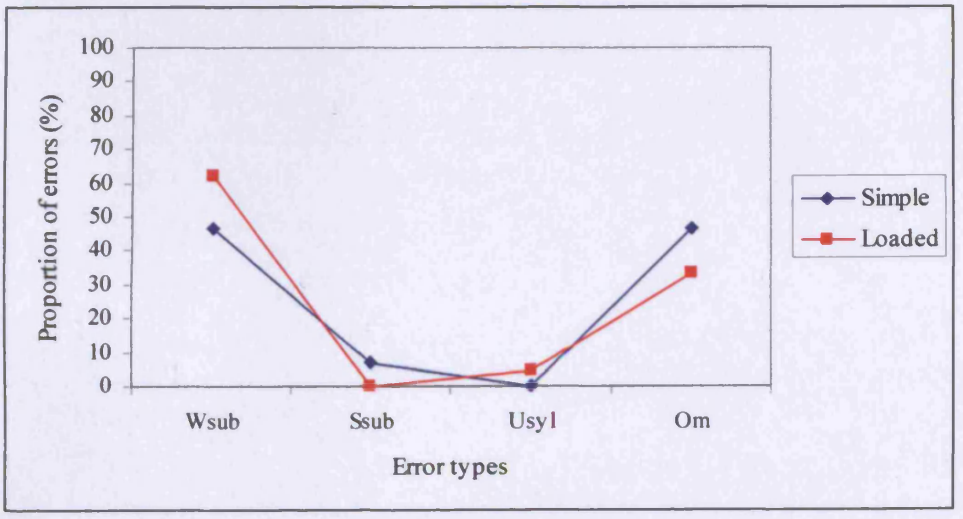

Figure A6.2 Combined content and function word analysis: simple versus loaded conditions: CM

Participant CH

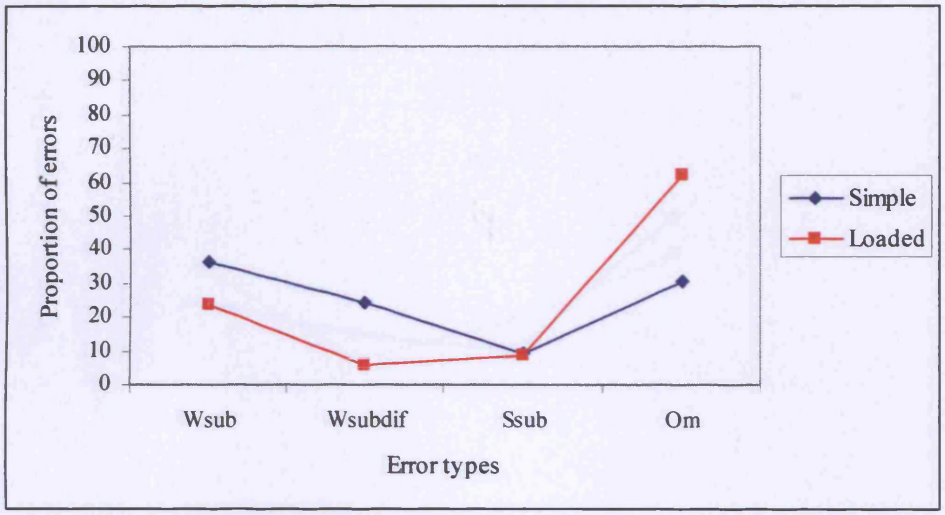

Figure A6.3 Combined content and function word analysis: simple versus loaded conditions: CH

Participant KA

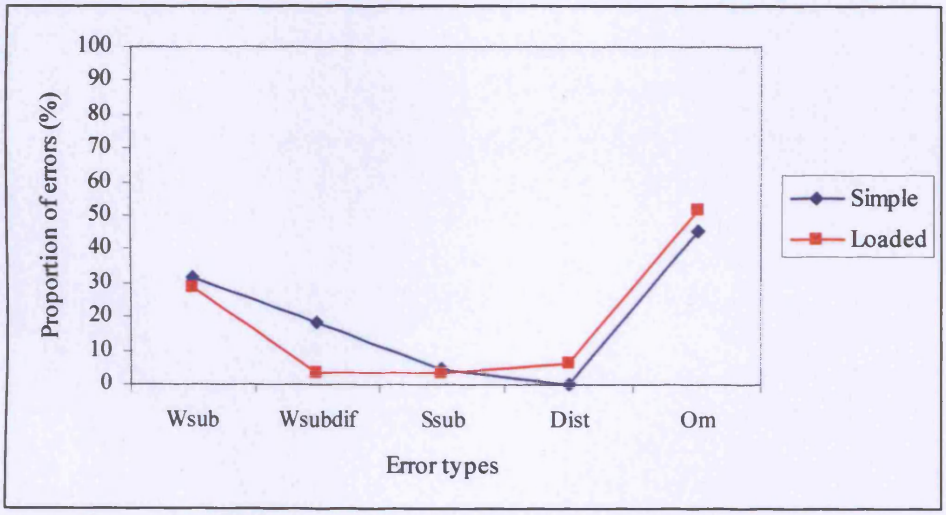

Figure A6.4 Combined content and function word analysis: simple versus loaded conditions: KA

Participant CK

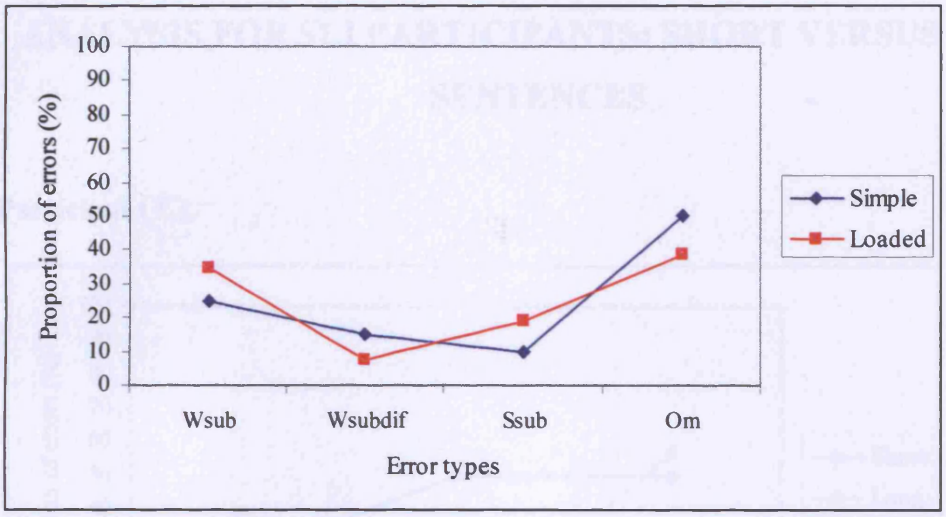

Figure A6.5 Combined content and function word analysis: simple versus loaded conditions: CK

APPENDIX 7

COMBINED CONTENT- AND FUNCTION-WORD ERROR ANALYSIS FOR SLI PARTICIPANTS: SHORT VERSUS LONG SENTENCES

Participant CL

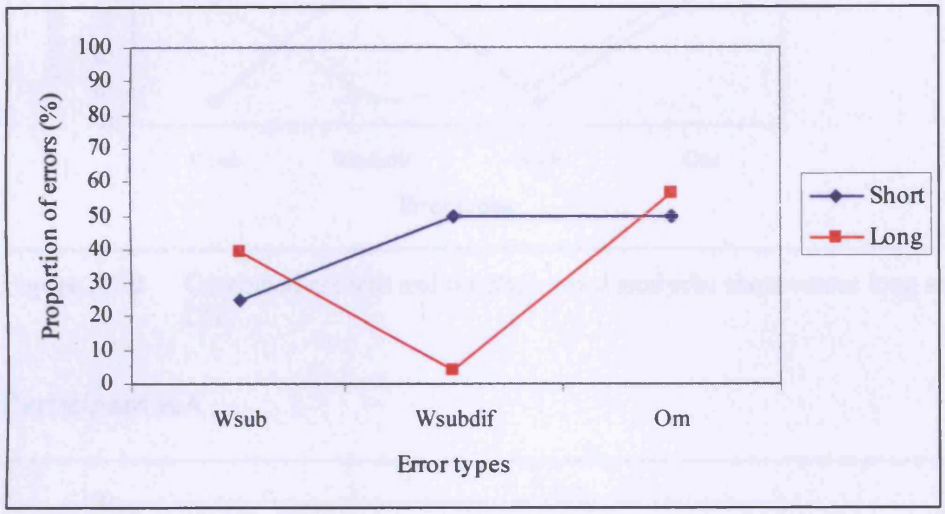

Figure A7.1 Combined content and function word analysis: short versus long sentences: CL

Participant CM

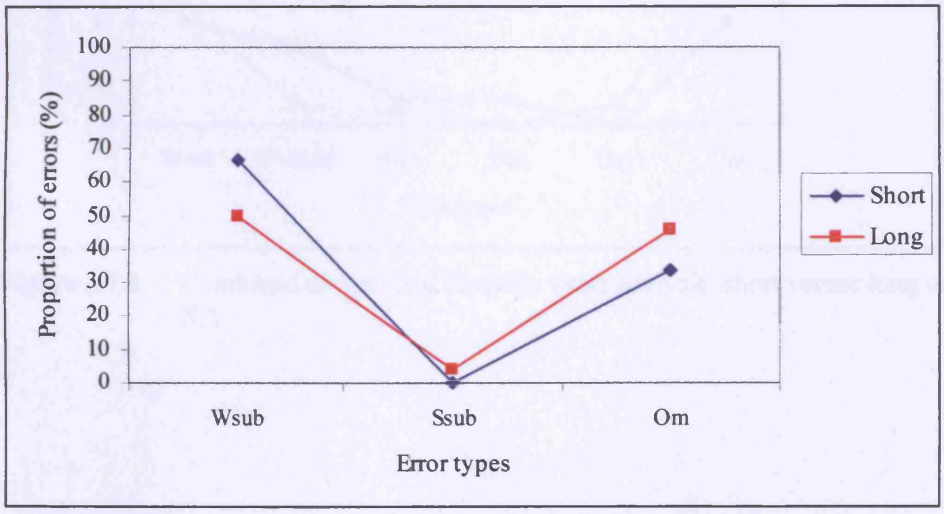

Figure A7.2 Combined content and function word analysis: short versus long sentences: CM

Participant CH

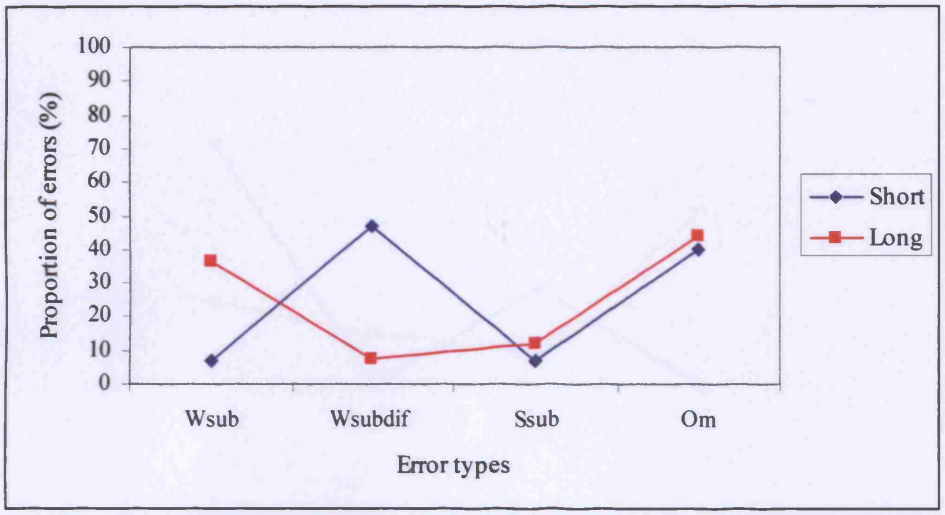

Figure A7.3 Combined content and function word analysis: short versus long sentences: CH

Participant KA

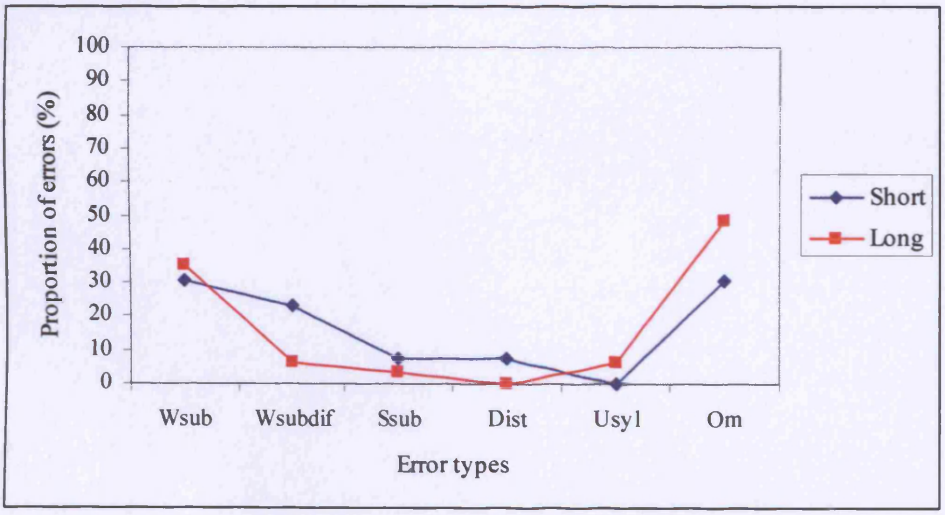

Figure A7.4 Combined content and function word analysis: short versus long sentences: KA

Participant CK

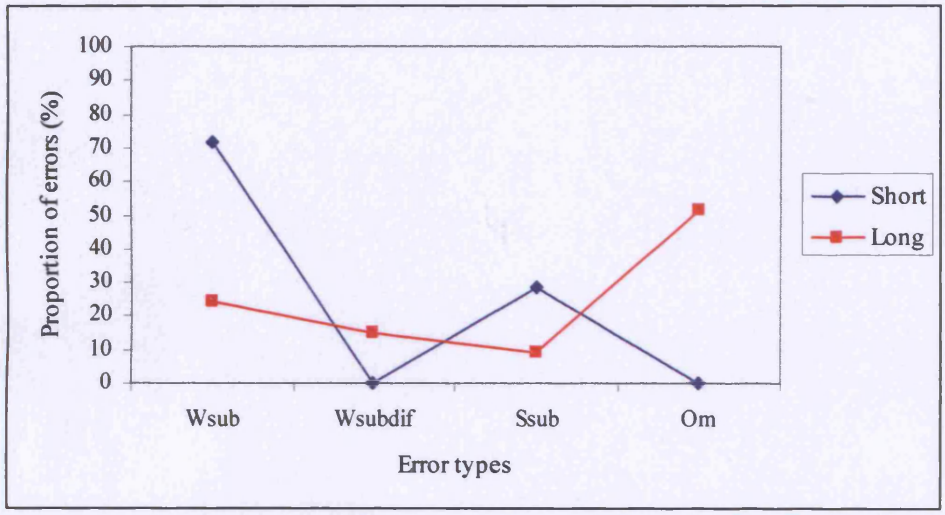

Figure A7.5 Combined content and function word analysis: short versus long sentences: CK