THE ACQUISITION OF PHONOLOGY AND THE CLASSIFICATION OF SPEECH DISORDERS IN GERMAN-SPEAKING CHILDREN

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DECLARATION OF ORIGINALITY

The material presented in this thesis is the original work of the candidate except as otherwise acknowledged. It has not been submitted previously in part or whole, for any award, at any university, at any time.

Annette V. Fox

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ABSTRACT

Phonological acquisition has been a major research topic for the past three decades. Several different theoretical concepts, accounting for the course of phonological acquisition, have emerged. While all these theories agree the need to explain language-specific differences during the course of development, they all also strongly argue for a universal pattern. This thesis aims to provide evidence for phonological theory in a cross-linguistic context by examining monolingual children acquiring German as their native language. A cross-sectional study of 177 normally developing children aged 1;6 to 5;11 was found to generally support the concept of universality but also showed significant acquisition differences especially in comparison with English, a closely related language. It will be argued that to date only the concept of *phonological saliency* (So & Dodd, 1994; Zua Hua & Dodd, 2000) is able to fully explain language-specific findings.

However, evidence for phonological theory cannot only be validated by using data from developmental cross-linguistic studies but also from data describing phonologically disordered children. The nature of the errors made and also the children's developmental history might provide information concerning the prerequisites for normal speech development and the cognitive processes involved in speech perception and production.

Furthermore, based on the concept of universality, cross-linguistic comparison of developmental speech disorders of unknown origin should also reveal a universal pattern, according to the assumption that the underlying deficits of speech disorders are language independent. A study of 100 German-speaking children, referred because of suspected speech disorders, evaluated two current classification systems for developmental speech disorders (Dodd, 1995 and Shriberg, 1993, 1994) from a theoretical and a clinical point of view. Findings supported the hypothesis of

universality in children with speech disorders. Moreover, results showed that only the psycholinguistic system by Dodd (1995) was applicable to German-speaking children. Risk factors, as suggested by the etiological model by Shriberg (e.g. 1993), did not allow the classification of the same group of children into his proposed subgroups. Even though certain risk factors proved to significantly distinguish normally developing from speech-disordered children, none of the risk factors was found inevitably to result in speech disorders.

Theoretical concepts can also be tested by means of intervention studies of children with speech disorders. Current classification systems divide developmental speech disorders into different subgroups according to their underlying deficits. The validity of the classification systems can be examined by cross-linguistic outcome investigations of children with speech disorders and their response to different intervention approaches. Findings from three descriptive intervention studies showed that German-speaking children benefited from intervention approaches that were designed for English-speaking children if these approaches were applied according to the hypothesised underlying deficits.

This thesis will argue that developmental speech disorders of unknown origin follow a language-independent course that is constrained by a universal pattern. On the basis of normative data for any language investigated, it should be possible to detect universal subgroups of speech disorders across languages. The clinical implication of this conclusion is that therapy techniques can be applied cross-linguistically.

PUBLICATIONS ARISING FROM THIS THESIS

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INTRODUCTION

By the time most children are six years old, they can communicate their wants and needs making few, if any, errors of pronunciation. Irrespective of the language being learned, the same language-learning milestones are observed. Infants start babbling at roughly the same age and their babbling patterns are initially similar (Locke, 1983). Differences between children learning different languages emerge towards the end of the first year in terms of babbled syllable structure and preferred speech sounds (Levitt & Aydelott Utman, 1992). Once words begin to be used their error patterns rarely break the phonological constraints of the language being acquired. Children do this, it seems, effortlessly.

Phonological development has been a major research area for phoneticians, phonologists, speech and language therapists and psychologists during the past 30 years. Specifically, linguists have been searching for the 'origins of language': "when 'something' (a linguistic system) seems to arise out of 'nothing' (pre-linguistic resources which may or may not bear some relation to the system which appears later)" (Vihman, 1993, p.1). Among the issues raised were:

- The necessary prerequisites for speech development to emerge e.g. genetic codes, perceptual and production abilities, cognitive-learning abilities, intact anatomy, the influence of babbling on later speech acquisition.
- To what extent phonological development is a universal, language-independent process.
- The degree of influence of the ambient language learned.

Starting with Jakobson's claim for an existing universal system of phonemic acquisition, which he presented in "Child Language Aphasia and Phonological Universals" (1941, 1969), subsequent researchers (e.g. Chomsky & Halle, 1968; Stampe, 1979; Olmsted, 1966; Locke, 1983; Handford-Bernhardt & Sternberger,

1998; Vihman, 1993) have sought to provide an explanatory account of speech acquisition that serves all languages.

Until now, however, the majority of studies have focused on the acquisition of English as the first language (e.g. Smith, 1973, Prather et al, 1975, Ingram 1981, Stoel-Gammon & Dunn 1985, Grunwell, 1987). Only more recent studies have investigated the speech development of children acquiring other languages (e.g. Xhosa (Mowrer & Burger, 1991), Cantonese (So & Dodd, 1994), Putonghua (Zhu Hua & Dodd, 2000a), Spanish (Goldstein & Iglesias, 1996)). These studies had two aims: 1) to determine the order and rate of acquisition of phonetic and phonemic inventories of different languages and to describe the developmental error patterns used and 2) to compare the new data with data derived from studies of other languages. While research indicates many similarities in acquisition patterns across languages, there are also some highly significant language-specific patterns of development.

This recent focus on cross-linguistic studies (Slobin, 1985, 1992, 1995, 1997 and the findings from the studies just mentioned) has led to the emergence of a new research field. The conclusions to be drawn concern the validity of existing theories about the universality of speech development across languages. If, as Ingram (1991) proposed, the phonological system being learned influences the type of errors made by children, the individual systems of the different languages deserve research attention. Since, to date, little information on languages other than English has been reported, further research on unexplored languages seems worthwhile.

In contrast to linguists' focus on theoretical accounts of speech acquisition data, speech and language therapists have been concerned with those children who do not follow the normal developmental pattern of speech acquisition. An estimated 3-10% of children differ from the norm in their phonological development (National Institute on Deafness and other Communication Disorders, 1994; Gierut, 1998; Shriberg,

Tomblin & McSweeny, 1999). The pronunciation of these children does not reflect how children typically acquire speech in terms of rate or order of acquisition or the types of substitutions and omissions of speech sounds made (Dodd, 1995). Speech and language therapists have compared the disordered phonology of these children with that of normally developing children. They have described surface error patterns, devised models to identify possible underlying deficits, proposed classification systems and evaluated treatment approaches.

However, phonological theory and clinical data need to go hand in hand. Phonological theory can not only be validated by using data from developmental cross-linguistic studies; it can also be validated by using data describing phonologically-disordered children. Firstly, the nature of the errors made and the developmental histories of speech-disordered children might provide information concerning the prerequisites for normal development and clarification of the mental processes involved in speech perception and production. Secondly, if the concept of universality holds, cross-linguistic comparison of reports on developmental speech disorders of unknown origin should also reveal a universal pattern. It seems unlikely that the cause of speech disorders lies in the ambient language to be acquired. This could only be the case if one language were more difficult than another, something that should become apparent in very different acquisition patterns for individual languages and which has never yet been described. A breakdown caused by developmental, medical or cognitive factors seems a more likely explanation. Such factors are language-independent. This thesis explores both developmental acquisition and the study of its disorders in German-speaking children.

There are a number of reasons why phonological acquisition and disorders in German-speaking children are worthy of study:

- German is spoken by 121 million people and is therefore one of the world's ten most frequent languages (Crystal, 1997). Therefore, research findings concerning

the speech-disordered population will have implications for a large number of people.

- Research into German provides information about a second West-Germanic language which makes findings highly comparable to those derived from English, the most frequently investigated language. Since both languages are highly similar in their structure, findings about German could support theoretical issues derived from research into English.
- There is a dearth of research into German speech and language either from the developmental or disordered point of view. In the wide field of possible researchers we find some activity in the early days of the 20th century (Ament, 1899; Stern & Stern, 1928; Hoyer & Hoyer, 1924; Möhring, 1938; Jakobson, 1941) but it was only recently that new research started to appear. Until now, however, linguists, have focused mainly on aspects of language other than phonetics or phonology.
- Both groups of speech and language therapists (Logopedics and Sprachheilpädagogists) in Germany have had only little opportunity for research concerning children with speech disorders. Speech therapy in Germany is therefore mainly based on two sources: knowledge based on clinical experience and translations of the Anglo-American literature. In general no crosschecks have been made to ensure that findings from English are applicable to German. Even though phonology is a strongly investigated and clinically applied field in the Anglo-American literature and countries, this is not the case in Germany. Due to the lack of research into German, phonology is only slowly finding its way into clinical practice.
- Developmental speech disorders of unknown origin have received little research attention in any language other than English. A thorough investigation of a different language, e.g. German, would provide information about whether the universal pattern described for speech development can also be found in speech

disorders and also whether findings about one language are applicable to other languages.

- Research providing precise information about the deficits of children with speech disorders, their intervention requirements and their outcome is of great clinical, social and economic interest. This thesis aims to add to the existing knowledge in order to increase treatment efficacy. Short and effective intervention programs are for the benefit of the child, the parents and the economic resources of a country's health system.
- Finally, German was chosen as it is the author's first language.

This thesis is divided into three parts. Part I (Chapters 1 and 2) deals with the acquisition of phonology in normally developing German-speaking children. Chapter 1 provides a review of the theoretical background to phonological theories and information on the developmental data available. Chapter 2 reports normative data from a cross-sectional study on children aged 1;6 – 5;11. This age-range was chosen because it mirrors that of the majority of children referred to speech and language therapy.

The reasons for carrying out this study were that the normative data on German is still incomplete. Normative data were obtained:

1. To evaluate theoretical models of phonological development from German data (i.e. to assess whether existing theory can account for the similarities and differences found between phonological development in German and other languages).
2. To provide norms for the development of German phonology, in order to diagnose children with delayed and disordered speech development. Because of the language-specific differences described in cross-linguistic research so far, it has become evident that data from one language may only provide broad developmental guidelines for another language.

Part II aims to investigate the nature of speech disorders in children, using data from German-speaking children to evaluate current approaches to the classification and treatment of phonological disorders. While Chapter 3 presents a theoretical overview of terminology, classification and intervention of speech disorders in Germany and Anglo-American countries, Chapters 4 and 5 explore to what extent existing models and research can be confirmed by and applied to data on German-speaking children.

Chapter 6 in Part III gives a detailed description of different treatment approaches in one group study and two case studies.

The concluding Chapter draws together the information from the normative study, the disordered studies and from treatment studies to evaluate findings from a theoretical and cross-linguistic perspective but also in order to summarise the clinical implications of this thesis, its limitations and to provide suggestions for further research.

CHAPTER 1

LITERATURE REVIEW

1.1 INTRODUCTION

The acquisition of intelligible speech requires children to master their native language's sound system. Step by step children add more speech sounds to their inventory and increase the number of phonemic contrasts. Research suggests that after the initial babbling stage children follow the legal constraints of their native language and exclude phonemes that are not part of the phonology of their language (Levitt & Aydelott Utman, 1992; de Boysson-Bardies et al, 1989). Theories of phonological development have aimed to provide universally valid explanatory concepts for speech acquisition. All theories stress the high similarity found across languages but also admit language-specific differences. This Chapter sets out to present the background information necessary to evaluate whether cross-linguistic research supports theoretical concepts.

The Chapter begins with a description of the phonological system of the target language investigated in this thesis: German. Information about the phonological system of the adult language will be presented, as well as existing research findings on the speech acquisition process in German-speaking children. The information on speech development in German will then be compared to findings from other languages, especially English, because of the assumption that speech development follows a universal pattern. However, cross-linguistic findings stress the need to account for language-specific patterns of development. Therefore, the following section will provide an overview of explanations given by phonological theories for a) universal and b) language-specific patterns. The Chapter will end with a presentation of the aims and hypotheses for the study of phonological development in German-speaking children presented in Chapter 2.

1.2 GERMAN PHONOLOGY AND VARIATIONS IN NORTHERN GERMAN

1.2.1 Modern Standard High German

German belongs to the Germanic languages and has about 121 million native speakers in 15 countries, the largest communities being in Western and Central Europe. It is the official state language in Germany, Austria, parts of Switzerland, Liechtenstein and Luxembourg (Crystal, 1997; Durell, 1992; Barbour & Stevenson, 1990; Lyovin, 1997). Strong regional variations in pronunciation, from accents to dialects, of the official language High German (Hochdeutsch), that is based on a North German pronunciation of the written language, can be found (Durell, 1922; Goltz & Walker, 1961; Barbour & Stevenson, 1990). However, over the past years, at least in Germany, the use of dialects has diminished although accent often makes it possible to identify the regional origin of a speaker. Children growing up in Germany use High German as their everyday language, since it is the official language spoken in kindergartens and schools. In general, the spelling of standard German gives a clear guide to pronunciation.

High German contains 23 consonants [p b t d k g f v s z ʃ x ç h m n ŋ l ʁ j ʔ pf ts]. In addition the sound [ʒ] is found in words of foreign origin but since it is not necessarily part of a child's phonological inventory, it will not be not considered here. The glottal stop [ʔ] appears before syllable initial vowels and is compulsory. The sounds [pf] and [ts] will be presumed to be affricates following Ternes (1987), and not two-element clusters even though there is disagreement about this in the literature (Kohler, 1995; Ternes, 1987; Wiese, 1996). Whether /ç/ and /x/ should be considered as two phonemes or as allophones is also a controversial issue (Kohler, 1995; Si-Taek Yu, 1992; Wiese, 1996). However, since children need to acquire both speech sounds the discussion is not relevant for this project, and for ease of presentation they will be classified as phonemes. Finally, Kohler (1995) claims that a third allophone [χ]

exists, but since it does not present a specific constrastiveness to /x/, it will be ignored. In word final position the contrast between voiced and voiceless consonants is neutralised, with all consonants being voiceless. In word initial position there are 23 two-element clusters and two three-element clusters. There are also many word medial and word final clusters. The vowel system contains 15 monophthongs and 3 diphthongs, which, in the North, have a tendency to be over stressed (Lenisierung) e.g. [kæːzə]→ [keːzə] *Käse* (cheese) .

The shortest possible syllables are the structures CV e.g. [kuː] = *Kuh* (cow) and VC e.g. [ap] = *ab* (off). Structures of the combinations $C_{1\text{-}3}VC_{1\text{-}5}$ in mono-syllabic words are possible:

$C_{1\text{-}3}$ e.g. [ʃtʁ] in *Strumpf* (sock); $C_{1\text{-}5}$ e.g. [mpfst] in *du schrumpfst* (you shrink). German is an agluttinating language where, by addition of nouns, words can be made up to about eight syllables or more e.g. "Hallenhandballweltmeisterschaft" (Meinhold & Stock, 1980).

A summary of the phonological systems of German and English is presented in Table 1.1. The two languages have been compared because a) the readers of this thesis will most probably be a native English-speaker and therefore more familiar with the English system and b) results of the studies of this thesis will often be compared to findings on English and thus the Table might provide important background information.

Table 1.1 German and English phonology

	German	English[1]
Initial Consonants	p b t d k g	p b t d k g
	m n	m n
	f v z ʃ ʁ h	θ ð f v s z ʃ ʒ h
	j	w j
	l	l r
	ts pf	tʃ dʒ
Medial Consonants	p b t d k g	p b t d k g
	m n ŋ	m n ŋ
	f v s z ʃ ç x[2] ʁ	θ ð f v s z ʃ ʒ
	l	l r
	ts pf	tʃ dʒ
Final Consonants	p t k	p b t d k g
	m n ŋ	m n ŋ
	f s ʃ ç x	θ ð f v s z ʃ ʒ
	l	l r
	ts pf	tʃ dʒ
Word Initial Clusters	b p g k f pf + l	p g k f + l
	b p d t g k f + ʁ	b p d t g k f ʃ θ + r
	k + n / v	b p d t g k m n f v tʃ θ + j
	ts + v	d t g k θ + w
	ʃ + l m n p ʁ v t	s + p t k m f l w j
	ʃ + p / t + ʁ	s + p + l
		s + p t k + r j
		s + k + w
Vowels	i y e ø o u ɪ ʏ ɛ œ a ʊ ə	i ɪ ɛ æ ʌ a ɒ ɔ u ʊ ɜ ə
Diphthongs	aɪ au ɔɪ (eɐ ɔɐ uɐ)	eɪ oʊ aɪ aʊ ɔɪ ɪə ɛə ɔə ʊə
Syllable Structure (Monosyllables)	[C 0-3] - V- [C 0-3] nouns [C 0-3] - V- [C 0-5] verbs	[C 0-3] - V- [C 0-4]

[1] Data for English from *Modern English Structure* by Strang (1969); Date for German by Kohler (1995)

[2] As previously discussed /ç/ and /x/ will be treated for ease of presentation as two phonemes instead of allophones.

1.2.2 North German Variation of High German

All children assessed for the studies reported in this thesis grew up in the North of Germany, in Hamburg or the south of Schleswig-Holstein. The German spoken there, to date, varies little from modern standard High German. The children speak almost with no accent and their variations from High German are minimal compared to other German regions. None of the parents of the children assessed spoke North Saxon or any other dialect. The data should, therefore, provide normative data applicable across Germany although dialectal regional variations would need to be described by further studies. The following section summarises the North German regional changes from High German in the use of consonants (according to Goltz & Walker, 1961; Durell, 1992; Barbour & Stevenson, 1990; Kohler, 1995). Vowel variations according to accent will not be described.

- The sound /r/ is always realised as [ʁ]. In all positions other than before vowels [ʁ] is realised as a vocalic *Ersatzlaut* (substitution sound) [ɐ]. This fact creates several additional long or short diphthongs as in *Wurst* [vuːɐst] (sausage) or *Berg* [beːɐk] (mountain).
- The phoneme [ŋ] in word final position can be either pronounced as [ŋ]or [ŋk], while in High German only [ŋ] is possible .
- The consonant /l/ before /ç/ as in *Milch* [milç] (milk), may be deleted and the vowel changed to [e].
- The final letter 'g' can be either pronounced as [k] or [ç], e.g. [beɐːk] or [beɐːç] *Berg* (mountain), while only the first option is legal for High German.
- In word initial position the affricate /pf/ may be reduced to [f] and /pfl/ may be reduced to [fl]. The loss of /p/ before /f/ has been recorded as a phenomenon that is very common in colloquial speech (Barbour & Stevenson, 1990) and in the North (Durell, 1992). Further, the deaffrication of /ts/ to [s] in word initial position has been described as common. Reduction is unlikely to cause problems

in understanding, since [s] stays contrastive with /z/ in word initial position and no homonyms are created.

- The word final unstressed syllables [ən] and [əl] can be reduced and assimilated: i.e. [ge:bm] instead of [ge:bən] *geben* (to give), [fo:gl] instead of [fo:gəl] *Vogel* (bird).

1.3 LATEST DEVELOPMENTS IN GERMAN RESEARCH

Even though detailed literature on the phonetic and phonological adult system of German is available this is not the case for data on child speech. There is a dearth of research in this field and existing published data are incomplete. The available studies vary in their choice of methodology: longitudinal versus cross-sectional, subject numbers, criteria for phone and phoneme acquisition and identification of error patterns. The term 'error pattern' will be preferred in this thesis to the commonly used terms 'phonological processes or rules'. Chapter 3 will provide a detailed explanation for this decision.

The earliest study was reported by Ament (1899) who described children's error patterns/ *Lautgesetze* "sound laws". Unfortunately his data present neither the ages of occurrence of error patterns nor the number or age of children assessed. The error patterns he observed are summarised in Table 1.2.

Ament's study was followed by single case studies reported by Stern & Stern (1928) who were more interested in the whole phenomenon of speech and language acquisition, without focussing particularly on the acquisition of speech. Nevertheless they describe some error patterns (see also Table 1.2) and present some information about phonological inventories of their own three children and some friends' children. They concluded that labials are acquired first, followed by alveolars, velars and then fricatives. However, Stern & Stern (1928) stated that the detailed investigation and

description of individual child data is unnecessary, since children are so highly variable in their sound productions and simplifications that data even provided counter evidence for any kind of 'sound law'[3]. Consequently, their study only gives a very general overview of phonological development.

Möhring (1938) described the error percentages for all sounds and clusters of German derived from a very large study of speech-disordered children (N = 2102). He concluded that sounds present different levels of difficulty and, therefore, a hierarchy can be identified that reflects the acquisition of speech sounds. Difficulty in sound production had earlier been described by Schultze (1880, cited by Möhring) as the amount of muscle- and nerve-work carried out in order to produce a certain sound[4]. However, Möhring saw no reason why one sound should be more difficult to produce than another, and thus claimed difficulty was demonstrated, not explained, by error percentage. However, he did not offer a different causal explanation. The three groups of different difficulty level were described as follows:

I. 1.5 - 11.1 % : m, n, b, d, p, l, t, f, v

II. 17.9 – 28 % : x, j, ʁ, ŋ, k, g

III. 33.5 - 54.5 %: ç, ʃ, s/z

The study most frequently cited in Germany on phonological acquisition, after Möhring's, was carried out by Grohnfeldt (1980). He investigated the order of phoneme acquisition assessing 312 normally developing children aged 3;0 – 6;0. In

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[3] "Denn bei der ungeheuren Individualisierung der Lautverstümmelungen in der Kindersprache war es wohl möglich, für viele linguistische Lautgesetze Belege zu finden – aber andererseits lieferte man auch zahlreiches Material, mit dem das Gegenteil bewiesen werden konnte." (Stern & Stern, 1928, p. 284)

[4] Physiologische Anstrengung: "das Maß der Nerven- und Muskelarbeit, welche nötig ist, um die zur Hervorbringung eines Sprechlautes notwendige Stellung der Stimmwerkzeuge herbeizuführen" (Möhring, 1938, p.190).

his "sound-diagram" isolated phonemes and clusters were grouped depending on their "grades of difficulty" which related to the idea that the later a phoneme is acquired the more difficult it is. A phoneme was judged to be acquired when it was at least 75% or 90% correctly produced in all children within a six month age range. Unfortunately, some phonemes were only described as part of consonant clusters and the subjects were already three years old at the start of the investigation.

As yet, there are only three studies that describe phonological acquisition in normal speech development in terms of error patterns (called "phonological process" by all following authors). Elsen (1991) described her own daughter's speech development. Unfortunately information about the criteria used to assess phonetic and phonemic inventories and her discrimination between the two inventories was unclear.

Fongaro-Leverin (1992) assessed 24 German-speaking children between the ages of 2;1 and 5;0 for her cross-linguistic study of German and Brazilian-Portuguese. The phonological inventories and error patterns observed in each of her six age groups showed very broad variations.

Romonath (1991) assessed 34 German-speaking children between the ages of 5;3 and 7;2, focusing on the error patterns that were still apparent. Unfortunately, she did not report the chronological age at which error patterns were still observable. Since the phonemic inventory can be supposed to be complete by the age of 5;0 years (see Fongaro-Leverin, 1992 and Elsen, 1991), error patterns reported by Romonath are unlikely to reflect typical development.

Table 1.2 Error patterns described by Ament (1899), Stern & Stern (1928), Elsen (1991), Fongaro-Leverin (1992) and Romonath (1991)

Error Pattern	Ament	Stern & Stern	Elsen	Fongaro-Leverin	Romonath
WSD	★	★	★	★	★
Assimilation	★	★	★	★	★
ICD	★	★		★	★
FCD	★	★	★	★	★
Cl Reduction	★	★	★	★	★
Cl Deletion				★	★
Velar Fronting	★	★	★	★	★
Sibilant Fronting	★	★	★	★	★
Backing of Sibilants	★			★	★
Backing					★
Stopping	★	★	★	★	★
Voicing	★	★	★	★	★
Devoicing	★	★		★	★
Nasalisation	★			★	
Denasalisation				★	★
Glottal Replacement	★	★		★	
Migration				★	★
Metathesis	★		★	★	★
Interdentality			★	★	★

WSD = Weak Syllable Deletion; ICD/FCD = Initial/ Final Consonant Deletion; Cl = Cluster

Three further studies need to be mentioned: Lleò & Prinz (1996) focused on the acquisition of clusters by 5 children aged 0;9 – 2;1. They found that cluster reduction patterns reflected a preference for preservation of the first element, while the second element was not realised. According to the authors this can be explained "in terms of parameterization of syllabification, which in German takes place from left to right" (Lleò & Prinz, 1996, p.31). Berg (1992) investigated early assimilation processes used

by his daughter aged 2;7 – 2;11. He found that all (but one) assimilation errors were regressive harmonies, affecting mostly bilabials or alveolars. Grijzenhout & Joppen (1998) carried out the most recent study. In their case study of a German-speaking child they focused on the acquisition of word-onsets. They challenged the assumption that the most basic syllable structure used by children is the CV syllable (Bernhardt & Stoel-Gammon, 1996). They found that for German, early words "may occur as a consonant-vowel sequence but also as a vowel-consonant sequence depending on the linear order of the adult form" (Grijzenhout & Joppen, 1998, p.26). They also reported a further interesting phenomenon. There is a bias in German children's speech for alveolars in words which contain a labial and an alveolar consonant in the adult form.

In summary, data from research into German-speaking children acquiring their first language, reveal the following:

- Order of acquisition: labials > alveolars > velars, fricatives and affricates > clusters
- Age of acquisition for individual phonemes: varies from study to study
- Age of completed phoneme acquisition: varies between 2;11 – 6 years,
- Most frequently cited error patterns: weak syllable deletion, assimilation (regressive rather than progressive), initial and final consonant deletion, cluster reduction, fronting of velars and sibilants, backing of sibilants, stopping, voicing.
- Ages of occurrence and disappearance for each error pattern: varies from study to study

These findings leave two major questions unanswered:

1) At what age do children typically acquire each sound of the phonetic and phonemic inventories of German? And which of the existing data can be used as reliable normative data?
2) At what age are the individual error patterns, described by most authors as developmental, age appropriate?

1.4 CROSS-LINGUISTICS RESEARCH

Cross-linguistic research into phonological acquisition has only emerged fairly recently. The two unanswered questions posed for German also apply to other languages. One major problem facing cross-linguistic research concerns the differences in methodologies for data collection both within and across languages.

Nevertheless, cross-linguistic comparison of the acquisition of phonology is of great interest and importance from an explanatory, theoretical point of view. Data from different languages can evaluate hypotheses about which factors are responsible for speech development in general and about the nature of the process of acquisition. If findings across languages are highly similar, irrespective of the phonetic and phonological systems of the language to be learned, then some kind of universal, possibly biological, phenomenon must be operating. If findings vary, factors other than a general ability to acquire speech must operate.

Some information about the acquisition of phonology in different languages exists. The languages assessed so far come from various language families including North- and West-Germanic, Italic, Sinitic, Turkic and Semitic languages. The language most investigated is English, which is why data on English are often used as a baseline to which other languages are compared. The following paragraphs will document the findings from various studies starting with English and will specifically mention differences in terms of age and order of phone and phoneme acquisition and error pattern usage in comparison to English.

- **English:** Several studies have investigated the phonological acquisition of English (Templin, 1957; Prather, Hendrick & Kern, 1975; Stoel-Gammon & Dunn, 1985). They show high agreement for the order of acquisition but disagree on the age of acquisition because all studies used different criteria in order to establish at what

age a phoneme was acquired. Prather et al (1975) used criteria most comparable to the study reported in Chapter 2. Thus their findings are presented in Table 1.3.

Table 1.3 Phoneme acquisition by English-speaking children (Prather et al, 1975)

Age (years)	English
2;0 – 2;5	m n p h
2;6 – 2;11	b f d t w j ŋ k
3;0 – 3;5	l s r g
3;6 – 3;11	ʃ tʃ
4;0 – 4;5	ð ʒ
> 4;6	dʒ θ v z

Grunwell (1987), Stoel-Gammon & Dunn (1985) and Khan & Lewis (1986) investigated developmental error patterns in English-speaking children. The most common error patterns found were the following: weak syllable deletion, final consonant deletion, reduplication, cluster reduction, velar fronting, assimilation, prevocalic voicing, epenthesis, gliding, vocalisation, stopping, depalatalisation.

- **Putonghua (Modern Standard Chinese):** Zhu Hua & Dodd (2000a) found that children mastered the four possible elements in Putonghua in the following order: tones < syllable final consonants, < vowels followed by syllable initial consonants. By the age of 4;6 90% of all children assessed had acquired the phonological system of Putonghua. Language specific error patterns such as X-velarisation, aspiration and de-asperation were found.

- **Spanish:** A study of the acquisition of Spanish carried out by Goldstein & Iglesias (1996) revealed the following language-specific error patterns: liquid deviation such as the replacement of the word initial and intervocalic trill /r/ by the uvular trill [R] or the velar fricative [x] and backing of alveolars. Furthermore, they

reported that the number of error patterns still present at the age of 4;6 was only very small.

- **Cantonese:** So & Dodd (1995) studied Cantonese-speaking children. They found that 75% of the children had completed their phonological acquisition by the age of 3;6, which is much earlier than previously reported for English data. The language specific error patterns were: deaspiration, affrication and a type of cluster reduction marking aspiration.

- **Xhosa:** Mowrer & Burger (1991) found that Xhosa-speaking children master their phoneme inventory earlier than English- speaking children.

- **Arabic:** A study of Arabic children focused on phonetic and phonological inventories. Amayreh & Dyson (1998) described an even later stage of phoneme acquisition and mastery than had been described for English. Children had not fully mastered the phonological inventory by the age of 6;4.

- **Maltese:** Grech (1998) investigated the phonological acquisition of Maltese-speaking children. She reported lateralisation of /r/: (/r/ → [l]) and fronting of sibilants specifically /s/ and /z/ → [θ] and [ð] as very frequent language-specific developmental error patterns.

- **Swedish:** Nettelblad (1983) found that Swedish children often replace /ʁ/ by [h] which agrees with findings by Magnusen (1983). She also reported that Swedish-speaking children used similar error patterns to those of children growing up with other West-European languages.

- **Turkish:** Turkish-speaking children were found to master their phoneme inventory by the age of 3;0 with three exceptions: the flap /ɾ/, the velar fricative /ɤ/ and some clusters (Topas & Konrot, 1997). The phoneme /k/ was acquired unusually early, by the age of 1;5. Language specific error patterns were liquid deviations and affrication.

- **Portuguese:** Yavas & Lamprecht (1988) investigated developmental phonological error patterns in Portuguese-speaking children. Their findings revealed that in comparison with English there was a difference in time of appearance of error patterns, but few differences in the types of error patterns used.

- **Italian:** Bortolini and Leonard (1991) reported that Italian children used similar phonological error patterns to those used by English-speaking children. One language-specific pattern was found: the substitution of /r/ → [l], which had also been reported for Maltese.

This summary of the characteristic errors associated with specific languages indicates the influence of the ambient phonological system on error types. However, in addition to the individual language-specific patterns further developmental error patterns are used which are similar across languages (see Table 1.4). The label 'NA' indicates that a specific error pattern is not applicable for a language because this error pattern is not possible due to the phonological system of this language, i.e. cluster reduction in Putonghua is not applicable because clusters are not part of the Putonghua phonological system.

Table 1.4 Language universal developmental error pattern

	English	German	Swedish	Spanish	Italian	Portuguese	Turkish	Putonghua	Cantonese
WSD	★	★	★	★	★	★	★	NA	NA
Velar Fronting	★	★	★	★	★	★	★	★	★
FCD	★	★	★	★	★	★	★	★	★
Assimilation	★	★	★	★	★	★	★	★	★
Voicing	★	★	★	NF	NF	★	★	NA	NA
Cl R	★	★	★	★	★	★	★	NA	★
Gliding	★	NF	★	★	★	★	★	★	★
Stopping	★	★	★	★	★	★	★	★	★
Front. Sibilant	★	★	★	★	★?	★	★	★	★

WSD = Weak Syllable Deletion, FCD = Final Consonant Deletion, Cl R = Cluster Reduction

NA = not applicable due to language-specific phonological system

NF = error pattern was not found to occur in normally developing children

The differences found across languages may partly depend upon the individual phonemic system of each language. However, differences might also be due to the study design, i.e. the criteria set for phoneme acquisition. Nevertheless, some differences were reported that cannot be explained this way i.e. differences in the age of acquisition of individual phonemes which are identical for a number of languages but are reported to be acquired at a different age in another language, e.g. the very early acquisition of /k/ in Turkish in comparison to findings for English. In addition some error patterns were reported for one language but not in another despite that possibility in terms of the phonemic inventory. For example X-Velarisation, a type of backing, in Putonghua has been described as a developmental error pattern. For English, however, any form of backing has been reported to be idiosyncratic.

1.5 THEORIES ABOUT THE ACQUISITION OF PHONOLOGY

Theories of phonological acquisition have tried to account for evidence from cross-linguistic studies. The focus of most theories lies in providing an explanation for universal patterns: Why do children acquire phonology at a similar rate and in a similar order across languages? To a lesser extent they have tried to explain the differences found between different languages: What causes the language-specific differences in age and order of acquisition and in error pattern usage apart from language-specific phonetic and phonemic inventories? However, even though most theories agree on the existence of both phenomena, they do not necessarily agree on which aspects of speech development are of a universal nature and whether they are innate or not. Different opinions exist about what causes language-specific patterns.

In 1941 Roman Jakobson, a linguist of the Prague School, set the foundations for all subsequent models and studies in developmental phonology. He hypothesised that the acquisition of phonology can be described as a universal innate process, which is governed by the acquisition of "simple, clear, stable phonic oppositions, suitable to be engraved in memory and realised at will" (Jakobson, 1949, p.369 cited by Vihman, 1993). "The unfolding of a phonological system is the progressive differentiation of a sequence of oppositions affecting successively smaller sound classes based on the principle of maximum contrast and corresponding to the 'implicational universals' of adult phonological systems" as summarised by Vihman (1993, p.17). He further suggested that the acquisition hierarchy should be guided by the frequency of sounds across all languages. The more widely a sound is distributed, the earlier it will be acquired. Nasals, front consonants and stops (found in virtually all languages) should be acquired earlier than orals, back consonants and fricatives.

Natural phonology takes a different point of view concerning the question of universality. According to Stampe (1969; 1979) it is not the sounds of a language and

a system of oppositions which are universal but phonological processes. Phonological processes were defined as being natural, universal and innately available to children. Children, therefore, do not need to learn these processes but need to learn, from exposure to the phonology of a particular language, to suppress, limit and order these processes as required by the language.

Generative phonology, which was proposed around the same time as natural phonology, opposes the concept of phonological processes as an innate mental operation system. In using the term phonological rules, rather than processes, a change of perspective was implied. In contrast to natural phonology, Chomsky (1965) argues that the child is innately provided with a 'tacit knowledge' of universal principles of language structure. Phonological rules are seen as only one part in a general linguistic framework based on distinctive features as described in the Sound Pattern of English by Chomsky & Halle (1968). Phonological rules operate on underlying lexical representations derived from adult surface forms, which are assumed to be accurately perceived and stored, and to interact with the child's output. In the course of development these rules have gradually to be unlearned, resulting in the acquisition of more and more features.

The theories described so far have seen the acquisition of phonology as a linear process. A fundamentally different point of view was presented by the *non-linear phonologies*. Their focus lies in the hierarchical nature of relationships among phonological units such as syllables or words in contrast to individual segments or features. Furthermore, phonological processes or rules are only seen as a useful tool to describe differences between the adult and the child's developing phonological system.

The basic concept of all non-linear theories has remained identical: the child comes to the language learning situation with a phonological representation framework and a set of universal principles or 'templates' (Bernhardt & Stoel-Gammon, 1994).

Exposure to language input will confirm the universally determined representation and also allow the less universal (more marked) aspects of the phonological system to be learned. The information contained in the template is thought to be basic syllable structures and the least marked or basic segmental features. "The universally determined representational framework can be described as a passive 'filter', both for perception and production" (Bernhardt & Stoel-Gammon, 1994, p.132). Changes in the system will be caused by a) maturation of the perceptual and productive systems and b) continuous exposure to the information, which forces recognition of it.

Optimality theory, the latest development in this field, continues the concept of non-linear phonology by assuming that the child is born with a set of universal constraints (markedness constraints) (Vihman & Velleman, forthcoming). Children's early productions are unmarked and reflect the different constraint rankings between the child's and adult grammar. It is assumed that unmarked options are highly ranked in early child's speech in contrast to language-specific constraints (faithfullness constraints). Over time, the child's system must change to approximate the target language, which implies re-ranking of constraints, with "demotion of the higher ranked markedness constraints below certain faithfulness constraints" (Barlow & Gierut, 1999, p.1487).

Completely different approaches to speech acquisition (and which aspects are universal) in comparison to the previously presented ones come from three different theories: the *behaviourist approach*, the *cognitive approach* and the *biological approach*.

According to *behaviourist theorists,* e.g. Mowrer (1952, 1960) and Olmsted (1966, 1971) the role of contingent reinforcement in phonological acquisition is crucial. The theory holds that it is a general innate ability for learning, rather than any kind of linguistic knowledge, that triggers phonological development. Mowrer proposed a learning theory (1952; 1960), which suggested four steps to vocalisation from

attention to, to identification with the caretaker. On this basis Olmsted (1966) postulated a specific course of acquisition. He suggests that phonemes are acquired hierarchically according to a) frequency of occurrence in input and b) ease of perception. Therefore, language universal aspects should be dependent on a universal ability of perception, and language-specific variations in phonological acquisition can be accounted for by frequency of input.

Cognitive models agree with the behaviourists in terms of innate perceptual abilities. They "share the expectation that the child comes to the acquisition problem with general, 'natural' capacities for perception and sound production but not with a specialised or 'innate' knowledge of linguistic categories" (Vihman, 1993, p.31 summarising Ferguson & Farewell, 1975, and Kiparsky & Menn, 1977). However, in contrast to behaviourist theory, the child plays an active role in the process of speech development by formulating and testing hypotheses regarding the sound system being acquired. According to Ferguson & Farewell (1975) "universal phonetic tendencies" only result from the universal physiology of the human vocal tract. Babbling is seen as a practice stage for motor activities, which subserve speech production. Exposure to the ambient language will account for the acquisition of the language-specific phonemic system.

Biological models take a similar point of view in terms of continuity between babbling and speech. Locke (1983), also in favour of the continuity model, claimed that the phonetic inventory of the pre-linguistic stage is highly similar to that of the early linguistic phase. His cross-linguistic findings lead to the assumption that babbling patterns are of a universal nature and that phonological development is part of a general maturational course guided by universal physiological, perceptual and cognitive abilities. Language-specific features of speech development are caused by cognitive adjustments to babbled sounds because of the phonemes perceived from language exposure.

In summary four different types of factors that may influence universal phonological development have been suggested:

1. Different kinds of linguistic/phonological knowledge which is assumed to be innate
2. Innate cognitive abilities i.e. for learning
3. Universal perceptual and productive abilities (i.e. ease of perception theory, ease of production)
4. Maturation

All theories aim to account for the many similarities that can be found in phonological development across languages and their explanations for universal factors have been detailed. Factors responsible for language-specific patterns, on the other hand, have been described only vaguely. In general it is claimed that exposure to the ambient language is responsible for language-specific findings. Only a few theories have provided a more detailed account for language-specific differences.

One explanation relies on the concept of '*markedness*'. However, the definition of the term markedness has changed constantly over the years. According to the Prague School (i.e. Trubetzkoy, 1939) markedness was simply a calculation system of the number of present and absent features of each segment. Phonemes with the least number of features were supposed to be acquired first. *Generative Phonology* (Chomsky & Halle, 1968) continued to use the concept of markedness but included additional factors such as the frequency of each sound across languages.

In current theories, the discussion on how to determine which features belong to a language universal set and which to the language-specific set, and each feature set's relative markedness value is seen as an ongoing enterprise. The concept of markedness, however, has been extended by linking it to the notion of 'Universal Grammar'. According to this view there is an unmarked and a marked option for all

aspects of grammar, including phonology. It is assumed that the unmarked options are the most basic, the innate ones, which do not have to be learned. Children's speech simplifications during phonological development are assumed to resemble the least marked options and gradually, with the acquisition of more marked options via language input, the system is expanded. There is a consensus in the Anglo-American literature that the least marked syllable structure is the CV-syllable and that the least marked segment is /t/. In terms of place of articulation, *coronal* is assumed to be the universally unmarked or 'default' place (Bernhardt & Gilbert, 1992; Bernhardt & Stoel-Gammon, 1996).

The concept of markedness has also been used to explain developmental error patterns. The idea is that children, at the beginning of their speech development, always aim for the least marked solution. For example, if one accepts the CV-syllable as the least marked syllable structure, the developmental error patterns final consonant deletion (/bo:t/ →[bo:]) or cluster reduction (/blu:me/ →[bu:me]) can be explained as the return to the preferred CV-syllable. Also the fronting of velars to alveolar position shows a preference for the least marked place feature.

A different point of view, focussing on frequency of phoneme occurrence within individual languages, has been taken by several authors. Olmsted (1971) claimed that, as one factor, the frequency of occurrence in input speech could predict phonological development, thereby modifying Jakobson's (1941, 1969) theory that the order of acquisition is guided by the frequency of phoneme occurrence across languages. Locke (1983) agreed that phones occurring with highest frequency during babbling could be assumed to be phonemes acquired early. However, he claims that frequency of occurrence in input only starts to influence speech acquisition once the first fifty words have been acquired. Until then, Locke (1983) argues, phoneme acquisition follows a purely maturational path.

Pye, Ingram & List (1987) investigated whether Locke's predictions would hold in a cross-linguistic experiment: for the acquisition of Quiché. They found that the first

phonemes acquired by Quiché-speaking children differed from those of English-speaking children and that their set included phonemes which are acquired rather late in English (e.g. [l] and [ts]). They concluded that linguistic input must have a stronger effect on early phonemic inventories than maturation, as suggest by Locke (1983). Therefore, they explored the possibility of explaining the rate and order of acquisition by using the concept of *functional load* (Ingram, 1989). Functional load was described as the extent to which a consonant phoneme is necessary to its phonological system. The number of oppositions, or minimal pairs, occurring for a phoneme within a specific language was suggested to be a useful measure. Since it proved to be difficult to measure functional load directly, the frequency of phonemes in early child vocabulary was used as an indirect measure. However, since no data of this kind are available for Quiché, adult data were used, a methodological approach (Locke's prediction), which had just been rejected by the authors.

So & Dodd (1995) criticised the concept of functional load for another reason. They argued that while the concept might account for the order of acquisition of consonants, it was not a plausible explanation for the rate of acquisition. Furthermore, they proposed the need to expand the concept by adding other aspects of phonology such as vowels, syllable structure, stress and tone. To include only consonants might provide too limited a perspective on the complete picture of speech acquisition. An expanded version of the concept of functional load was successfully applied to Cantonese and was more deeply considered by Zhu Hua & Dodd (2000a) for Putonghua (Modern Standard Chinese).

As the basic concept of functional load had changed significantly, Zhu Hua & Dodd (2000a) presented a concept called *phonological saliency*, which is syllable based and (as needs to be stressed) language specific. The order and rate of the acquisition of different aspects of phonology are determined by a combination of three factors:

(a) "The status of a component in the syllable structure, especially whether it is compulsory or optional; a compulsory component is more salient than an optional one;

(b) The capacity of a component in differentiating lexical meaning of a syllable; a component which is more capable of distinguishing lexical information is more salient than one which carries less lexical information;

(c) The number of permissible choices within a component in the syllable structure. e.g. 21 syllable initial consonants would be considered less salient compared to four tone contrasts."(p. 7)

In applying the concept of phonological saliency to Putonghua and studies of other languages, such as Xhosa (Mowrer & Burger, 1991), English (Prather et al, 1975) and Cantonese (So & Dodd, 1995), they were able to explain discrepancies in consonant acquisition rates.

If this concept proves to be valid, it should be possible to make predictions as to the order and rate of phonological acquisition in languages that have not yet been investigated. *Phonological saliency* might provide an explanation for those aspects of a specific phonology that are responsible for language-specific differences.

1.6 AIMS OF CURRENT INVESTIGATION

This chapter has provided background information about past and current research in the field of developmental phonology. A detailed description of the phonological system of the target language of this thesis, German, has been presented. In addition, existing literature on child phonology in German-speaking children was evaluated. It was found that the data available are incomplete and research findings sometimes

contradictory. Therefore, current data do not provide precise enough information to provide norms on phonological development, on which basis it would be possible to differentiate typical from atypical speech development, in terms of rate of acquisition and types of errors.

English is the most thoroughly investigated language in the area of child phonology and research findings were described in detail for two reasons. First, possibly due to the same language origin of English and German both languages have a very similar phonological system and should, therefore, be highly comparable. Secondly, findings on English have been used by most other studies on phonological development as a comparison measure. Research into languages other than English or German was also presented. The aim was to evaluate the extent to which findings from different languages showed similar acquisition patterns, and whether more differences than similarities could be observed. It was found that similarity was very high. However, language-specific differences cannot be ignored. Therefore, different explanatory approaches to the observed phenomena were also described. One of these approaches, the concept of phonological saliency (Zua Hua & Dodd, 2000a) is based on each language's individual phonological system. The concept has been applied by Zhu Hua & Dodd (2000a) to several languages and seems to serve as a predictor for language-specific patterns of phonological development.

The study presented in Chapter 2 sets out to provide normative data on the phonological development of German-speaking children via a cross-sectional study on children aged 1;6 – 5;11. The focus will lie on the order and age of phoneme acquisition, possible differences between the acquisition of phonetic versus phonemic inventories, the types and age of persistence of developmental error patterns and the most likely phonemes to be replaced and to be used as replacements. Of further interest will be the investigation of gender variables.

Results will be compared with data from other cross-linguistic studies especially ones on English. These data will be used:

- to allow further insight into the general process of phonological acquisition, set in the context of phonological universals
- to evaluate the applicability of current explanations of language-specific findings
- as a normative baseline for all further studies in this thesis concerning developmental speech disorders of unknown origin.

1.7 HYPOTHESES

The hypotheses for the study in Chapter 2 were based on the assumption that speech development in different languages follows, in general, a universal pattern, but that further language-specific variations should be found:

- A highly similar pattern concerning the order and age of acquisition in comparison to English should be found for German, since both languages have a highly similar phonological system, which is assumed to be caused by them both being West-Germanic languages.
- The most frequent error patterns in German should be similar to those described for other languages.
- Language-specific differences in comparison to other languages should be able to be explained by two factors: a) the language-specific sound system and b) the theory of phonological saliency.
- According to the concept of phonological saliency it is expected that:
  - → German-speaking children should not make vowel errors during their development, since vowels are highly salient, due to their small range in contrast to other options in the phonological system and they obligatory.
  - → German-speaking children should complete the acquisition of their phonological system earlier than English-speaking children, since the overall number of options within the phonological system is smaller than in the

English system (i.e. fewer diphthongs 3:9 and less consonants to be acquired across word positions 52:65, less WI consonants).

→ German-speaking children should acquire the following phonemes first, because they are part of words of high communicative meaning and therefore are of high frequency as has been described by Piske (1998) and Krüger (1998):

/ m	p	b	d	n /
/mama/	/papa/	/bal/	/da/	/naɪn/
Mama	Papa	Ball	da	nein
mummy	daddy	ball	there?!/where?!	no

→ German-speaking children should acquire the phonemes /v/ and /z/ earlier than English-speaking children for two reasons. Firstly, German words containing /v/ word initially are of high communicative importance and very frequent in comparison to English. Secondly, in German /z/ and /s/ follow a language-specific distribution pattern (WI /z/ only; WM /z/ and /s/; WF /s/ only). Due to this distribution they are equally frequent, which is not the case in English, where /z/ can only occur in word-initial and word-medial position and in additionally only occurs in word-initial position in words of Latin origin such as "zoo".

CHAPTER 2

OBSERVATIONAL STUDY: A DESCRIPTION OF THE ACQUISITION OF THE PHONOLOGICAL SYSTEM IN GERMAN-SPEAKING CHILDREN

2.1 INTRODUCTION

The current study seeks to describe the phonological development of German-speaking children between the ages 1;6 and 5;11. For this purpose a group study was chosen where children were divided into different age groups and assessed once. Conclusions were then drawn by comparing the speech errors of children within and across age groups.

2.2 METHOD

2.2.1 Subjects

The phonological development of 177 monolingual German-speaking children aged 1;6 to 5;11 years will be presented. The children were assessed by a German speech and language therapist in their normal crèche, kindergarten or home environment in Hamburg and the South of Schleswig-Holstein. None of the children or the children's parents spoke any kind of dialect but their speech might have shown slight North-German accent variations.

The children were divided into 9 age groups with an age range of six months each. There were approximately 10 boys and 10 girls in each group (see Table 2.1). The parents or the nursery nurses had reported that none of the children showed any intellectual or hearing impairment nor any history of speech and language disorders. The kindergartens chosen for assessment reflected a range of socio-economic status.

Table 2.1 Subject information in age ranges

Age group	Age	Children	Boys	Girls
1	1;6 – 1;11	18	10	8
2	2;0 – 2;5	19	10	9
3	2;6 – 2;11	20	10	10
4	3;0 – 3;5	20	10	10
5	3;6 – 3;11	20	10	10
6	4;0 – 4;5	20	10	10
7	4;6 – 4;11	20	10	10
8	5;0 – 5;5	20	10	10
9	5;6 – 5;11	20	10	10
Total		177	90	87

2.2.2 Materials

A picture-naming assessment procedure was used to elicit data. The assessment included 99 items assessing all German phonemes in all possible word positions as well as most word initial clusters and a sample of word medial and final clusters (see Appendix I for complete list of items). For the first age group, children's spontaneous speech was included in the sample, because of their restricted vocabulary and young children's reluctance to name pictures. A Sony Professional Micro Stereo Recorder was used to record all sessions.

2.2.3 Procedures

The children were seen individually in a separate room and could be accompanied by their parents or a friend. They were asked to say the names of pictures in a book. If a picture was not named spontaneously, semantic or sentence completion cues were offered. If children in the first three age groups did not respond to these cues, a forced choice of two words was verbally offered, or, if that failed, children were asked to imitate the assessor.

2.2.4 Analysis

All utterances were audio-taped and immediately transcribed by the assessor using the International Phonetic Alphabet (IPA) revised 1993. The utterances were transcribed again later from audio-tape to check on the original transcription and a second rater (a native German-speaker who was a phonetician) additionally transcribed 10% of the data. The inter-rater-reliability was 96.5% when sibilant differences were excluded and 94.8% when they were included.

The material was analysed to provide normative data on the acquisition of phonetic and phonemic inventories and phonological process use in German-speaking children. Criteria set for each sub-analysis will be described in the results section. The criteria will remain constant for similar analyses throughout all studies reported in this thesis. Two further analyses were carried out: the overall error rate for phonemes (PPI) and for consonants (PCI) was calculated in order to describe a very broad acquisition pattern of speech and to provide some evidence concerning phoneme acquisition in different word positions. These figures will also be used as a baseline (z-scores) for comparing data from children with speech disorders to the norm. The second analysis evaluated the percentage correct for every individual phoneme. This was done because Möhring (1938) suggested that it is possible to predict the order of phoneme acquisition by identifying the sounds most prone to error in children with speech disorders. If this prediction is true, there should be a relationship between those phonemes last acquired in the normative data and the most vulnerable phonemes in speech disordered data (see Chapter 4). The calculations were carried out to investigate this hypothesis.

2.3 RESULTS

2.3.1 Overall Error Rate

The overall error rate of phonemes for each age group is given in Table 2.2. In row 1 the mean of incorrect phonemes across all children (PPI = Percent Phonemes Incorrect) for each age group are shown, with standard deviation values shown in row 2. Rows 3 - 4 present the mean error percentage for single consonants compared to the total number of consonants (PCI) occurrences per word position. A phoneme was accepted as correct when it was used in correctly in its correct word position environment.

Table 2.2 Percentage Phoneme/Consonants Incorrect (PPI/PCI) depending on age (WI/ WF = word initial and word final % incorrect consonant production)

Age	1;6 -1;11	2;0-2;5	2;6-2;11	3;0-3;5	3;6-3;11	4;0-4;5	4;6-4;11	5;0-5;5	5;6-5;11
$\overline{X}$ PPI	26.05	21.19	12.59	9.011	5.75	4.86	3.80	2.57	1.92
+/- SD	11.1	10.5	8.1	5.1	4.1	3.5	4.0	2.4	2.3
PCI WI	28.05	26.14	15.40	9.93	5.98	5.56	3.85	2.77	2.31
PCI WF	25.71	31.73	14.93	11.39	7.51	10.06	6.55	4.67	4.88

2.3.2 Percentage Correct in Sound Production

Table 2.3 describes the percentage of correct pronunciations for each individual sound across children in all age groups. The sounds with the highest percentage correct are the labials /n/, /m/, /p/ and /b/ and the alveolar stops /d/ and /t/. The lowest percentage correct can be found for all German sibilants.

Table 2.3 Percentage correct per phoneme

Phoneme	%	Phoneme	%	Phoneme	%	Phoneme	%
p	99.82	f	98.93	v	96.98	ʃ	85.13
n	99.67	l	98.41	ʁ	95.34	ts	73.09
m	99.65	ŋ	98.03	h	95.29	s/z	69.34
b	99.60	pf	97.91	g	94.75		
d	99.49	x	97.65	j	91.69		
t	99.16	k	97.18	ç	91.65		

2.3.3 Segment Acquisition

The analyses of the data collected differentiated between phonetic and phonemic inventories because the ability to produce a sound is not the same as the ability to produce the sound in the correct environment. Phonetic proficiency should be reached earlier than phonemic proficiency.

2.3.3.1 Phonetic Inventory

In order to describe the acquisition of the phonetic inventory, two criteria were used: when 75% of the children in an age group produced this phone at least twice[5] throughout the speech sample in any word position, whether this position was correct or not. A phone was counted as having been mastered by an age group when 90% of the children produced the phone at least twice throughout the sample. Table 2.4 displays the results found.

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[5] For age group 1 the appearance of a phone once was accepted as the phone being acquired, since the data in this age group were so limited.

Table 2.4 Phone-acquisition according to 75%- and 90%-criterion

Age group	Age	75% Criterion	90% Criterion
1	1;6 – 1;11	m b p v f d t n l g k h	m b d t n
2	2;0 – 2;5	pf	p f v l
3	2;6 – 2;11	j ŋ ç x ʁ	x g k h ʁ pf
4	3;0 – 3;5		j ŋ
5	3;6 – 3;11	ʃ	
6	4;0 – 4;5		ç
7	4;6 – 4;11		ʃ
8	5;0 – 5;5		
9	5;6 – 5;11		

2.3.3.2 Phonemic Inventory

Two criteria were used to evaluate phoneme acquisition: when 75% and 90% of the children within one age group were able to produce a phoneme at least 2 out of 3 times correctly in its correct word position environment[6] (see Table 2.5).

Table 2.5 Phoneme-acquisition according to 75%- and 90%-criterion

Age	Age	75% Criterion	90% Criterion
1	1;6 – 1;11	m b p d t n	m p d
2	2;0 – 2;5	v h s/z*	b n
3	2;6 – 2;11	f l j ŋ x ʁ g k pf	v f l t ŋ x h k s/z*
4	3;0 – 3;5	ç ts*	j ʁ g pf
5	3;6 – 3;11	ʃ	ts*
6	4;0 – 4;5		ç
7	4;6 – 4;11		ʃ
8	5;0 – 5;5		
9	5;6 – 5;11		

[6] If a phoneme was assessed only by two items, as it could happen for 3 phonemes if not all words of the material were named, it was marked as acquired when it was once produced correctly.

Table 2.5 shows that the phonemes /s/, /z/ and /ts/ were marked with an asterisk to indicate that no age group produced more than 70% of these phonemes correctly. Throughout all age groups, as many as 40% of the children replaced these sounds in the following way: /s/ →[θ], /z/ → [ð] and /ts/ → [tθ]. Since [θ] and [ð] are not German phonemes, they were accepted as allophones of /s/ and /z/, and not counted as errors. The variation in the production of /s/ and /z/ is seen as an articulatory problem rather than a phonological one. However, Figure 2.1 compares the pattern of acquisition of /s/, /z/ and /ts/ (both phonetically and phonemically correct) with the acquisition of /s/, /z/ and /θ/ and /ð/ as their allophones. The bars present the percentage of children for each age group producing the phonemes correct for each of the two conditions. Interestingly no pattern of acquisition can be found in [s], [z], while a pattern of the type expected appears as soon as [θ] and [ð] are included as their allophones.

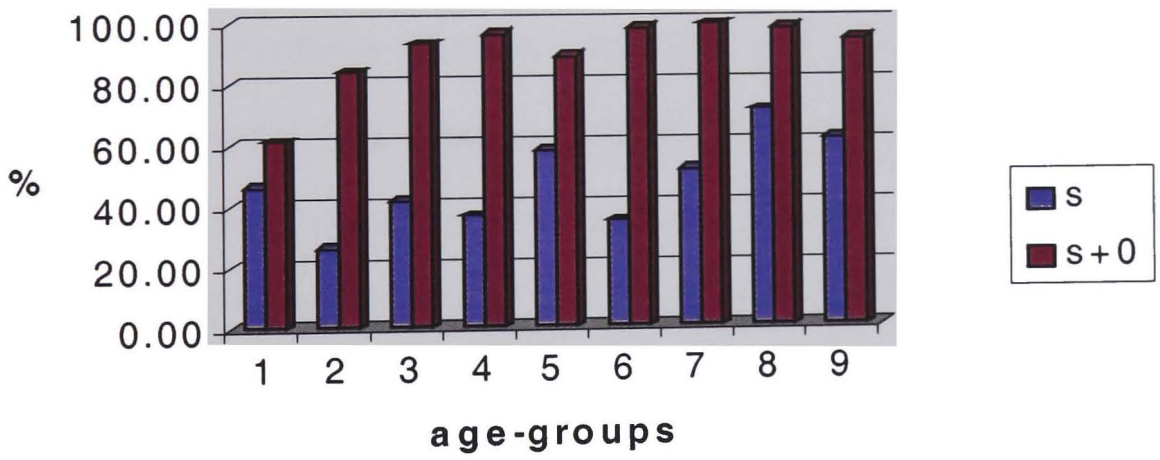

Figure 2.1 The acquisition of the phonemes /s/ and /z/ versus /s/ and /z/ including [θ] and [ð] as allophones

2.3.3.3 Comparison of Phonetic and Phonemic Inventory

Phonemes (75% criterion) can be grouped in the following way:

1) Sounds which are very early phonetically and phonemically acquired during age groups 1 and 2: [m, n, p, b, t, d]
2) Sounds which are acquired later (> 2;6 years) but nevertheless phonetically and phonemically parallel: [j, ŋ, ʁ, x, ʃ]
3) Sounds which are acquired phonetically about two to three age groups before they are acquired phonemically: [v, f, l, g, k, h, ç, pf]
4) Sounds which are not acquired phonetically within the age groups assessed, while they have already been acquired phonemically: [s/z*, ts]

2.3.3.4 Vowels

The complete sample from the assessment procedure contained 150 vowel monophthongs and fifteen diphthongs. Added to the three diphthongs in German described in Chapter 1 were three diphthongs which occurred because of the vocalization of /ʁ/ in Northern German: [ɐɐ, ʊɐ, ɔɐ]. The overall vowel error percentage found within the first three age groups was less then 3%. In the later age groups the error percentage was about 1%. The most common error in monophthongs was the replacement of many vowels by the vowel /a/ (32.4%), one of three vowels acquired early. Diphthong errors were more common, the first element being retained in 67% of error examples.

2.3.3.5 Word Initial Clusters

Clusters consisting of a stop or fricative /f/ + /l/ or /ʁ/ are acquired by three and a half years (75% correct criterion) or by 4 years of age (90% correct criterion). There were three exceptions to this pattern: /kʁ/, /kv/ and /kn/. These clusters were acquired at the same time as other clusters consisting of /ʃ/ + continuant/ stop/ nasal (X) and /ʃ/ + stop + /ʁ/. The correct production of the clusters containing /ʃ/ + X was acquired by the age of four and a half years (75% correct criterion) or by the age of 5;0 (90% correct

criterion). Three element clusters were the last ones to be mastered (see Table 2.6). Clusters were assessed by only one or two items each. Thus a clusters was marked as acquired if the child produced it once correctly.

Table 2.6 Cluster-acquisition according to 75%- and 90%-criterion

Age	75% Criterion	90% Criterion
3;0 – 3;5	bl bʁ fl fʁ dʁ tʁ gl kl	fʁ kl
3;6 – 3;11	gʁ kʁ kv ʃm ʃn ʃʁ ʃp ʃv	bl bʁ fl gl gʁ
4;0 – 4;5	kn ʃl ʃpʁ ʃtʁ ʃt	dʁ tʁ kʁ kn kv ʃl ʃm ʃn ʃʁ ʃp ʃv ʃt
4;6 – 4;11		ʃpʁ ʃtʁ

2.3.3.6 Gender Comparison

The acquisition of phonemic inventory was compared in relation to gender in Table 2.7. A Chi-Square-Test revealed a significant difference between boys and girls ($\chi^2_{obt} = 4.9556 > \chi^2_{crit} = 3.841$ for $\alpha = 0.05$), when comparing the number of phonemes acquired before and after the age of 2;5.

Table 2.7 Gender comparison of phoneme acquisition

Age groups	Age	90% Criterion Boys	90% Criterion Girls
1	1;6 – 1;11	m p d	m b p d t
2	2;0 – 2;5	n	l n h ŋ s/z*
3	2;6 – 2;11	b f l t ŋ x h ʁ k	f v x k
4	3;0 – 3;5	v j g pf s/z* ts*	j ʁ pf
5	3;6 – 3;11	ç	g ts*
6	4;0 – 4;5		ç ʃ
7	4;6 – 4;11	ʃ	

2.3.4 Developmental Error Patterns

The data collected were analysed to describe the use of error patterns in children acquiring German as their first language (Table 2.8 presents these error patterns in a screening sheet). An error pattern was accepted as being used by children of an age group when the percentage of children using the pattern was greater than 10%. A pattern was judged as used by an individual child when it occurred at least twice. The following error patterns divided into structural and systemic simplifications according to Grunwell (1985) were found:

Table 2.8 Screening sheet for developmental error patterns in German-speaking children

Age	1;6-1;11	2;0-2;5	2;6-2;11	3;0-3;5	3;6-3;11	4;0-4;5	4;6-4;11
Weak Syllable Deletion							
Assimilation General							
/tʁ → kʁ/							
Initial Consonant Deletion General							
/g/							
Final Consonant Deletion General							
/l/							
Initial Cluster Deletion							
Final Cluster Deletion							
Cluster Reduction							
Fronting of Plosives							
of Sibilants							
/ŋ/							
Backing of Sibilants							
Stopping							
Voicing							
Cluster Devoicing							
Nasalisation							
Glottal Replacement General							
/ʁ/							
Deaffrication							
Vokalisation of /l/							
Interdentality							

> 20% of the children: ——— 10% -20% of the children: ·····

2.3.4.1 Structural Simplifications

Weak Syllable Deletion

"Weak syllable deletion (WSD) is omission (or loss) of an unstressed syllable in a word of more than one syllable." (Grunwell, 1997, p.51) Even though this process was found up to the age of 3;5 in more than 10% of the children it only occurred with a mean of around three items out of 64 in the first three age groups and with a mean of two items in age group four.

Assimilation or Consonant Harmony

Assimilation processes were divided into five subgroups: contact assimilation within a cluster: occurred mainly in /dʁ/ and /tʁ/ → [gʁ, kʁ] up to 4 years. An overall preference for regressive assimilation was observed with a p-Value = 0.022 significance (binomial test) over progressive assimilation. Both processes could be found up to the age of 4;0 years in about 20% of the children with a mean = 1 item. These findings agree with those of Berg's (1992) diary study of his daughter. Syllable harmony and syllable assimilation across syllables only played very minor roles.

Initial Consonant Deletion

Initial consonant deletion only occurred for the sounds: /v/ and /k/ up to the age of 2;0 years, for /ʁ/ and /ts/ up to the age of 2;5 years, for /h/ up to the age of 3;0 years and for /g/ up to the age of 4;0. The sound /g/ was for the most part only deleted in the words *Gitarre* [gitaʁə] (guitar) and *Gespenst* [gəʃpɛnst](ghost). In both words the position of /g/ represents a special case: the syllable /gə/ is usually used to indicate the grammatical phenomenon of the regular past participle in verbs, i.e: *ich gehe* (I go) → *ich bin gegangen* (I have gone), but it can also occur in nouns simply as a syllable. The correct production of this prefix presents a special difficulty for German-speaking children in that it will often continue to be fronted (/gə/ → [də]), even though the sound /g/ has been acquired.

Final Consonant Deletion

Phonemes were found to be deleted in word final position only up to the age of 2;5 years, apart from the phoneme /l/, which was deleted up to the age of 4;0 years. Grunwell's (1997) review of English data led her to conclude that this error pattern should be termed vocalisation or vowelisation if it occurs for the phonemes /l/, /r/ and for nasals. In German-speaking children, however, the deletion of WF /l/ was judged to reflect final consonant deletion, since there is a further process whereby /l/ is produced as a vowel other than /ə/. This latter process was called vocalisation of /l/ (see below).

Cluster Deletion in WI Position

The only clusters deleted by more than 10% of the children were /kv/ up to the age of 2;0 years and /kʁ/ up to the age of 3;0 years.

Cluster Deletion in WF Position

There were only very few clusters in word final position included in the assessment. Deletion of those could be found only in the first age group up to the age of 2;0 years.

Cluster Reduction

For clusters in word initial position the following patterns of reduction were found:

1. While clusters containing stops or /f/ + /ʁ/ were reduced up to 3;5 years mostly to their first element, clusters containing stops or /f/ + /l/ were reduced either to their first or second element (see also Table 2.9).
2. Clusters containing /ʃ/ + nasal/ continuant/ stop were reduced to their second element, clusters containing /ʃ/ + Stop + /ʁ/ were reduced to either C_3 or C_2C_3. Cluster reduction was found for most clusters up to 3;5 years, only for three element clusters up to 4;5 years.

Table 2.9 Pattern of cluster reduction found in first three age groups for clusters consisting of a plosive (P) or /f/ + /l/ or /ʁ/

Age	P/ f +ʁ → [P/ f]	P/ f + ʁ → [ʁ]	P/ f + l → [P/f]	P/ f + l → [l]
1;6 – 1;11	83%	17%	53%	47%
2;0 – 2;5	94%	6%	54%	46%
2;6 – 2;11	68%	32%	50%	50%

P = Plosive; % = percentage of children who used either of the two patterns within an age-group

2.3.4.2. Systemic Simplifications

Fronting

Fronting of plosives, mainly velars, and for the sibilants /ʃ/ and /ç/ occurred up to the age of 3;6 – 3;11. In addition, fronting of /ʁ/ → [l] in WW position was found in age group 1 and fronting of /ŋ/ → [n] and its clusters in WW and WF position up to the age of 2;5 years.

Backing

The process of backing in WI position was found for only one phoneme in normally developing children: /ʃ/ → [ç]. In WW and WF position backing was found for /ʃ/, /ç/ and /s/. This process was observed to fade out after 3 years. Backing of the phonemes /t/ and /d/ could only be observed as part of assimilation processes and then only between the ages of 2;5 and 3;5. Backing is, therefore, atypical of normal development, except for sibilants.

Stopping

Fricatives were found to be stopped up to the age of 2;5 - 3;0 years.

Voicing/Devoicing

Voicing errors in plosives and /f/, /v/ were found for these sounds when they were not in clusters up to the age of 2;6 years. Devoicing only occurred in clusters and continued up to 5;5 years.

Nasalisation

In word initial position Nasalisation could only be observed for the phonemes /g/ and /j/. In word medial position the phonemes /l/ and /ʁ/ were affected. Nasalisation can be seen as a developmental process up to the age of 2;5 years.

Glottal Replacement

Glottal Replacement was defined as the substitution of a phoneme by the phoneme [h]. This was found for /f/, /v/ and /ʃ/ within the first age group, but also especially for /ʁ/ up to the age of 3;0 years. The replacement of /ʁ/ has also been reported by Nettelbladt (1983) as often found in South Swedish children. Since vowels in initial position are necessarily accompanied by glottal stops in German (Kohler, 1995, Wiese, 1996), the replacement of a consonant by a glottal stop in WI position was always accounted for as initial consonant deletion rather than glottal replacement.

Deaffrication

Only the affricate /ts/ was reduced to [s] in more than 10% of the children. This could be found for all word positions up to the age of 3;0, but for the word initial position even up to the final age group. As described earlier the deaffrication of /ts/ in word initial position could be claimed to be a regional variation for German spoken in the North and it can therefore be excluded from the list of developmental processes.

Vocalization of /l/ in Word Final Position

Vocalization of /l/ was defined as the substitution of a vowel for /l/, i.e.: [ʃtue] for /ʃtul/ *Stuhl* (chair). This process only appeared in WF position and was observed up to the age of 2;5.

Interdentality

This process was defined as /z/ or /s/ being replaced by [ð] and [θ]. It can be argued that this kind of substitution is not a phonological process but an articulatory variation that does not affect phonology, since the substituted phonemes are not part of the German phonological system. As shown earlier in this Chapter, about 35% of the children still distort /z/ or /s/ in the oldest age group. It is suggested that this phenomenon will still be present in older children and adults and further research on this topic needs to be carried out.

2.4. DISCUSSION

The development of a phonology in German-speaking children aged 1;6 to 5;11 has been described in terms of overall error rate, percentage phonemes correct, order and age of phoneme acquisition and developmental phonological processes. This discussion sets out to investigate how far findings from this study agree with data from earlier studies on phonological acquisition in German-speaking children. The discussion of the hypotheses made in Chapter 1 concerning this data will be postponed until Chapter 7. This was decided in order to present a theoretical interpretation of issues concerning cross-linguistic comparison and the testing of phonological theory in a combined discussion for both parts of this thesis: normative data and data from speech-disordered children.

As expected children of the youngest age group made the highest number of errors in phoneme production, which in the course of development dropped to 1.92%. This pattern reflects the acquisition and mastery of more and more phonemes over time. Once children are over 3 years of age, the mean error percentage in all word positions dropped below 10%. Word final position was more prone to error than word initial position, since the PCI in word final position continued to be higher than the PCI in word initial position. With a low final error rate at the age group 5;6 – 5;11 years the

acquisition could be seen as completed and stabilised. Errors accounting for the final percentage of 1.92%, and for the majority of errors in earlier age groups, were those involving the phonemes /s/, /z/ and /ts/, which appeared fronted to /θ/, /ð/ and /tθ/. Since these substitution sounds are not part of the German phonemic inventory this phenomenon was concluded to present a phonetic rather than a phonemic problem. Further research is needed to clarify whether older children ever acquire the correct production of these sounds.

According to our findings German-speaking children have acquired the majority of all phonemes except /ts/, /ç/ and /ʃ/ by the age of 3;5 years (90% criterion). The acquisition of the phonemic inventory was found to be completed by the age of 4;11. These findings mostly agree with results provided by Elsen (1991), even though her subject was able to produce all phonemes correctly at the earlier age of 2;5 to 3;0 years with only minor phonetic distortions. Three factors could explain Elsen's (1991) findings of an earlier acquisition pattern: firstly, data were collected in a longitudinal study, which could lead to more precise results, since more data per phoneme are available. Secondly, the relationship between subject and examiner was that of mother and daughter. It is possible that the high emphasis on language due to the mother being a phonetician and being highly interested in child's speech had a supporting influence on the speed of acquisition. Thirdly, the different findings could just be due to the well-known variability in phonological acquisition in young children, which has already been stressed by several authors (see Vihmann & Vellemann, forthcoming). Analysis of data from individual children in our study revealed that some children between the age of 2;3 and 2;7 years also showed an already complete phonemic inventory.

Concerning the order of acquisition Elsen (1991) described the following patterns which were supported by our study:

1) plosives + nasals	>	fricatives,	2) voiced phoneme	>	voiceless phonemes
3) front phonemes	>	velars,	4) single consonants	>	clusters

The pattern of voiced phonemes appearing before voiceless ones could only be supported for the phonemes /p/ and /k/ while /d/ and /v/ were acquired before their voiceless counterparts, a phenomenon which will be discussed in detail in Chapter 7.

In comparison with the study by Fongaro-Leverin (1992) there is little agreement on the age and order of acquisition between our findings and her results. According to her study the process of acquisition (75% criterion) was not completed by the age of 4;5 years. Furthermore, only a third of the phonemes were reported to be acquired around the same age as found here. The finding of a rather late completed phonological acquisition by Fongaro-Leverin (1992) could be assumed to be caused by the small number of children assessed per age group and imprecise exclusion criteria in order to avoid subjects with a speech disorder.

Möhring's (1938) predicted hierarchy of sound acquisition, based on the percentage of correct production per sound in children with speech disorders, was basically supported. Discrepancies could only be found for two sounds per acquisition criterion set (75% criterion: /pf/ and /ʁ/; 90% criterion: /h/ and /v/).

Even though a different criterion was used in order to define a phoneme as acquired and not all phonemes were considered or described individually, a comparison based on the 75% criterion reveals only minor differences between this study and the one by Grohnfeldt (1980). Because of this and because his study was carried out in the South of Germany it seems possible to accept this chapter's data as valid across Germany.

From a phonological error pattern point of view, findings from this study in general agree with those from earlier studies. Differences were minor and will be assumed to be caused by three factors. Firstly, the assessed children's ages for some studies differed significantly from the ones in this study. Children in some earlier studies were considerably younger (e.g. Elsen, 1991; Stern & Stern, 1928; Ament, 1899).

Therefore, they might have shown patterns which could no longer be observed in the children assessed here. Secondly, the criteria set in order to mark a pattern as present differed and other studies might therefore include error patterns which were excluded here due to the strict criteria. Thirdly, longitudinal versus cross-sectional studies require and allow different criteria in order to observe developmental error pattern. Single case studies do not allow the same data comparison as cross-sectional studies and might lead to findings that are not representative.

However, one of the few differences found shall be mentioned. It concerned the pattern of cluster reduction. Three different patterns were found to operate in German-speaking children:

- In clusters such as /k/ + /v, n/ and /ʃ/ + /X/, the first element was deleted.
- In clusters such as Plosive/ /f/ + /ʁ/ the second element was deleted.
- In clusters such as Plosive/ /f/ + /l/ either the first or the second element was deleted.

A similar mixed pattern as described by pattern 3) was also found by Fongaro-Leverin (1992), in contrast to data by Elsen (1992) and Lleò & Prinz (1996), which showed a pattern as described for English, where /l, r w j/ are deleted post-consonantally. The difference in results between this study and the one by Lleò & Prinz (1996) could be caused by the age of the children assessed. Their study was carried out on five children between the age of 0;9 – 2;1 years, which only includes our first age group. The cluster production at this stage is very limited due to the limited vocabulary of these children; a larger vocabulary would possibly change the picture.

In the Anglo-American literature the most common tool used to evaluate and plan intervention for the speech of children with a functional speech disorder is the analysis of the child's speech via phonetic and phonemic inventories and phonological process use (e.g. Grunwell, 1985; Grundy & Harding 1989; Gierut, 1998). Dodd (1995) proposed that children with speech disorders can be sub-grouped

on the basis of their surface speech error patterns. One important factor for differential diagnosis is whether the surface speech error patterns found reflect the pattern of a normally developing child of a younger age or whether at least some of the phonological processes found are idiosyncratic rather than developmental. This Chapter presented data that forms a normative baseline for the analysis and differential diagnosis of children with developmental speech disorders. Chapter 3 will discuss the theoretical issues relevant to speech disorders, such as classification models, while Chapter 4 presents a classification study of one hundred children with speech disorders based on surface speech error pattern.

PART II

SPEECH DISORDERS IN GERMAN-SPEAKING CHILDREN

CHAPTER 3

Literature review: diagnosis, classification systems and intervention for speech disorders

INTRODUCTION

Chapter 2 suggests that German-speaking children can be expected to have acquired their phonological system by the age of five years. However, approximately 3 - 10% of children (National Institute on Deafness and other Communication Disorders, 1994; Gierut, 1998) fail to follow the process of normal speech acquisition in terms of age or pattern of acquisition, which can include the use of idiosyncratic error patterns. A higher percentage of about 20% in four to six year old children is reported for Germany (Wirth, 1990; Wendler Seidner, Kittel & Eyshold, 1996). The children show various patterns of speech disorder. It is usually at the age of 4;0 years that parents, nursery nurses or paediatricians start to become concerned and children are referred to speech and language therapists.

Children with developmental speech disorders often make so many errors of pronunciation that their speech is difficult or impossible to understand. Their mispronunciations do not necessarily reflect how children typically acquire speech in terms of the chronology of acquisition or the types of substitutions and omissions of speech sounds made. The analysis of the speech error pattern is of clinical importance for each individual child but these data also provide information concerning two theoretical issues:

1) It has been argued that the development of speech is universal, i.e. that similar, though not identical, developmental errors characterise all languages (Stampe, 1969; Jakobsen, 1941,1968; Hacker & Weiß, 1986; Tobin, 1997). One question addressed by theorists and researchers concerns the extent to which the phonological structure of a language influences the phonological error patterns made by a child (Ingram, 1991). Cross-linguistic studies can provide evidence for the influence of a variety of factors on phonological development (e.g. Kamhi, 1992). If the nature of normal phonological development shows universal tendencies, then the nature of

developmental speech disorders might also be universal. According to So & Dodd (1994) "comparisons of phonologically disordered children who are acquiring different languages should (...) provide evidence concerning the effect of the ambient language on disordered development" (p.238).

2) Various deficits have been hypothesised as underlying speech disorders. If children growing up with different languages show similar error patterns of speech disorder, data from cross-linguistic research can test hypotheses about proposed underlying deficits. This again could provide support for the aspect of universality in speech disorders, since hypothesised underlying deficits are language-independent.

From the clinical point of view, Part II of this thesis aims to add support to the most important and basic goal of speech and language therapy: the provision of highly efficient treatment for patients with communication disorders. It is assumed that treatment efficacy is highly dependent on knowledge about phonological disorders. The factors that should be investigated are as follows:

1. Do children with developmental speech disorders a) form a homogeneous group, or b) is it possible to classify these children into subgroups or c) does every child present with an individual, not classifiable, pattern of disorder?

2. What kind of classification systems for children with developmental speech disorders exist and what kind of information (e.g. etiological, linguistic, psycholinguistic) is required by the different systems for classification? What are the suggested deficits underlying different models? What is known about the applicability of these models to other languages?

3. Are risk factors such as pre-and perinatal problems, middle ear involvement, positive family history, psychological involvement etc. present in all children with

speech disorders and are these factors necessarily associated with speech disorders?

4. What is known about developmental speech disorders from languages other than English? Does this knowledge support the hypothesis of universality in speech disorders?

5. What information is available about German-speaking children with speech disorders? What classification models are currently used? What kind of therapy provision is available for children with speech and language problems?

6. Do children with developmental speech disorders benefit from treatment and which approaches have been shown to be beneficial for English-speaking children? On what basis should treatment approaches be chosen for a child?

These questions provide the framework for this Chapter's review of literature.

3.1 DIFFERENTIAL DIAGNOSIS OF SPEECH DISORDERS

The terminology referring to children whose speech is difficult to understand has undergone several changes in the past. These changes reflect the change in views about underlying deficits and the "change in the prevailing model on which the classification of children's speech and language disorders is based." (Lambert & Waters, 1995 p. 96) Thirty years ago, the terms most commonly used were *articulation defect* and *functional articulation disorder*. These terms reflected the view that the underlying deficit was of a peripheral, articulatory nature. The term *functional* denoted that no organic defect was present. Intervention at this stage focused on the treatment of each mispronounced speech sound, targeting, place, voice and manner of the sound (Elbert, 1997). However, this approach was questioned by research investigating children with speech disorders from a phonological theory perspective. McReynolds & Hustonas (1971, cited by Elbert (1997, p.45) concluded from their study that "articulation problems cannot be regarded solely as problems in motor production; they also consist of inappropriate phonemic rules. Inappropriate use of features contributes considerably to the articulation problems of these children." Influenced by emerging phonological theory such as generative phonology and natural phonology, continuing research increasingly incorporated more and more knowledge about phonology into the analysis of children's speech disorders.

During the following years the cognitive neuro-psychological and psycholinguistic models, "which view a child's speech problem in terms of breakdowns in aspects of input processing, output processing and internal representation, have begun to influence terminology and understanding of the nature of developmental speech disorders" (Lambert & Waters, 1995 p. 97). These new models stress that the opportunities for breakdown do not lie in only one area, but that different parts of the speech-processing chain can be affected.

A change of terminology has occurred that marks the acceptance of a psycholinguistic approach to speech disorder. The terms *phonological impairment, disorder or disability* are now common. However, the meanings implicated by this terminology vary. As cited by Gibbon (1999), Stackhouse (1993) refers to the term phonological disorder only in a descriptive sense expressing a speech output difficulty "that involves a neutralisation or loss of phonological contrasts, regardless of the underlying cause" (p.383). Conversely the term is very frequently used as a diagnostic label, implying a specific underlying breakdown on the cognitive level concerning linguistic knowledge and organisation (Grunwell, 1990). In this thesis the later point of view will be adopted and the following terminology will be used:

Speech Disorder will be used as the generic term for all children with developmental speech disorders of unknown origin (*functional*). The term does not imply any underlying deficit.

Phonological Disorder will be used for a specific subgroup of children with developmental speech disorders. The term implies an underlying breakdown on the cognitive level concerning linguistic knowledge and organisation as stated by Grunwell (1990).

Articulation Disorder will again be used in order to refer to a subgroup of children with developmental speech disorder. It is seen as a synonym for the frequently used term phonetic disorder (Hewlett, 1985) implying an underlying deficit of peripheral nature.

The terminology just described implies that children with developmental speech disorders do not form a homogeneous group. They differ in severity, etiology, symptomatology and response to treatment. The need to classify subgroups of children with speech disorders has been widely accepted (Shriberg, 1982; Dodd,

1993, Stackhouse & Wells, 1997; Gibbon, 1999), yet the discussion as to which classification system should be preferred is ongoing.

Three classification methods have been predominant, of which two (an etiological and a psycholinguistic approach) will be investigated in detail throughout this thesis:

Medical-etiological orientated approaches

A number of medical conditions have been found to be related to speech and language disorders, such as cerebral palsy, severe hearing deficits, cleft palate, and a number of syndromes, e.g. Down Syndrome (Byers-Brown & Edwards, 1989; Rhea, 1995; Gerber, 1998). However, even though these conditions are important as part of the differential diagnosis, most children with speech disorders do not show any form of unusual developmental or medical history (Dodd, 1995; Stackhouse & Wells, 1997).

Clinical-inferential/linguistic-descriptive approach

A more successful approach has been the clinical-inferential analysis of a child's speech data. This includes an examination of the child's pronunciation pattern and phonological errors. Since this approach describes children's speech errors using linguistic tools, it is also often referred to as the linguistic-descriptive approach (Stackhouse & Wells, 1997). Even though an assessment procedure of this kind should "provide some framework for the identification of different types of disordered pronunciation patterns in children" (Grunwell, 1985, p.3), they lack explanations as to the underlying deficit of the disorder types.

Psycholinguistic methods

Psycholinguistic models, as mentioned previously, focus on this problematic lack of explanation by viewing children's speech problems as derived from the breakdown at one or more levels of input, stored linguistic knowledge, or output as stated by

Stackhouse & Wells (1997). Stackhouse & Wells (1993, 1997), for example, provided a framework which is described as a "clinically usable and needs-driven framework for investigation that draws upon psycholinguistic theory" (Stackhouse and Wells, 1993, p.333). It allows the analysis of each individual child's specific speech processing, based on psycholinguistic assessment tasks. The framework distinguishes between the different levels of possible breakdown but also identifies the child's intact abilities. On the basis of a child's weaknesses and strengths profile, an individual remediation program can be designed. In addition to the psycholinguistic information drawn from their framework, they stress the importance of etiological information and the need for an analysis of surface error patterns, in order to select the appropriate sounds for each child which will be targeted by certain intervention tasks.

Other psycholinguistic approaches argued that it is possible to group children with speech disorders in contrast to seeing them only as individuals. They classify children within the speech-disordered group according to their differences in terms of severity, type of error patterns observed and response to treatment. Different subgroups were described by several authors, like "delay" (Fletcher, 1990), "consistent but unusual (non-developmental) errors" (Leonard, 1985) and "inconsistent errors" (Dodd & Leahy, 1989). These differences prompted research into the nature of the underlying deficits in the speech-processing chain which led to the proposal of different psycholinguistic models.

According to Dodd (1995) research findings suggest that it is possible to identify the underlying deficit of a child's speech disorder from an analysis of surface error patterns. This analysis is typically based on several elements:

Description of the phonetic inventory of a child: does the child show an age appropriate phonetic inventory, i.e. is the child able to produce the age appropriate phones of his language individually?

Description of the phonemic inventory of the child: is the child able to produce the phones of his native language in a correct phonemic context?

Description of the phonological error patterns: what kind of phonological error patterns are observed? Are the error patterns developmental or non-developmental/ idiosyncratic? In the clinical literature the terms 'phonological processes', 'phonological rules' and 'error pattern' are used interchangeably. In this thesis the term 'error patterns' is used exclusively unless in citations of other authors or in reference to phonological theory. This term was chosen to imply its purely descriptive use.

Description of the syllabic structures used: are children able to realise the correct syllable structure the words in their vocabulary require?

Description of the consistency in sound production: This fairly new assessment procedure is not yet part of typical assessment procedures. It is included here since its results have implications for a classification approach described later. The child is asked to name the same set of pictures (e.g. N = 25) at different stages during a session three times. Is the child consistent in the way words are realised or do the realisations differ from each other?

3.1.1 Classification system by Dodd

The first classification model presented will follow a psycholinguistic method. A recent study of 50 Australian-English-speaking children with phonological disorder (Bradford & Dodd, 1996) has suggested that speech disorders can be classified into four subgroups in terms of surface error patterns that reflect different underlying deficits in the speech-processing chain.

- **Articulation Disorder**

  The consistent mispronunciation/distortion of a phoneme in isolation or any other phonetic context resulting from an impairment of the 'processes involved in the planning and execution of smooth sequences of highly overlapping gestures of the speech organs' (Fey, 1992).

- **Delayed Phonological Development**

  "A classification of delayed phonological acquisition is warranted when all phonological processes derived to describe a child's speech errors occur during normal development but are typical of a younger chronological age level" (Dodd, 1995 p.55). A delay of six months has been suggested to be significant (Crystal, Fletcher & Garman, 1989)

- **Deviant-Consistent Phonological Disorder**

  Children should be classified as having a deviant-consistent disorder if at least one of the error patterns they use are non-developmental (i.e. processes not found in normal phonological development) or occur on phonemes that are not affected by this pattern in normally developing children. For example: in German the process 'final consonant deletion' (FCD) occurs in normally developing children only on [t k l]. FCD is idiosyncratic if it occurs on any other final consonant. Similarly 'backing' is only a developmental process when applied to sibilants. However, it is idiosyncratic if it occurs on alveolar plosives or nasals. "Most children who use non-developmental rules also use some developmental rules that may, or may not, be appropriate for their chronological age. They should nevertheless be classified as having a 'deviant-consistent disorder', since the presence of unusual processes signals an impaired understanding of their native phonological system" (Dodd, 1995 p.56)

- **Inconsistent Phonological Disorder**

  Children who do not consistently pronounce the same lexical item in the same way in one word elicited utterances fall into the subgroup of inconsistent phonological disorder. Children are classified as inconsistent if their inconsistency rate is greater than 40% on a specific test of the same 25 lexical items produced on three separate trials in one assessment session (Dodd, 1995). Forty percent inconsistency is an arbitrary criterion selected because normally developing children (who have a vocabulary of more than 50 words) show inconsistency of less than 10% and children with phonological delay and deviant-consistent disorder show inconsistency of less than 30% (McCormack & Dodd, 1998).

Experimental studies comparing the three phonologically impaired subgroups (Dodd, Hambly & Leahy, 1989) provided an initial validation of the classification. Further experiments suggested that the use of non-developmental rules in children might be attributed to an impaired ability to abstract knowledge about the nature of the phonological system to be acquired. Children whose speech is characterised by the use of non-developmental error patterns perform more poorly than the other subgroups on tasks assessing rhyme and alliteration awareness, awareness of phonological legality and literacy measures (Dodd & McCormack, 1995). This would seem to reflect a cognitive difficulty which lies at the organisational level of the speech chain (Grundy, 1989). The classification has been further validated by Leitão, Hogben & Fletcher (1997) who found the same subgroups in their group of English-speaking subjects with speech disorders, the deviant-consistent subgroup being those most likely to experience difficulties in the acquisition of literacy.

In contrast, children who make inconsistent errors seem to have an intact phonological system. A series of experiments indicated that children classified as inconsistent perform as well as age matched, normally speaking controls on tasks

assessing phonological awareness, yet they perform poorly on tasks assessing phonological working memory (Dodd & Horsely, submitted), lexical measures (Dodd & McCormack, 1995) and motor planning (Bradford-Heit, 1996).

3.1.2 Classification System by Shriberg

A second classification system frequently cited in the literature is that by Shriberg. In contrast to most approaches, Shriberg's classification system (Shriberg & Kwiatkowsky, 1982; Shriberg, 1993; Shriberg, 1994; Shriberg & Kwiatkowsky, 1994; Shriberg, Austin, Lewis, McSweeny & Wislon, 1997a) is based specifically on etiological factors. He argues in favour of an etiological model because:

> "Recent findings from several research groups suggest that the traditional concept of developmental phonological disorders as functional disorders of unknown origin is incorrect. Several independent studies support familial aggregation, which means that the origins could be found in a common genotype or common environment, most likely in the former, considering the weight of evidence for genetic factors in the variety of other childhood area (e.g., reading disability, psychosocial problems" (Shriberg, 1994, p.44).

Shriberg suggests that a number of factors (not only genetic ones) might play a causal role in the search for the origins of developmental speech disorders. According to Shriberg (1994) five subtypes need to be distinguished:

- **Speech Delay (SD; possibly genetic)**

  The biggest group of children referred because of suspected phonological disorder of unknown origin fall into the subgroup of *speech delay*. Parental report data from studies by Shriberg and colleagues suggest that as many as 60% of children with SD have one or more nuclear family members who have or had a speech disorder.

- **Speech Delay associated with Otitis Media with Effusion (SD + OME)**

  Children in this subgroup must have had at least six episodes of recurrent otitis media with effusion in the first three years of life. Additionally, most children show evidence of fluctuating hearing loss. Children are supposed to show a specific speech-error profile "reflecting the phonological consequences of the ages at which they experienced fluctuant hearing loss" (Shriberg, 1994, p.46). About 30% of all children referred are supposed to fall into this category.

- **Speech Delay associated with Developmental Apraxia of Speech (SD + DAS):**

  "'In addition to developmental errors similar to those made by children with SD, these children seem to have problems selecting and sequencing speech sounds and present with a different prosody pattern" (Shriberg, 1994, p.47). About 3 - 5% of all children with developmental phonological disorders are expected to show SD + DAS.

- **Speech Delay associated with Developmental Psychological Involvement (SD + DPI).**

  The claim for this subgroup is that distinct speech and prosody-voice errors can be found which are different from the children in the core SD group. It is suggested that about 5 - 7% of children meet this criterion and that the disorder is of a transient nature, reflecting a response to environmental stress.

- **Residual Articulation Errors (RE)**

  The subgroup of *Residual Articulation Errors* covers articulation distortion errors persisting in children after the age of six (when the errors should be classified as questionable) or at the age of nine years. Approximately 5% of children should show residual errors.

The central feature for all children with speech disorders is the either transient or persistent involvement of cognitive-linguistic functions (Shriberg, 1994). Depending on the subtype of speech disorder, the outcome over time and following intervention should be different. The classification system is based on several studies that investigated risk factors in children referred for speech and language assessment. The risk factors mentioned in the five subgroups were the most frequently found factors in this population. Unfortunately, as Shriberg (1993) states, no data have been available to investigate whether these factors differentiate children with speech disorders from normally developing populations. The following section presents further research carried out to investigate the relationship between the risk factors mentioned by Shriberg and speech disorders. The aim is to establish whether support for an influential relationship exists or whether, so far, research has not been able to answer this question.

3.1.3 Risk Factors and Speech Disorders – Literature Review

The risk factors mentioned by Shriberg have been frequently investigated: genetic origin, otitis media and less predominantly psychological involvement:

Genetic origin

Case histories often reveal a positive family history of communication disorder. Between 28 and 60 percent of children with a speech and language deficit have a sibling and/or parent also affected by speech and language difficulties (e.g. Bishop & Edmundson, 1986; Lewis, 1992; Tallal, Ross, & Curtiss, 1989; Whithehurst, Arnold, Smith, Fischel, Lonigan, Valdez-Menchaca, 1991). This incidence is significantly higher than that found in control populations. Male family members are affected more than female ones. However, most of the data have been obtained from language-disordered children only and not from children with isolated speech disorders. Lewis & Freebairn (1997) hypothesised that children with a positive family history of speech

disorder would form a specific group within the speech-disordered population. Their findings did not support the hypothesis. They looked at measures of articulation, phonology, language, oral-motor skills, and literacy. No significant differences were found between children with and without a family history of speech disorder. Nevertheless, it was concluded that a positive family history could still "serve as a risk factor that allows early identification and therefore the possibility of early intervention for children whose families demonstrate familial aggregation of disorders" (p. 398).

Otitis media

About 80% of all pre-school children in the Netherlands experience one or more episodes of AOM (acute otitis media) or OME (otitis media with effusion) (Grievink, Peters, van Bon, & Schilder, 1993). There is no reason to assume that these findings are different in any other Western country. During these episodes, children experience fluctuating hearing loss, usually between 20 and 50dB (see Gravel & Nozza, 1997 for review), affecting the amount and quality of speech and language perceived. Numerous studies have reported a possible causal connection between otitis media, with or without effusion, and later speech and language development. Five major articles have recently reviewed the existing literature (Pagel Paden, 1994; Roberts & Clarke-Klein, 1994; Roberts, Burchinal, & Davis, 1991; Roberts, Wallace, & Henderson, 1997; Schwartz, Mody, & Petinou, 1997). The reviews concluded the following:

- Some, but not all, children who have experienced episodes of middle ear infection have speech and language disorders.
- Not all children who have speech and language disorders have experienced middle ear infections.
- No measures have been determined, as to what can predict a negative influence on speech development, neither concerning the time (only during

the first year or also later), the number (one or two versus at least six) or the length of occurrence.

- Some middle ear infections are 'silent', so that their occurrence might not be noticed.
- Parents, who are the most common source of information for studies, have been found to be not necessarily reliable in their memory. Furthermore, their awareness of terms such as "long", "many" or "serious" varies greatly.

In summary, to date research has not been able to establish clearly whether middle ear infections necessarily have a negative effect on speech and language development. It is, therefore, questionable whether the criterion set by Shriberg and his colleagues can actually be accepted as a predictor for speech difficulties and whether their data is reliable, since they rely exclusively on parental report.

Psychological involvement

It is often difficult to distinguish between causal and consequent psychological factors in children with communication disorders. Few research studies have addressed the issue and the results are 'suggestive' (Shriberg, 1994, p.48) rather than clear-cut. Even in areas such as child neglect and abuse, the literature is limited, although it is thought to demonstrate a negative effect on speech and language acquisition (e.g. Allen & Oliver, 1982; Culp, Watkins, Lawrence, Letts, Kelly & Rice, 1991; Egeland, Stroufe, & Erickson, 1993; Law & Convay, 1992). No study so far has focused on children with isolated speech disorders. Thus the effects of different psychological factors on speech development require further research.

Another risk factor that has frequently been mentioned and investigated in connection with speech and language deficits is pre- and perinatal problems including preterm birth and low birth weight. Even though they do not occur in Shriberg's etiological

model they will still be considered here because of their importance in the general literature.

Pre- and perinatal problems

A specific causal connection between pre- and perinatal difficulties and speech and language disorders has also yet to be established. Infections during pregnancy, preterm birth and low birth weight have been reported to have negative effects on speech and language development (Byers-Brown & Edwards, 1989; Gerber, 1998; Peters, Grievink, van Bon, van der Bercken, & Schilder, 1997; Tomblin, Hardy, & Hein, 1991; Tomblin, Smith, & Zhang, 1997). However, Bax & Stevenson (1982) and Menyuk, Liebergott, & Schultz (1986) found no significant differences between preterm and low birth weight children and controls. While most studies have focused on children with a language disorder, Byers-Brown, Bendersky, & Chapman (1986) reported a significant delay in the speech sound acquisition of preterm children. Further studies are needed that focus on children with an isolated speech disorder.

In summary, the relationship between risk factors and speech and language development remains unclear. Furthermore, most studies have focused on children with combined speech and language or isolated language disorders only and so might not be representative of children with isolated speech disorders. Even the several studies by Shriberg (1993, 1994) and Shriberg et al. (1994, 1997a) do not completely account for the amount of influence risk factors have on speech disorder as there is no normative control data. Further research is needed that includes a control group of normally developing children.

Additionally, nearly all studies mentioned in the previous sections have focused on English-speaking children growing up in either Great Britain or North America. Very little is known about the occurrence of risk factors in speech disordered children growing up in other countries. Since no major cultural differences should be expected

between these countries and other western European countries, patterns of occurrence as described by Shriberg (1993, 1994) should be similar. It should therefore be possible to classify a large group of children growing up in Germany according to his classification model. The validity of Shriberg's model will be tested and the results reported in Chapter 5. Psycholinguistic classification models such as the one by Dodd (1995) should also be applicable to languages other than English.

3.2 CROSS LINGUISTIC STUDIES: SPEECH DISORDERS IN LANGUAGES OTHER THAN ENGLISH

Research into speech disorders has mostly focused on English-speaking children. So far little evidence from languages other than English exists. Studies have been carried out on speech disordered children speaking Italian (Bortolini & Leonard, 1991), Portuguese (Yavas & Lamprecht, 1988), Swedish (Nettelbladt, 1983), Cantonese (So & Dodd, 1994) and Turkish (Topbas & Konrot, 1996), Spanish (Goldstein, 1996) and Putonghua (Zhu Hua & Dodd, 2000b). Several case studies on speech disordered bilingual children have been carried out by Holm (1998). Most of these studies consisted of very small numbers of subjects (4-20 children). Nevertheless it was found that the error patterns which have been described as most frequent in the speech disordered children of different language origins are similar across languages. Furthermore, these patterns can also be observed in normally developing children of the same languages (Yavas, 1998, p.219 and see Table 1.4 in Chapter 1).

These findings argue for universality from two angles: the similarity in error pattern usage in speech disordered and normally developing children and the similarities across speech disordered children acquiring different languages. Phonological theorists aiming to account for similarities of phonological development across languages (i.e. similarities in developmental error patterns) have argued that language independent, universal and innate prerequisites must be responsible for phonological

development (see Chapter 1 for detailed description). For example Murai (1963) and Mowrer (1960) argued for general learning abilities driving the process of speech development. Cognitive models argue for the natural abilities of perception and production to govern the course of development and Locke (1983) favours a maturation model. Further authors such as Jakobson (1941, 1969), Stampe (1979) and the non-linear phonologists argue for innate universal linguistic knowledge. The similarities in error pattern usage across children with speech disorders and normally developing children could therefore be interpreted in terms of identical universal prerequisites existing in both groups of children. Accepting the theory of innate, universal prerequisites, it can be argued that speech disorders are either caused by a defect of these prerequisites (defect of perception or production abilities, genetic defect etc) or that postnatal factors, which disturb the development and the expansion of the innate system must be operating (disturbed perception or production abilities, deprived learning environment, disturbance of maturation). In both cases defects and disturbances causing speech disorders are not connected to the ambient languages learned and should therefore lead to a universal pattern of disorders.

The findings that children with developmental speech disorders, independent of the language they acquire, have been reported to show very similar error patterns supports the hypothesis just drawn. If the hypothesis holds, then it should be possible to apply classification systems which are based on underlying deficits of the speech disorders across different languages.

Four studies have investigated whether the classification for English, proposed by Dodd (1995), is actually applicable to other languages: So & Dodd (1994), Topbas & Konrot (1996), Goldstein (1996) and Zhu Hua & Dodd (2000b). In general the studies supported the subgroup classification. Goldstein (1996) found no children with inconsistent errors, but he did not test for consistency. As shown by Table 3.1 the distribution pattern (percentages per subgroup) was similar across the languages

assessed. Too few Turkish-speaking children were assessed to describe distribution patterns.

Table 3.1 Distribution pattern (percentages per subgroup) found across languages assessed

	English	**Cantonese**	**Putonghua**	**Spanish**
No of children	55	17	33	20
Articulation	14%	12%	3%	10%
Delay	58%	47%	55%	65%
Deviant	12%	29%	24%	25%
Inconsistent	16%	12%	18%	n.a.

The primary purpose of the study, which will be reported in Chapter 4, is to investigate whether the four hypothesised subgroups of speech disorders (Dodd, 1995) can also be found in German, as a second West-Germanic language, in a large-scale study. These data would provide further evidence concerning the classification of speech disorder and its universal nature.

3.3 SPEECH THERAPY PROVISION IN GERMANY AND SPEECH DISORDERS IN GERMAN-SPEAKING CHILDREN

There is a dearth of research into paediatric speech and language therapy in Germany. Data currently available describing speech-disordered children are insufficient to evaluate classification systems. This section aims to set the data, to be presented in the Chapters 4-6, into the context of existing research and classification approaches for children with speech disorders in Germany. To provide a better understanding of the situation, a brief description of speech therapy provision will be given.

As previously mentioned, there are currently two groups of speech and language therapists in Germany. This has implications for research and for the classification of speech disorders. The first group, Logopedics, treats people with all kinds of communication impairments. Their training, at Colleges or Polytechnics, is practically orientated and they do not gain a university degree. All referrals to Logopedics are via a medical route and must come from either a paediatrician, ENT-specialist, phoniatrist or neurologist. The second group, Sprachheilpädagogists, is educated at University and may be employed in language units, nurseries, and schools for speech and language impaired children. Their focus lies on the educational aspects of children with speech and language problems. Both groups are employed predominantly in clinical work, rather than universities where research is done. Consequently, research is rare and the theoretical knowledge base underdeveloped. Textbooks in the area of Logopedics are usually designed and written by phoniatrists who are ENT-medical doctors specialising in speech, language and voice disorders. However, they rarely carry out research in child speech and language disorders and the literature therefore grows slowly.

In the German Logopedics' literature, speech disorders are referred to as 'Articulation Disorder' or 'Dyslalia' and sometimes even "Stammeln" (stammer). The distinction between phonological and phonetic disorders was initially described by Scholz (1974), and more recently by Dickmann et al (1994), Hacker (1992), Böhme (1997) and Hacker & Wilgermein (1999). Speech disorders are still, however, mostly classified according to severity (e.g. Van Riper, 1984), etiology or co-existing symptomatology (Wirth, 1990; Biesalski & Frank, 1994; Böhme, 1997). All types of classification systems are used in parallel. Treatment is typically based on articulation therapy approaches (e.g. Van Riper, 1963) and more recent, but rarely applied, approaches are based on translations of English work (e.g. Metaphon: Jahn, forthcoming). Consequently there is a need for research to establish the extent to

which diagnostic categories developed from research on English-speaking children are applicable to monolingual German-speaking children.

Two studies have assessed the distribution of phonological processes in speech disordered children. Hacker & Weiß (1986) described the phonological processes of 15 speech-disordered children aged 5 - 7 years (see Appendix III). They found that 90% of all errors were substitutions, while only 8.11% were deletion and 3.8% were assimilation errors. The processes most frequently identified were cluster reductions and changes, fronting, stopping and backing processes. One aim of their study was to identify processes reflecting delayed or deviant acquisition, but this could not be achieved since normative data are limited.

Romonath (1991) assessed 35 children aged 5;3 – 7;2 years and compared the number and types of phonological processes of speech disordered children with an age-matched normally developing control group. She found that the speech disordered group used a greater number of processes and that about a quarter (25.9%) of these processes could not be found in the speech of normally developing children of the same age. The processes described as occurring most frequently were velar fronting, backing of consonants, prevocalic voicing, alveolar assimilation, stopping of liquids, obstruent devoicing, cluster reduction and final consonant deletion. For a complete list of processes mentioned by Romonath see Appendix III.

In Chapter 1 the study by Möhring (1938) was mentioned, because he drew conclusions about normal development from data on speech disordered children. He had investigated the vulnerability to error of each phone of German in about 1000 children and described a hierarchy of phone difficulty according to the percentage of incorrect production. Three groups of different difficulty level were identified which were presented in Chapter 1.

All studies had a primarily descriptive purpose and did not aim to subgroup children with speech disorders. The study carried out by Romonath (1991) additionally intended to evaluate whether there was a clear differentiation in phonological error pattern usage of speech output patterns between normally developing and speech-disordered children of the same age. However, her control data did not include material from children younger than 5;3, which would have made it possible to assess whether the speech disordered children used the same error patterns as younger, normally developing children. The study by Hacker & Weiß (1984) included no control data at all. Consequently, and because of a general lack of normative data on German, it has so far not been possible to establish whether German-speaking children with speech disorders fall into different subgroups according to their error patterns. Neither has any study ever aimed to apply any etiological classification system to German-speaking children with speech disorders.

The studies presented in Chapters 4 and 5 will, therefore, be the first to investigate the applicability of two different classification models to German-speaking children with developmental speech disorders of unknown origin. These studies could provide cross-linguistic evidence for either of the classification models described earlier and further support the hypothesis of universal features of speech disorders.

3.4 TREATMENT STUDIES

One further way of testing classification systems lies in treatment studies. Etiological or clinical-inferential classification systems have been criticised for not providing an explanation according to the underlying cognitive processes of a disorder that would allow selection of an appropriate treatment approach (Stackhouse & Wells, 1997). Psycholinguistic models, however, allow description of the area(s) of breakdown within the speech processing chain for each individual child (framework by Stackhouse & Wells, 1997) or children within subgroups of speech disorders (Dodd, 1995). Intervention should target the underlying deficit of a child's speech disorder,

implying the need for different approaches. If it is true that speech disorders and classification systems can be applied across languages, then it should be possible to apply intervention approaches shown to be beneficial for English-speaking children in each subgroup (Dodd, 1995) to children speaking any other language than English, e.g. German. If underlying deficits are indeed universal, the approaches should be equally beneficial. In the following section current Anglo-American intervention approaches will be described. Further, research will be presented that investigated the effectiveness of these approaches on the different subgroups hypothesised by Dodd (1995).

3.4.1 Current Intervention Approaches

A broad range of treatment approaches exists. They can be classified into two basic categories: the sensory-motor approach and the cognitive linguistic approach (Bernthal & Bankson, 1993). Intervention strategies used in the first category have existed longer and are therefore often called 'the traditional approach' (Fey, 1992; Gierut, 1998). They are based on the idea that articulation is a peripheral problem and focus on motor training supported by 'ear-training' and auditory bombardment (Van Riper, 1963). One further approach focusing on increasing a reduced phonetic inventory is called the '*stimulability approach*' (Powell, Elbert & Dinnsen, 1991; Powell, 1996). As argued by Miccio & Elbert (1996) "increasing the number of sounds in the phonetic inventory increases the number of possible contrasts that can be produced and subsequently increases intelligibility." The typically impoverished phonetic inventories of children with persistent disorders of speech sound production (Jaffe, 1986) reduce the children's intelligibility in addition to the number of error patterns used. The stimulabilty approach can therefore be seen as a prerequisite treatment before, or parallel to, phonological intervention if a child has a non-age appropriate phonetic inventory.

Cognitive linguistic approaches have criticised the sensory-motor approaches for simply teaching sounds rather than "facilitating cognitive reorganisation of the child's phonological system and his phonologically-orientated processing strategies" (Grunwell, 1985, p.99). Phonological intervention approaches were designed to nurture the child's system (Fey, 1992). A number of different approaches exist: such as '*minimal pair treatment*'. The goal of this approach is to teach the child that it is necessary to use two different sounds to signal differences in meaning between words. A second approach is '*Metaphon*' (Howell & Dean, 1995). This aims to increase metalinguistic awareness as a means of facilitating phonological change and improved sound production.

One further approach is called *phonological treatment in cycles* (Hodson & Paden, 1991), which like a traditional approach involves auditory bombardment in conjunction with sound production. However, it emphasises groups of sounds affected by phonological rules, rather than individual sounds. All sounds in error are introduced in turn in successive treatment sessions. In each cycle all of the child's error patterns are treated. According to the name 'phonological approach', all types of phonological disorders are targeted in the same way.

However, treatment studies investigating the outcome of different approaches on different subgroups of speech disorders show that a differentiation is necessary. Dodd & Bradford (2000) found that children with a deviant-consistent phonological disorder benefited, as hypothesised, from a phonological approach focusing on phonological error patterns. This finding was supported by other studies (Dean, Howell, Waters & Reid, 1995; Leahy & Dodd, 1987; Holm, 1998). Children with an inconsistent phonological disorder showed the most improvement when their consistency of production was targeted. This was done using a core-vocabulary approach that teaches a small vocabulary of functional words that are to be produced

in a developmentally appropriate way (Dodd & Iacono, 1989; Dodd & Bradford, 2000).

Dodd & Bradford's study (2000) also reported that children with speech disorders can show more than one deficit in the speech-processing chain and should, therefore, benefit from two approaches. For example a child assessed as having a deviant-consistent phonological disorder also presented with an articulation disorder. Therefore, his sound distortions benefited from a motor-articulation approach called "PROMPT", while this had no impact on his phonological errors. A child diagnosed as having an inconsistent phonological disorder made progress with the core-vocabulary approach, which established consistency and then benefited from a phonological approach. It is necessary to bear in mind the possibility of two underlying deficits in one child when planing intervention. When treatment plateaus for some time the possible need for a second approach has to be considered.

The measurement of treatment effects is also dependent on the approach chosen. In the case of an articulation disorder, positive treatment effects should be measurable by the percentage of correct sound production in isolated sounds, syllables, words and spontaneous speech and by an increase in the correct phonetic inventory. In the case of a phonological delay or disorder treatment effects can be measured by 1) the percentage of correct phonemes/consonants across a single word naming test or spontaneous speech, 2) an increase in phonetic and phonemic inventory, 3) the number and types of error patterns used and 4) syllable structure changes. Finally for the group of inconsistent phonologically disordered children changes in the rate of consistency should form the most important feature. Chapter 6 will present two single case studies and one group study. The effect of different treatments, targeting different underlying deficits for three of Dodd's (1995) proposed subgroups will be investigated.

3.5 AIMS OF THE CURRENT INVESTIGATIONS

This chapter has provided the theoretical and research background for the studies that will be presented in Chapters 4-6. The literature review focused on knowledge about the nature and treatment of children with developmental speech disorders. It also investigated the current terminology in the field of child speech disorders. The review revealed the need for precise definitions for the terminology used, since many terms that might have different meanings are used interchangeably. Additionally, the way terminology is used often depends on the classification approach used by different authors referring to children with speech disorder.

A psycholinguistic (Dodd, 1995) and an etiological (Shriberg, 1993) approach were introduced. In connection with Shriberg's model the literature was reviewed to clarify the influence of risk factors on speech disorders. Findings from research indicated that, to date, no clear connection has yet been established.

Support for classification models can be provided by cross-linguistic research. Section 3.2 reviewed available research on children with speech disorders speaking languages other than English. The few existing studies provided evidence for similar cross-linguistic error pattern usage in speech disordered children and four studies described the successful application of Dodd's (1995) classification system. To evaluate whether German-speaking children follow the same pattern, the current literature about German-speaking children with speech disorders was reviewed. However, little research literature is available. No preference for one classification system was found, rather several systems were applied in parallel. The terminology of 'phonological disorders' has only recently been introduced, without clear definition. Studies concerning children with speech disorders were descriptive rather than explanatory.

The final section of the chapter described current knowledge about intervention approaches for children with speech disorders and the literature was reviewed to discover when each approach was found to be most beneficial.

3.6 HYPOTHESES FOR THE STUDIES PRESENTED IN CHAPTERS 4-6:

- The four subgroups of speech disorder proposed by Dodd (1995) will be evident in German-speaking children. The distribution percentages will also be similar (Chapter 4).
- If Shriberg's (1993) classification model is valid, it should also be applicable to German-speaking children. Children should, then, be classifiable according to risk factors (Chapter 5).
- German-speaking children with speech disorders should benefit from the same intervention approaches that have been successful for English-speaking children (Chapter 6).
- A precise diagnosis to identify the underlying deficit(s) of a child's speech disorder is necessary to apply deficit-orientated intervention. Intervention approaches ignoring the underlying deficit(s) should not be beneficial to the child (Chapter 6).

CHAPTER 4

OBSERVATIONAL STUDY: DESCRIPTION OF SPEECH DISORDERS IN GERMAN-SPEAKING CHILDREN

4.1 INTRODUCTION

This Chapter presents an observational study of one hundred German-speaking children with speech disorders of unknown origin. The hypotheses for this study are:

- German-speaking children with speech disorders can be classified according to four subtypes based on their surface error patterns: articulation disorder, delay, atypical error patterns and inconsistent errors. This hypothesis is based on the assumption of the universal nature of speech development and its disorders. The data will provide evidence concerning the validity of the classification procedure and the assumption of universality.
- The frequency of occurrence distribution of the four subgroups should be similar to the ones found for English (see Chapter 3).
- Differences in the use of error patterns between German, English and other languages should be found, since the phonetic inventory and phonological constraints of the languages differ (e.g. there is no /θ/, /ð/ → /s/, /z/ differentiation in German).

4.2 METHODS

4.2.1 Subjects

One hundred and ten children between the ages of 2;7 and 7;7 years were assessed. They had been referred to Speech and Language Therapy because of concerns about their speech. Most children (N = 79) were on the waiting lists at two private practices in Northern Germany and were randomly chosen for an appointment by the therapists of the practices for this study. Additional children (N = 31) were referred to the study by nursery nurses during the collection of data on normal speech development in kindergartens. Criteria for participation in the study were:

- Aged between 2;6 and 8 years
- Referred for assessment of suspected speech disorder

- No previous therapy
- No sensory impairment, organic motor disorder, cranio-facial anatomical anomaly or intellectual impairment
- Being monolingual in German
- No hearing loss detected at assessment

One hundred children proved to be suitable for the study. Ten were excluded for the following reasons: one child did not speak; two children named too few pictures to obtain an adequate speech sample; seven children no longer evidenced speech problems. There were 63 boys and 37 girls in the population. This proportion is reported to be commonly found in children with speech and language difficulties (Romonath, 1991).

4.2.2 Procedure

The children were assessed individually in a single session at the private practice to which they had been referred. The assessment took place in a quiet room with only the tester, the child and the mother (or parents) present. The session consisted of three parts: assessment tasks, free play, parental advice. The whole session was recorded on audiotape using a Sony Professional Micro Stereo Recorder for a second phonetic transcription of the assessment. During the assessment the mothers were asked to fill in a questionnaire about the child's developmental and medical history and for their permission to use all data anonymously in the study. At the end of the session the mothers were informed whether treatment was indicated and were advised how to deal with the speech and language problem supportively in daily communication.

The aim of the study was to investigate whether Dodd's (1995) classification system is applicable to a large group of German-speaking children. In this classification system subgroup identification is exclusively based on a surface error pattern analysis. The assessment tasks chosen were limited to single-word-naming tasks and a test of oro-motor abilities. This task was included since it is part of the German procedures

assessing speech problems. In general clinical practice a child referred because of a suspected speech disorder would also be tested on speech perception and general language abilities. All children underwent the following assessments:

Single Word Test

A picture naming assessment procedure was used to elicit data. The assessment was the same one that had been used to collect the normative data presented in Chapter 2. It included 99 items assessing all German phonemes in all possible word positions as well as most word initial clusters and a sample of word medial and final clusters (see Appendix I). The aim was to investigate the child's phonetic and phonemic inventory and to derive the error patterns used. The children were asked to name the pictures presented and were offered a sentence completion task in case of any difficulties. If this did not provide enough help, they were offered a choice of possible answers. Direct imitation was avoided.

The 25 Word Consistency Test

A German version of the 25-Word-Consistency-Assessment (Dodd, 1995) was created. It is a picture-naming task containing words of up to five syllables, with many consonant clusters or words that are, from clinical experience, difficult for German-speaking children to produce. Children are asked to name the pictures on three separate occasions within one assessment session, each occasion being separated by another activity. The words of this assessment could all be found in the Picture Naming Test. The child was asked to repeat these 25 words twice more throughout the session, which was either done as a straightforward picture-naming task or integrated in a game, depending on the child's age and co-operation. The word list can be found in Appendix II. This task was carried out to assess whether the child was consistent in his pronunciation of phonemes in an identical phonetic context, when producing single words.

Oro-motor screening, including Ozanne's (1992) sequencing tasks

An oro-motor ability screening test was created, since this type of assessment is common standard in assessment procedures in Germany. The screening partly consisted of isolated movement tasks for lips and tongue, which can be found in Appendix IV. The screening was supplemented by the Ozanne's (1992) standardised sequencing tasks where the child was asked to produce two oral movements successively. Since there are no normative data for the individual tongue and lip movements the following criteria were used for analysis:

- Was the child able to carry out the task requested by verbal description and imitation? If yes, it was marked with a '+'.
- Was the child able to carry out the task but the movement appeared to be weak or imprecise? If so, the task was marked with a '+/-'.
- Was the child able to carry out the task but showed compensatory movements? If so, the task was marked with a '+/-'.
- The child was not able to carry out the task. The task was marked as '- '.

Ozanne's sequencing task was judged the same way, since many children found the tasks embarrassing and did not complete the assessment. Therefore the norms given could not be used consistently.

A child was classified as showing reduced oro-motor skills when 14-16 out of 24 items were marked as '+' and as showing severe reduced oro-motor skills when fewer than 14 of the tasks were marked '+'. This classification system was based on results from a small sample of normally speaking children (N = 13) assessed on the same assessment and the clinical experience of the examiner. The control data had shown that the mean number of correctly (marked as '+') realised tasks was 20.85 with a standard deviation of 2.12 (see also Appendix V).

Free play phase

The formal assessment was followed by a period of free play to gain a sample of spontaneous speech. The amount of data available from this task varied greatly across all children. Therefore, transcription of all utterances was only used for comparison purposes with data from the picture-naming tasks.

4.2.3 ANALYSIS

The examiner, using the International Phonetic Alphabet Revised (1993) transcribed all utterances made by each child. The picture-naming tasks were transcribed on-line during the session, and again later from tape, while spontaneous speech utterances were only transcribed from tape. Intra-rater (point-to-point) reliability on data from 10% of the children randomly chosen for transcription reliability assessment (the picture-naming task, the consistency task and the free play phase) was 95%. Additionally, ten percent of the picture-naming task data of the children assessed had been chosen randomly to assess reliability of phonetic transcriptions of two examiners, one being again the first author. The second person was a native German phonetician. The inter-rater reliability of broad phonetic transcription for consonants and vowels (as suggested by Shriberg et al. 1997b) was 96.2%.

The criteria for classification into subgroups were strict and based on the single word naming task and the 25-Word-Consistency Test. To be classified as delayed, all a child's error patterns had to be identified as being used by at least 10% of children in the normative sample sometime during development between 18 months and 6 years. At least one of those error patterns had to be inappropriate for the child's chronological age, being typical of an earlier stage of phonological development. To be classified as belonging to the deviant-consistent subgroup, a child had consistently to use at least one error pattern that was not used by more than 10% of children in the normative sample at any age. To be classified as inconsistent a child had to realise at

least 40% of words in the 25-Word-Consistency-Test differently on at least two of the three opportunities. Two independent speech and language speech therapists were each asked to classify 20% of the children randomly chosen out of the 100 subjects: a native German therapist fairly unfamiliar with the procedure and an Australian therapist who regularly uses the classification system in clinics. The classification reliability was 94.7%.

Each child's transcript was analysed to derive the following measures (see also Chapter 2):

Phonetic Repertoire: A phone was accepted as being part of a child's phonetic inventory if it had been correctly articulated at least twice within the data elicited from the picture-naming task, irrespective of whether the word uttered was phonologically correct.

Phoneme Repertoire: A phoneme was accepted as being part of a child's phonemic inventory if it was produced correctly at least 66.7% (on two out of three occasions) within the picture-naming task data.

Percent Phonemes Incorrect (PPI): The percentage of phonemes incorrect was calculated by multiplying the number of incorrect phonemes by one hundred, and dividing by the total number of phonemes produced within the picture-naming task.

Inconsistency Score: An inconsistency score was derived by calculating the number of trials where a word was not produced identically on all three opportunities, multiplied by 100 and divided by the number of trials (out of 25) where a word was attempted at all three opportunities. Only spontaneous productions of the target word are included in the analysis. For example, if the target '*Hund*' was produced once correctly, once with initial consonant deletion and once with cluster reduction it would count as being an inconsistent trial as would an example where '*Hund*' was produced once with initial consonant deletion and twice with cluster reduction.

Number of Error Patterns: an error pattern was counted as being present if it occurred more than twice in different lexical items of the picture-naming task. Utterances from the free play phase were only used in order to cross check whether additional or different error patterns were used in comparison to the ones found in the picture-naming task.

Children were classified into the four sub-groups with reference to the study of normal phonological development in 177 monolingual children acquiring German aged 1;6 - 6;0 (Chapter 2).

4.3 RESULTS

The data were inspected to determine whether the subgroups of articulation disorder, delay, deviant-consistent and inconsistent were apparent. Twenty children (20%) were classified as having an articulatory disorder, distorting the sounds /s/, /z/, /ç/ and /ʃ/. Fifty-one children (51%) were classified as having delayed phonological development. Seventeen children (17%) were classified as having a deviant-consistent phonological disorder and twelve children (12%) were classified as having an inconsistent phonological disorder (see Table 4.1). Individual data on all children concerning their error patterns usage can be found in Appendices VI a-c.

Table 4.1 Subject information

	Articulation	Delay	Deviant	Inconsistent	Total
No and % of children	20	51	17	12	100
No and % of children when pure /s/ and /z/ distortions are excluded	4 = 4.8%	51 = 61%	17 = 20.2%	12 = 14.3%	84 = 100%
No of children additionally classified as articulation disordered	n. a.	23	10	3	
No of children additionally classified as articulation disordered, excluding interdentality	n. a.	4	6	0	
No of boys	13	31	12	7	63
No of girls	7	20	5	5	37
$\bar{X}$ **age**	5;9	5;1	4;9	4;2	5;0

Already in Chapter 1, the question was posed whether interdentality needs to be seen as a variation of the norm, a discussion that will be continued in this Chapter. Therefore numbers of children with and without interdentality are quoted, questioning whether interdentality is an articulation disorder.

Only two children showed major differences between single word production and spontaneous speech. In both cases all velar plosives were fronted in spontaneous speech only. Table 4.2 gives an overview of the children in each subgroup, the error patterns used, their mean inconsistency percentage, the percent phonemes incorrect (PPI), their mean number and types of missing phones and phonemes and results concerning their oro-motor ability.

4.3.1 Articulation Disorder

Children who consistently distorted one or more particular phones in all phonetic environments, but made no other errors, were classified as having an articulation disorder. There were seven girls and thirteen boys in the articulation disordered group. They were aged between 4;8 and 7;8 with a mean age of 5;9 years. Fifty percent of the children showed mildly reduced oro-motor skills while 10% showed reduced and 5% showed severely reduced oro-motor skills.

An incomplete phonetic inventory is the main feature of this disorder: nineteen children replaced /s/ and /z/ by [θ] and [ð] and /ts/ by [tθ] and one child replaced these phones by a lateral [s]. Four children lateralised the phone /ʃ/. The distortions identified here were interdentality and lateral production of sibilants. The percentage of phonemes incorrect lay between one and two standard deviations above the mean for normally developing age-matched children. No children showed an incomplete phonemic inventory. Their inconsistency rating was 0%. Interdentality on its own might, as will be discussed (see section 4.4), not necessarily merit classifying a child as articulation disordered. In this case sixteen children need to be excluded from this study. Thus the percentage of articulation disorder is reduced to 5% (see Tables 4.1 and 4.3).

Table 4.2 Information about subgroup results

	Articulation	Delay	Deviant	Inconsistent
Articulatory Error Patterns	★	★	★	★
Developmental Error Patterns		★	★	NA
Idiosyncratic Error Patterns			★	NA
$\overline{X}$ **Inconsistency**	0%	13%	19%	59%
$\overline{X}$ **no Error Patterns**	1.15	2.55	5.06	n.a.
Range no of Error Patterns	1 to 2	1 to 7	3 to 10	n.a.
$\overline{X}$ **PPI**	7%	9%	19%	22%
$\overline{X}$ **z-score PPI**	1.89	0.74	3.98	3.97
$\overline{X}$ **PCI**	10%	14%	29%	35%
$\overline{X}$ **no missing phones**	2.05	1.9	3.6	2.25
Most frequently missing phones	s/z ts ʃ	s/z ts ʃ ŋ g k	s/z ts ʃ ç ʁ t d n pf	s/z ts ʃ ʁ pf v x
$\overline{X}$ **no missing phonemes**	0	1.72	4.29	4.75
SD missing phonemes	0	1.64	2.7	3.7
Most frequently missing phonemes		ʃ g k ŋ	ʃ ts s/z ç f v pf d t n k g ʁ	All but m n ŋ p b ç
Reduced oro-motor skills	10%	32%	40%	8%
Severely reduced oro-motor skills	5%	16%	13%	50%

PPI = Percentage Phonemes Incorrect; PCI = Percentage Consonants Incorrect

4.3.2 Delay

Fifty-one children (22 boys and 19 girls) were classified as delayed. They were aged between 3;3 and 7;9 years with a mean age of 5;1 years. Thirty two percent of the children showed reduced oro-motor skills while 16% showed severely reduced abilities on the oro-motor task. The percentage of phonemes incorrect lay between one and two standard deviations above the mean for normally developing age-matched children, but increased in children older than 5;3 years to two to four standard deviations above the age-matched appropriate mean (see Figure 4.2).

Figures 4.1 - 4.4 show the distribution of the percent phonemes incorrect (PPI) for each child per subgroup. Each child's PPI was compared to the mean PPI z-scores obtained from the normative study presented in Chapter 2; i.e., depending on the child's age, a child's PPI was compared to the z-scores of the appropriate normative age-group. Furthermore, for each child an additional comparison was made with the normative mean PPI z-scores to which two standard deviations were added.

A oneway ANOVA comparing the PPIs of each of the four subgroups revealed significant differences between the subgroups: $F_{(3,99)} = 31.772$ $p<.001$. Posthoc analysis using Student-Newman-Keuls showed no significant differences between 1) the articulation disordered and delayed and 2) between the deviant-consistent phonologically disordered and inconsistent phonologically disordered subgroups. On the other hand the articulation disordered and delayed subgroups were significantly different from the phonologically disordered subgroups.

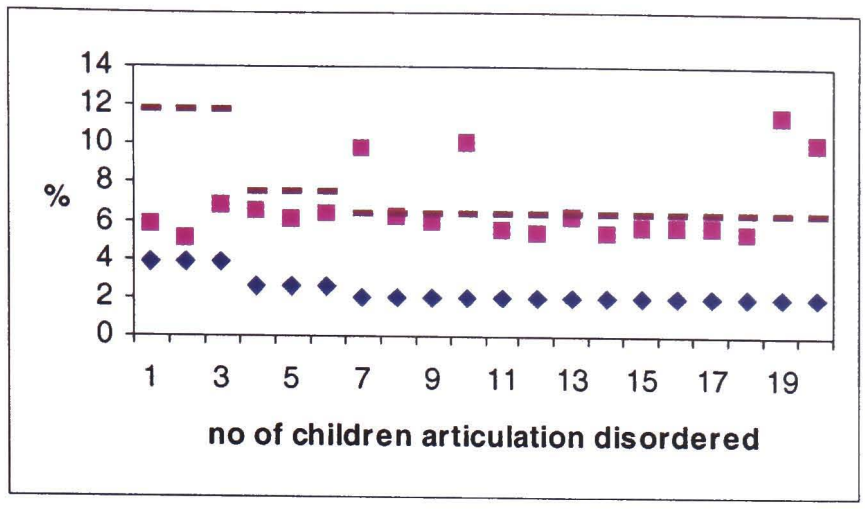

Figure 4.1 Percentage Phonemes Incorrect (PPI) for articulation disorder

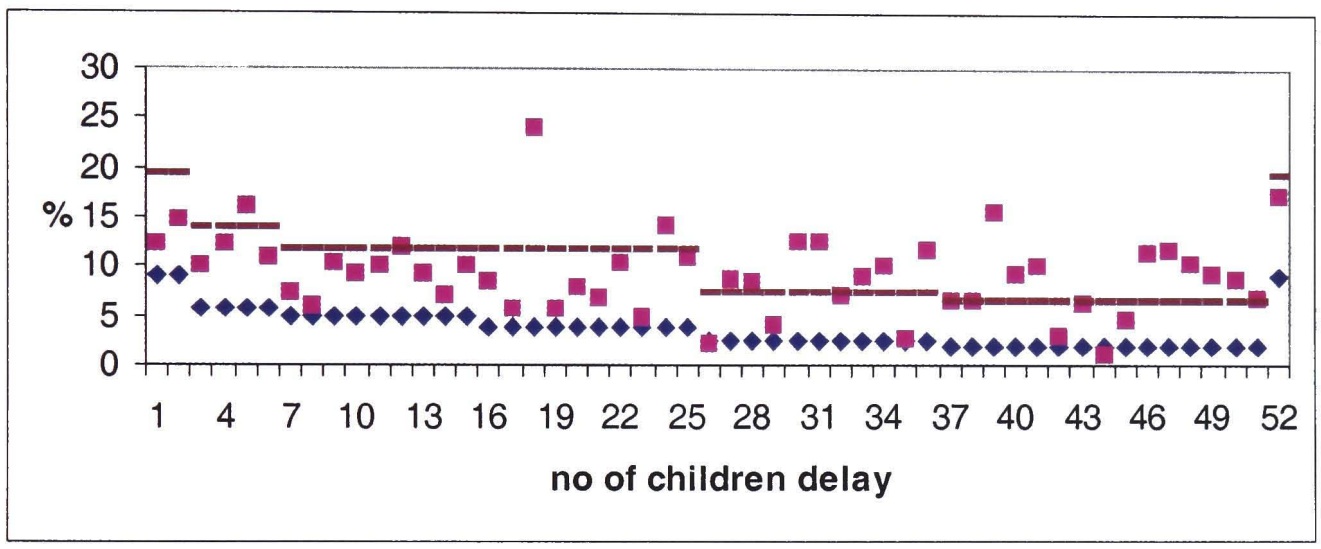

Figure 4.2 PPI for delayed phonological development

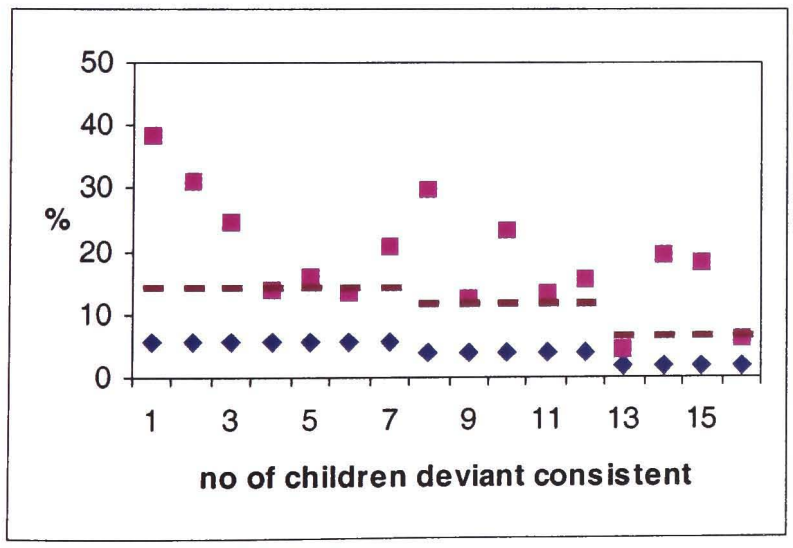

Figure 4.3 PPI for deviant-consistent phonological disorder

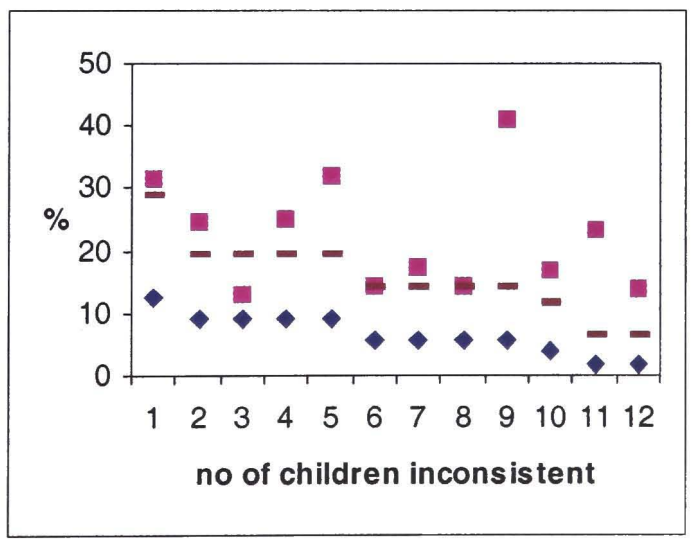

Figure 4.4 PPI for inconsistent phonological disorder

■ = PPI subjects ◆ = PPI age matched controls ▬ = PPI norm + 2 x Standard Deviation

Thirty-seven children (73%) showed an incomplete phonetic inventory when the phones /s/, /z/ and /ts/ were included, but only 26 (51%) did so when these phones were excluded. Apart from /s/, /z/ and /ts/ the main missing phones were identical to the missing phonemes. Thirty-five of the delayed children (69%) showed an age inappropriate phonemic inventory, with a mean of 1.72 (SD 1.6) missing phonemes per child (usually /k/, /g/, /ŋ/ /ç/ or /ʃ/). The mean inconsistency rate of this group was 13%.

The error patterns of the children classified as showing a delay had to reflect normal development but be inappropriate for chronological age. The most common delayed error patterns were cluster reduction, fronting of plosives and sibilants and interdentality as an additional articulatory distortion.

4.3.3 Phonologically Disordered – Deviant Consistent

Seventeen children were classified as having a deviant-consistent disorder. The twelve boys and five girls were aged 3;5 - 6;11 years with a mean age of 4;9. Reduced oro-motor abilities were found in 40% of the children and severely reduced abilities in 13% of the children.

Their inconsistency rate was 19% and the mean PPI was 19%, which is twice as high as that found in children with a delay. Even though this mean percentage was high there was considerable individual variation: while some children's PPI was only one or two standard deviations above the mean for normally developing children, others reached a PPI of six to eight standard deviations above the mean.

Fourteen children (82%) showed an incomplete phonetic and fifteen children (88%) an incomplete phonemic inventory. Unlike the pattern found for delayed children there were no phones or phonemes (excluding /s/, /z/ and /ts/) which were particularly affected. Phonemes missing in four to seven of the children were /d/, /t/, /n/; /f/, /v/, /pf/; /s/, /ts/, /ç/; /k/, /g/ and /ʁ/. These phonemes do not include missing phonemes that were still age appropriate.

All children showed developmental error patterns as well as idiosyncratic ones. Furthermore, some children used a very unusual pattern of cluster reduction and were therefore classified as deviant-consistent disordered. The most common developmental and idiosyncratic error patterns were fronting, backing of plosives, /f/ → [s] or [θ] and cluster reduction. Interdentality as an articulatory phenomenon was also common.

4.3.4 Phonologically Disordered - Inconsistent

Twelve children were classified as inconsistent. There were seven boys and five girls aged 2;7 - 5;8 years with a mean age of 4;2 years, which therefore represents the youngest group with a significant difference of P = .039 (t-test for Equality of Means) between the deviant-consistent and this group. Fifty percent of these children showed a severely reduced performance in the oro-motor tasks, with 8% having difficulties.

The mean inconsistency rate lay at 59%, with all children scoring more than 40%. A oneway ANOVA comparing the rates of consistency between the four subgroups demonstrated that significant differences could be found: $F_{(3,88)} = 52.336$ $p<.001$. Posthoc analysis using Student-Newman-Keuls showed that the inconsistent disordered group proved to be significantly different from all other subgroups. The same was found for the articulation-disordered group, which was highly consistent. No significant differences were found between the delayed and the deviant-consistent phonological disordered subgroup.

The mean PPI in the inconsistent disordered group was 22% and the highest of all groups. Nine children showed incomplete phonetic and ten incomplete phonemic inventories. However, if the phones /s/, /z/ and /ts/ are excluded, only seven children (58%) show incomplete inventories with fewer phones than phonemes missing. The most vulnerable phonemes were /k/, /ʁ/, /f/, /v/, /x/ and /pf/. Appendix VIc shows the range and error patterns used by each child. However, since the main feature of these children is inconsistency, these patterns are only present at the moment of assessment and would differ on reassessment. Ball (1994) therefore argues that it is inappropriate

to analyse inconsistent errors for error patterns. Figure 4.5 illustrates this argument by showing one child's range of substitutes for each phoneme.

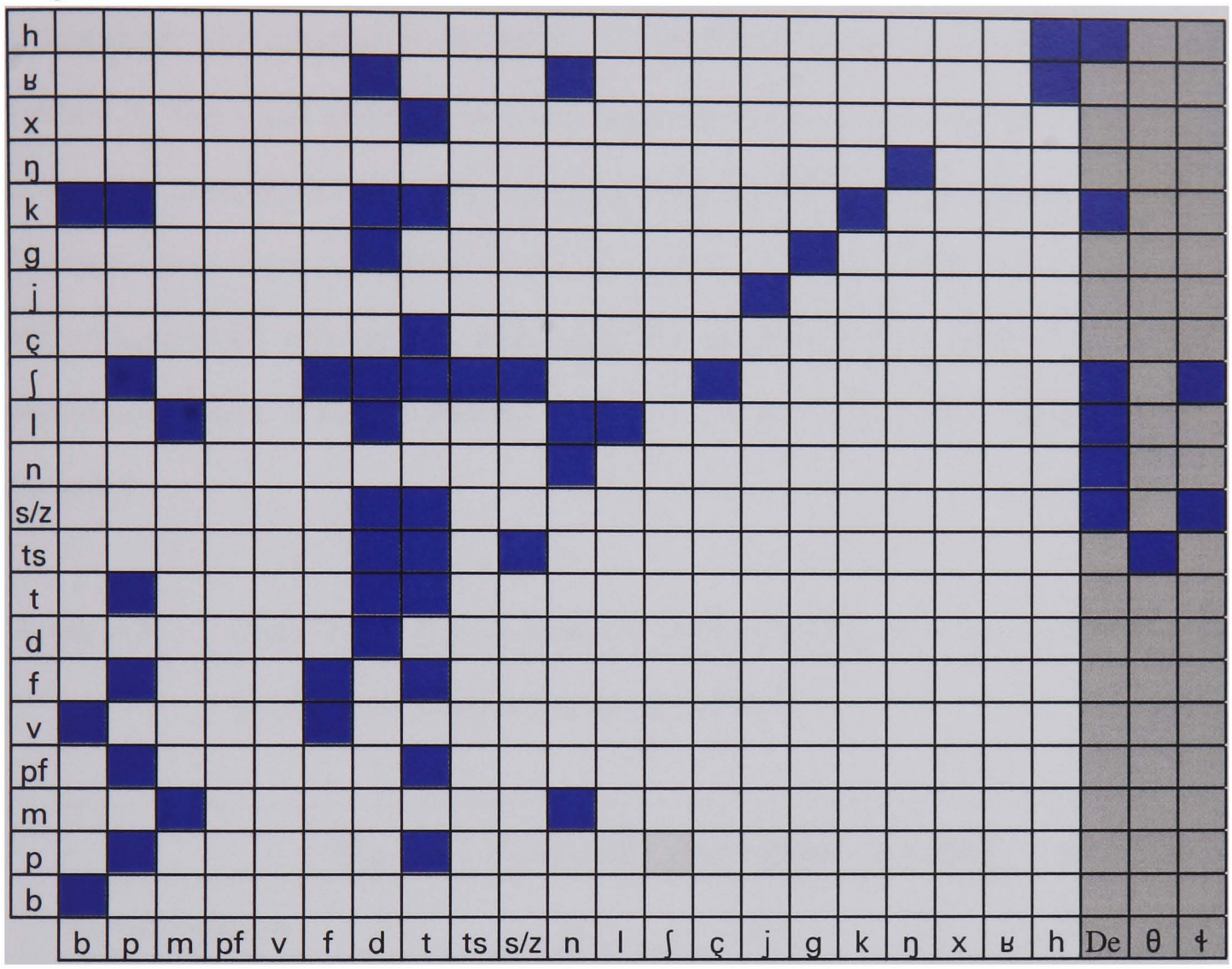

Figure 4.5 Inconsistency matrix of phoneme production in a girl aged 3;4

The vertical left border line represents the target phonemes, while the horizontal bottom line represents the phoneme realisations found for each phoneme in this child. The grey area indicates phoneme realisations used by the child which are not part of the German phonetic or phonemic inventory such as deletions (De), /θ/ and /ɬ/. The optimal pattern describing a completely acquired phonemic system would be presented in one single diagonal line from the top right corner to the bottom left corner.

4.3.5 Cross-linguistic Comparison of Classification

In general, studies carried out to test the applicability of Dodd's classification system (1995) supported the subgroups, although Goldstein (1996) found no children with inconsistent errors since he did not test for consistency. The distribution pattern (percentages per subgroup) was similar across the languages assessed as is shown in Table 4.3. The small numbers of Turkish-speaking children (N = 10) assessed did not allow the presentation of distribution percentages (Topas & Konrot, 1996). For German, two types of percentages are presented. The left column shows the percentages of all 100 children assessed while the right column shows the distribution percentage when sixteen children with an isolated interdental /s/-production are excluded.

Table 4.3 Cross-linguistic comparison of the distribution of subgroups according to Dodd's classification system (1995)

	English	**Cantonese**	**Putonghua**	**Spanish**	**German**	
No of children	55	17	33	20	100	84
Articulation	14%	12%	3%	10%	20%	5%
Delay	58%	47%	55%	65%	51%	61%
Deviant	12%	29%	24%	25%	17%	20%
Inconsistent	16%	12%	18%	n.a.	12%	14%

English (Dodd, 1995); Cantonese (So & Dodd, 1994);

Putonghua (Zhu Hua & Dodd, 2000b); Spanish (Goldstein, 1996)

4.4. DISCUSSION

Cross-linguistic research provides evidence concerning the validity of classification of speech disorders. As previous studies have shown for Cantonese (So & Dodd, 1994), Turkish (Topas & Konrot, 1996), Spanish (Goldstein, 1996) and Putonghua (Zhu Hua & Dodd, 2000b), this study of German-speaking children has further supported Dodd's (1995) classification of speech disorders that was based on English-speaking children. The four subgroups of articulation disorder, delay, deviant-consistent and inconsistent phonological disorder were apparent in 100 German-speaking children referred to speech and language therapy due to a suspected speech disorder.

Twenty children (20%) were classified as having a specific articulation disorder. This is high in comparison to English-speaking children where children with an articulation disorder alone constitute only 14% of all speech disordered children (Dodd, 1995). There are two possible reasons for this finding. Data for this study were only collected in private practices and kindergartens. Children with an articulation disorder are not usually referred to a public clinic but only to a private practice because of the mildness of the disorder. In public clinics an articulation disorder would not have priority for treatment. Data for the other languages have been collected in hospital clinics or community centres. Thus sampling may explain the difference in distribution of articulation disorders. Another explanation is that correction of a lisp is often judged a necessity in Germany. Thus cultural factors may also be operating.

However, even though the phones /θ/ and /ð/ are not part of the German phonetic inventory the study of developing children up to the age of 6;0 showed that 35-40% of the children in the oldest age group used /θ/ and /ð/ consistently as allophones of /s/ and /z/ (see Chapter 2). The question arises whether the interdental production of the phonemes /s/ and /z/ really describes an articulation disorder, or whether this kind of replacement needs to be accepted as a normal variation. If the later is true, sixteen of

these 20 children would need to be excluded from this study leaving only 5% of children with an articulation disorder which is more similar to the findings for English (14%) Putonghua (3%), Cantonese (12%), Spanish (10%) and Punjabi (14%).

Fifty-one children (51%, or 61% if 16 articulation disordered are excluded) were classified as showing a delay in speech acquisition. The percentage found is similar to findings for all other languages reported. These children used developmental error patterns typical of a younger child. The majority of children in this category presented a speech delay of six to nine months. However some children showed a much more distinct delay of more than 18 months. One question arising from these findings is whether children with a severe delay in speech development will behave differently in treatment than children with a shorter delay period. Further research is needed in order to address this question.

Some children showed error patterns which were chronologically mismatched, which has also been reported by Grunwell (1987) and So & Dodd (1994). For a complete list of a hierarchy of error pattern usage across the two subgroups of delay and deviant-consistent phonological disorder see Table 4.4.

Seventeen children (17% or 20.2% if excluding 16 children classified as articulation disordered) were classified as having a deviant-consistent phonological disorder. This finding is comparable with those for languages other than German. As expected all children showed three types of error patterns: age appropriate developmental error patterns, age inappropriate developmental error patterns and non-developmental, idiosyncratic error patterns. The most common idiosyncratic error patterns were: backing of plosives (/t/ and /d/ -> [k] and [g]), fronting of /f/ to [s] or [θ] and metathesis. All other error patterns were only used by one or two children. Table 4.4 ranks all developmental and idiosyncratic error patterns according to the number of children using them. The error patterns listed under the heading 'deviant', which can also be found in the developmental column, are those mentioned in section 3.3.1

(definition deviant-consistent phonological disorder). They are only developmental in connection with specific phonemes and need to be classified as idiosyncratic if they occur in additional phonemes.

Table 4.4 Ranked percentages of error pattern usage within different subgroups

Consistent Deviant Patt.	**No**	**%**	**Consistent Develop. Patt.**	**no**	**%**	**Delay Develop. Patt.**	**No**	**%**
Backing of Plosiv	6	35.3	Interdentality	9	52.9	Interdentality	25	49.0
f → /s/ or /θ/	6	35.3	Fronting Plosives	6	35.3	Fronting Plosives	23	45.1
Metathesis	3	17.6	Cluster Red.	5	29.4	Fronting Sibilants	13	25.5
Intrusive Conson.	2	11.8	Fronting Sibilants	4	23.5	Cluster Red.	12	23.5
Consonant Del.	2	11.8	/tʁ/ → /kʁ/	3	17.6	Lateral Sibilants	8	15.7
/ʁ/ or /l/ → /j/	2	11.8	Glottal Repl. /ʁ/	3	17.6	Fronting /ŋ/	8	15.7
Allo Fricatives	2	11.8	FCD /l/	3	17.6	/tʁ/ → /kʁ/	7	13.7
Cl Changes	2	11.8	Assimilation	2	11.8	Mult. Interdent.	4	7.8
Favorite Sound	2	11.8	ICD	2	11.8	FCD	3	5.9
Deaffrication	1	5.9	WSD	2	11.8	Devoicing of Cl	3	5.9
Glottal Repl.	1	5.9	Deaffrication	2	11.8	Stopping	3	5.9
Unusual Vowel Errors	1	5.9	Lateral Sibilants	1	5.9	Assimilation	2	3.9
Sib →/x/	1	5.9	FCD	1	5.9	ICD	2	3.9
Stopping unusual	1	5.9	Devoicing of Cl	1	5.9	Voicing	2	3.9
/ʁ/ →/s/	1	5.9	Stopping	1	5.9	Glottal Repl. /ʁ/	2	3.9
Allophonic Nasals	1	5.9	Voicing	1	5.9	Spont. Speech	2	3.9
/ŋ/ Del before /k/	1	5.9	Backing Sibilants	1	5.9	WSD	1	2.0
X → /f/	1	5.9	Devoicing	1	5.9	FCD /l/	1	2.0
Cl Assimilation	1	5.9				Backing Sibilants	1	2.0
						Deaffrication	1	2.0

Cl = Cluster; Del = Deletion; Repl. = Replacement; Red. = Reduction; WSD = Weak Syllable Deletion; ICD/FCD = Initial/Final Consonant Deletion

No/% = number/percentage of children showing this process

As can be seen, the most frequent developmental error patterns in both subgroups are identical. However, more error patterns are used by higher percentages of children in the deviant-consistent subgroup.

Twelve children (12% or 14.3% if excluding 16 children classified as articulation disordered) were classified as inconsistent, a result which is similar to findings for other languages. These children present the youngest age mean of all subgroups, which was also found for Putonghua (Zhu Hua & Dodd, 2000b). There are two alternative explanations: Ingram (1989) argues that very young children (vocabularies of up to 50 words) show a rather inconsistent pattern of word production, which seems to be part of the acquisition process. Since these children represent the youngest age group, their inconsistency might, therefore, be a symptom of very severe delay. However, if this were so it would be expected that the children would also show an accordingly small phonetic inventory as is found in young children, which is not the case. Furthermore, Dodd (1995) found that even very young children (aged 20-24 months) show a very consistent pattern of word production once they have a vocabulary of more than 50 words.

Alternatively, the younger mean age of the inconsistent group might reflect their unintelligibility. These children are often unintelligible even to their parents who cannot acquire knowledge of how particular words are pronounced, and thus parents might refer children who make inconsistent errors earlier. Data from the other subgroups provide some support for the suggestion that degree of unintelligibility affects the age at which children are referred. Children with an articulation disorder are usually intelligible and this subgroup had the highest mean age (5;9 years, the youngest child being 4;8 years). Similarly, children in the delayed subgroup, who make fewer errors than the two disordered groups, had a mean age of 5;1 years. The argument that it is the type of errors that is important, rather than the absolute number, is emphasised by comparison of the two disordered groups. Although these two

groups had similar PPI z-scores (3.98 and 3.97), the inconsistent group had a younger mean age (4;2 years). Parents with children who consistently make the same errors (mean age in the current study, 4;9 years) learn to translate. Inconsistency makes such translation impossible, and is likely to increase parental anxiety.

As mentioned in earlier studies, some children show an articulation disorder in addition to a phonological delay or disorder (Dodd & Bradford, 2000). So & Dodd (1994) described two children with deviant-consistent disorder who also had an articulation disorder. In this study, five of the children who were classified as being delayed and one child classified as deviant-consistent disordered, were additionally classified as having an articulatory disorder in that they were unable to produce acceptable versions of particular phonemes in any phonetic context. All distorted the phones /s/ and /ʃ/ consistently as /ɬ/. This is not surprising since the co-occurrence of phonological and articulation (or phonetic) disorder has already been recognised (Fey, 1992; Kamhi, 1992). In all three phonological subgroups about half of all children showed an interdental production of /s/ and /z/ (Delayed: 47%; Deviant: 53%; Inconsistent: 50%). Given that up to 40% of children in the normative study also evidenced interdentality, this is more likely to reflect allophonic variation rather than an articulation disorder. The other subgroups - delay, deviant-consistent and inconsistent - are mutually exclusive.

For most children, classification into the four subgroups was obvious, given the strict criteria. In only a few cases did children show patterns that were ambiguous. Two children from the delayed subgroup made rare vowel errors, which was atypical of normally developing children of the same age, and six children made errors on up to three lexical items that were atypical of normal development. They were nevertheless classified as delayed because these few errors were the only sign of phonological disorder as opposed to delay.

All the children's oro-motor abilities were assessed. The group of children classified as articulation disordered had the lowest percentage with reduced oro-motor abilities. This finding appears to contradict literature that suggests articulation problems are the result of poor oro-motor skills (see Hahn, 1988, for review). The majority of children in the articulation group in this study had incorrect sound placements, not inadequate tongue and lip function. Instead their errors may be the result of having learnt an incorrect placement for the sound. The two subgroups, delay and deviant-consistent phonological disorder, cannot, according to our findings, be differentiated by their oro-motor abilities. Children with an inconsistent phonological disorder presented the highest percentage of severe problems. This is coherent with the presumed underlying deficit of complex motor sequencing problems (see Chapter 3 and Bradford-Heit, 1996). However, the assessment used was a non-standardised procedure and therefore the findings need to be considered with caution.

In comparison with the results of previous studies of German-speaking speech disordered children (Hacker & Weiß, 1986; Romonath, 1991) a general agreement is found. The main error patterns reported were initial and final consonant deletion, weak syllable deletion, cluster reduction, assimilation, metathesis, fronting, backing, stopping, voicing and devoicing (see Appendix III for results). All other processes described seem to belong to a category of less frequent or idiosyncratic processes. The hierarchy of 'phone difficulty' as described by Möhring (1938) was also supported, apart from the positions of the two fricatives /x/ and /ç/ and the approximant /j/ which appeared to be less vulnerable in this study (see section "Speech Therapy Provision and Phonological Disorders" in Chapter 3 and Table 4.5).

Table 4.5 Comparison of two studies ranking phones according to the percentage of children producing a specific phone incorrectly

	Most correct			Least correct
Möhring	m n h b d p l t f v	x j ʁ ŋ k g	ç ʃ s/z	
This study	m p b l j h f x v n t d pf	k ç ŋ ʁ g	ʃ ts s/z	

Möhring (1938) does not present data for /ts/ and /pf/

The classification of speech disorders is currently a controversial topic and different systems exist. The system most commonly applied is the one by Shriberg (1994). As described in Chapter 3, his system is based on etiological factors and, therefore, requires different information about the children than can be provided by children's error patterns. Shriberg criticises psycholinguistic classification systems for failing to offer nosological systems that identify and classify children with phonological disorders. He further criticises the trend to avoid classification labels and the emphasis on children's symptomatology (Shriberg, 1993). Chapter 5 aims to investigate the influence of risk, and therefore nosological, factors on speech disorders and the applicability of Shriberg's model to the same set of children as described in this Chapter.

CHAPTER 5

RISK FACTORS AND SPEECH DISORDERS

5.1 INTRODUCTION

Risk factors play an important role in accounting for developmental speech disorders. They are often used by clinicians as part of a differential diagnosis checklist for possible additional assessments that are carried out by other specialists (e.g. audiologists, psychologists). According to Shriberg (1994), the value of risk factor information has been underestimated. His research set out to subgroup speech disorders according to clinical-inferential typologies because only "they convey the central phonological information about the disorder, the causal inference, normalisation history, and current status" (p.41). In his opinion, they provide the highest clinical validity. On the other hand, he strongly criticises those typologies based only on phonological data because they "lack real-world correspondence to the clinical presentation of children with speech disorders. Particularly from the perspective of potential genetic antecedents, where gene regulation issues require a thorough profile of speech development as a behavioural trait, classification based solely on descriptive linguistics may be inadequate for an eventual explanation of the onset and normalisation of disorders" (p.40).

However, as already stated in Chapter 3, many children with functional speech disorders present no known organic, medical or environmental causal factors. Other children present more than one reported risk factor. Furthermore it is not necessarily possible to establish objective background data for earlier problems at the time of referral e.g. auditory deficits. Even if it were possible, it is not always clear how these factors should influence therapy planning.

Whatever classification system is adopted it should be applicable across languages. It has been possible to apply Dodd's (1995) psycholinguistic system successfully to several languages and treatment studies have further confirmed their clinical validity (Dodd & Iacono, 1989; Dodd & Bradford, 2000; Holm, 1998). In contrast, Shriberg's

classification model has not been applied to languages other than English. If his classification approach is valid, it should be language independent and, therefore, it should be possible to classify a group of German-speaking children according to the etiological subgroups he describes. This Chapter sets out to investigate two issues:

- Whether the same group of children who have been classified using a linguistic typology can also be classified by an etiological approach. The necessary data had been obtained by a questionnaire.
- Additionally, the same questionnaire was handed out to a group of fifty normally developing children without any record of speech and language problems. The aim was to identify whether the risk factors used for sub-grouping children with speech disorders significantly distinguished children with and without speech disorders.

5.2 METHOD

5.2.1 Subjects

Data were obtained by a questionnaire from two different groups of children:

1. Children diagnosed with a phonological speech delay or disorder: sixty six children aged 2;7 - 7;2 with a mean age of 4;10 years (see Chapter 4). Children who had been classified with an isolated articulation disorder were excluded from this study to conform to Shriberg's (1994) criteria for 'speech delay'.
2. Control group: 48 normally developing children matching the age range of the speech disordered children with a mean age of 4;10 years.

All children were monolingual, with German as their native language, in Hamburg or Schleswig-Holstein in the north of Germany. None of the children had shown any sensory impairment, organic motor disorder, craniofacial anatomical anomaly or intellectual impairment and no hearing loss was detected at the time of assessment. Data concerning the characteristics of the children's speech disorder can be found in

Chapter 4. No children in the control group were reported by either parents or nursery nurses to show any signs of speech or language difficulties.

5.2.2 Procedure

All parents were asked to fill in a questionnaire about their child's development before or while the child was seen by a German speech and language therapist for an assessment in a private practice or kindergarten. The same questionnaire was used for all children in the control group where the head nursery nurse of a kindergarten had handed out the questionnaire to children who fulfilled the criteria. An English version can be found in Appendix VII. Parental consent about using the data anonymously was asked for on the questionnaire.

5.2.3 Analysis

The answers from the questionnaires were analysed for each individual child. However, the results will be presented via the following groups: controls, speech disordered children, three subgroups of speech disordered children. The analysis compared: a) the group of all speech disordered children versus the control group, b) each individual subgroup versus the control group and c) between the three subgroups of speech disorders.

The questionnaires focused on nine precipitating factors, which were divided into four categories:

1. **a) Pre- and b) perinatal problems**. The following occurrences were included as risk factors: extreme stress, maternal infections, foetus damaging medication during pregnancy; forceps or suction bell delivery, induced delivery because the infant was overdue, complications such as umbilical cord strangling, infections, preterm birth, reanimation after birth. Caesarean births were excluded as a risk factor.

2. **Hearing problems** caused by a) **acute middle ear infections, AOM** (more than two occurrences), b) a high number of further **ENT-problems** or c) **middle ear infections with effusion, MEE.**
3. **Sucking habits**, including a) **dummy**, b) **bottle** (used as a pacifier, excluding feeding times) and c) **thumb sucking** (habit continuing longer than 24 months).
4. **Positive family history** for speech and/or language difficulties.

Since the first three risk factor categories contained several individual factors, results were evaluated according to a) the mean score of all risk factors combined per category and b) the scores of the individual risk factors per category.

Three statistical methods were used. The Fisher Exact test was used to evaluate possible significant differences between groups for each individual risk factor. The Wilcoxon-Mann-Whitney was used to evaluate possible significant differences between groups for the mean scores of the first three risk factor categories. Finally, simultaneous logistic regression with all factors as predictor variables was used to predict group membership. A significant value shows an independent effect of a predictor when all other predictors are taken into account.

5.3 RESULTS

The data[7] (see Table 5.1) were inspected to determine whether precipitating factors could be identified that distinguished children with speech disorders from normally developing children and which might be specific for certain subgroups of speech disorders.

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[7] See Appendixes VIIIa-b for summary of responses to questions concerning family history and pregnancy and birth problems.

Table 5.1 Subject information and percentage of reported risk factors per subgroup

	Delay	Deviant	Inconsistent	Total	Control
No of children	**42**	**15**	**9**	**66**	**48**
Age (mean)	**5;1**	**4;10**	**4;2**	**4;10**	**4;10**
Percent of children reported to have:					
Prenatal Prob.	7	7	30	11	0
Perinatal Prob.	15	0	56	17	3
AOM	41	20	13	33	23
MEE	40	33	22	36	23
ENT Prob.	30	27	22	28	15
Dummy	41	64	56	48	38
Bottle	48	36	33	43	13
Thumb	8	14	0	8	4
Genetic	25	33	33	28	4

AOM = acute otitis media; MEE = middle ear infection; ENT = ear, nose and throat

5.3.1 Speech Disorder versus Control

Overall group results for speech disordered versus normally developing children were compared. The results of a Fisher Exact test showed significant differences for these factors: pre- and perinatal problems, positive family history and bottle usage. By using the Wilcoxon-Mann-Whitney test, significant differences were found for all three categories (see Table 5.2).

Table 5.2 Speech disorder versus control: significant values for individual risk factors (Fisher Exact Test) and significant values for risk factor categories (Wilcoxon-Mann-Whitney Test)

F-E	**Prenatal**	**Perinatal**	**AOM**	**ENT**	**MEE**	**Dummy**	**Bottle**	**Thumb**	**Genetic**
Test	.026	.013	NS	NS	NS	NS	.004	NS	.004
W-M-W	**Pre- and Perinatal Problems**		**General ENT Problems**			**Sucking Habits**			
Test	.001		.002			.004			

W-M-W Test = Wilcoxon-Mann-Whitney Test; F-E Test = Fisher Exact Test

Logistic Regression Analysis showed significant independent effects for family history (p = .004), pre- and perinatal problems (p = .05) and sucking habits (p = .013) but not ENT problems. A stepwise logistic regression supported the findings: family history (p = .007), sucking habits (p = .004) and pre- and perinatal problems (p = .004) were differentiated.

5.3.2 Individual Subgroups versus Control

When comparing each subgroup of speech disorders (Dodd, 1995) with the control group using the Fisher Exact Test, the only factor on which *all* subgroups differed significantly from the controls was Positive Family History. Further analyses revealed different profiles of significant differences for each subgroup in relation to the control group. The delayed group differed from the control group significantly on perinatal problems and bottle usage and additionally on the percentage of AOM occurrences. The inconsistent group differed from the control group significantly on pre- and perinatal problems alone. No further significant differences could be found in the deviant-consistent group, so that the only risk factor differentiating them from the control group was Family History (see Table 5.3).

Table 5.3 Values of significance: four subgroups versus individual risk factors (Fisher Exact Test)

	Prenatal	Perinatal	AOM	ENT	MEE	Dummy	Bottle	Thumb	Genetic
Delay	NS	.037	.018	NS	NS	NS	.003	NS	.016
Consistent	NS	NS	NS	NS	NS	NS	NS	NS	.011
Inconsistent	.001	.000	NS	NS	NS	NS	NS	NS	.034

When Wilcoxon-Mann-Whitney tests compared controls and each of the three subgroups on the three risk factor categories, significant differences on all three risk factors were found for the delayed subgroup. The inconsistent group differed on the pre and perinatal factor and the consistent group differed significantly on the sucking category (see Table 5.4).

Table 5.4 Values of significance: four subgroups versus categories of risk factors (Wilcoxon-Mann-Whitney Test)

	Pre/ Perinatal	General ENT	Sucking Habit
Delay	P = .006	P = .002	P = .016
Deviant	NS	NS	P = .013
Inconsistent	P = .001	NS	NS

5.3.3 Subgroup versus Subgroup

Comparison of the reported risk factors between the subgroups of speech disordered children revealed few differences when the data were analysed for individual factors or categories of risk factors. The only significant difference found was for comparison of the consistent and inconsistent phonologically disordered groups, showing that the

inconsistent group differed significantly in the number of reported birth difficulties (Fisher Exact Test: perinatal problems: p = .003, Wilcoxon-Mann-Whitney Test: pre- and perinatal problems: p = .001). This is hardly surprising, since no birth problems were reported in the deviant group, in comparison with 56% in the inconsistent group. The results were further supported by regression analyses. Only one significant effect was found between the groups. A stepwise logistic regression revealed a difference on pre- and perinatal problems between the deviant-consistent and inconsistent phonologically disordered subgroups (p = .001).

5.3.4 Application of Shriberg's Classification System

This section addresses the question of whether it would be better to classify the data obtained according to Shriberg (1994) and Shriberg & Kwiatkowski (1994). Shriberg (1994) posits four etiological categories: unknown origin (possibly genetic); otitis media with effusion; developmental verbal apraxia; and developmental psychological involvement. Table 5.5 shows the percentages of the speech-disordered children in each of the four etiological categories. Inspection of the Table shows that 49% of the children were not reported to have had any of the etiological conditions, 10% showed two risk factors, and 2% showed three risk factors. According to this analysis 61% of the children in the current study could not be differentiated according to Shriberg's (1994) etiological factors.

Table 5.5 Distribution of risk factors (RF) within a group of speech-disordered children according to categories by Shriberg (1994)

	Risk Factors				*No and % of RF per child*			
	Genetic	**OME**	**DAS[8]**	**DPI**	**0 RF**	**1 RF**	**2 RF**	**3 RF**
Children	18	19	1	2	31	25	6	1
%	29	30	2	3	49	40	10	2

Genetic = positive family history; OME = Otitis Media with Effusion;
DAS = Developmental Apraxia of Speech; DPI = Psychological Influence

5.4. DISCUSSION

The purpose of the study was to investigate the relationship between reported risk factors and developmental speech disorders in children. One hundred and fourteen questionnaires (66 for children with speech disorders and 48 for controls) were evaluated. Risk factor categories that were found to statistically discriminate between the speech-disordered and control groups were: positive family history, pre- and perinatal problems, general ENT problems and sucking habits. These risk factor categories have been previously reported in literature for less homogeneous groups of children with communication disorders. Individual risk factor analysis only showed significant differences for pre- and perinatal problems, positive family history and use of bottle as a pacifier.

5.4.1 General Findings - Control versus Speech Disorder

Twenty-eight percent of the children with a speech disorder had a positive family history, most involving a member of the nuclear family (see Appendix VIII). The percentage of affected family members was similar to the lower percentages reported

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[8] Data concerning DAS and DPI were obtained in the last section of the questionnaire, asking for special circumstances, question 10.

in the literature for children with speech and language difficulties. The higher figure of affected male versus female family members as reported by Lewis & Freebairn (1997) and Tallal, Ross & Curtis (1989) was not found; about the same number of affected male and female family members was reported. A range of communication disorders was reported (e.g. lisp, specific language impairment, dysfluency). The children did not necessarily show the same pattern of speech and/or language problems as their affected family members. This finding differed from that of Shriberg & Kwiatkowski (1994) who reported that affected family members showed the same speech problems as the child. The significant difference between the speech disordered and control groups on this risk factor might then be due to a genetic factor that predisposes a child to speech disorder, rather than the language learning environment.

Approximately thirty percent of the children assessed had some history of middle ear problems. Even though the mean value for general ENT problems, including occurrences of AOM and/or MEE, differentiated the speech-disordered group significantly from the control group, this was not true for any of the three risk factors analysed individually. The findings fail to resolve the uncertainty in the literature about the influence of middle ear infections on speech development. Many children who have a similar history of suspected fluctuating hearing loss acquire phonology without difficulty (see control data). It may be that to establish a causal relationship between ear infections and speech disorder, prospective longitudinal research will need to control for the number of objectively identified occurrences, their duration and the age at which they occur, rather than relying on parental report (Paden, 1994). Another factor worth considering is the extent to which periods of hearing loss might causally interact with other risk factors (e.g. genetic predisposition). The current literature suggests that while a general history of ENT difficulties was associated with speech difficulties, it is neither a necessary, nor a sufficient, condition.

For the children with speech disorders, 11% of the mothers reported complications during pregnancy, and 17% reported birth difficulties. In comparison there were no incidents of pregnancy complications reported in the normally developing group and only 3% reported birth complications. Both risk factors significantly differentiated the groups. The two main birth complications associated with communication disorders in literature are prematurity and anoxia, although findings are contradictory. Only one study appears to have investigated forceps delivery and vacuum extraction, which was the difficulty most commonly reported in the current study. Tomblin, Smith, & Zhang (1997) found no significant differences in the occurrence of forceps delivery for SLI children and controls. Nevertheless prenatal and perinatal difficulties might be considered a risk factor worthy of further research.

A further point of investigation was the sucking habits of children. The speech-disordered group were more likely than the control group to have used a dummy, a bottle or a thumb as a pacifier for more than 24 months (see Table 5.1). However, only bottle usage yielded a significant difference between speech-disordered and control groups. So far little research has investigated whether a causal connection between any kind of sucking habit and speech disorders exist (Arditti, 1999), even though a connection is assumed by some authors (e.g.: citations in Hahn, 1988, p. 206-210; Hensel & Slieth, 1998; Garliner, 1971)

5.4.2 The Application of two Classification Systems

One question addressed in this study concerned the extent to which the data on risk factors would support recent classification systems for developmental speech disorders. Shriberg (1994) proposed that developmental speech disorders could be classified by etiology. When the data from the questionnaires was classified according to his four etiological factors, more than half the children could not be classified, either because there was no parental report of any one of the etiological factors posited, or because more than one factor was reported. It might be argued that

parental report is unreliable and that objective testing or recourse to medical case histories would have yielded a better fit between the current data and Shriberg's (1994) classification system. Nevertheless, even if this were so, two issues remain. Two risk factors revealed in the current study as important are not included in Shriberg's classification system (sucking habits and pre- and perinatal factors). Secondly, clinicians assessing and planning intervention for children with speech disorders do not always have available the data needed to establish etiological factors and consequently need to plan therapy according to presenting symptomatology.

The current study suggests that is not possible to match children belonging to subgroups characterised by specific types of surface speech errors with a single specific risk factor. Nevertheless, the profiles of individual risk factors associated with the subgroups as compared to controls are intriguing, even though specific significant differences between the subgroups were rare (see Table 5.6).

Table 5.6 Profiles of risk factors by subgroup of speech disorder

	Pre/ Perinatal		**Hearing**			**Sucking**			
	Prenatal	**Perinatal**	**AOM**	**ENT**	**MEE**	**Dummy**	**Bottle**	**Thumb**	**Genetic**
Delay		☆	★				☆		☆
Consistent									★
Inconsistent	★	★							☆

5.4.3 Delay

All risk factor categories were found to differ significantly from the controls for this subgroup. However, the analysis of individual factors showed significant differences only for family history, perinatal problems, bottle usage and AOM. The subgroup of children with delayed speech is the only subgroup to show a significant value for

Hearing/AOM in the category factor analysis and in the individual factor analysis. Research has shown that a high number of children with middle ear problems either have no speech and language problems at all or that the majority of children with problems "catch up" by themselves (Needleman, 1977; Peters, Grievink, van Bon, van der Bercken & Schilder, 1997). These findings suggest that middle ear infection might cause delayed speech development rather than disorder. This finding is consistent with a recent longitudinal study of children classified as having delayed speech while they were on a waiting list for treatment. Most children showed spontaneous improvement (Dodd, Zhu Hua & Shatford, in press).

5.4.4 Deviant-Consistent Phonologically Disordered Subgroup

This subgroup presents a very interesting picture: only family history and sucking habit (for the category analysis alone) differentiated this subgroup from the control group. This group of children has also been shown to be at risk for literacy disorders (Dodd, Gillon, Oerlemans, Russel, Syrmis & Wilson, 1995; Leitão, Hogben & Fletcher, 1997), which are also reported to be familial (e.g. Lewis & Freebairn, 1997).

5.4.5 Inconsistent Phonologically Disordered Subgroup

Risk factor analysis presented a distinct picture: both the group factor analysis and the individual factor analysis show significant differences for pre- and perinatal problems. It is the only subgroup with a significant value for prenatal problems, perhaps indicating neurological impairment. However the number of children assessed was very small and a larger study needs to validate these findings.

All findings need to be interpreted with care. Even though each subgroup was statistically differentiated from the control group, the relationship between any subgroup and a particular risk factor only accounted for a percentage of children within a subgroup (see Table 5.1). Furthermore, logistic regression demonstrated that in general these subgroups did not significantly differ from each other, apart from one

significant difference found on pre- and perinatal problems for the deviant-consistent and the inconsistent phonologically disordered subgroup. Thus while case histories provide important information, planing intervention for functional speech disorders currently depends more in presenting symptomatology than reported etiological factors.

One group study and two case studies focusing on intervention presented in Chapter 6 will further support this assumption. None of the children described there showed any etiological history and the choice of treatment approach depended on a surface error pattern analysis. The aim of Chapter 6 will be to investigate the effectiveness of different intervention approaches.

PART III

INTERVENTION IN GERMAN-SPEAKING CHILDREN

AND

GENERAL DISCUSSION

CHAPTER 6

INTERVENTION FOR CHILDREN WITH SPEECH DISORDERS

6.1 INTRODUCTION

Chapters 4 and 5 investigated the application of different classification systems for children with speech disorders of unknown origin to a group of German-speaking children. It was found that a linguistic typology presented a more valid differential diagnosis than an etiological system. According to Dodd's (1995) classification system, four subgroups are proposed (articulation disorder, delayed phonological development, deviant-consistent phonological disorder and inconsistent phonological disorder). Crucial to the classification system is that each subgroup is hypothesised to have a different specific underlying deficit. An *articulation disorder* was suggested by Hewlet (1985/1992) (*phonetic disorder* according to his terminology) to result "from a disorder to the mechanism of phonetic implementation of phonological representations" (1985, p.160). Thus the underlying deficit is hypothesised to lie in an incorrect motor plan for a specific phone. No specific deficit has yet been identified as underlying *delayed phonological development*. It is hypothesised to be associated with impoverished language learning environment, neglect, overprotection, slower neurological maturation, fluctuating hearing abilities or general cognitive delay (Powers, 1963). *Deviant-consistent phonological disorders* are suggested to be caused by a cognitive deficit arising at the internal organisational level of the speech processing chain (Dodd & McCormack, 1995; Grundy, 1989). Finally, for children with an *inconsistent phonological disorder* it is assumed that they have an impaired ability to assemble a phonological plan (Bradford & Dodd, 1996). Because of the different nature of the underlying deficits, it seems reasonable to argue that rather specific intervention strategies might be necessary for successful remediation of each deficit.

A number of different intervention approaches exist, which can basically be classified as being either sensory-motor approaches or cognitive-linguistic approaches (see Chapter 3 section 3.4.1). Studies investigating the effectiveness of the different

approaches demonstrated that approaches are specifically beneficial if they target the underlying deficits in the speech processing chain (e.g. Dodd & Bradford, 2000). Therefore, articulatory approaches focusing on the correct motor plan for phones realised in distortion should be beneficial for remediation of an articulation disorder. Phonological intervention was reported to be beneficial for children with a deviant-consistent disorder (e.g. Metaphon), while children with a high percentage of inconsistent errors (>40%) respond best when the focus lies on reaching consistent word realisation.

The following Chapter presents three descriptions of therapy programs provided for children with speech disorders: one group study and two case studies. The group study describes an intervention procedure for children with an isolated articulation disorder with interdental realisation of /s/ and /z/ being the only symptom. The aim of this study is twofold. First, it continues the discussion as to whether this kind of /s/ distortion needs to be considered for German as an articulation disorder rather than a variation of the norm. Secondly, it aims to determine whether the intervention program chosen remediates articulation disorders cost-effectively. The aim of the two case studies is to evaluate the benefits of different intervention approaches for children with phonological disorders.

6.2 ARTICULATION DISORDER: GROUP RESULTS

In Germany children with an isolated articulation disorder will usually be referred for speech therapy because of a lisp (interdental, addental or lateral distortion of /s/ and /z/ or a lateral distortion of /ʃ/). Even though it is questionable whether interdental realisation of /s/ should be treated as a speech disorder (see Chapters 2 and 4), parents, teachers and speech therapists do consider it as a disorder. This study aims to describe an articulation group intervention program designed by Karen Grosstück, Speech and Language Pathologist.

6.2.1 Subjects

Data were obtained from nine children who had been classified as articulation disordered. All had been assessed as part of the observational study in Chapter 4. At the time of their initial assessment, all children had shown only interdental production of /s/, /z/ and /ts/ in all phonetic contexts. They had then been placed on a waiting list (WL) for 6 – 15 months. At the beginning of their intervention program they had been reassessed and none of them had shown any sign of change in their distortion pattern. Five of the children had shown oro-motor abilities within the normal range, four children showed mildly reduced abilities (see Table 6.1).

Table 6.1 Subject information

Child	Boys	Girls	Age	WL	Oro-mot. Scores	Oro-motor Ab.
42	★		58	6	18/22	normal
44		★	58	10	19/24	normal
62	★		64	15	15/23	m. reduced
64	★		65	9	17/24	m. reduced
72	★		67	9	17/24	m. reduced
84		★	71	12	17/24	m. reduced
90	★		74	9	23/24	normal
91	★		75	7	20/21	normal
96	★		78	6	18/24	normal
Total	7	2	$\overline{X} = 68$	$\overline{X} = 9$		

Age = in months; WL = months on waiting list; Oro-motor Ab. = abilities

6.2.2 Procedure

The intervention program that will be described here has been designed by a clinician. It is based on her many years of work experience and was influenced by the following factors:

- Children with an isolated articulation disorder constitute a large group of the clinical load in a German practice of speech and language therapists. However, since their disorder is less severe than those of most other patients seeking intervention, they do not require urgent intervention and should have a low

priority for treatment. The need to cope with a large caseload led to a group approach with a restricted number of sessions.

- Children with an isolated articulation disorder are usually referred at the age of five or six years. Most of them do not feel the need for intervention at this age and show very little interest in intervention that requires daily work. Intervention in a group can increase children's motivation. During group-sessions individual improvement can directly be compared, challenging the children.
- Parents are far more willing to support intervention with daily home activities if the number of sessions is restricted.

The intervention program was carried out in twelve group sessions once weekly[9]. There was a final reassessment session with each individual child. Each group session lasted 45 minutes and groups contain six children of a similar age. Therefore, the children from this study were in two different groups, which followed an identical program and were run by the same therapist. The approach is based on three different components:

- Oro-motor, myofunctional exercises (based on Garliner, 1983)
- Stimulation of the correct phone production
- Articulation therapy involving progressive stages: production of phones in isolation; in syllables; in words and sentences; and in conversation (see Gierut, 1998).
- Ear-training as described by Van Riper (1963)

At the end of each session the parents were informed about the content and aims of the session and home activities were explained. All parents had been informed before intervention started that a change in oro-motor abilities, and in the distortion pattern, can only be reached if home activities are carried out daily. The aim of the twelve sessions is to reach a 100% correct phone production at sentence level and in elicited

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[9] A plan about the content of the 12 sessions can be found in Appendix IX.

spontaneous speech (such as rhymes, short stories). Spontaneous speech should show an approximately 80% -100% correct phone usage.

The thirty-minute reassessment session took place four to six weeks after the last group session. Percentage correct phone production was calculated during this session from speech samples gained from tasks on sentence and elicited spontaneous speech level and during conversation.

6.2.3 Phone Production after Completion of the Intervention Course

Case files indicated that in the reassessment session all children reached 80 – 100% correct phone production during exercises on all levels including spontaneous speech during the sessions. Four children used the new phones 100% correctly in their spontaneous speech, while five had reached 80% correct spontaneous speech production. Results for all children are presented in Table 6.2. The children and parents were advised to regularly go through their exercises for several weeks in order to stabilise the result.

Table 6.2 Articulation disorder group study intervention outcome

Child	Boys	Girls	Intervention success
42	★		100%
44		★	100%
62	★		100%
64	★		80%
72	★		80%
84		★	80%
90	★		80%
91	★		80%
96	★		100%

6.2.4 Discussion about Group Intervention for Articulation Disorders

Nine children classified as having an articulation disorder with an interdental realisation of /s/ and /z/ as the main feature received twelve sessions of articulatory intervention. Findings indicated that the intervention procedure chosen was beneficial.

Although sibilant distortions, especially the interdental realisation of /s/ and /z/, have been reported to be common in children by several authors across languages (English: Ingram, 1978; Smit, Hand, Freillinger, Bernthal & Bird, 1990; Felsenfeld, Broen & McGue, 1992; Shriberg & Kwiatkowsky, 1994; Swedish: Harsten, Nettelblad Schalen, Kalm, Prellner, 1993; Finnish: Loutonen, 1995; Qvarnström, 1993; German: e.g. Biesalky & Frank, 1994) the number of studies investigating the effectiveness of articulation intervention is comparably small. Powell, Elbert, Miccio, Strike-Roussos & Brasseur (1998) reported a study where the correct production of /s/ was successfully established using a motoric training program. A further efficacy study by Powell et al (1999) supported the previously used approach, additionally demonstrating that conceptual treatment was not as effective as a motor program approach. Gommerman & Hodge (1995) reported the effective treatment of an interdental /s/-production in a 16-year-old girl in one session of articulatory intervention after several myofunctional therapy sessions for tongue thrust. The study presented in this Chapter adds to the earlier findings. The summary of results suggests that the 'traditional' articulation approach targets the underlying deficit of the disorder, which had been defined by Hewlet (1985) as an incorrect motor plan or similarly by Fey (1992) as follows: "errors in articulation must be seen as disruptions at some level of the relatively peripheral articulatory processes" (p. 225). The literature, in general, presents a consensus in terms of these definitions. However, very few statements can be found concerning this 'level'. A more precise definition is important for the discussion as to whether interdentality needs to be considered a disorder in German.

If articulation learning implies the "acquisition of the ability to move the articulators in the rapid and precise manner" (p. 225) as suggested by Fey (1992) three hypotheses about the level/type of deficit can be made:

1. The peripheral level for speech consists of those organs that are necessary to produce sounds i.e. lips, tongue, teeth etc. and the ability for fast and co-ordinated movements. Thus the breakdown must be connected with a breakdown in either one or more of the organs. Myofunctional disorders including tongue thrust, for example, have been reported as a possible cause for sibilant distortions (Umberger & Johnston, 1997; ASHA, 1996; Overstake, 1975; Baskervill, 1976; Christensen & Hanson, 1981; Pierce, 1996). Alternatively, immaturity in the control of oral articulatory movements could be the cause (see Qvarnström, 1993; Milloy, 1985).
2. Some authors have suggested that the problem lies rather at a higher level than the peripheral one, such as an organisational level for fast movement control patterns. Following this point of view, sibilant distortion is seen as a form of mild developmental dyspraxia (DVD) (see citations Qvarnström, 1993). However, it seems unlikely that an isolated lisp as found in the children in this study is the only symptom of DVD, which has been defined as a multi-deficit disorder (e.g. Stackhouse, 1992a; McCabe, Rosenthal & McLeod, 1998). This hypothesis is further rejected because of the high consistency rate in phone distortion (100%) in the children assessed, since it is known that inconsistency in word production is one of the main characteristics of children with DVD (e.g. Ozanne, 1995).

1. The interdental realisation of /s/ and /z/ in German-speaking children might not necessarily need to reflect any organic cause of articulation disorder. It could, rather, result from an incorrectly learned placement pattern for two specific phones that is not due to any peripheral organic insufficiency or central motor programming problem. Since up to 40% of normally developing six-year-old children show interdentality for /s/ and /z/ consistently in their speech, it seems more likely that a large proportion of these children have learned the phone placement incorrectly rather than showing a peripheral muscular or central deficit.

If interdentality is then considered as a variation of the norm, the question arises as to whether intervention should be provided.

Two assessment procedures were used to identify children for the training program described in this section: a) a speech sample was obtained in a picture-naming task and from spontaneous speech and b) an oro-motor screening procedure was carried out (see Appendix IV). These procedures can also be used to clarify the question of the underlying deficits. For hypothesis 1, children would be expected to show severely reduced oro-motor abilities in the case of a myofunctional disorder. In the case of immature abilities, children would be expected to score at least at the lower end of normal performance. None of the children showed severely reduced abilities or tongue thrust, open bite or any other symptom of oro-facial muscle weakness, but four children scored at the lower end of the normal range obtained from a control sample. These four children might have shown immature articulatory skills. Intervention to encourage maturation, for instance through oro-motor training, and practice of correct sound production should be beneficial, as was demonstrated.

Five of the children had shown no reduced oro-motor abilities. It seems that their sibilant distortion may have been learned. Training correct phone production placement, which is part of the articulatory approach, and training oral cavity placement awareness, which can be gained by tongue placement tasks, should be beneficial for these children, as was shown.

The findings from this study support the efficacy of articulation therapy in combination with oro-motor practice. However, findings also indicate that a differential diagnosis of articulation disorders may be necessary to adapt the approaches chosen more precisely to different causal factors. In the case of immature or disordered oro-motor abilities, it would be more important to emphasise the training of reduced oro-motor abilities, in contrast to children with an incorrectly

learned placement, where the emphasis should lie on articulatory movement and correct sound production.

Although it can be argued that an incorrectly learned placement pattern for two phones, if occurring in a large proportion of children who show no further symptoms of speech disorders or oro-motor deficits, should not be classified as a speech disorder, intervention might still be considered important. Parents are often concerned about the distortion. Children who lisp may be perceived negatively, and considered speech-disordered. Most professions require error-free speech production and thus remediation of a lisp is important for the future prospects of a child. Intervention programs like the one described in this section might, therefore, be a cost-effective solution to the high prevalence of lisping in German-speaking children.

6.3 CASE STUDY: NILS

The first case study reported here investigates the effect of two therapy approaches for a child with a severe speech disorder. Nils was a 4;7 year old monolingual German-speaking boy when he was first referred to speech and language therapy because of high unintelligibility. When treatment started, an articulation therapy approach was chosen that focused on isolated phones and phonemes. This approach reflects the most commonly practised therapy method in Germany. After 16 months of intervention with very little progress in spontaneous speech Nils, started a phase of phonological intervention that focused on onset and rhyme awareness and production. This case study describes changes in Nils' phonological system during these two phases of therapy.

6.3.1 Subject Information

Nils was born on 17.7.93 his brother being four years older. Pregnancy and birth (forceps delivery) were without incident and no major illnesses were reported. His hearing had been monitored by his paediatrician during regular developmental check ups and was always reported to be within the normal range. He was reported by his parents to have reached all developmental milestones age-appropriately but seemed to have some problems with body awareness (balance problems), which led to referral to physiotherapy. No family history of speech, language or academic problems was reported.

Nils' speech onset was significantly delayed. At the age of two years, he did not use any of the usual first words such as 'mama' and 'papa', but had created a small idiosyncratic vocabulary (i.e. 'didi' for *Käse* [kæzə] (cheese), 'di' for *Ente* [ɛntə] (duck). At the age of three he started to attend a playgroup which increased his spoken output, but he was unintelligible to everybody apart from his mother. While his speech remained unintelligible his comprehension developed and was considered age

appropriate by his first speech therapist when assessed by existing non-standardised screening procedures for German.

6.3.2 Pre-Intervention Assessment

Before intervention began, Nils' speech status was assessed. The following information (see Table 6.3) was obtained from his file. A picture-naming task as presented in Appendix I was used to elicit data and these data were compared with a spontaneous speech sample. No differences were reported for data from the picture-naming task and from spontaneous speech. Furthermore, Nils was reported to find oro-motor tasks very difficult when his ability was assessed by the screening procedure described in Appendix IV.

Table 6.3 Pre-intervention status of Nils' speech

Assessment	Findings
Phonetic Inventory[10]	m n b p d t l j h ɬ
Phonemic Inventory	m n b p d t l j h
Error patterns[11]	
A) Developmental	cluster reduction, fronting, stopping, voicing, final consonant deletion, glottal replacement
B) Idiosyncratic	lateral production of sibilants, intrusive consonants, vowel errors, favourite consonant /d/, unusual errors, final vowel deletion, medial consonant deletion
PCI	62%
Inconsistency	not assessed
Oro-motor abilities	severely reduced

[10] Appendixes X and XI allow a comparison between the different levels of phonetic and phonemic inventory at times of reassessment.

[11] A detailed list of all error patterns used by Nils at all assessment stages is shown in Appendix XII.

Inconsistency was not assessed since this is not part of a regular assessment procedure in Germany. It is therefore not possible to say whether Nils was consistent in his repeated word production. However, although there seemed to be some variability for substitution patterns, inconsistency did not appear to be the most salient characteristic of Nils' phonological disorder. The error patterns observed in his speech were partly developmental - age-appropriate and delayed - and partly idiosyncratic.

6.3.3 Intervention Phase I: Articulation Therapy

6.3.3.1 Intervention provided during Phase I (February 1998 –July 1999)

For the first intervention phase, Nils' therapist chose a traditional articulation program that was used to increase Nils' phonetic and phonemic systems. One-to-one therapy was provided twice a week at a private practice for speech and language therapy and sessions were approximately 40 minutes long. Although his parents did not attend the sessions, they were given feedback on his performance and activities for him to do at home.

The articulation program had three different targets:

1. *Oro-motor exercises* to increase Nils' voluntary movements of lips and tongue and oral awareness.
2. The *articulation program* involved progressive stages: production of phones in isolation; in syllables; in words and sentences; and in conversation.
3. *Exercises for sound awareness* such as sound discrimination tasks: "Whenever you hear this sound, you...". This again involved progressive stages: listening to isolated sounds of high contrasts, of low contrasts; then sounds in syllables and words.

6.3.3.2 Progress during Articulation Therapy (measured July 1999)

The approach described above was carried out for 53 sessions. Progress on all target areas was slow and plateaued after 35 sessions, according to his therapist. Nils' status,

after all 53 sessions, was investigated by a new therapist using procedures described in Table 6.4.

During Phase I (articulation therapy), Nils' phonetic inventory had increased by nine phones (see Table 6.4). He could produce all phones in isolation apart from /v/. At the next level, the production of new phones within syllables, he showed a heterogeneous pattern: he was able to produce /m, b, p, d, t, l, n, ç, j, g, k, x, h/ at a syllable level in all positions (syllable initial, medial, final), while all other fricatives were realised as /d/, e.g. /fa/ → [f - da]. The same realisation patterns were evident for isolated words, when he was asked to name pictures he was familiar with from therapy sessions for specific sounds or when asked to repeat words. No generalisation occurred from word to sentence level or in spontaneous speech. Thus, Nils' phonemic inventory had hardly increased at either the single word level, or for spontaneous speech. The decrease of PCI can be explained by the acquisition of three new phonemes and by his correct production of final consonants. Overall only minor changes in error pattern usage were observable. The number of 'one-off' unusual errors was reduced and vowel errors or vowel deletions no longer occurred.

In summary, the aims set in Intervention Phase I had partly been achieved. Nils no longer showed problems with oro-motor tasks and he was able to detect speech sounds in other speakers. In terms of increase in his phonetic and phonemic systems, however, improvement was only observable in isolated phone-production and at the syllable level, although this excluded most fricatives. Progress did not extend to word, sentence or spontaneous speech level and Nils therefore remained highly unintelligible.

Table 6.4 Assessment findings in July '99

Material	Assessment	Result
Single-Word-Naming Task	Phonetic Inventory	m n b p d t g k f v ç x ʁ h l j pfç ɬ ʂ
	Phonemic Inventory	m n b p d t ç x h l j pfç
Single-Word-Naming Task/ Spontaneous Speech Sample	Error Patterns A) Developmental B) Idiosyncratic	cluster reduction, fronting, stopping, voicing, glottal replacement lateral production of sibilants, intrusive consonants, favourite consonant /d/, unusual errors, medial consonant deletion
Single-Word-Naming Task	PCI	53%
Oro-motor screening	Oro-motor abilities	within normal range
Imitation task	Imitation of individual phones	all German phones apart from /v/
Repetition task	Repetition at syllable level for all appropriate word positions	95% correct for: /m b p d t l n ç j g k x h/ for all other fricatives realisation always such as: /fa/ → [f - da] (100%)
	Repetition of words with word initial target	95% correct for: /m b p d t l n j g k h/, but for fricatives always the same pattern as for syllables (100%)
	Repetition of sentences with target phones	no transfer of target phones at sentence level (0%)
	Spontaneous speech	no transfer of target phones into spontaneous speech (0%)
Discrimination task	Discrimination of every-day noises (taped sounds)	100% correct identification of all targets
	Discrimination of musical instrument sounds	100% correct identification of all target sounds
	Same/different identification for individual phones	100% reliable, if the two phones compared did not belong to either of the same group as /m n ŋ/, /g k d t/, /s z ʃ ç/. For these groups reliability of 70%.
Detection task	Detection of pronunciation errors in other people	80% correct
	Detection in his own pronunciation errors	0%

6.3.4 Intervention Phase II: Phonological Therapy

Since little progress was evident in Nils' spontaneous speech, and progress in therapy had plateaued, it was decided that Nils should attend eight sessions with a therapist specialising in phonological intervention. Intervention continued twice weekly for four weeks, each session lasting 45 minutes. This phase was followed by a holiday break of three weeks after which Nils was reassessed.

6.3.4.1 Additional Assessments (July 1999)

In addition to the assessments carried out thus far, Nils' phonological awareness abilities were examined using a non-standardised procedure for German based on phonological assessment material described by Stackhouse & Wells (1997) and Burt, Holm & Dodd (1999). The following results were found (see Table 6.5):

Table 6.5 Phonological awareness test results

Tasks	7/99
Real Word Discrimination	10/10
Legal Non-Word Discrimination	5/10
Cluster Non-Word Discrimination	10/10
Illegal and Exotic Non-Word Discrimination	5/5
Complex Non-Word Discrimination	6/10
Alliteration Detection (words named by tester)	3/10
Alliteration Production	Not possible
Rhyme Detection (words named by tester)	6/10
Rhyme Production	Not possible
Syllable Segmentation	6/10

6.3.4.2 Intervention Targets of Phase II

The focus of intervention in Phase II lay in a *phonological approach.* The phonological awareness assessment had revealed severe problems in onset/rhyme awareness and production. Since Nils used a default rule of replacing most phonemes by /d/, especially in word initial position (as revealed by the single word-naming task), a connection was hypothesised between his poor understanding of the concept of onset/rhyme and the use of this default rule. Therefore the following targets were set:

- Onset and Rhyme
  - → Alliteration and rhyme awareness

    Aim: the concept of word and syllable onset
  - → Alliteration and rhyme production

    Aim: training self-awareness and expressive abilities, reduction of the default substitution pattern /d/
- Syllable Segmentation
  - → Syllable Segmentation Awareness (counting/pointing) and Production (expressive task)

    Aim: Training of awareness of word length and syllable onset

6.3.4.3 Progress during Intervention Phase II in September 1999

The tasks chosen for the eight sessions of phonological intervention aimed to increase Nils' awareness of the importance of distinguishing between different word onsets. A second aim was to provide the opportunity for production tasks focussing on Nils' self-awareness in his onset productions. Nils' phonological awareness and production abilities increased significantly during intervention (see Table 6.6). Continuing errors in 'alliteration production' were now only caused by his phonetic limitations. The effectiveness of the approach was also demonstrated by Nils finding himself able, for

the first time, to detect his own errors at the syllable and word level (70% correct) and being able to correct himself (see also Table 6.7).

Table 6.6 Reassessment results for phonological awareness tasks

Tasks	July 1999	September 1999
Real Word Discrimination	10/10	10/10
Legal Non-Word Discrimination	5/10	10/10
Cluster Non-Word Discrimination	10/10	9/10
Illegal and Exotic Non-Word Discrimination	5/5	10/10
Complex Non-Word Discrimination	6/10	10/10
Alliteration Detection (words named by tester)	3/10	9/10
Alliteration Production	Not possible	4/10
Rhyme Detection	6/10	10/10
Rhyme Production	Not possible	10/10
Syllable Segmentation	6/10	10/10

6.3.4.4. Changes in Phoneme Production Accuracy following Phonological Intervention (September 1999)

When reassessed in September 1999 Nils showed considerable progress. His speech status is summarised in Table 6.7. Seven phonemes emerged in Nils' phonemic inventory that had not before been observed in his spontaneous speech (i.e. phonemes started to become part of his phonemic inventory, but did not reach the criterion set for being marked as acquired: 66.7% correct phoneme production). No idiosyncratic error patterns were observed apart from 'favourite sound usage'.

When his ability to integrate target phones into syllable or word level was reassessed, the default pattern of inserting /d/, the favourite sound, at word or syllable onset was no longer evident. The use of this default pattern was also found to be reduced in

clusters in the picture-naming task. Nils now realised the second element correctly in clusters containing /ʃ + m, n, l, p/ thereby improving his intelligibility.

Table 6.7 Nils' speech status in September '99

Material	Assessment	Result
Single-Word-Naming Task	Phonetic Inventory	m n b p d t g k f v ç x ʁ h l j pfç ɬ ʂ
	Phonemic Inventory Acquired (66.7% correct) Emerging (<66.7% correct)	 m n b p d t ç x h l j pfç v (WM) f (WF) s/z ʁ g ɬ
Single-Word-Naming Task/ Spontaneous Speech Sample	Error Patterns: A) Developmental B) Idiosyncratic	 cluster reduction, fronting, stopping, voicing, glottal replacement lateral production of sibilants, favourite consonant /d/
Single-Word-Naming Task	PCI	47%
Imitation task	Imitation of individual phones	all German phones apart from /v/
Repetition task	Repetition at syllable level for all appropriate word positions	100% correct for: /m b p d t l n ç j g k x h f ʃ s z ʁ/
	Repetition of words with word initial target	90% correct for: /m b p d t l n j g k h f ʃ s z ʁ/
	Repetition of sentences with target phones	transfer of target phones at sentence level 60%
Detection task	Detection pronunciation errors in other speakers	90%
	Detection in his own pronunciation errors on word level	80%

Nils' overall Percentage Consonants Incorrect (PCI) had decreased. An analysis of the PCI according to word position showed that the word initial position was weakest in comparison to the word medial or final position which seemed to have benefited most from intervention (see Figure 6.1).

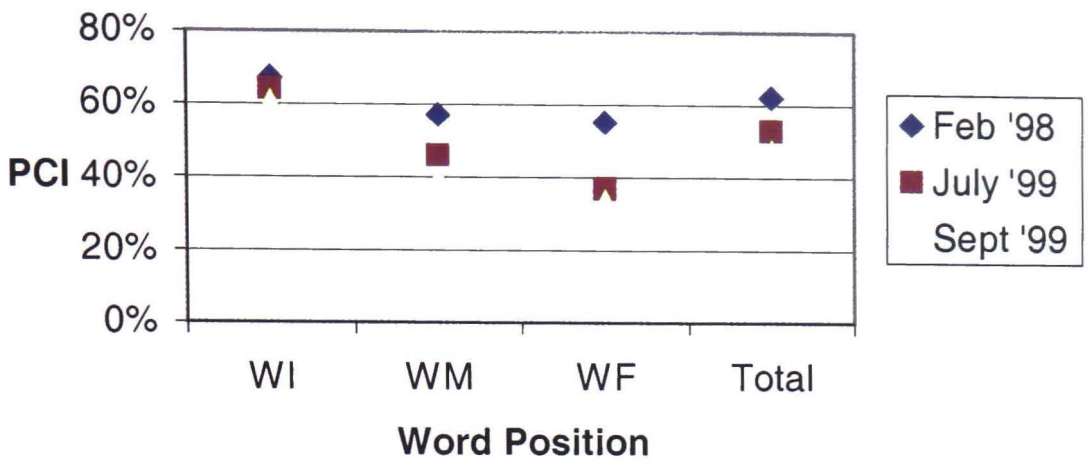

Figure 6.1 Nils' PCI change over time

The most important change, however, can be found in his substitution patterns. Figure 6.2 demonstrates the change in numbers of substitutes used in error and the number of phonemes which could be realised correctly at the three assessment stages: February 1998, July 1999 and September 1999.

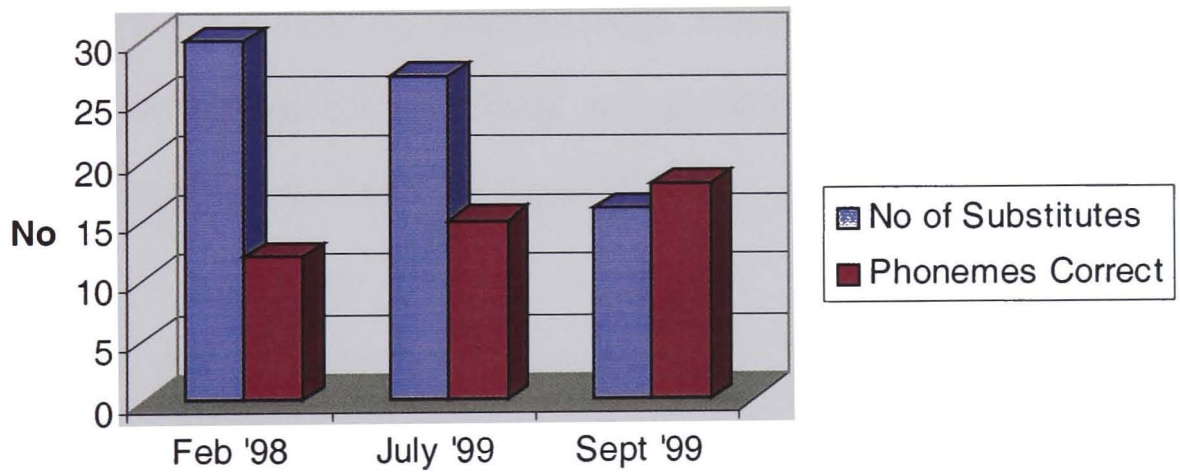

Figure 6.2 Number of substitutes in error and phonemes realised correctly at the three stages of assessment

While articulation intervention had only had little effect on Nils' substitute variability (July '99), after only eight sessions of phonological intervention the number of correctly realised phonemes had increased and the number of substitutes in error had

dropped by half. The decreased variability in phoneme production and the decreased PCI improved his intelligibility substantially.

6.3.5 Discussion: Nils

The aim of this case study was to describe the effectiveness of different intervention approaches in a severely speech-disordered child.

Initially Nils' therapist chose an articulation-orientated approach. Following standard German textbooks, this choice reflects the most widely-used method of intervention for all children with developmental speech disorders of unknown origin in Germany. Logopedic textbooks mention three areas that intervention should always focus on (e.g. Böhme, 1998; Biesalski & Frank, 1994; Wendler et al, 1996). The main aim is to teach those phones missing in the child's phonetic inventory and to drill them in their correct phonetic contexts. These production exercises are supplemented by Van Riper's (1963) concept of ear training, because of his assumption that articulation is a sensory-motor skill, involving both listening and speaking. Oro-motor training is included to train the sequencing of speech organ gestures.

As shown in Table 6.4 (Single-Word-Naming Task: Phonetic Inventory) and Appendix X, the aims of the intervention program were partly achieved. At the time of reassessment, Nils' oro-motor abilities lay within the normal range. His phonetic inventory had reached a nearly age-appropriate level for isolated phone production, lacking only the correct phonetic production of most sibilants and /ŋ/. However, Nils' intervention had plateaued at the single phone level for most fricatives and at the syllable level for all other phones. Additional sessions did not change this. His phonological system was hardly affected by the articulation approach.

The phonetic progress Nils made during the first phase of intervention could provide some evidence that he had an articulation disorder. On the other hand, it is not

possible to determine whether Nils' progress in phone production was specifically due to articulation intervention or whether it was rather caused by the 'ear training', which is more a form of phonological, than articulation, intervention. The plateau effect and the limited increase of his phonemic system indicate that Nils' speech disorder was not mainly of an articulatory nature, if at all. Had an articulation disorder been present, progress would have been expected to expand onto further levels, such as word and sentence level and even spontaneous speech and, therefore, to become noticeable in his phonemic system. These findings add to Fey's (1992) claim that the "(*traditional*) procedures have served us well and, it is likely, that they will continue to do so. They are inadequate, however, in those cases where errors result from factors other than articulation" (Fey, 1992, p.226).

At the beginning of the second phase of intervention, a speech error pattern analysis was carried out to investigate the nature of Nils' deficit on the assumption that intervention so far had not targeted his main deficit effectively. The analysis revealed a high number of developmental and idiosyncratic error patterns, which indicated the presence of a phonological disorder. For the second phase of intervention, therefore, a phonological approach seemed to be appropriate.

Since inconsistency had not been assessed formally, no further classification could be made on the basis of the existing data. However, previous research had suggested that it is possible to differentiate between children with an inconsistent and with a deviant-consistent phonological disorder by their performance in phonological awareness tasks. While children with an inconsistent phonological disorder do not have problems with these tasks, children with a deviant-consistent phonological disorder do (Dodd, Leahy & Hambly, 1989). To investigate whether Nils showed any deficits in phonological awareness abilities, further assessments were carried out. The findings indicated that Nils could be classified as showing a deviant-consistent phonological disorder: he showed problems with alliteration and rhyme identification and was unable to carry out alliteration and rhyme production tasks.

It was argued that these findings reflected Nils' most predominant error pattern, the default pattern of substituting most phonemes by /d/, in word onsets. Successfully targeting these deficits should therefore result in a reduction of default pattern usage, an increase in his phonemic inventory, a reduction in the number and types of error patterns and a much higher consistency in his substitution pattern. Intelligibility should increase. Post-intervention assessments confirmed the hypothesised changes and, therefore, confirmed the suspected underlying deficit.

This treatment case study suggested that articulation and phonological therapies cause different types of change in the speech of a child with a phonological disorder. This finding emphasises the need to identify and target the deficit(s) underlying phonological disorder to achieve cost-effective remediation. The articulatory approach from treatment Phase I may have provided the articulation abilities for correct speech-sound production in isolation. In contrast, phonological intervention, in treatment Phase II, seemed to be able to "...facilitate cognitive reorganisation of the child's phonological system and his phonologically-orientated processing strategies" (Grunwell, 1985, p.99).

6.4 CASE STUDY: MORITZ

The second case study focuses on intervention for a young child with an inconsistent phonological disorder exacerbated by a very restricted phonetic inventory. Moritz was a 3;0 year old boy who was referred for speech and language therapy. The purpose of this study is to describe:

- The application of three different intervention techniques: core-vocabulary, articulation and phonological awareness approach and the progress made.

6.4.1 Subject Information

Moritz was born on 5.1.96 and first assessed by a speech and language therapist at the age 3;0 years. He is the second child, his sister being five years older. Pregnancy and birth history were without incident and he had experienced no major medical problems. Moritz's hearing had never caused any concern and he passed the screening tests when assessed by a paediatrician. His parents reported that all his developmental milestones had been normal apart from speech and language. No family history of speech, language or academic problems was reported. The reason for Moritz's referral to speech therapy was the parents' concern about his speech and language development. He had first started to use words at the age of 2;6 and at 3;0 his vocabulary only contained about 15 words. These words usually did not resemble the adult version. His communication was basically non-verbal accompanied by vocalisation. Moritz appeared to react age appropriately to instructions and play, even though he mainly directed play.

6.4.2 Pre-intervention Assessment

The pre-intervention assessments (spontaneous speech sample, oro-motor screening) revealed the following results:

Table 6.8 Moritz's speech status in February '99

Material	Assessment	Findings
Speech sample	Phonetic inventory[12]	m n ŋ b p d t v ç x h s
Imitation task	Stimulability	p h ʃ ts
Speech sample	Phonemic inventory	m n b* d v * = (WI only)
	Inconsistency	70%
	Syllable structure[13]	69% monosyllabic 24% polysyllabic
	Utterance length	one word utterances
	Expressive vocabulary	about 15 words
Oro-motor screening	Oro-motor abilities	severely reduced

Phonetic Inventory

Moritz's phonetic inventory was neither age-appropriate, nor was his inventory pattern consistent with the pattern of a younger child, since he was also able to produce three phones usually found only in older children: /ŋ, ç, s/. Interestingly, a difference between the phones he used during speech and the phones he was able to produce in isolation could be found: Moritz was only able to imitate /p, h, ʃ, ts/. The voluntary production of vowels, apart from /a/, also proved to be difficult.

Phonemic Inventory

Only four phonemes had been acquired completely, although /b/ was found to be acquired for word initial position only, and two phonemes were found to be emerging: /p, x/ (less than 66.7% correct phoneme production).

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[12] Appendices XIII (phonetic inv.) and XIV (phonemic inv.) provide data from all assessment stages.

[13] Detailed data on syllable usage over the period of intervention can be found in Appendix XV.

Analysis of Inconsistency

A formal assessment of inconsistency, such as the 25-Word-Consistency Test, could not be carried out due to Moritz' refusal to name pictures. However, when his spontaneous speech was analysed, which contained several (N = 10, see Table 6.9) of his utterances repeated at different stages of the session, it became apparent that Moritz was inconsistent in his word production (7 out of 10 inconsistent = 70% inconsistency). He especially varied in his word onset, either by replacing the initial consonant by [h] or by inserting [h] before a vowel, or by deletion of the initial consonant.

Table 6.9 Examples of Moritz's inconsistent speech production

Target		1. Realisation	2. Realisation	3. Realisation
ja	ja	ja	ja	ja
ab	ap	ap	ap	ap
da	da	da	da	da
Schiene	ʃiːnə	hiːnə	hiːnə	iːnə
Biene	biːnə	iːnə	hiːnə	hiːnən
auch	aux	au	aux	
Stein	ʃtaɪn	daɪn	hain	aɪn
hier	hia	hia	ia	
rauf	ʁauf	hauf	auf	au
Bahn	baːn	haːn	aːn	haːŋ

6.4.3 Intervention Phase I: Core Vocabulary Approach and Stimulability Approach

6.4.3.1 Intervention provided

During the first phase, Moritz was seen once a week by a clinician in a private practice for speech and language therapy for approximately 30 minutes. The phase consisted of ten individual sessions starting at the beginning of February. His mother was present on all occasions.

Two treatment approaches were chosen:

1. The *stimulability approach* which is articulatory-based focussing on a) the acquisition of new phones, b) increasing the ability to imitate phones spontaneously and c) oro-motor movements and oral awareness exercises. This approach was chosen following Miccio & Elbert's (1996) argument: "Increasing the number of sounds in the phonetic inventory increases the number of possible contrasts that can be produced and subsequently increases intelligibility (p.335)". They further cited findings by Miccio (1995) and Powell et al (1991) stating that sounds that were stimulable were most likely to be added to the phonetic inventory regardless of the sounds selected for treatment, while non-stimulable sounds are not likely to be acquired without treatment.
2. The *core vocabulary approach* teaches a small vocabulary of functional words that are to be produced in a developmentally appropriate way. Consistency of production is reinforced during intervention sessions and in the child's everyday environment.

6.4.3.2 Progress during Phase I (May 1999)

1. Stimulability approach

Moritz acquired four new phones which he could imitate voluntarily but did not include in his spontaneous speech. He was also able to carry out isolated lip and tongue movements with greater accuracy.

2. Core vocabulary approach

Moritz's inconsistency in word production had decreased to a level where he could no longer be classified as inconsistent. Unfortunately it was still not possible to carry out the 25-Word-Consistency Test to assess this formally, because Moritz refused to name the pictures repeatedly.

A summary of the progress achieved during the three months of intervention is presented in Table 6.10:

Table 6.10 Moritz's speech status in May '99

Material	Assessment	Findings
Picture-naming task	Phonetic inventory	Identical to February 1999
Imitation task	Stimulability	m b p f h ʃ ts s
	Stimulability syllables	0%
Picture-naming task	Phonemic inventory	m n ŋ b* d v x * = (WI only)
	Inconsistency[14]	27%
Speech sample	Utterance length	2-3 word utterances
	Expressive vocabulary[15]	around 80 words
Oro-motor screening	Oro-motor abilities	increased ability for isolated movements

Interval therapy was arranged for Moritz because of the severity of his disorder, his young age and because the therapist would be absent for two months. Another reason for it was that past experience had shown how the effects of treatment continue during intervention breaks. Just as normal developmental stages take their time, the progress made in treatment needs time to stabilise and will continue once the last developmental stage has been consolidated.

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[14] A table with repeated targets in spontaneous speech to analyse Moritz's inconsistency in speech production can be found in Appendix XVI.

[15] Vocabulary was also assessed by the number of pictures named spontaneously in the naming task.

6.4.3.3 Speech Status after Interval of Two Months (July 1999)

Moritz was reassessed in July 1999 after the therapy-free interval. His speech status is described in Table 6.11.

Table 6.11 Moritz's speech status in July '99

Material	Assessment	Findings
Picture-naming task	Phonetic inventory	m n ŋ b p d t g k f v x h l j ʃ s ʔ
Imitation task	Stimulability	m b p t f x h ʁ ʃ s ts
Picture-naming task	Phonemic inventory	m ŋ b* p d v * = (WI only)
	Error patterns[16]	developmental and idiosyncratic patterns
	Syllable structure	50% monosyllabic 50% polysyllabic
	Word-onset realisation as /h/ or deleted	43%
Speech sample	Utterance length Expressive vocabulary	three to four word utterances continuing acquisition
Oro-motor screening	Oro-motor abilities	age-appropriate

Moritz's phonetic inventory was still not age-appropriate but the delay was far less apparent. Even though exercise at home had been limited, as reported by his mother, the number of phones that were stimulable had increased. In terms of his phonemic inventory no progress was visible, even though more and more phonemes started to emerge in their correct position (emerging phonemes appear in spontaneous speech but have not reached the 66.7% correct production necessary to be classified as acquired; see Appendix XIV).

[16] A complete list of error pattern usage over the period of intervention can be found in Appendix XVII.

Due to Moritz's consistent phoneme production, it was now possible to describe the developmental and idiosyncratic error patterns of his speech, which are summarised in Appendix XVII. The two most important changes were his increased syllable structure and his increased length of utterance. As presented in Table 6.11, Moritz now used only 50% instead of 69% monosyllable utterances and 50% polysyllabic utterances, the majority being two-syllable utterances. Furthermore, he had started to use two-to-four-word-utterances and had drastically reduced his non-verbal communication.

6.4.4 Intervention Phase II: Stimulability Approach and Phonological Intervention

6.4.4.1 Intervention Targets for Phase II

1. The *Stimulability Approach* was continued with the aim of increasing the voluntary production of phones in isolation and words. Three different levels of this approach were chosen: a) imitation of individual phones, b) production in CV syllables of the phones acquired and c) exercises at the word level, incorporating acquired phones in word initial position.
2. The new approach chosen was *Phonological Intervention.* The aim was to increase Moritz's phonemic inventory, his phonological awareness and syllable length. A further aim was the reduction of idiosyncratic and age-inappropriate phonological processes. The different stages of phonological intervention were:
   - *Word Onset* Training: onset awareness and production training
   - *Word Coda* Training: awareness
   - *Syllable Segmentation*: syllable awareness and polysyllabic word production training

6.4.4.2 Progress during Phase II (November 1999)

Phase II took place over a period of 5 months and consisted of two sessions per week of 45 minutes' length (N= 22), if not interrupted for holiday or illness reasons.

Table 6.12 Moritz's speech status in November '99

Material	Assessment	Findings
Picture-naming task	Phonetic inventory	m n ŋ b p d t f v x ʁ h l j ʃ s pf
Imitation task	Stimulability	m b p t f x ʁ h ʃ s ts
	Stimulability of syllables	CV: /m b p t f ʁ ʃ/ 80% correct, others not possible
	Stimulability of words	Onset /m b p f/ 80% correct, others not possible
Picture-naming task	Phonemic inventory	m n ŋ b p d t x h
	Error patterns	many developmental and one idiosyncratic patterns
	Syllable structure	36% monosyllabic 64% polysyllabic
	Word-onset realisation as /h/ or deleted	30%
Speech Sample	Utterance length	three to four word utterances
	Expressive vocabulary	continuing acquisition
Oro-motor screening	Oro-motor abilities	within normal range

1. Stimulability approach

Moritz's phonetic inventory only showed little improvement but was very stable. He had lost the two phones /g/ and /k/, which had previously only been used as substitutes in idiosyncratic processes. Stimulability could not be increased for any further individual phones but for CV-syllables and for words with /m b p f/ onset.

2. Phonological intervention

Moritz benefited from a phonologically orientated approach. Some progress was made in his phonemic inventory, and he became much more consistent in his

substitution and deletion patterns (fewer error patterns). As can be seen in Table 6.12 and Appendix XVII at the time of the final assessment, his error patterns consisted basically of developmental patterns apart from 'medial consonant deletion'. The focus of intervention had been to increase the realisation of initial consonants and to expand the syllabic structure. Both aims had been successfully realised. Again the most important changes could be found in his increased syllable length and also in increased utterance length.

In the middle of November a second interval of non-treatment started to allow treatment effects to stabilise.

6.4.5 Discussion: Moritz

The main aim guiding Moritz's case study was to investigate how different intervention approaches are related to different types of progress in a child with a severe speech disorder.

Even though the speech material available for analysis was limited and formal assessments were difficult or impossible to carry out, Moritz seemed to have an inconsistent phonological disorder exacerbated by a limited phonetic inventory. Support for this classification was drawn from his inconsistency in the production of repeated words in his spontaneous speech and by his greatly reduced ability to imitate phones or oro-motor tasks.

Previous research into intervention for children with developmental speech disorders has indicated that children with an inconsistent phonological disorder benefit mostly from intervention when consistent word production is the first target (Dodd & Iacono, 1989; Dodd & Bradford, 2000). Therefore, the *core vocabulary approach* was first chosen for intervention and findings at the time of reassessment supported its

effectiveness. During the first phase of therapy, Moritz reached a consistency level which was below the cut-off point for classifying a child as inconsistent. Despite his more consistent speech production, Moritz's speech remained highly unintelligible.

In conjunction with *core vocabulary intervention* the *stimulability approach* had been applied to increase Moritz's very restricted phonetic inventory and phone-imitation abilities. This approach was chosen because Powell (1996) argues: "the number and types of sounds available to a speaker will necessarily limit the complexity of differentiated utterances and this, in turn, will affect intelligibility" (p.318). During Phase I progress was made as expected, but only slowly. The approach was continued with considerably greater success in Phase II, when phonological intervention was added. This raised the question of how far progress was due to the stimulability approach or to phonological intervention. On the other hand it could be possible that progress was due to the combined approaches based on Powell's (1991, 1996) and Miccio & Elbert's (1996) hypothesis.

At the beginning of Phase II a new surface error pattern analysis was carried out which revealed developmental and idiosyncratic error patterns and suggested the new classification of a deviant-consistent phonological disorder. Accordingly, as discussed in the previous case study, *phonological intervention* was applied in Phase II, targeting awareness and production of word-onset and word syllable length. After five months of intervention Moritz was reassessed and phonological intervention was found to have been beneficial.

In summary, this case study suggested that different intervention approaches might be necessary for the effective treatment of one child. In Moritz's case three problem areas could be detected, which were targeted using three different approaches to remediation. The study revealed that the positive effects of intervention only occurred in the target area of each individual approach, but not in other areas.

6.5 ISSUES ARISING FROM THE TWO CASE-STUDIES

Three issues arise from the two case studies on Nils and Moritz. First, identification of the possible underlying deficits has been shown to be important for applying deficit orientated and, therefore, beneficial therapy. Both studies demonstrated the effectiveness of phonological intervention that targeted an inappropriate phonological system. The study on Moritz provided further evidence for the effectiveness of the *core-vocabulary approach* in children with inconsistency in word realisation, which had been suggested by Dodd & Bradford (2000).

Both studies involved the application of articulation approaches in targeting restricted phonetic inventories. However, the changes observed might have been due to additional phonological intervention (ear-training in Nil's case and the application of a parallel phonological approach in Moritz's case) than to articulatory intervention on its own. On the other hand, according to the stimulability approach, the availability of a large number of phones is a prerequisite for phonemic contrasts. Therefore, articulation intervention might have positively influenced the success of phonological intervention. It is likely that both approaches contribute to changes. Future research needs to address the question of whether additional articulation therapy is more beneficial for phonologically disordered children with a restricted phonetic inventory than phonological intervention alone.

Another issue raised by Moritz's case concerns the concept of providing therapy at intervals. The concept of interval therapy relies on the idea that successful intervention not only improves treated targets but also functions as a kind of trigger for further development during non-treatment phases. Children should therefore continue to make progress even in untreated areas since, if triggered, the developmental course should go its own way. When Moritz was reassessed after an intervention break of two months, he showed considerable progress. Progress during

non-intervention phases needs to be carefully measured to establish the circumstances in which it occurs.

The final issue again relates to Moritz's case study. He was 3;0 years old when he was referred to speech and language therapy, an age considered very young for referral in Germany, because the general medical opinion is that children at this stage are too young to participate in, and to benefit from, intervention. Even though Moritz found some of the objective assessment procedures too tiring to complete, it was still possible to analyse his level of speech and language development and enough insight was gained to establish an effective treatment program. As shown by the several re-assessment stages, intervention, even though applied at a very young age, was beneficial. If children are referred at an early age and intervention can be implemented, idiosyncratic patterns have less time to become a habit and remediation could be faster. This case study supports therapists' calls for early referral.

6.6 CONCLUSION

This Chapter presented one group study and two case studies describing the effectiveness of different intervention approaches. Several clinical implications have been drawn from them, which will be further discussed in Chapter 7.

CHAPTER 7

GENERAL DISCUSSION AND CONCLUSION

7.1 INTRODUCTION

This chapter summarises the major findings of the studies reported in this thesis in relationship to the aims set and hypotheses made. The first part of this chapter will set these findings into the theoretical context of phonological theory. Theories will be evaluated for their ability to account for universal and language-specific phenomena. The second part of the chapter will focus on the clinical implications that can be drawn from the studies presented.

7.2 DISCUSSION OF THE MAJOR QUESTIONS AND FINDINGS

7.2.1 Normal Speech Development

Chapter 2 aimed to provide normative data for phonological development in German-speaking children. A cross-sectional study of 177 children provided data concerning the order and age of phonetic and phonemic inventory acquisition and error patterns. Three major hypotheses were proposed:

- The phonological acquisition of German-speaking children will show some characteristics observed for phonological development in other languages. The error patterns found for German should be similar to those frequently described for other languages.
- A comparison of the phonological acquisition of English and German should reveal highly similar patterns, since the two languages have a very similar phonemic system, which is assumed to be related to both being of West-Germanic origin.
- Any language-specific differences found in comparison to other languages should be able to be accounted for by two factors: a) language-specific sound system and b) the theory of phonological saliency.

The results of the study agreed with earlier research findings on phonological acquisition by German-speaking children for order of phoneme acquisition and type of error patterns used. Differences in age of acquisition and some error pattern variation were explained by differences between the studies' methodologies (e.g. cross-sectional versus longitudinal and differing criteria for phoneme acquisition).

7.2.1.1 Universality in Phonological Acquisition: Evidence from Developmental Error Patterns

Methodological differences present a problem for cross-linguistic comparisons of phonological acquisition. Nevertheless, the error patterns that have most frequently been described for all other languages so far investigated are highly similar to the ones found in this study: deletion of weak syllables and final consonants, fronting of velars and sibilants, consonant harmony (or assimilation), cluster reduction, and stopping and voicing (see Table 1.2 in Chapter 1). This agreement supports the concept of universality especially since the languages compared belong to different linguistic families, English and German being West Germanic, Swedish being North Germanic, Spanish, Portuguese and Italian being Italic, Turkish being Turkic and Cantonese and Putonghua being Sinitic (Crystal, 1997).

On the other hand, some developmental error patterns observed for German are not typical of development in some other languages and thus provide evidence against a strict concept of universality. For example, backing was found to be a developmental pattern in two cases for German: a) backing of sibilants and b) backing of /ç/ → /x/. Backing has also been described as a developmental error pattern in Putonghua where alveolars were produced as post-alveolars and /x/ was substituted for a variety of front fricatives (X-Velarization) in normally developing children (Zhu Hua & Dodd, 2000a). In contrast to these findings, backing has been described as an idiosyncratic pattern for many other languages investigated (e.g. English). Other patterns that are idiosyncratic in English (Dodd, 1995) but developmental in German are: initial

consonant deletion (except /h/-deletion), nasalisation and glottal replacement of initial consonants, especially /ʁ/, the last being common also in Swedish-speaking children (Nettelblad, 1983).

Even though these findings provide evidence of cross-linguistic differences, such differences do not allow the negation of the idea of universality. Most phonological theories admit the influence of the ambient languages in the language-learning environment (e.g. Natural Phonology, Generative Phonology, Non-linear Phonologies, Biological, Cognitive and Behaviourist Approaches). However, the findings challenge Stampe's (1979) theory that phonological processes are innate, universal and natural, since the processes "represent a natural response to phonetic forces implicit in the human capacity for speech" (Donegan & Stampe, 1979 p.130). If this was indeed the case, children should show the same developmental error patterns irrespective of the language they are learning.

7.2.1.2 Comparison of the Process of Phonological Acquisition in German- and English-speaking Children

One further question addressed was the comparability of the order and age of phoneme acquisition in children acquiring English and German. A high rate of similarity was expected since both languages have a very similar phonemic system, which was assumed to be related to them both being West Germanic languages.

The findings of this study into German were compared with the results reported by Prather et al. (1975) because the same acquisition criteria were used. Similarities were found in the order, and to some extent the age of phoneme acquisition in both systems. The pattern found agreed with Jakobson's (1941) law of irreversible solidarity that predicts that nasals should be acquired before orals, front consonants

before back consonants and stops before fricatives. This is not very surprising, since Jakobson's (1941) theory was heavily dependent on data from Germanic languages.

However, although the findings revealed high similarity, there were also some language-specific differences, even for phonemes shared by both phonological systems. For example /d/, /v/ and /z/ are acquired earlier in German than in English (see Table 7.1). These findings provide evidence against theories of a universal, innate pattern of acquisition (Jakobson, 1941, 1969) or acquisition dependent on biological maturation (Locke, 1983). An alternative account needs to be considered.

Table 7.1 Comparison of phoneme acquisition in English (Prather et al, 1975) and German (study Chapter 2)

Age (years)	German	English
1;6 – 1;11	m b p d t n	No data
2;0 – 2;5	v h s/z	m n p h
2;6 – 2;11	f l j ŋ x ʁ g k pf	b f d t w j ŋ k
3;0 – 3;5	ç ts	l s r g
3;6 – 3;11	ʃ	ʃ tʃ
4;0 – 4;5		ð ʒ
> 4.6		dʒ θ v z

● Phonemes shared by both languages ● Language specific phonemes

● Phonemes shared by both languages, but acquired at very different ages

7.2.1.3 Accounting for Language-specific Findings

The third hypothesis proposed that language-specific differences could be accounted for in terms of linguistic theory. The most frequently cited linguistic approach is the concept of markedness. It states that those options of the universal grammar, which are default options, should be acquired first, followed by the other options in the

following order: from the least marked to the most marked. According to Bernhardt & Gilbert (1992) "the general framework and set of marked and unmarked features is assumed to be universal, but specified (marked) representations of the individual feature system will differ for languages because languages have different segmental inventories" (p.129). However, phonemes that belong to the phonemic inventory of two languages should have the same markedness values and acquisition order should be governed by the same rules. Furthermore, it has been claimed that developmental error patterns can be explained by markedness (Yavas, 1998) and certain predictions can be made about the patterns of occurrence. Table 7.2 investigates whether default predictions on the basis of markedness as described by Bernhardt & Stoel-Gammon (1996) can account for findings for German as they do for English.

Table 7.2 Acquisition predictions by markedness

	Predictions	Finding
1.	Default feature of stop : [- continuant] and [- nasal]	★
2.	Early specification of [+ nasal]	★
3.	A) Specification of fricatives after stops and nasals	0
	B) Specification of liquids after fricatives	0
4.	Default feature [- voice] and [- spread glottis]	0
5.	Default place feature coronal [+ anterior]	★
6.	Default syllable structure: CV	0

★ = data supported prediction; 0 = data did not support prediction

The first two predictions were supported by the data found. Nasals and stops were acquired first. Prediction 3A) was only partly supported since velar stops and the velar nasal /ŋ/ were either acquired later than fricatives (75% criterion) or at the same time (90% criterion). The same applies to prediction 3B). The default feature [- voice] was only supported for /p/ and /k/, while /d/ and /v/ were found to be acquired earlier than their voiceless counterparts. Prediction 5 was supported by the findings. While two very frequent error patterns, cluster reduction and final consonant deletion, supported

prediction 6 (the default syllable structure CV) the equally common pattern of initial consonant deletion provided evidence against the prediction. These findings indicate that the concept of markedness does not fully explain the language-specific acquisition pattern found for German nor the differences in comparison with English.

An alternative approach relying on frequency of phoneme occurrence focuses on an expected relationship between phoneme acquisition and the frequency of phoneme occurrence in adult speech (Jakobson, 1941; Olmsted, 1971). Pye, Ingram & List (1987) claimed that this approach was not reasonable because frequency in adult vocabulary is not necessarily identical to frequency in children's vocabulary. They argued that the latter should be used as an indirect measure of their newly introduced concept of *functional load*. Functional load aims to explain the language-specific order of phoneme acquisition in terms of the importance of a phoneme in a language as determined by the number of phonemic contrasts each phoneme has. According to the example given by Ingram (1989), a phoneme which can occur in more word positions than another should have a higher functional load. Therefore, for German, the phonemes /v/ and /d/ have a lower functional load than /f/ and /t/ since they only occur in two word positions, while the latter two occur in three. They, consequently, should be acquired later or at least at the same time as their unvoiced counterparts, as is the case for English. *Functional load*, then, does not provide an explanation for these language-specific findings for German-speaking children.

The most recent approach is the concept of phonological saliency (So & Dodd, 1995; Zhu Hua & Dodd, 2000a). It is argued that the role played by a specific phoneme within its languages might be important, considering three factors: a) the status of a component in the syllable structure, b) the capacity of a component in differentiating the lexical meaning of a syllable and c) the number of permissible choices within a component in the syllable structure. The important difference between this and other theories described so far (apart from *functional load*) is that the concept is based on

the language-specific phonological system and in contrast to *functional load* considers all phonological aspects of a language, not only consonants. The following hypotheses had been developed for German:

- → German-speaking children should not make vowel errors during their development, since vowels are highly salient.
- → German-speaking children should complete the acquisition of their phonological system earlier than English-speaking children, since the overall number of phonemes and word-initial clusters is smaller.
- → German-speaking children should acquire the following phonemes at a very early stage, because they are part of words of high communicative meaning: /m p b d n/.
- → German-speaking children should acquire the phonemes /v/ and /z/ earlier than English-speaking children, because of the communicative importance of words containing /v/ in German and because of the language-specific distribution pattern of /z/ and /s/ in German, which makes both phonemes equally important.

All four hypotheses could be supported. Children did not show vowel errors as a developmental error pattern. Vowels were acquired very early and were nearly always correct (only a mean of 2% of the incorrect vowels were observed in the normative data). German-speaking children indeed finished their phonological acquisition process earlier than English-speaking children, but later than Cantonese- and Putonghua-speaking children, whose number of component options was again smaller than those in German. Tyler & Langsdale (1996) suggested that at an early age (10-18 months) an interaction of rate and place of acquisition of vowels and consonants exists. Additionally it will be assumed that further component options, such as cluster acquisition, interact similarly. The number of options that need to be acquired in English is higher than the number of options possible in German. The number of options in Cantonese, however, is again smaller than the number of options for German. If the speed of phonological acquisition is dependent on the numbers of

options that need to be learned, children acquiring Cantonese should complete their phonological acquisition before children acquiring German and they in turn should complete their acquisition earlier than children acquiring English. Findings from studies of these languages support this hypothesis: Cantonese-speaking children were found to complete their phonological acquisition by the age of 3;6 years, German-speaking children by the age of 3;11 years and English-speaking children later than the age of 4;6 years (all based on 75% criterion) (So & Dodd, 1995; Prather et al, 1975; Chapter 2).

The first three phonemes acquired (90% criterion) were / m p d / followed by / b n /. These findings exactly follow the hypothesis made. The hypothesis was based on the factor in the concept of phonological saliency which concerns "the capacity of the component in differentiating lexical meaning of a syllable" and in carrying communicative intent. In view of this hypothesis the unusual phenomenon of the early acquisition of /d/ in German can be explained: the phoneme /d/ is necessary to build one of the most common first German words: *Da* (there). Its communicative meaning is very high, since it can be used as a question word (*Da*? You mean this person/thing there?), for pointing (*Da*! That's what I mean), for reassurance (*Da*? - Are we talking about this thing/person there?), for expressing a wish (*Da*! I want this).

Two further phonemes were found to be acquired earlier in German- than in English-speaking children (/v/ and /z/), which again is accounted for by the concept of phonological saliency. The explanation for the earlier acquisition of /v/ is similar to the explanation presented for /d/. The phoneme /v/ occurs word initially in most German question words (*Warum?* (why), *Wo*? (where), *Wer?* (who)...) The letter 'w' is always pronounced as [v]. Furthermore it is the first phoneme of the animal sound for dogs: *wau wau* [vau vau] and since this is one of the first German words to be acquired while replacing the real word *Hund* (dog). The importance of the phoneme

/v/ is therefore much higher for German-speaking children than for English-speaking children.

The explanation for the early acquisition of /z/ will be related to the distribution pattern and frequency of occurrence of /s/ and /z/. For German the usage of /z/ and /s/ is evenly distributed with a similar number of occurrence possibilities for both phonemes. This distribution pattern makes /z/ highly necessary for German and could also be the reason why German-speaking children do not make voicing errors on these phonemes. For English, however, /s/ is the far more frequent phoneme, even though on the surface the distribution looks similar - apart from clusters, where only /s/ is possible (see also Table 7.3). Even though the phoneme /z/ can occur in all word positions (with the exception of clusters) its frequency is low. In word-initial position, for example, it only occurs in a very restricted number of words, most of them not being part of child vocabulary. Consequently, since the saliency of /z/ is much higher in German than in English, the concept of phonological saliency can account for the different acquisition findings.

Table 7.3 Distribution of occurrence of /s/ and /z/ in German

Position	word-initial	word-medial	word-final	WI-clusters
German	z	z s	s	/
English	z s	z s	s	s

In summary, the aims of Chapter 2 were fulfilled. A set of normative data concerning phonological development in German-speaking children was established. These data allow the classification of children with developmental speech disorders according to psycholinguistic and linguistic-descriptive models. Secondly, the hypothesis of language universals in speech development was further supported by these data. German and English, two closely related languages, were found to be highly similar

and strong similarities existed between German and other languages of different language origin. Finally, it was possible to account for the language-specific findings made using the concept of phonological saliency, while other theories failed to provide an explanation.

7.2.2 Speech Disorders in German-speaking Children

The study of children with speech disorders raises important theoretical and clinical issues. One theoretical issue concerns the universality of speech disorders. If the same specific deficits in the speech-processing chain underlie speech disorders, then irrespective of the language learned, the same types of surface error patterns should be observable across languages.

Clinically, this thesis has argued that it is possible to evaluate the validity of current classification systems in the Anglo-American literature by their applicability to languages other than English. Since Dodd's (1995) classification system hypothesises that specific underlying deficits are associated with subgroups, it can further be supported by studies investigating outcomes for the efficacy of intervention targeting specific deficits. The clinical importance of these studies lies in their direct influence on diagnostic and intervention approaches for practising speech and language therapists. The data from Parts II and III aimed to clarify the following issues:

- Is it possible to classify German-speaking children with speech disorders according to the four hypothesised subgroups of Dodd's (1995) psycholinguistic model?
- Is it possible to classify the same group of children according to Shriberg's (1993, 1997) etiologically-based model, excluding the children of the articulation subgroup to conform with Shriberg's criteria for speech delay?
- Does a relationship between risk factors and developmental speech disorders exist?
- Do German-speaking children benefit from deficit-orientated intervention approaches designed for English-speaking children?

- Do findings from these studies support the concept of universality in developmental speech disorders?

7.2.2.1 The Application of Dodd's Classification Approach

As hypothesised it was possible to classify 100 German-speaking children with suspected speech disorders into the four subgroups proposed by Dodd's (1995) psycholinguistic model. The four subgroups could be identified on the basis of their surface error pattern.

Articulation Disorder: specific phones were consistently distorted in their articulation pattern, irrespective of the phonetic context.

Delayed Phonological Development: delay in phone/phoneme acquisition; only developmental error pattern usage as determined by normative data.

Deviant-Consistent Phonological Disorder: non-developmental pattern of phone/phoneme acquisition (inventory and rate); idiosyncratic error pattern usage with additional developmental error patterns.

Inconsistent Phonological Disorder: inconsistent phoneme realisation in recurrent productions of the same words in the same single word context.

The classification of all children according to the proposed subgroups was unambiguous, apart from very few cases (N = 8), where children scored just above the criterion for the error pattern set (3 instead of 2 occurrences) or made errors in three specific lexical items. These findings further validate the classification system. However, some issues should be taken into consideration to make the system more clinically valid.

The first issue concerns the subgroup of articulation disordered children. According to the definition of this subgroup, children will be classified as showing an articulation

disorder when they use a consistent, phonetic-context-independent distortion of one or more phonemes. The underlying deficit is defined as a peripheral articulatory one. However, findings from the intervention group study into sibilant distortions in Chapter 6 indicated that more than one deficit might underlie an articulation disorder. Different researchers have suggested that immature articulation abilities, myofunctional disorders, mild developmental dyspraxia and incorrectly learned placement pattern underlie articulation disorders. The differences in the proposed causal factors suggest that additional assessments are necessary for deficit-specific intervention planing. The surface error pattern analysis only identifies a disorder category. To provide an assessment tool to reveal a differential diagnosis, oro-motor screening was used, a procedure that seems a useful addition to the surface error pattern analysis.

The second issue concerns the subgroup of children with delayed phonological development. A delay of six months has been found to be significant when classifying children as delayed. However, no statement has been made as to whether the length of delay may indicate subtypes of delays, which again might influence the outcome for these children. Children have been said to show 'frozen' phonological development (Dodd, 1995). They were nevertheless classified as delayed. Other authors, however, classify these children as disordered rather than delayed (Stackhouse & Wells, 1997). Future research needs to investigate whether a specific length of delay or a specific age, after which a delay is still apparent, significantly changes children's outcome, i.e. different pattern of spontaneous change while being on the waiting list or different progress during intervention. Findings from this kind of research should identify which classification is justifiable.

The third issue concerns the subgroup of children classified as deviant-consistent phonologically disordered. Even though these children resemble each other in that they show idiosyncratic and developmental error patterns, they do not necessarily

have the same area of breakdown in the processing chain. Further assessments, specifically focussing on areas of phonological awareness such as assessed by the psycholinguistic framework by Stackhouse & Wells (1997), are needed to identify target levels for deficit orientated remediation.

7.2.2.2 The Application of Shriberg's Etiological Classification Approach

As hypothesised, it was not possible to classify 66 German-speaking children with speech disorders from the previously mentioned group (excluding children with an isolated articulation disorder to agree with Shriberg's criteria for 'speech delay' and those children whose parents did not complete the questionnaire) according to Shriberg's model (1993). Only a certain number of children showed etiological factors as described by Shriberg, while a further number of children had no history of any risk factors or several factors were reported in parallel.

While the use of a medical model (e.g. Shriberg, 1994, 1997) provides important information concerning influential causal and maintenance factors, it has limited clinical applicability. By the time a child is referred for assessment a number of causal and maintenance factors might be apparent (e.g. history of otitis media, older sibling who 'interprets' for speech-disordered child, family history of speech disorder). Given that a clinician's task is to remediate the problem, classification in terms of the surface speech error patterns provides more relevant information for determining therapy targets.

7.2.2.3 Discussion of the Psycholinguistic Framework by Stackhouse & Wells

The psycholinguistic framework by Stackhouse & Wells (1997) follows the current concept that speech disorders need to be evaluated from a psycholinguistic perspective. The area(s) of breakdown in the speech processing chain as well as the child's intact abilities are identified to determine deficit orientated intervention. This framework implies that children with speech disorders cannot be classified into subgroups. It is argued that every child's disorder needs to be seen as an individual

problem caused by a breakdown at one or more levels of the speech processing chain. This point of view argues that the assessment of a child with speech disorder requires a range of analysis in addition to a speech surface error pattern analysis as suggested by Dodd's (1995) classification system. Stackhouse & Wells (1997) claim that it is not necessary to use the whole range of proposed assessment tasks with every child, stating "tests will be selected on the basis of observations, linguistic and educational assessments and medical information" (1997, p.102). However, Stackhouse & Wells' (1997) approach requires considerable assessment time before a child's speech problem can be identified adequately. Stackhouse & Wells' (1997) procedure is important for designing individual intervention strategy. In contrast it can be argued that a classification system such as the one by Dodd (1995) can reveal sufficient information after a short assessment session to interpret whether intervention is immediately necessary and what general type of intervention approach might be most successfully.

One further point is worth consideration when selecting assessment tasks. Even though Stackhouse & Wells' (1997) framework considers the input, internal representation and output of the speech processing chain, most of the suggested tasks investigate children's phonological awareness and phonological manipulation abilities in order to gain information about their internal representation. Research by Dodd, Leahy & Hambly (1989) and other research cited by the former authors, however, demonstrated that children who show an articulation disorder, a delay or who are inconsistent in their speech production do not have problems with these kinds of tasks. Therefore, the application of a series of the framework assessments would not be necessary or useful for designing an intervention strategy for a large number of children with speech disorders (~ 80%). As reported by Dodd (1995) children with a delay do not perform significantly differently from normal controls on any tasks and thus investigation using Stackhouse & Wells' framework might not be time-cost effective. Children with an articulation disorder or an inconsistent phonological

disorder on the other hand would require more tasks on the output side than available to determine their specific problems.

Two further problems exist for the evaluation of the data of a child with a speech disorder. First, so far, no normative data for the complete framework has been published and it is, therefore, difficult to identify whether a child's performance in a task is age-appropriate. Stackhouse & Wells (1997) argue that the framework is a means of systematically interpreting data, collected from whatever source. The second problem concerns the study of German-speaking children. No normative data exist for German-speaking children in terms of phonological awareness and no information is available about whether German-speaking children perform on these tasks in the same way as English-speaking children. The interpretation of findings for a large part of the framework from German-speaking children with speech disorders, at this stage, is consequently very subjective. On the other hand, it was demonstrated that the application of parts of the assessment framework was highly beneficial when determining target areas for intervention in a speech-disordered child. It will be suggested that for children with a deviant-consistent phonological disorder a detailed assessment as given by the framework is appropriate when determining the precise breakdown in the speech processing chain as well as determining the child's strength. Future research should design a German version of the framework and needs to investigate the phonological development and abilities of German-speaking children with and without speech disorders.

7.2.2.4 Relationship between Risk Factors and Speech Disorders

The literature cites many research studies that have sought to establish the relationship between risk factors and developmental speech disorders. Unfortunately, study designs and findings vary greatly. Even though findings from the study presented in Chapter 5 indicated that it is possible to distinguish speech disordered children from normally speaking children by some risk factors, only 52% of all children actually

present a history of at least one risk factor. It seems that while children with risk factors are more likely to develop a speech disorder, they do not inevitably do so. On the other hand, awareness about existing risk factors "can allow early identification and therefore, the possibility of early intervention" in children with speech disorders as stated by Lewis & Freebairn (1997, p. 398).

A second aim of the study in Chapter 5 was to explore how far a distinct pattern of risk factors is linked to three of the hypothesised subgroups proposed by Dodd (1995), perhaps associating organic causal factors with the hypothesised specific underlying deficit in the speech processing chain with the surface error patterns of each subgroup. Even though it was not possible to match each subgroup with one specific type of risk factor, in comparison with the control group statistical analysis revealed a profile for the subgroups, which agrees with the presumed underlying deficits:

Delayed Phonological Development: this is the only subgroup that was differentiated by acute otitis media.

Deviant-Consistent Phonological Disorder: the subgroup was only significantly different from the control group on positive family history, unlike the other subgroups

Inconsistent Phonological Disorder: this group differed significantly in pre-and perinatal problems.

These findings can only be seen as preliminary for several reasons. First the number of children within the subgroups was not matched. Second the numbers of children within the two phonologically disordered subgroups were very small and significantly more data are needed to confirm these results. Third, research so far has not been able to determine standard measures for any of the risk factors presented; such measures would allow a prediction of a true causal connection. Consequently, the measures used in this study differ again from those used in earlier studies. Finally, most risk factors rely on the subjective reports given by parents. The reliability of these reports

can be questioned. Nevertheless, considering all these problems carefully, the findings presented agree with the hypothesised causes of the underlying deficits proposed by Dodd (1995) and, therefore, additionally support the classification system.

7.2.2.5 Intervention in German-speaking Children with Speech Disorders

German-speaking children with developmental speech disorder benefited from deficit-orientated intervention programs, designed for and validated on English-speaking children. Intervention was shown to be beneficial only for the specific targets of individual approaches. No effect on untargeted areas could be observed i.e. articulation therapy did not affect the phonological system of a child. This stresses the importance of a precise differential diagnosis when determining the correct underlying deficit. Support was demonstrated for effective phonological intervention remediating phonological disorders and for the core-vocabulary approach targeting consistent speech production. Articulation intervention showed some effect in increasing a restricted phonetic inventory. The question was raised whether additional articulation intervention for children with a phonological disorder and a restricted phonetic inventory might be more beneficial than the isolated provision of phonological intervention. Future research is necessary to clarify this question. Even though the findings from these descriptive studies supported the existing literature on English-speaking children it is important to keep in mind that there is a need for more rigorously designed efficacy studies. Such studies should evaluate the efficiency of different intervention approaches with different subgroups of children of different ages. Pre-therapy multiple baseline measures should be established and control measures (i.e. for non-therapy targets) should be taken. The use of these variables would provide data that evaluates these preliminary descriptive findings.

A number of further issues arising from the data presented in this thesis are worthy of discussion.

Oro-motor skills

One issue concerns the assessment of oro-motor skills and the implications of the results. All children with a suspected or diagnosed speech disorder underwent an oro-motor screening. Oro-motor screenings are part of the standardised assessment procedures in Germany (e.g. Böhme, 1998), based on the assumption that speech disorders are significantly related to inappropriate oro-motor abilities as was found by Gabriel, Chilla & Kozielski (1976). Their findings were supported by the significantly poorer performance of a group of children with speech disorders presented in Chapter 4 in comparison with a small control group. According to German textbooks, an increase in oro-motor abilities is essential to achieve correct phone-production (e.g. Böhme, 1998).

In general, the nature of the inappropriate oro-motor abilities is not described. Gabriel et al (1976) suggested a mild dyspraxia. This hypothesis seems unreasonable considering the large percentage of articulation disordered children who showed inappropriate skills in their study. Two further reasons suggested by other authors (e.g. Böhme, 1998) were 'oro-facial muscle imbalance' as caused by a myofunctional disorder, which is assumed to be, for example, a major causal factor in sibilant distortions, and decreased tactile-kinaesthetic oro-motor awareness. In all suggested cases, a child can be expected to score poorly on an oro-motor screening, but the screening itself does not provide a differential diagnosis in terms of cause. A further problem arises due to the lack of normative data for any of the assessment procedures used. Their evaluation is therefore rather subjective. The small normative sample used for comparison in this thesis is not sufficient to make the procedure objective and can only be seen as a guideline.

The findings, however, suggest that normally developing children do not have problems with oro-motor tasks. The comparison of the normative sample with the speech disordered children revealed that at least a certain percentage of children with speech disorders perform significantly more poorly than controls and the rest of the

group of speech disordered children. Oro-motor abilities might therefore be important for differential diagnosis and, as suggested, for successful intervention. Unfortunately no treatment efficacy study has provided any proof that oro-motor training is a necessary prerequisite for the teaching of missing phones. Future research needs to investigate how far oro-motor screenings are relevant for differential diagnosis and what their implications are for intervention.

The special case of /s/ and /z/

A second issue related to the previous one is the question whether an isolated /s/z/-distortion in the form of interdentality presents an articulation disorder or whether it should be considered as a variation of the norm. According to German speech therapists and phoniatrics, the interdental production of /s/ and /z/ is an articulation disorder called *Sigmatism,* which requires intervention. Speech therapy textbooks dedicate many pages to this topic, which is interesting, considering how minor the problem is and that interdentality does not at all reduce intelligibility. Furthermore, it has been widely recognised that a very high percentage of children (35% according to Biesalski & Frank, 1994) will not have acquired phonetically correct /s/-production by the age of 6 years, which at that age is already labelled as a disorder. The findings from the study in Chapter 2 of this thesis confirmed the percentage stated by Biesalski & Frank (1994) and raise the question of whether a percentage like that really indicates a disorder or rather a variation of the norm, a variation possibly due to an incorrectly learned placement for a specific phone. The group study in Chapter 6 discussed this possibility, using an oro-motor screening as a differential diagnosis tool. Children were assumed to have learned an incorrect placement position when they performed within the normal range of the control sample in the oro-motor screening.

This discussion has implications for the question of whether speech therapists should provide intervention for children with interdentality as the only symptom of a speech disorder. It was argued in Chapter 6 that a group intervention approach of a maximum

of twelve sessions might be adequate to handle the large group of children referred because of a lisp and to satisfy society's demand for therapy provision within financial limits.

The need for early intervention

The third issue concerns the age at which intervention can be effective. According to medical opinion in Germany "speech therapy for children is viable at approximately four years of age[17]" (Böhme, 1997, p.47). This thesis opposes this assumption for two reasons. Firstly, the case study of Moritz presented in Chapter 6 and the classification study presented in Chapter 2 demonstrated that speech disorders can be detected in children younger than four years of age. Secondly, Moritz's case showed that the effectiveness of speech therapy is not necessarily dependent on the child's age, since intervention was shown to be beneficial when he was only three years old. In contrast to existing medical opinion, it will be argued here that it is highly beneficial to refer children as young as possible since changing idiosyncratic speech patterns is easiest before they have had time to stabilise.

Early intervention is associated with another issue relating to interval therapy, which argues for therapy and therapy-free phases in intervention. Moritz's case demonstrated that progress was evident during phases of no-intervention. The finding suggested that progress was due to intervention stimulating development. If further intervention efficacy studies support this hypothesis, interval therapy could be beneficial for several reasons:

- it increases the motivation in long-term patients and parents,
- it would be more cost-effective than uninterrupted long-term intervention,

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[17] "Eine logopädische bzw sprachheilpädagogische Behandlung ist etwa ab dem vierten Lebensjahr möglich." (Böhme, 1998, p.47)

- it would provide more intervention places due to a rotation system, which is very important because of the long waiting lists in Germany.

7.2.2.6 Evidence of Universality in Developmental Speech Disorders

This thesis argues that phonological theory and clinical data need to go hand in hand. It was claimed that phonological theory can be validated by using data from phonologically disordered children. One of the major claims of phonological theory is that phonological development follows a universal pattern. Because of the similarities found in phonological development across children acquiring different languages, it was suggested that factors other than the ambient language learned must be responsible for speech acquisition, for example, universal cognitive abilities, general perception and production abilities and maturation. Therefore, the developmental history and nature of the errors made by children with speech disorders might be able to confirm the hypothesised prerequisites for normal development.

As mentioned in Chapters 1 and 3 several phonologists have claimed that speech development follows a universal course because it relies on universal non-linguistic abilities (Locke, 1983; Olmsted, 1966/1971; Mowrer, 1952/1960). These abilities are maturation, learning abilities and general perception and production abilities. None of the children investigated in this thesis was known to have any kind of intellectual, cranio-facial or sensory disability, neither was a general lack of maturation reported by parents, doctors or nursery nurses. For this reason, they were also described as children with a speech disorder of unknown origin and it can be assumed that their proposed prerequisites for phonological acquisition are intact. However, some children with speech disorders of unknown origin are reported to have had pre-and perinatal problems which led to the idea of possible minimal brain damage, which could have a negative effect on general maturation, learning etc (see section 5.4.5) and therefore speech development. Additionally, evidence of negative influences on speech development caused by deficits in all the areas assumed to underlie

phonological acquisition can be found in the literature (Byers-Brown & Edwards, 1989; Rhea, 1995; Gerber, 1998).

Other phonologists emphasise an innate and universal linguistic knowledge, although they may disagree about the nature (e.g. Jakobson, 1941; Chomsky & Halle, 1968; non-linear phonologists). If this hypothesis is correct, it seems likely that this knowledge is stored in some kind of genetic form. Speech disorders could then be caused by a breakdown at the genetic level. A high incidence of positive family history in children with developmental speech disorders reported for English- and German-speaking children supports the hypothesis of some kind of genetic involvement.

Finally, linguists have argued for the strong influence of the input of the ambient language on speech development. According to Mowrer (1960), Ferguson & Farewell (1975) and Locke (1983) frequent and repeated input of speech from the child's environment plays an important role in phonological acquisition. Furthermore, exercising of the articulation organs was stressed to be important (e.g. Ferguson & Farewell, 1975; Locke, 1983). Speech development may be disturbed when either input cannot be correctly perceived, input is not sufficiently available (poor language environment) or when children can not exercise their oro-facial organs. Reports from children with speech disorders suggest that temporarily disturbed hearing caused by repeated ENT-diseases or middle ear involvement, especially acute otitis media, might delay speech development. Additionally sucking habits such as continuous dummy or bottle use have been reported to differentiate speech-disordered children from normal controls. These sucking habits could have a negative influence on exercising the oro-facial organs and therefore on speech development.

The findings from this study support all the prerequisites for speech development as suggested by linguists. None of these influencing factors for speech development is

dependent on a specific language and this therefore suggests universal causes of speech disturbances.

Further support for the concept of universality can be found in the error patterns which have been described for speech disordered children. The developmental error patterns found in German-speaking children with speech disorders were again similar to those described for normally developing children. Findings from this study further support the existing literature.

Finally, additional evidence for a universal pattern in speech disorders can be drawn from cross-linguistically applicable classification models. The proposed subgroups in Dodd's psycholinguistic model (1995) have been hypothesised to be connected with different specific underlying deficits. These deficits are again independent of the ambient language spoken by children with speech disorders and can be tested using cross-linguistic data on several levels:

a) the cross-linguistic applicability of the model: classification of groups of speech-disordered children of different languages according to proposed subgroups
b) similar distributions of the subgroups across languages
c) highly effective intervention when the same deficit focused intervention approaches are applied to children with speech disorders speaking different languages.

The data from German-speaking children have further supported Dodd's (1995) classification model on all levels and have therefore added to other cross-linguistic findings by Dodd (1995), Goldstein (1996) Topas & Konrot (1996), So & Dodd (1994), Zhu Hua & Dodd (2000b), Holm (1998) and Dodd & Bradford (2000). The different origins of all languages, which have been investigated in terms of the applicability of Dodd's classification system, stress the universality of the system, the different underlying deficits and speech disorders in general.

7.3 CLINICAL IMPLICATIONS

Not only theoretical implications arise from this thesis. The results also have significant clinical implications since the main focus of the research lay on children with speech disorders.

Classification of speech disorders has been and still is a controversial topic in the Anglo-American literature. In the German literature classification of speech disorders has never received major attention and most authors have simplified the topic by using several approaches in parallel: linguistic-inferential approaches (Sigmatism, Kappazism..), severity (according to Van Riper, 1963), etiology (sensory impairment, e.g. hearing or visual) and some obscure labels such as 'central speech disorder', a term used at the Hamburgian College for Speech and Language Therapy. None of these approaches have any direct clinical implications in that they lead to a specific intervention approach. This thesis, however, has demonstrated that the model proposed by Dodd (1995) provides a cross-linguistically valid classification system which is deficit orientated and therefore implies therapy focusing on the cause.

The application of Dodd's psycholinguistic classification relies on a surface pattern analysis that analyses phonetic and phonemic inventory, error pattern usage and consistency. This has two implications for clinicians. First, language specific normative data are absolutely necessary to differentiate between children with and without speech disorders. Judgements based on experience are not precise enough. Second, it is insufficient to assess a child's speech using a taxonomic analysis, as is done most often in German practice. Therefore phonology needs to become part of the training in German colleges of speech and language therapy and that further education for therapists in practice is necessary.

Not only a change in assessment practice but also in intervention practice is important. This thesis has shown that it is not sufficient to apply only one general

approach (i.e. the "traditional" articulation approach) as still practised in Germany for all children. Children with speech disorders benefit most from deficit orientated approaches.

Etiological factors do not necessarily differentiate children with speech disorders from normally developing children. However, risk factors can be used as precipitating factors in the sense that they may serve prevention purposes. Since risk factors such as pre- and perinatal problems, high occurrence of middle ear involvement and positive family history are associated with speech disorders, it would be important for parents and paediatricians to keep this in mind and observe the speech development of affected children more carefully so that if intervention is necessary, it could start as early as possible.

One final important point shall be mentioned. In addition to theoretical and clinical implications the findings also have financial implications. The availability of normative data and treatment efficacy studies can show insurance companies the need for intervention with speech disordered children and stress the importance of financed therapy. Furthermore, if treatment approaches are deficit focused they should be more effective and, therefore, also less costly at a time when health budgets are being drastically cut.

7.4 LIMITATIONS OF THE STUDY AND SUGGESTIONS FOR FURTHER RESEARCH

Several factors limited the findings reported in this thesis. Some suggestions for future research arise from these limitations. Further suggestions for research will be added.

Chapter 2 presented data on the acquisition of phonology in German-speaking children from the age of 1;6 years on. The reason for choosing this age as a starting

point was that at this stage children are expected to have a vocabulary that allows them to cope with a picture-naming task. Two problems became apparent: Some children did indeed have a quite amazing vocabulary even at the age of 1;7 years, but others were still on a ten word level. The variability between children at this early age led to a very uneven pattern from which it was difficult to draw precise conclusions about phone and phoneme acquisition and error pattern usage. The second problem was that depending on how developed their social skills were, a picture-naming task was inadequate for some children and even extending the session and observing the child during play did not necessarily prove sufficient.

Suggestion for future research:

The two problems described and the current discussion about whether the acquisition of speech is governed by phonetics or phonology led to the following suggestion: to achieve a complete picture about child speech development in German-speaking children it will be necessary to collect data from speech onset on. The most precise procedure would most probably be a longitudinal observational study of several individual children. The very early data on babbling would require an acoustic analysis while transcription might be sufficient from 1;0 year on depending on the speech status of the child. Data should be collected in individual sessions for at least one hour each and at regular intervals at least twice a month.

The observational study presented in Chapter 4 classified speech disordered German-speaking children into four subgroups. Previous research has thoroughly investigated the two subgroups of phonological disorders. However, little information is available about the subgroup of phonological delay although the largest percentage of speech disordered children fall into this subgroup. Future research should investigate the extent to which the age of the children and the length of the delay is important, whether children within this subgroup show different patterns of spontaneous change or outcome after intervention.

Chapter 5 presented an investigation into the relationship between risk factors and developmental speech disorders. Even though a direct causal link between risk factors and etiological subgroups of speech disorders could not be confirmed, the different psycholinguistic subgroups seemed to show a subgroup specific pattern of risk factors. The study's main problem, however, was that the subgroups contained unequal numbers of children. Specifically, in the "inconsistent phonological development" subgroup the number of children investigated was very small.

Suggestion for Future Research:

It is suggested that future research could be to collect data in a larger scale study. The number of children in each subgroup should be identical to investigate whether the pattern found so far can be confirmed.

If the hypothesis of underlying deficits holds, children within the proposed subgroups of speech disorders (Dodd, 1995) can be expected to show different patterns of spontaneous change while on a waiting list for intervention and during intervention. Previous research has suggested that children within the delayed group are more likely to show spontaneous improvement than children with a phonological disorder. Findings of this kind could have implications for the management of case loads in that phonological disorders should have priority for intervention while children with a delay should be closely monitored for approximately three to six months depending on the age of the children before intervention starts. Further research is necessary to investigate this topic.

Suggestion for Intervention Studies

Only very few treatment reports and studies exist about German-speaking children with speech disorders. This thesis stressed the importance of applying intervention according to the underlying deficit. Future research should provide treatment efficacy

studies to demonstrate the most beneficial approaches for different types of speech disorders. Efficacy studies should also address additional questions such as:

- Does the stimulability approach support intervention in children with a phonological disorder and restricted phonetic inventory more efficiently than phonological intervention only?
- Is oro-motor training a prerequisite for the acquisition of new phones in articulation disordered children?
- Is intervention beneficial in children younger than four years of age?
- Is interval therapy beneficial?
- Is the application order of different intervention approaches in children with co-existing deficits of importance?

Suggestion for Diagnostic Material

To ensure a proper assessment of children with developmental speech disorders, surface speech error patterns must be analysed. At present there is no suitable assessment material for German-speaking children that a) allows such an assessment in reasonable time; b) provides the clinician with normative data; c) leads directly to intervention. An assessment procedure that meets these requirements needs to be designed in a future project.

Suggestion for Normative Data

The dearth in research in the field of speech and language therapy is specifically demonstrated by the lack of developmental norms. Two important issues are the lack of norms for oro-motor and phonological awareness development. Future research needs to design appropriate test material, provide standardised norms in both areas and investigate their relevance and implications for speech disordered children.

Suggestion for the Investigation of Literacy Disorders

It has been reported that children with speech disorders often develop literacy difficulties at a later age. Specific subgroups were more likely to be at risk than others

(Leitão et al, 1997). Two future studies would be of great interest: 1) A follow-up study of children with speech disorders who have finished their course of intervention. What literacy difficulties appear later in the different subgroups of speech disorders? 2) A study of children who are referred for suspected literacy problems. What is their developmental profile?

Suggestion for Studies of Bilingual Children

The number of children in Germany growing up in bilingual language environments is increasing steadily. The most frequent languages are Turkish, Serbo-Croatian and Russian. However, very little information is available about phonological development in children acquiring these languages monolingually and no information exists about the phonological development in children acquiring either of these languages plus German. Future research needs to investigate normal phonological development in these children as that has significant implications for bilingual children with speech disorders as described by Holm (1998).

7.5 SUMMARY AND CONCLUSION

The most important findings of this thesis are:

- German-speaking children acquire their phonological system during their first four to five years of life, with labial and alveolar stops and nasals being acquired first, followed by fricatives and velars and with sibilants and clusters concluding the development.
- Age and order of phonological acquisition in German-speaking children for all phonemes and word initial clusters was established, as were the types and percentages of occurrence of developmental error patterns within all assessed age groups.
- Findings from the normative study supported the concept of universal phonological acquisition as well as hypotheses drawn from the concept of

phonological saliency, which was the only concept able to account for the language-specific findings.

- German-speaking children with developmental speech disorders of unknown origin can be classified according to the system proposed by Dodd (1995). They fall into the same four proposed categories: articulation disorder, delayed phonological development, deviant-consistent phonological disorder and inconsistent phonological disorder.
- It was not possible to apply the etiological classification system proposed by Shriberg (1993, 1994, and 1997) to German-speaking children with speech disorders.
- However, risk factors are able to differentiate normally developing children and children with speech disorders. Unfortunately, not all children show risk factors and, therefore, the relationship between risk factors and speech disorders still remains a topic of discussion.
- Articulatory and phonological errors and intervention need to be clearly distinguished.
- Assessment procedures investigating the articulatory part of speech only or resulting in a sound-by-sound description are inadequate to explore the deficits underlying a child's speech disorder.
- Intervention for children with speech disorders needs to target the underlying deficits to be effective.
- Findings from all the studies focussing on children with speech disorders suggest that speech disorders are of a universal, language-independent nature.
- Therefore, research findings in this field can be and need to be tested in cross-linguistic studies.
- Findings that have been validated by cross-linguistic studies are universally applicable.
- However, the cross-linguistic application of research findings requires precise knowledge about normal phonological acquisition of each language.

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Appendix I

List of Picture-Naming-Test Items

Mond	[m]	Zitrone	[tʁ]	Schnecke	[ʃn]
Eimer	[m]	Jäger	[j]	Schrank	[ʃʁ]
Baum	[m]	Eichhörnchen	[ç]	Schwein	[ʃv]
Ball	[b]	Milch	[ç]	Spinne	[ʃp]
Gabel	[b]	Taucher	[x]	Spritze	[ʃpʁ]
Blume	[bl]	Buch	[x]	Stuhl	[ʃt]
Brille	[bʁ]	Roller	[ʁ]	Kiste	[st]
Brief	[bʁ]	Schere	[ʁ]	Nest	[st]
Pilz	[p]	Gießkanne	[g]	Strumpf	[ʃtʁ]
Wippe	[p]	Nagel	[g]	Rutsche	[tʃ]
Korb	[p]	Berg	[k,ç]	Fenster	[nst]
Pferd	[pf]	Glas	[gl]	Heizung	[ŋ]
Apfel	[pf]	Gras	[gʁ]	Gespenst	[ʃp], [nst]
Topf	[pf]	Grün	[gʁ]	Schornstein	[nʃt]
Pflaster	[pfl]	Schlange	[ŋ]	Zebra	[bʁ]
Vogel	[f]	Anker	[ŋk]	Bild	[lt]
Marienkäfer	[f]	Kuh	[k]	Punkt	[ŋkt]
Schiff	[f]	Jacke	[k]	Bank	[ŋk]
Flasche	[fl]	Sack	[k]	Arzt	[tst]
Frosch	[fʁ]	Kleid	[kl]	Hund	[nt]
Wurst	[v]	Krokodil	[kʁ]	Gitarre	
Löwe	[v]	Knopf	[kn]	Tiger	
Lampe	[l]	Quak	[kv]	Erdbeere	
Teller	[l]	Sonne	[z]	kaputt	
Ball	[l]	Hase	[h], [z]	Unfall	
Nuß	[n]	Haus	[s]	Elefant	
Kanne	[n]	Hexe	[ks]	springt	
Telefon	[n]	Zwerg	[tsv]		
Dusche	[d]	Zange	[ts]		
Feder	[d]	Katze	[ts]		
Rad	[t]	Pilz	[ts]		
Drachen	[dʁ]	Schuh	[ʃ]		
Tasse	[t]	Tasche	[ʃ]		
Auto	[t]	Fisch	[ʃ]		
Bett	[t]	Schlüssel	[ʃl]		
Traktor	[tʁ]	Schmetterling	[ʃm]		

Appendix II

25 Word Inconsistency Test – List of Items

Träcker	Marienkäfer	Elefant	Krokodil	Schiff
Flasche	Eichhörnchen	Schwein	Gespenst	Zwerg
Fisch	Strumpf	springt	Brief	kaputt
Unfall	Rutsche	Schlüssel	Drachen	Glas
Knöpfe	Gitarre	Spritze	Frosch	Tiger

Appendix III

Phonological Processes found by Romonath (1991) and Hacker & Weiß (1986)

Error Patterns	Romonath*	Hacker & Weiß
Initial Consonant Deletion	★	☆
Final Consonant Deletion	★	★
Medial Consonant Deletion	★	
Vowel Deletion	★	
Weak Syllable Deletion	★	★
Cluster Deletion	☆	☆
Cluster Reduction	★	★
Assimilation	★	☆
Intrusive Consonants		★
Metathesis	★	☆
Reduplication	very rare	★
Migration	very rare	★
Epenthesis	★	★
Fronting	★	★
Backing	★	★
Stopping	★	★
Nasalation	★	★
Denasalation	★	☆
Gliding		☆
Glottal Replacement /ʁ/		★
Fronting /ʁ/ -> /j/		★
Affrication	★	★
Voicing	★	★
Devoicing	★	★
Lateralisation	★	
Palatalisation	★	

*Processes found by Romonath are only mentioned if they occurred in more than 2.0% of the words assessed

☆ = Process occurred rarely ★= Process occurred frequently

Oro-motor Assessment

Child:	DOB:	Age:	DOB:
LIPS	+ +/- -	**TONGUE**	+ +/- -
Push		Position in mouth	
Pull		stick out	
press		Towards right	
change push-pull		Towards left	
blow		Change right left	
blow cheeks		to upper lip	
suck cheeks		to lower lip	
		to Alveoles	
		to upper teeth	
SEQUENCES		lick lower lip	
blow + stick u.lip		lick upper lip	
lick lip + roar		circle around lips	
kiss + cough		into cheeks right	
yawn + lick side		into cheeks left	
T.to u.lip + in side		click	
		suck tongue	
		lick upper teeth	
		lick lower teeth	

Appendix V

Normative Control Data for Oro-motor Study

Children	Age	Total	Stats
1	3;0	23	
2	3;4	21	
3	3;6	19	
4	3;7	22	
5	3;7	20	
6	3;8	21	**Mean**
7	3;9	19	**20.85**
8	3;11	18	
1	4;1	22	**SD**
2	4;3	17	**2.12**
3	4;4	23	
4	4;6	22	
5	4;8	24	

Total: Total number of correct task productions

Appendix VI-a

Error Patterns: Articulation Disordered Subgroup

Age	56	58	58	62	64	65	66	67	67	67	67	71	74	75	75	75	75	76	78	80
Int	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	
Lat							★			★									★	★
1 off		3		3	2		1		1	1					1	1	1			

Age = Age presented in months; Int = Interdentality; Lat = Lateral production of Sibilants (→ ɬ)

Appendix VI-b

Error Patterns: Delayed and Deviant Subgroup

Age	Ass	ClR	CD	WSD	Fro	Sto	Voi	BkS	GlR	Daf	Vow	Met	Affr	f-θ	s-f	CD	IntC	BkP	UnD	Gl/l/	ʁ/l-j	ʁ-s	FavS	Allo	ClCh	ŋD/k	1 off
39	☆	☆	☆		★																						4
40		☆	★		★	★																					8
43		☆	★				★																				6
44					★																						3
47	☆	☆			☆		★	☆	★										★								4
47	☆				★																						2
48		☆																									4
50	☆	☆		★	★																						5
50	☆	☆			★																						5
52		☆																						★			7
52					★																						
53		☆	★		★	★					★																4
53					★		☆																				1
53		☆			★		☆				★																4
53																											
55		★			★																						3
55		★			★	★								★											★		7
55					★		☆						★														5
56					★																						2
56		★			★																						6
58	★				★																						1
58					★																						2
59		★			★																						9
59		★			★		☆																				4
59										★																	4
62			★																								4
62		★																									8
62							★																				2
63					★																						2
63					★		★	★						★													7
63		★	★		★																						5
64					★																						1
64					★																						
65		★								★																	4
65		★			★																						4
65	★																										1
66	★																										2
66		★																									2
67			★		★																						1
67																											2
67					★																						1
71	★				★		★																				2
72					★																						1
73	★																										3
73	★				★																						
74					★																						2
78		★																									3
79					★																						1
80	★				★																						1
80		★																									3
81	★																								★		4
41		☆			☆																						8
49		☆			★		★					★		★	★	★		★							★	★	4
49		☆	★		☆						★	★						★		★							1
50		☆			☆													★		★							5
51		☆			☆			★							★										★		4
54		☆	★	★	☆					★				★													2
53		☆			★				★					★													5
53		☆			★	★	★		★					★				★							★		8
54	★	★		★	★				★			★															4
58																				★							7
60					★		★																				6
63		★	★		★					★				★													
65			★																						★		2
69		★	★																	★						★	2
70		★												★											★		2
71	★	★			★															★							★
91																											

Appendix VI-c

Error Patterns: Inconsistent Subgroup

Age	Ass	ClR	CD	WSD	Fro	Sto	Voi	BkS	GlR	Daf	Voc	Nas	Vow	Met	Affr	f-θ	CD	intC	intV	BkP	UnD	Gl/l/	r/l-j	FavS	Allo	ClCh	unid	1off
31		☆	☆	☆	☆	☆	☆						★			★			★	★	★							7
39	☆	☆	☆	☆	☆			☆			★	★				★					★							6
40	☆	☆	☆															★								★		11
40	☆	☆	☆		★	★	★	☆				★		★										★				11
45	☆	☆	☆	★	☆	★	★						★				★			★	★							11
46		☆	☆		☆		★															★				★		6
50	☆	☆	★		★			★					★			★		★								★	5	7
52	☆	☆			★		★								★	★										★		
45	☆	☆	★	★	★					★			★		★		★				★		★	★	★	★	49	12
64		★					★		★						★													9
68	★	★		★	★	★							★							★		★						6
69		★			★			★												★								4

Age = presented in months; Ass = Assimilation; ClR = Cluster Reduction; CD = Initial or Final Consonant Deletion; WSD = Weak Syllable Deletion; Fro = Fronting of Plosives/ Sibilants; Sto = Stopping; Voi = Voicing, Devoicing, Cluster Devoicing; BkS = Backing Sibilants; GlR = Glottal Replacement; Daf = Deaffrication; Voc = Vocalisation of /l/; Nas = Nasalation; Vow = Vowel Errors; Met = Metathesis; Affr = Affrication; f-θ = /f/→[θ]; s-f = /s/→[f]; CD = unusual Consonant Deletion; intC = intrusive Consonant; ntV = intrusive Vowel; BkP = backing of Plosives; UnD = unusual Developmental Processes; Gl/l/ = Glottal Replacement of /l/; ʁ/l-j = /ʁ/, /l/→[j]; ʁ-s = /ʁ/→[s]; FavS = Favourite Sound; Allo = allophonic use of a sound class (i.e. nasals, fricatives); ClCh = Cluster Changes or Assimilation; ŋD/k = /ŋ/ deletion before /k/; unid = unidentifiable Processes; 1 off = number of processes only appearing once or twice in sample

☆ = Process used is still age appropriate ★ = Process used is not age appropriate

Appendix VII

Developmental Questionnaire

1. Date of Birth: _____
2. Sex: M ❒ F ❒
3. Which position was your child born in: _____
4. Have pregnancy and birth been normal? Yes ❒ No ❒

   If no, why?_____
5. Does or did your child ever have any type of hearing problems? Yes ❒ No ❒

   Has or had your child ever middle ear infections? How many?____ No ❒

   Did/does your child suffer often from other ENT-illnesses? Yes ❒ No ❒

   Did your child have grommets inserted? Yes ❒ No ❒

   Have adenoids been removed? Yes ❒ No ❒
6. At what age did your child start to speak? _____
7. Does/ Has anyone in your family suffered from speech and/or language problems?

   Yes ❒ No ❒ Who?_____
8. Does your child grow up monolingual? Yes ❒ No ❒

   Does/did your child a dummy? Yes ❒ until when?_____ No ❒

   …a bottle (excluding feeding times)? Yes ❒ until when?_____ No ❒

   …to suck the thumb? Yes ❒ until when?_____ No ❒
9. Which hand uses your child? Right ❒ left ❒ both ❒
10. Is anything special in your child (twin, allergies, operations, special illnesses, other interventions…)_____

    _____

    _____

12) Does/has your child receive(d) speech therapy intervention? Yes ❒ No ❒

I give permission for these data to be used anonymously in Ms Fox's PhD thesis and further publications.

_____ _____

Signature Date

Appendix VIII-a

Distribution of Affected Family Members and their Type of Disorder per Subgroup

Subgroup	Family	Lisp	Delay	Deviant	SLI /+SD	Stammer	Other
Delay	Sibling		★★★★		★		
	Parent	★★★			★		
	other				★★		
Deviant	Sibling	★	★	★			
	Parent			★	★★★		
	other						
Inconsistent	Sibling				★		Cleft Palate
	Parent				★★		
	other						

- SLI /+ SD = SLI possibly with speech disorder or speech disorder only. It was often not possible to clearly identify what kind of problems the parents had.
- ★ = each ★ symbolises one affected person

Appendix VIII-b

Distribution of Birth Difficulties within Different Subgroups

Subgroup	Forceps Del	Vacuum Ex	Premature	Anoxia	Other
Delay			★★	★★	★
Deviant					
Inconsistent	★	★★		★	★

Appendix IX

Plan for Articulation Therapy in Groups

	Oro-motor exercises	auditory discrimination exercises	isolated phone training	phone training at syllable level	phone training at word level	phone training at sentence level	phone training at elicited spontaneous speech level
Session 1	★	★					
Session 2	★	★	★				
Session 3	★	★	★	(★)			
Session 4	★	★	★	★	(★)		
Session 5	★	★	★	★	★		
Session 6	★		★	(★)	★		
Session 7	★		★		★		
Session 8	★		★		★	★	
Session 9	★		★		★	★	
Session 10	★		★		★	★	★
Session 11	★					★	★
Session 12	★					★	★

Appendix X

Nils' Phonetic Inventory over Time

Age group	Phone	2/98 4;7	7/99 6;0	9/99 6;2	9/99 exercise
1;6 - 1;11	m	■	■	■	
	b	■	■	■	
	d	■	■	■	
	t	■	■	■	
	n	■	■	■	
2;0 - 2;5	p	■	■	■	
	f		■	■	
	v		■	■	
	l	■	■	■	
2;6 - 2;11	x		■	■	
	h	■	■	■	
	g		■	■	
	k		■	■	
	ʁ		■	■	
	pf		pfç	pfç	
3;0 – 3;5	j	■	■	■	
	ŋ				
4;0 - 4;5	ç		■	■	
4;6 – 4;11	ʃ	ɬ	ɬ	ɬ	
	ts				
	s/z		ʂ	ʂ	s

■ Phone evident in spontaneous speech

■ Phone evident during exercise task requiring voluntary production

Appendix XI

Nils' Phonemic Inventory over Time

Age group	Phoneme	2/98	7/99	9/99
1;6 - 1;11	m			
	p			
	d			
2;0 - 2;5	b			
	n			
2;6 - 2;11	v			WM
	f			WF
	l			
	t			
	ŋ			
	x			
	h			
	k			
	s/z		50%	50%
3;0 – 3;5	j			
	ʁ			28%
	g			25%
	pf		pfç	pfç
3;6 – 3;11	ts			
4;0 – 4;5	ç			
4;6 – 4;11	ʃ		WM, WF ɬ	WM, WF ɬ

- Phoneme evident in spontaneous speech, being acquired (66.7% correct phoneme production)
- Phoneme evident in spontaneous speech, emerging (< 66.7% correct phoneme production)

Appendix XII

Error Patterns found in Nils' Speech

Pattern	2/98	7/99	9/99
Developmental Error Pattern	Cluster Reduction	Cluster Reduction	Cluster Reduction
	Fronting /g, k, ŋ/	Fronting /g, k, ŋ/	Fronting /g, k, ŋ/
	Voicing	Voicing	Voicing
	Stopping Fricatives	Stopping Fricatives	Stopping Fricatives
	Final Consonant Deletion		
	Glottal Repl. /ʁ/	Glottal Repl. /ʁ/	Glottal Repl. /ʁ/
Artic. Pattern	Lateral /s, z, ʃ, ts/	Lateral /s, z, ʃ, ts/	Lateral /s, z, ʃ, ts/
Idiosyncratic Error Pattern	Intrusive Consonants	Intrusive Consonants	
	Favourite sound /d/	Favourite sound /d/	Favourite sound /d/
	Vowel errors		
	Unusual errors	Unusual errors	
	Final Vowel Deletion		
	Medial Consonant Deletion	Medial Consonant Deletion	

Appendix XIII

Moritz's Phonetic Inventory over Time

Age group	Phone	2/99 3;0	Imita-tion	5/99 3;3	Imita-tion	7/99 3;6	Imita-tion	11/99 3;10	Imita-tion
1;6 – 1;11	m	■		■	■	■	■	■	■
	b	■		■	■	■	■	■	■
	d	■		■		■		■	
	t	■		■		■	■	■	■
	n	■		■		■		■	
2;0 - 2;5	p	■	■	■	■	■	■	■	■
	f				■	■	■		■
	v	■		■		■		■	
	l					■		■	
2;6 – 2;11	x	■		■		■	■	■	■
	h	■	■	■	■	■	■	■	■
	g					■			
	k					■			
	ʁ						■	■	■
	pf							■	
3;0 – 3;5	j					■		■	
	ŋ	■		■		■		■	
4;0 - 4;5	ç	■		■					
4;6 – 4;11	ʃ		■		■	■	■	■	■
	ts		■		■		■		■
	s/z	■ s		■ s	■ s	■ s	■ s	■ s	■ s
						■ ʔ			

■ Phone evident in spontaneous speech sample

■ Phone can be imitated voluntarily

Appendix XIV

Moritz's Phonemic Inventory over Time

Age group	Phoneme	2/9	5/99	7/99	11/99
1;6 - 1;11	m				
	p				
	d				
2;0 - 2;5	b	(WI)	(WI)	(WI)	
	n				
2;6 - 2;11	v				
	f				
	l				
	t				
	ŋ				
	x				
	h				
	k				
	s/z				
3;0 – 3;5	j				
	ʁ				
	g				
	pf				
3;6 – 3;11	ts				
4;0 – 4;5	ç				
4;6 – 4;11	ʃ				

- Phoneme evident in spontaneous speech, being acquired (66.7% correct phoneme production)
- Phoneme evident in spontaneous speech, emerging (< 66.7% correct phoneme production)

Appendix XV

Syllable Structure Moritz

Date	2/99		7/99		11/99	
Total utterances	**48**	**%**	**80**	**%**	**98**	**%**
CV	8	17	15	19	10	10
CVC	6	8	5	6	10	10
CVV	6	8	9	11	7	7
CV'V					14	14
CVVC	5	6	4	5	3	3
CVCC			1	1		
CVCV	2	3	6	8	6	6
C – VC			1	1		
Polysyllabic 5-6 Phones	3	6	14	16	11	11
V	1	1	3	4	4	4
VV	8	10	5	6	3	3
V'V					10	10
VC	4	5	2	3	2	2
VCV	2	3			7	7
V'VC	1	1	4	5		
VV'V					1	1
V'VCV	1	1	4	5	1	1
VCV'V			1	1		
VCCV			1	1	1	1
VCVC			3	4	1	1
VVCV					2	2
Polysyllabic 5-6 Phones			2	1	5	5
Total monosyllabic		69%		50%		36%
Total poli-syllabic		24%		50%		64%

Appendix XVI

Inconsistent Speech Calculation for Moritz in May 1999

	Target		1. Trial	2.Trial	3. Trial	
1	Ball	bal	dal	dal	/	+
2	Brot	bʁoːt	doː	doː	/	+
3	Biene	biːnə	hiːnɐ	diːnɐ	hiːnɐ	-
4	Bär	beːɐ	deːɐ	deːɐ	/	+
5	Schlange	ʃlaŋə	aŋə	haŋə	haŋə	-
6	Banane	baˈnaːnə	hiˈaːŋə	hiˈaːŋə	hiˈaːŋə	+
7	Da hin	da hɪn	da hɪn	da hɪn	da hɪn	+
8	Auto	auto	auˈo	auˈo	auˈo	+
9	Haia Bett	haia bɛt	haia dɛ	haia dɛ	haia e	-
10	Burg	buːɐk	uːa	uːa	uːa	+
11	Baum	baum	baum	baum	baum	+

3/ 11 inconsistent = 27% inconsistent

Appendix XVII

Moritz's Error Pattern Usage over Time

Pattern	July 1999	November 1999
Developmental Error Pattern	Voicing	Voicing
	Weak Syllable Deletion	Weak Syllable Deletion
	Final Consonant Deletion	Final Consonant Deletion
	Fronting of Velars	Fronting of Velars
	Stopping of Fricatives	Stopping of Affricates
	Cluster Reduction	Cluster Reduction
		Cluster Deletion
	Initial Consonant Deletion	Initial Consonant Deletion
	Glottal Replacement of word initial phonemes	Glottal Replacement of word initial phonemes
		Assimilation
		Vocalisation of /l/
Idiosyncratic Error Pattern	Unusual Errors	One off errors
	Backing of Alveolars	
	Medial Consonant Deletion	Medial Consonant Deletion
	Glottal Stop Insertion	
	Stopping + Backing of Fricatives	