Prosodic organization in the babbling of German-learning infants between the age of six and twelve months

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Zusammenfassung

Die vorliegende Arbeit befasst sich mit der Fragestellung, wie die Wortbetonung in der kanonischen Lallenphase organisiert ist. Diese Entwicklungsphase tritt für gewöhnlich in der zweiten Hälfte des ersten Lebensjahres auf, wenn Kleinkinder erstmalig phonetisch wohlgeformte Silben äußern. Dabei gibt es jedoch noch keine klare Beziehung zwischen Wortbedeutung und bestimmten Sprachlauten. Die Einzelsilben werden allerdings schon zu größeren wortartigen Einheiten zusammengefügt und erscheinen in betonten wie unbetonten Positionen.

Es wurden Sprachdaten von sieben deutschlernenden Kindern im Alter zwischen 0;5 und 1;0 gesammelt. Die phonetisch wohlgeformten Lalläußerungen wurden einer Reihe von perzeptiven und akustischen Analysen unterzogen, um der Frage nach einer bereits vorhandenen prosodischen Organisation der Wortbetonung nachzugehen. Die Äußerungen der Probanden werden anschließend mit einem theoretischen Parametermodell verglichen. Hierbei wird untersucht, ob Lalläußerungen eher sprachliche Universalien vorweisen oder doch eher durch ihre sprachliche Umgebung beinflusst sind. Dazu wird eigens eine Reanalyse des Betonungssystems des Deutschen vorgenommen.

Die Ergebnisse zeigen, dass eine leichte Tendenz hin zum trochäischen Betonungsmuster in Zweisilbern zu erkennen ist. Diese Tendenz lässt sich allerdings nur mit zwei der fünf Analysemethoden der vorliegenden Arbeit nachweisen. Bei Mehrsilbern scheint die Lage der hauptbetonten Silbe durch keine Analysemethode vorhersagbar zu sein. Es kann dennoch festgestellt werden, dass Silben vom Typus CVV in signifikanter Weise Betonung auf sich ziehen. Diese Ergebnisse lassen den Schluss zu, dass die Parameter der Betonungszuweisung während des kanonischen Lallens noch nicht zur Gänze gesetzt sind. Nur diejenigen für Fußform und Quantitätssensitivität erscheinen so konfiguriert, dass ein Einfluß der Umgebungssprache, des Deutschen, erkennbar wird.

Schlagwörter:

Spracherwerb, kanonisches Lallen, Prosodie, Wortbetonung

Abstract

The current work addresses the question, how word stress is organised during the developmental stage of Canonical Babbling, which usually emerges in the second half of the first year of life. In this period infants begin to utter phonetically well-formed syllables, although there is no clear relationship between meaning and single speech sounds. However, syllables are combined to form larger word-like units containing prominent and less prominent syllables.

Data was gathered from seven German-learning infants aged between 0;5 and 1;0. The phonetically well-formed babbling vocalizations were subject to perceptual and acoustical analyses, in order to find out whether there is already a prosodic organization of word stress. The subjects' utterances are then compared to a theoretical parametric framework. It will be examined, whether babbling vocalizations are more universal or rather influenced by the ambient language. Therefore a reanalysis of the German system of word stress will be undertaken.

Results indicate that there is a weak tendency towards the trochaic stress pattern in disyllabic babbles. This tendency is, however, only predictable in two of the five analysis parameters used in this study. In polysyllabic vocalizations, the location of main stress appears not to be predictable by any analysis. It can nevertheless be stated that CVV syllables tend to attract stress significantly. These results point to the fact, that the parameters of word stress assignment are not yet completely set during Canonical Babbling. Instead, only those for foot shape and quantity-sensitivity appear to be set in a fashion reflecting an influence of the subjects' ambient language, German.

Keywords:

    language acquisition, canonical babbling, prosody, word stress

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1   Introduction

This chapter introduces the purpose as well as the structure of this work. Additionally it will present the most basic theories in prosody this work is based on. Hence, the framework of metrical phonology is introduced along with the specific parametric notation for stress assignment.

1.1   Purpose of this work

The purpose of this work is to present an empirical analysis of the prosodic structure of infant babbling. At an age of around six months, babies reach a point in vocal development, where they start to produce utterances which appear to be phonetically well-formed. This type of vocalization, the so called Canonical Babbling (see Oller (1980) and (2000) and Stark (1980)) reminds listeners of sequenced adult-like syllables and thus "real" words. Hence, parents believe, that their infants begin to "talk" around this time in life. Although these word-like babbles are not yet meaningful in the sense that infants do not use any kind of a semantic notion to initiate a verbal communication with their social environment, parents clearly realize the phonetic change occurring to their babies' utterances, when the developmental stage of Canonical Babbling is reached (see Oller, Eilers, Neal & Schwartz (1999)).

Canonical Babbling is an important milestone within the development of speech in infancy, as the learning baby now gains access to the building blocks of mature language, the syllables (Oller & Lynch (1992)). Throughout the entire babbling stage, children produce polysyllabic word-like utterances, which usually do not have any semantic content. However, many researchers all over the world have claimed, that these early utterances indeed possess a strong linguistic significance. It has, for example, been shown, that babbling and early lexical items share a number of acoustic and phonemic properties (see Oller, Wieman, Doyle & Ross (1976), Vihman, Macken, Miller, Simmons & Miller (1985), Sendlmeier & Sendlmeier (1991), Hallé, de Boysson-Bardies & Vihman (1991) and Lleó, El Mogharbel & Prinz (1994)). Furthermore, many studies have illustrated, that the ambient language of a learning infant strongly influences the shape of babbling utterances (see de Boysson-Bardies, Sagart, Hallé & Durand (1986) and (1989)). Hence, Brown (1958) introduced the term "Babbling Drift" to express, that the phonetically well-formed babbling clearly reveals the language en-

vironment of any infant, although there are at that age still crucial similarities to be found in the production of speech sounds by children all over the world.

1.1.1 Central question

The central question of this work is to examine, how the phonetically well-formed syllables within word-like canonical babbles are organized in terms of prosody. If infants begin to make extensive use of fundamental units of adult-like speech such as syllables, this poses the question as to whether it is possible to find any kind of underlying rule system that describes how these units are arranged.

In human language, the unit syllable is understood as a node within a hierarchical system of metrical phonology (Liberman & Prince (1977)). This hierarchy determines prominence and word stress. Canonical Babbling utterances by young infants on the other hand are not monotonous. Some syllables within them appear to adult listeners as more prominent than others (see Oller & Lynch (1992) and Davis, MacNeilage, Matyear & Powell (2000)). An example oscillogramme of a trisyllabic babble can be seen in the following figure.
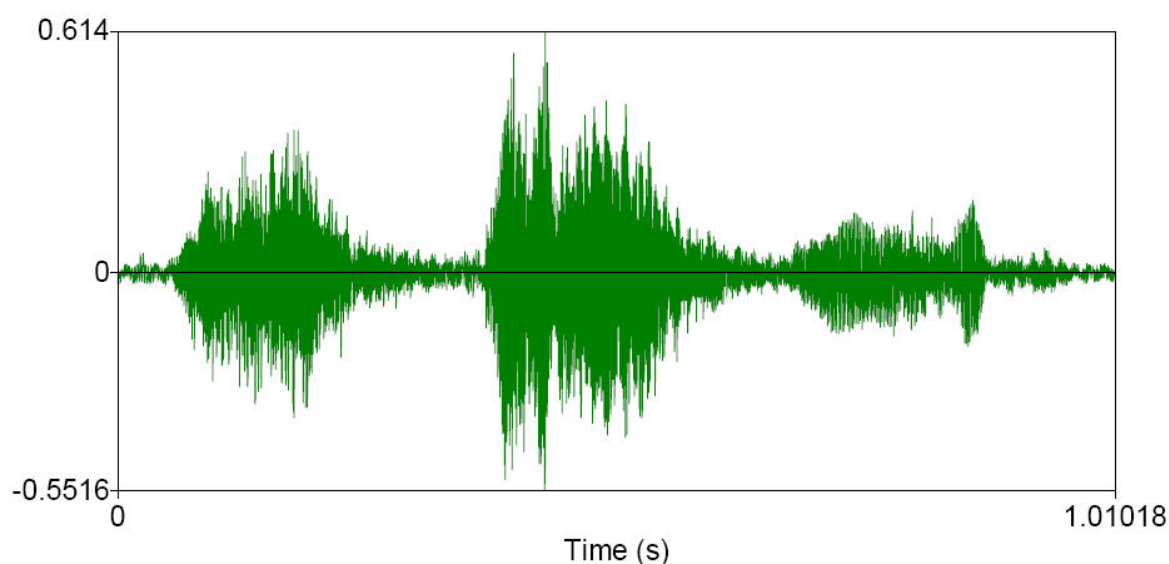
Figure 1: Trisyllabic canonical babbling sound by JR at an age of 0;11,14

Thus the current work addresses the question as to whether any underlying rule system for prosodic organization can be observed in Canonical Babbling, or in other words, if the placement of stress is predictable. This will contribute to the continuity debate in language ac-

quistion research in a very important way, as it will show how much of the prosodic structure of adult language is present during the babbling stage.

1.1.2 Method

Word stress is a linguistic phenomenon and therefore abstract in the sense, that the world's languages can behave rather differently in the way in which stress is placed within words and how it is expressed in the phonetic output of the speaker. Thus, studies on word stress can have either a phonetical or phonological base depending on the major focus. Phonetically based studies investigate the acoustic properties of stressed versus unstressed syllables to describe what physical parameters in the speech signal serve to mark the abstract phonological stress. According to Hayes (1995), this question is still unsolved, as there seems to be no direct physical correlate to word stress. Acoustic properties such as duration, loudness or frequency do play a role, when human speakers produce linguistic prominence. However, none of these properties can be understood as the one and only manifestation of word stress in general. As Ramers (2001) furthermore points out, stress cannot be measured in absolute values. That means that even if we had a direct acoustic correlate to stress, it would still be a relative parameter.

Phonologically based studies on the other hand examine whether it is possible to determine principles for a particular language, which enable us to predict the location of stressed and unstressed syllables within higher-level prosodic units. Hence, such studies analyze an abstract linguistic phenomenon of human language. They have to deal with some framework of rules and parameters, which determine the way word stress is projected.

In order to answer the question of stress assignment during Canonical Babbling this work will combine both resources. Thus, spontaneous babbling data from seven German-learning infants was gathered from 0;5 to 1;0. The data will then be perceptually analysed by three independent adult listeners. There also will be a massive acoustic analysis examining the properties intensity, fundamental frequency and spectral tilt.

The theoretical basis for the analysis on word stress assignment in infant babbling as well as for the subjects' ambient language German is a parametric theory of metrical phonology (see Kaye (1989), Dresher & Kaye (1990) and Fikkert (1994)). Hence, the underlying viewing point of the current study can be understood as a basically nativistic one, as parametric theory

requires the Universal Grammar (UG) assumed by Chomsky (1986). The subjects' data will then be compared to a detailed examination of the German stress system. The aim of this comparison is to determine the extent to which babbling prosody is influenced by the ambient language.

1.2   Metrical Phonology

The majority of studies on the predictability of stress assignment is based on the theory of Metrical Phonology (Liberman & Prince (1977) and Selkirk (1980)), which - in contrast to the earlier formulated framework of Linear Phonology (Chomsky & Halle (1968) - assumes the existence of a hierarchy of different prosodic tiers. Each of these tiers contains its own prosodic units. Hence, units such as syllables, feet or phonological words represent an own tier within this hierarchy, which is arranged in the following way (see Liberman & Prince (1977), Selkirk (1980) and Nespor & Vogel (1986)).

(1) Prosodic hierarchy

```
Prosodic Word (PWd)
       |
Prosodic Foot (F)
       |
Syllable (σ)
       |
Mora (μ)
```
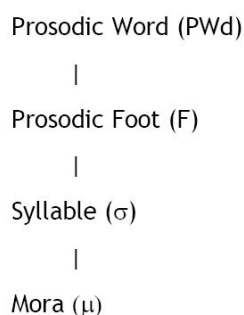
The prosodic units are arranged in a tree structure. Its nodes are binary and each branch "downwards" into either a strong (s) or a weak (w) node on the adjacent prosodic level below (see Liberman & Prince (1977) and Giegerich (1985)). "Strong" (s) here means, that the node is more prominent than a weak (w) node within the same domain. Prominence can be described as stressedness, meaning that a prominent constituent of a metrical structure can be recognized as more stressed by a human listener. In the example below, a phonological word (PWd) branches into two prosodic feet. The second foot is more prominent than the first. Both feet branch into two syllables. The left syllable of the second foot bears the main stress of the word.

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Table 1: Metrical tree structure of a word with two prosodic feet

```
                        PWd
                       /    \
                      /      \
                    F w      F s
                   /  \      /  \
                  /    \    /    \
                σ s   σ w  σ s   σ w
```
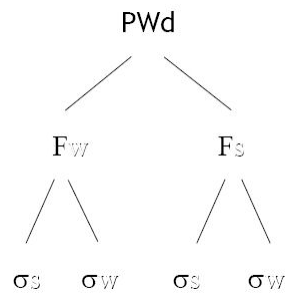
Furthermore, metrical phonology assumes that there are processes which occur in only one particular tier without affecting the neighbouring ones. Thus, this framework basically suggests that prosodic processes for different tiers can in principle operate in parallel.

There are several arguments which favour the assumption of this parallellity of tiers and hence constituents within the metrical structure. Most importantly, it can be demonstrated, that there are phonological processes, which only operate on a particular tier. Some of these processes in German will be presented and explained in 3.2. Especially in utterances by young children clear evidence can be found for the existence of the units and structures introduced by the framework of metrical phonology (see Fikkert (1994), Demuth & Fee (1995), Ohala (1999) and Levelt, Schiller & Levelt (2000)).

In addition to the arboreal structure Liberman & Prince (1977) also introduced the so called "metrical grid" (see Prince (1983)). In this notation prominence is indicated by a sequence of crosses above the syllables of a word or utterance. These crosses represent rhythmic beats as they occur in musical rhythm. The actual number of crosses distinguishes different stress levels. The metrical grid is, thus, most efficiently used to explore phrasal or compound stress distribution. Such a grid structure for a multiply compounded word looks like the following.

(2)   x

x				x	
x		x		x	
x	x	x		x	x
x	x	x	x	x	x
Weih	nachts	baum	be	leuch	tung

In studies on word stress assignment the arboreal notation is however, usually preferred because of the fact that it also displays the way in which prosodic units are grouped together and branched towards units of adjacing prosodic tiers. Hence, the present work will also make extensive use of the arboreal notation.

In addition, a further tier is assumed for the segments themselves, which is actually derived from the framework of Autosegmental Phonology (see Goldsmith (1990)). In this specific tier, each segment is represented by a slot. There are basically two different types of slots, C-slots for consonants and V-slots for vowels. They describe the skeletal structure of a word by indicating the location of possible nuclei and margins of syllables, whilste the actual segmental content is irrelevant in this notation. Most studies dealing with stress assignment frequently use this formalism because of its simplicity in indicating open and closed syllables.

1.2.1 The syllable

The syllable (σ) may be called the most popular unit of the prosodic system. As Ramers (2001) points out, even children, who have not yet learned to write, are very well able to segment words into syllables correctly. Thus, the syllable seems to be a central part in the metrical system of human language. Nevertheless, as Goldsmith (1990) shows, the definition of this important prosodic unit has come a long way in literature. Linguistically speaking, a syllable is a sequence of sounds containing a sonority peak. Sonority is, following Goldsmith, "a ranking on a scale that reflects the degree of openness of the vocal apparatus during production, or the relative amount of energy produced during the sound" (p. 110). Vowels are the most sonorant speech sounds. Glides, nasals, fricatives and stops are each less sonorant (see Selkirk (1984) and Ohala (1999)). Hence, a syllable can be understood as a sonority wave, representing a rise of sonority up to the vocalic part and again a fall of sonority towards the offset of the vowel or the closing consonant, if there is one. This aspect is spelled out in the Sonority Sequencing Generalisation (SSG) by Selkirk (1984).

(3) Sonority Sequencing Generalisation (SSG):

> *In any syllable, there is a segment constituting a sonority peak which ispreceded and/or followed by a sequence of segments with progressivelydecreasing sonority values.*

Thus the syllable consequently has to be made up of smaller constituents arranging the segments according to their sonority. The syllable node branches downwards into the onset and

the rhyme. The onset contains all consonantal material before the sonority peak, whilste the rhyme contains the - in most cases vocalic - sonority peak itself plus all consonants thereafter. Hence, the rhyme itself is separated into the branches nucleus and coda. The nucleus is the constituent for the vowel (Selkirk (1984)). This hierarchical model of syllable structure will be illustrated in the following.

Table 2: The constituents of the syllable
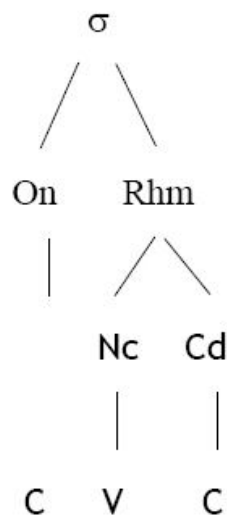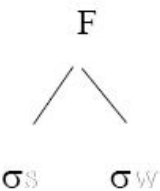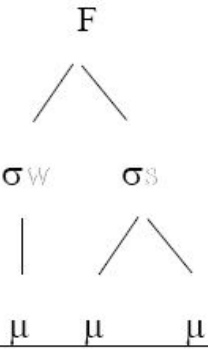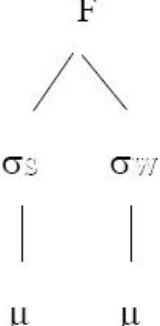
In addition to this hierarchical model of the syllable's internal structure, other attempts have been made to describe the make-up of this unit. The so called "flat" syllable model branches directly towards the skeletal tier (see Wiese (1988)). This work will, however, use the hierarchical representation, as it has been demonstrated that the constituents of the syllable can be clearly observed in the prosodic development of young children (see Fikkert (1994), Levelt (1994), Levelt, Schiller & Levelt (2000) and Kehoe & Stoel-Gammon (2001)).

1.2.2   The prosodic foot

The prosodic foot (F) is the domain in which syllabic prominence is assigned. The foot groups syllables under its node (see Selkirk (1980), Hayes (1980) and Halle & Vergnaud (1987)). If in a particular language there are maximally two syllables in the same foot then the foot is called "bounded". If there more than two syllables are allowed to branch to the same foot, then it is called "unbounded". In a system of bounded feet, one of the maximally two syllables is under a strong (s) branch of the foot and must therefore be more prominent, whilste the other syllable is under the remaining weak (w) branch and thus unstressed. The stressed sylla-

ble under the strong branch is called the head of the foot. The head can either form the left or the right branch of the foot, resulting in a trochee or an iamb. In his large typological study on the stress systems of the world's languages Hayes (1995) observed the following bounded foot types.

Table 3: Universal foot inventory found by Hayes (1995)

As table 3 indicates, there are (only) three different shapes of the prosodic foot to be found. The syllabic trochee contains two syllables of variable size. Thus, this foot is quantity-insensitive. This necessarily implies that if a language is quantity-insensitive, it also must be trochaic. The two other foot types, the iamb as well as the moraic trochee, are, according to Hayes (1995), binary and mora-counting. The moraic trochee contains two equally shaped syllables each with one single mora whilste the iamb has a branching head with two moras.

A cause for this rather limited inventory of possible foot types is a fundamental restriction on rhythm perception by human beings. When we listen to a sequence of elements with uneven

intensity, we perceive it as a left-headed and thus trochaic sequence of strong and weak elements, whilste a sequence of elements with uneven duration on the other hand is perceived as a right-headed and thus iambic sequence of short and long elements (Hayes (1995)).

1.2.3   The mora

The mora (μ), which is hosted by the tier below the syllable, is basically speaking a weight unit (Hyman (1985)). In quantity-sensitive languages the nodes on the moraic tier determine the actual weight of a syllable. Most basically syllables with a single mora below them are defined as "light", whilste those with two moras are "heavy". Exactly how syllable weight is actually calculated in detail depends however, largely on the individual properties of a particular language.

The mora is only assigned to the skeletal slots of the syllable rhyme. The onset does not contribute to syllable weight in any case, as its size is irrelevant for stress assignment. However, languages can differ in the way, in which the types of segments are related to moras. Coda consonants for example might not influence syllable weight in a particular stress system, whilste in others it does. Generally speaking, if a language is quantity-sensitive it distinguishes syllables with one mora from those with two moras, where these two moras can either be linked to a long vowel or to a sequence of a vowel and a coda consonant. This will be shown in the following tree structure.

Table 4: Internal structures of heavy syllables
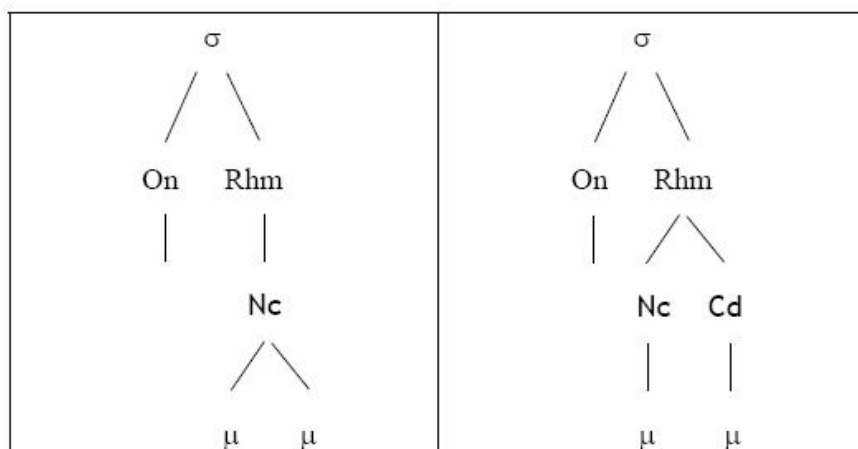
There are languages, which furthermore distinguish a third type of syllable weight, that is superheaviness. A superheavy syllable appears like a heavy one with an additional final consonant (Goldsmith (1990)).

Table 5: Internal structure of superheavy syllables
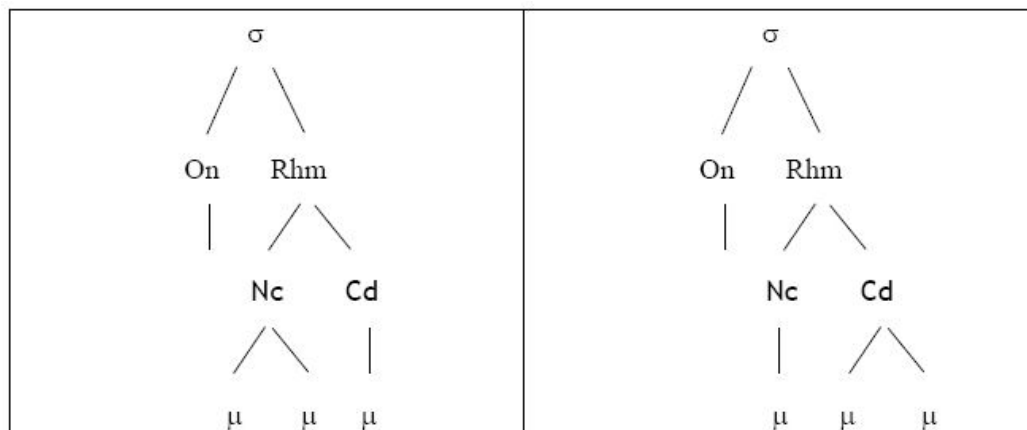
The branches of the syllable node pointing towards the moraic tier are not divided into strong and weak ones, as none of the moras within a syllable is more prominent than the other moras of the same syllable.

1.2.4   Parametric theory

Metrical phonology has developed a specific notation in which stress rules are defined by a number of parameters introduced and discussed by Hayes (1980), Prince (1983) and Halle and Vergnaud (1987) and have since then undergone several changes and adjustments to fulfil the specific need of the languages to which they have been applied (see Kaye (1989), Dresher & Kaye (1990) and Fikkert (1994)). In a parametric notion the stress system of human language is seen as a predefined space of options, where each language represents a specific selection of these options. The listing in (4) shows these parameters as well as their unmarked values in UG written in small capitals.

(4)   a) Foot shape parameters

Headedness: Feet are strong on the [left/right]

Quantity-sensitivity: Feet are [quantity-sensitive/-insensitive]

Weight: Feet are quantity-sensitive to

[closed syllable/nucleus/rhyme]

Foot branching:	Feet must be branching [yes/no]
Boundedness:	Feet are [binary/unbounded]

b) Foot construction parameters

Directionality:	Feet are built from the [left/right]
Iterativity:	Feet are built iteratively [yes/no]

c) Word tree dominance parameters

Main stress rule:	The word tree is strong on the [left/right]
Extrametricality:	There is an extrametrical unit [yes/no]
Edge of extrametricality:	The extrametrical unit is on the [left/right]

d) Compound stress parameter

Compound stress rule:	Compounds are strong on the [left/right]

These parameters and their specific values build the basis for stress assignment in the world's languages. Each language has, however, its own combination of values in order to define its own way of projecting stress onto the subunits of the prosodic word. Thus, to find out how stress is assigned in a particular language, it is necessary to define its specific parameter setting.

The parametric theory furthermore has been used to simplify the understanding of prosodic language acquisition (see Dresher & Kaye (1990), Pinker (1994) and Fikkert (1994)). Hence, this prosodic parametry can be seen as an attempt to expand the developmental model of principles and parameters by Chomsky (1986) onto suprasegmental phonology. Generally, parameters are capable of describing the rather complex typology of stress systems throughout the world in a constrained and restrictive way. Thus this notion can reduce complexity to a small set of options. A parametric learning model thus assumes that children acquire a stress system by setting parameters to their language-specific values, which is obviously a much simpler task than that of deriving rules from a non-defined magnitude of possibilities.

1.2.5   Acoustic correlates of word stress

Throughout the literature on word stress and its phonetic nature it is emphasized that there is no single acoustic correlate of stress in the speech signal. Instead, there are a number of properties, which actually tend to change whenever a particular syllable is more prominent than

other syllables within the same word. These properties traditionally include the subglottal air pressure, intensity, F0 modulation, duration and accuracy of articulation (see Pompino-Marschall (1995), Sluijter (1995) and Hayes (1995)).

The more modern literature emphasizes the importance of the loss of energy in the higher formants. This property is reported to indicate in languages like Dutch and German, that the corresponding syllable is less prominent (Sluijter (1995) and Claßen, Dogil, Jessen, Marasek & Wokurek (1998)). Here, the abruptness of the glottal closure is of interest, which Sluijter (1995) also calls skewness. The more abrupt the glottal closure is, the more energy can be observed in the middle and high formants of a vowel. Hence, in the case of an abrupt closure the corresponding vowel appears to be more stressed.

The actual impression of prominence in a human listener is, however, caused by a combination of modifications in each of the properties mentioned. It also has to be said, that not only the vowels as the nuclei of syllables are affected by these modifications but also the consonants of a stressed syllable. Hence, prominence has to be understood as the property of a whole syllable, rather than of single segments (see Pompino-Marschall (1995) and Hayes (1995)).

1.3 Outline of this work

The present work is divided up into four chapters. The first is intended as an introduction, presenting an overview of the structure of this study as well as a short summary of the basic terminology in prosodic phonology.

Chapter two provides an overview of the present state of the art in the linguistic work on the acquisition of phonology. In particular, the focus lies on the development of prosody and stress assignment in young children. The most wide-spread issues on language acquisition will be introduced, followed by a summing up of the different developmental stages during the infant's first three years of life. Then, the question of continuity between babbling and the later lexical acquisition will be discussed, which is of a central interest for an investigation on an early stage of vocalizations such as the Canonical Babbling stage.

Chapter three presents a reanalysis of the stress system in Standard German on the basis of a parametric theory. Although there have previously been several approaches towards this goal,

all lack some important details, that cannot be left out from an analysis of the underlying prosodic system and - most importantly for this work - the acquisition of it.

Chapter four then is the empirical part of this work. It contains the data of seven German-learning infants during their babbling stage (roughly from 0;6 to 1;0). The data will be acoustically and perceptually analysed in detail to trace down prominence. The main questions are how stress patterns are distributed and whether the location of more prominent syllables within these patterns can be predicted by any kind of stress rules. Also of interest will be the development of stress distribution over time.

For the ease of reading, each chapter is preceded by short abstracts, containing the central statements and findings.

2 The acquisition of phonology

This chapter presents the current state of the work within the linguistic branch of phonological language acquisition. Hereby it pays special attention to the acquisition of prosodic systems and parameters during the first three years of life. The chapter opens with an introduction to the most famous theories on language acquisition in general. Then there follows a detailed overview of the child's vocalizations up to an age of roughly 3;0. However, the focus lies here on the developmental stage of well-formed babbling. Finally a discussion of the continuity issue will follow, which will then lead back to the purpose of this work.

2.1 General questions in language acquisition

Language is one of the most central elements of our life. It enables us to handle information, express feelings and ideas and binds us into a community, in which we feel understood. Most importantly, it offers the possibility to solve problems by exchanging opinions and finding compromises. The lack of language and therefore of communication has always led to aggression and war throughout the history of mankind.

Although we seem to know about this major importance of language, it is surprising that we do not pay much attention to it in every-day life. The fact that language is with us in our minds all the time makes us forget to think about it. We simply use it just as we use our hands. Thus, we are not conscious of the complex ways, in which language operates.

Human language is, for example, a system, that uses two separate levels of coding (Zimmer (1986)). The first one is the level of the segments. Each of them represents a unique sound, which is formed by a specific configuration of the articulators within the vocal tract. However, taken as they are on their own the segments do not bear any meaning. Instead, they have to be combined in order to spell out words. The second level of coding is syntax. Words for themselves bear meaning, but they have to be combined to make complex sentences, which finally form complete expressions, where meanings are put in relation to each other.

With such a double-coding system it is possible to use language-forming resources most efficiently. The number of speech sounds that a human being can utter, is extremely limited due to the rather small space of the vocal tract and the functionality of the articulators. However, human language is able to use them in such an efficient way, so that we are capable of building an infinite number of sentences with a finite number of sounds.

2.1.1   The "logical problem of language acquisition"

The question of how the infant engages towards his or her grammar has long been discussed in the literature. What makes the infant trigger the process of language acquisition, which at this point of development seems to be a rather tough task. The most problematic fact in this respect is that the infant's cognitive capabilities are far from coping with complex problems such as a grammatical system including all its units, rules and exceptions. This means, however, that the infant acquires his or her language while from a cognitive point of view not being able to do so. This paradox, which in literature is referred to as the "logical problem of language acquisition", leads us on to a number of different problems, that arise from the process of language acquisition.

Logging into a system like a grammar has to be done step by step. The child has to find out information about basic linguistic units, which then are combined to larger ones in running speech. Yet how can the child know, where to find these basic units? This question has been referred to as the "segmentation problem" (Cutler (1994) and Juszcyk (1997)). The importance of segmentation can be shown by the following simple example: A speaker of English is able to notice the word boundaries of any English sentence. He or she can thus derive the meaning of this sentence by putting together the meanings of the content words combined with the syntactic and morphological information given through the function words. If the

same speaker of English however, listens to a Chinese sentence, he or she won't be able to identify the words or even the phonemes as such, because on one hand the phoneme inventory might differ from the English one, and on the other hand the location of word boundaries within the sentence is unclear.

When starting to acquire any human language the learning infant is in the same situation. The surrounding input appears like an indefinable queue of sounds without any meaning. Brown (1958) notes, that spoken language would not sound at all familiar and hence seems to appear like white noise to the infant. Thus, the very first task is to establish some kind of structure within this queue of sounds to which the infant listens.

In order to start building up the basis of his or her grammar, the infant has to be able to recognise the specific units of the language system to learn about their functionality or meaning. Without any kind of segmentation strategy these units remain, however, inaccessible and unclear to the infant, and the acquisition process will not succeed. Hence it has to be asked, how does the newborn solve the segmentation problem?

A different but also problematic fact for the acquiring infant is the input itself, which in many cases appears to be confusing or even misleading. As an example one may look at the opposition of stress assignment for polysyllabic monomorphematic words and on the other hand compound words in German. Whilste for the latter, main stress is located on the first stem, simplicia in contrast are strong on their right-most foot. The existence of these two concurring input forms should make the parameter of word stress totally useless for the infant, unless he or she has any knowledge about the actual content of the words. Thus, how is the child able to cope with such misleading input?

One might furthermore ask, what is the minimum of linguistic information required to ensure that the acquisition task will operate successfully? Are there any restrictions on either quantity or quality of the input? How about slips of the tongue, that are supposed to happen every day? How about grammatical errors, interrupted or canceled phrases? How about interindividual differences in speakers, either caused by physiologal properties like the differences in the F0-ranges in men and women, or by influences of dialects and sociolects? Do they slow down the acquisition process for the infant, who listens to them?

This sounds like hard work for the newborn, who is exposed to a completely unknown environment, as well as for the linguist, who tries to understand, how the infant is able to cope

with all the mentioned difficulties. Thus, it may not be too surprising, that up to the present day no theoretical approach has managed to explain exactly, what makes an infant acquire human language as fast as only an infant can handle it. However, four major theoretical approaches have risen to solve the problem, how the infant comes to speech. Although each of these approaches has a different theoretical background, they are not really contradictory, as none of them can actually proof to be more sufficient than all the others.

2.1.2 The behavioristic approach

The first theoretical approach to be presented here was drawn by Skinner (1957). He argued, that language acquisition is a result of an imitational behaviour. The infant pays attention to what ever the adults in his or her environment use to do, and begins then to imitate all this. This includes all kinds of gestures produced by the adults. Thus, the child also imitates the linguistic input, his or her environment utters, attempts to reproduce it, awaits a parental reaction to his or her own output and improves it if necessary. Skinner's theories were therefore called "behaviouristic" or "empiristic". Behaviorism hence states, that language is completely learned.

Imitation has been reported to begin on a very basic level of phonetic properties in speech sounds. For example, Sander (1981) states, that a German-learning infant at an age of 0;3 imitates the intonational movements of his mother's utterances. Most impressively, the baby copies the absolute F0-values, his mother produces. Similar data were presented for Japanese infants by Lieberman (1984), who suggests, that imitating intonation contours can be seen as a starting point for infants to go on imitating all kinds of speech sounds (see also Peters (1997) and Hsu & Fogel (2001)).

In the behavioristic approach generalization plays an important role. It is argued that the child will compare phrases uttered by his or her environment to one another in order to gain the capability of building new phrases. If the child has, for example, already listened to the three sentences "Timmy likes toys.", "Timmy likes ice cream." and "Susan likes toys." he or she will hence be capable to form the new sentence "Susan likes ice cream."

However, there obviously is a problem. In order to be able to form new sentences, a speaker of a language should have lots of sentences in mind, to compare them against each other. As sentences and phrases can be extremely complex, this procedure would require an enormous

amount of cerebral resources. Furthermore, speakers are able to utter sentences, which they've maybe never heard before, as well as they easily manage to understand sentences, which they had not yet come to conclude by themselves. On the other hand, some sentences, which should be concluded from other available ones, simply never appear. After an English learning child has, for example, come across the expressions "Peter kissed Mary" and "Who did you say that Peter kissed?" he or she should conclude, that the question *"Who did you say that kissed Mary?" was also syntactically well-formed. However, that's not the case (see also Grewendorf, Hamm & Sternefeld (1987)).

2.1.3   The nativistic approach

A theoretical counterpart to the behavioristic approach has been formulated by Chomsky (1959). He argues that a behavioristic procedure in language acquisition would never manage to establish the learner's ability to build an infinite number of sentences with a finite number of syntactic rules. This "creative aspect", how he calls it, which is closely tied to the nature of human language, would not be available through simple imitation. Additionally, in most cases the input to the speech learning infant is defective; that means either interrupted by noise or other voices or even grammatically incorrect. This would certainly lead into trouble, if language acquisition was purely a matter of imitation. The infant would hence be led to a number of wrong generalizations, and the acquisition of his or her language would therefore require much more time than it actually does.

Thus, Chomsky (1965) claims, that the newborn comes equipped with an innate mechanism, that initiates and guides the process of language acquisition. This mechanism, which is described as an innate species-specific aspect of a human being, Chomsky calls "Language Acquisition Device" (LAD). As soon as the LAD begins to be fed with input, the "primary linguistic data", the process of language acquisition is initiated, leading then towards the construction of a mental grammar in the child. With this device, the infant is in a way "programmed" to begin to acquire language. Therefore, this theoretical approach is called "nativistic" (see also Pinker (1994)).

In his later work the concept of the LAD was replaced by the model of principles and parameters, which consequently required the so called Universal Grammar (UG). In Chomsky's (1986) view the UG holds a fundamental knowledge on the structure of human language and

enables thus an infant to acquire each of the world's languages. This knowledge is organised into principles and parameters, which define the space of grammatical variation, in which the languages of the world may appear.

Principles describe a very basic structure of human language in terms of its major constituents. The Sonority Sequencing Generalisation formulated by Selkirk (1984) can be viewed as such a principle in UG.

(1) Sonority Sequencing Generalisation (SSG):

> *In any syllable, there is a segment constituting a sonority peak which ispreceded and/or followed by a sequence of segments with progressivelydecreasing sonority values.*

Parameters on the other hand define the shape of fundamental linguistic units and are in most cases binary. The fundamental assumption is, that parameters have a default setting, which in the following example under (2) is marked with small capitals for each parameter respectively. When an infant begins to acquire language, he or she is bound to these default values, that means he or she is in a state of complete universalness. During the ongoing process of acquisition, all the parameters are set to the values they have in the ambient language (Pinker (1994)). However, they have to be set step by step. As long as not all of them are set correctly, the output forms cannot match the target representations exactly (Chomsky (1986), Kaye (1989), Dresher & Kay (1990), Fikkert (1994) and Fikkert & Penner (1999)).

Specific work on the phonological aspect of parametric learning models comes from Kaye (1989), Dresher and Kaye (1990) as well as Fikkert (1994). Here the parameters for metrical phonology introduced and discussed by Hayes (1980), Prince (1983) and Halle and Vergnaud (1987) are seen as basic knowledge of the learning infant.

(2)   a) Foot shape parameters

Headedness:	Feet are strong on the [left/right]
Quantity-sensitivity:	Feet are [quantity-sensitive/-insensitive]
Weight:	Feet are quantity-sensitive to [closed syllable/nucleus/rhyme]
Foot branching:	Feet must be branching [yes/no]
Boundedness:	Feet are [binary/unbounded]

b) Foot construction parameters

Directionality:	Feet are built from the [left/right]
Iterativity:	Feet are built iteratively [yes/no]

c) Word tree dominance parameters

Main stress rule:	The word tree is strong on the [left/right]
Extrametricality:	There is an extrametrical unit [yes/no]
Edge of extremetricality:	The extrametrical unit is on the [left/right]

d) Compound stress parameter

Compound stress rule:	Compounds are strong on the [left/right]

These parameters describe the possible shapes of stress patterns that can occur in the world's languages and the rules, which determine them. I will come back to parametric learning models again when presenting Fikkert's findings in more detail. There will furthermore be a detailed analysis of German word stress assignment on the basis of a parametric model in chapter three.

Chomsky went even further. He believed language to be something "organic", which is about to "grow" by itself. In this sense he formed the term of "language acquisition" instead of "language learning" for the developmental process of any human being's first language, to point out the difference in the way a newborn discovers his or her mother tongue's grammar and in contrast an adult has to lexically learn the vocabulary of a foreign language.

Other researchers have found some more arguments in favour of the assumption of a basic inherent knowledge in the newborn. Pinker (1994) emphasises, that the phenomenon of pidgin language illustrates the presence of universal constraints in the human grammar. Without these, pidgin language would not be possible.

Even more support for the nativistic point of view comes from a number of experiments on speech perception in newborns. Eimas, Siqueland, Jusczyk and Vigorito (1971) found, that babies as young as 0;1 could reliably discriminate adult speech sounds. For example the stop consonants /p/ and /b/ appeared to be distinguished by these subjects in the way of a categorical perception. This means, that the infants perceived small physical differences in speech sounds better, when these differences also appear to separate phonemes in adult language. Discrimination of the same physical differences within the phonetic range of an adult pho-

neme was more difficult for the subjects. The stimuli used in this study were manipulated in terms of voice onset time (VOT), which is the time between the burst of a stop consonant and the onset of glottal pulsing. By changing the VOT speakers of human languages separate voiceless from voiced stops. Eimas, Siqueland, Jusczyk and Vigorito (1971) found, that adult native speakers of English tend to perceive a stop as voiced, when the VOT is smaller than 25ms. However, when it is above this value, the consonant is perceived as voiceless. Most importantly, the subjects at an age of 0;1 distinguished sounds with a varying VOT in the same two categories, as adults do. This indicates that there is a universal notion of a fundamental phonetic feature already available to newborns, who couldn't actually have learned it from the input at this early age.

Although the nativistic point of view has reached a relatively wide acceptance in the field of language acquisition research, it hasn't remained uncriticized. The most crucial aspect of criticism certainly is, that Chomsky's assumptions cannot be verified empirically. His earlier proposal of the LAD consequently has to be understood as a theoretical hypothesis (Ramge (1993)). There are no facts, which reliably proof its existence. Instead, there just are a number of arguments emphasising the need for anything, that offers the functionality of an LAD (see also Zimmer (1986)).

As a second point of criticism Ramge (1993) points to the fact, that the lacking capability of the behavioristic – or any other - approach to explain language acquisition satisfactorily, does not necessarily imply, that biological predetermination - and only biological predetermination - is needed. There might be a number of other solutions imaginable to solve the logical problem of language acquisition. In fact, there are for example particular stages in the development of prespeech sounds of the infant, which can be perfectly explained by biological maturation processes (see Lieberman (1984), Michelsson (1986), Wermke & Mende (1992), Kent (1992) and Davis, MacNeilage & Matyear (2002)).

Finally, Smith Cairns (1991) emphasises, that the human DNA actually stores information on cells and their maturation rather than on any kind of knowledge. Consequently, UG should be viewed as the result of a particular developmental process in early infancy and not as basis of this process.

2.1.4 The interactionist approach

Other theoretical approaches to language acquisition also come from other scientific disciplines. As Zimmer (1986) points out, young children watching foreign TV programs won't be able to also acquire this foreign language. Hence it seems that the interaction of mother and infant builds a very important social basis for the emergence of speech. Grimm (1999) argues that the fundamental rules of social communication enable the infant's capability to acquire grammatical rules. The theoretical basis of this approach comes from Wygotzki, who argued in the early 1930s, that the development of an infant as an individual human being can be seen in processes of interaction and intermental communication (Wygotzki (1969)). The social environment of an infant plays a very central role in these processes. According to Wygotzki, adult caretakers actually synchronise their behaviour to the infant's developmental state, in order to fit the infant's needs to be able to derive information from the interaction with his or her environment.

A central aspect of this "interactionist" point of view is the role of the mother, as she creates situations, from which the infant can learn about the relationship of his or her mother's actions and reactions. As Locke (1993) states, young infants especially pay attention to the voice of their mother, because of the simple fact, that they've already listened to this voice during pregnancy. After birth they furthermore recognise the emotional states of their mother and begin to be interested in the way she acts, to collect information on their surrounding environment (see also Kent & Miolo (1995) and Papoušek (2001)). Many researchers have also emphasised the importance of infant-directed speech, the so called "baby talk". When adults speak to young infants, they often change a number of articulatory and acoustic features in their output. The fundamental frequency is raised and its modulation range is enlarged, pauses are lengthened, the rate of speech is lowered, and parts of phrases are focussed or repeated (Fernald & Kuhl (1987) and Grimm (1999)). Even syntactic constructions are simplified in infant-directed speech (Zimmer (1986)). Adults, thus, tend to make their utterances more transparent to the listening infant, as in baby talk segments and phrases become more sharply separated than in fluent adult speech. Hence, this type of interactional sociolect has to be seen in opposition to Chomsky's argumentation, that the input to the child was in many cases insufficient in quality. Instead, infant-directed speech seems to perfectly fit the needs of the acquiring infant.

Furthermore, Grimm (1999) found that there is a strong relation between mother-infant-interaction and lexical development in the sense, that interaction causes development. In contrast, children who show social deficits are in many cases also slowed down significantly in language acquisition development (see also Hsu & Fogel (2001)).

2.1.5   The cognitivist approach

In the field of psychology the work by Piaget was intended to answer the question of how children develop their mental capabilities. Piaget (1923) also examined the process of language acquisition. In contrast to the nativistic point of view Piaget suggested, that language acquisition is a part of a fundamental maturation of the child's cognitive capabilities. This approach is therefore called "cognitivist" or "constructivist".

In order to understand, how the child's consciousness is constructed, developmental milestones in the perceptual and motor skills were closely observed by Piaget. An important finding of his work was, that a young child seems to be unable of understanding the perspective of other human beings in his or her environment. Instead, the environment itself and the perspective of the child seem to be one. Hence, throughout the maturation process of his or her higher mental functions the child has to discover finally his or her own "self". At this point, the child is then also able to recognise that other human beings do have different perspectives. This means, that in Piaget's view the child is not able to produce a particular type of linguistic form, as long as he or she is not yet capable, to understand this form from a cognitive perspective.

The actual development of grammar in the young child has been closely examined by Slobin (1973), who also tried to introduce a more cognitivist viewing point to language acquisition research. He mainly compared child data from several different languages, to find out the extend to which they differ. He observed morphosyntactic categories in respect of their emergence in the cross-linguistic data. He found, that children of different language backgrounds acquired the same categories at different ages. This developmental difference was, however, related to the way, these categories were actually expressed in the corresponding language. Slobin concluded that children at a particular age focus their attention to only specific parts of speech, as they seem to be limited cognitively to a particular point of view. This kind of focussed attention he illustrated with the so called "operating principles". These principles he

suggested to "guide the child in developing strategies for the production and interpretation of speech and for the construction of linguistic rule systems." (p. 194) Some operating principles by Slobin are for example "Pay attention to the end of words." or "Keep track of the frequency of occurrence of every unit and pattern that you store.". Thus, the operating principles contain short and precise instructions for the language learner in order to identify the relevant information within the linguistic input.

The concept of Slobin's operating principles has been expanded by other linguists and cognitivists, as they have formulated additional principles and constraints (see Peters (1985)). The so called Whole Object Assumption (WOA), for example, provides the child with the guideline to treat "objects as wholes rather than their parts or properties" (Woodward & Markman (1998)). In daily life a language learner is confronted with input forms in different environments, that is, in changing situations as well as changing linguistic surroundings. A word can occur solely or within a phrase or a compound, having the effect that its reference also changes. This makes it very problematic for a speech learner, to work out what a word actually is supposed to mean. By the help of the WOA, however, the child is a priori restricted to one simple assumption. If any new word occurs, it will refer to an object as a whole. This strategy may help the child in mapping labels to objects without having to calculate the specific relation, a word is used in, each time that a new label appears in the input.

Although the cognitivist point of view sees no difference in language acquisition and the development of other cognitive capabilities, it shares one crucial similarity with the nativistic approach. Both theories assume that the actual developmental process is initiated as well as determined by either an innate knowledge or a genetic programme. Hence, both theories claim, that the capabilities for using language are basically not learned.

2.1.6   Early vocalizations in the view of current theorists

As a final remark to the four theoretical approaches presented so far in this section, it has to be repeated that none of them can actually explain language acquisition perfectly on its own. However, they should be viewed as complementing one another, as each of them appears to have a particular perspective on language acquisition. It is obvious, that equipped with the universal principles and parameters from UG, with cognitive constraints and with the bootstrapping mechanism and the facilities of the child's social interaction with his or her envi-

ronment, the process of language acquisition appears much more solvable. It has then not to be understood as rather automated or - to speak with Chomsky's words - naturally growing. As Pinker (1994) puts it, the child somehow cannot resist acquiring a language.

Additionally, many theorists have tried to explain how the language learner can benefit from the linguistic input in a wider sense, where different theoretical issues come to interact with each other. They have brought up the rather metaphoric term of "bootstrapping", which describes the child's ability to "bootstrap" him- or herself higher up through the developmental stages, while the acquisition of the target language already is in progress (see Pinker (1982) and Gleitman & Wanner (1982)). Functionally bootstrapping is referred to as a systematic use of clues, which come with the linguistic input. It can be characterised as being semantic, syntactic or prosodic. An example for prosodic bootstrapping is phrase marking. Prosodic domains like intonation and pauses in between phrases can be used by the learner to derive syntactic information from, although intonation by itself is not a component of the syntactic part of the generative grammar. However, it provides some helpful clues about syntax (see Peters (1985), Gerken, Jusczyk & Mandel (1994), Cutler (1994) and Juszcyk (1997)). Semantic and syntactic bootstrapping function in similar ways.

As the current work especially deals with data from very young infants $(0;5 - 1;0)$, it is of further interest, how these early vocalizations are seen in present theoretical frameworks. Generally, there are two major theoretical directions, on how to explain the earliest stages of articulatory development. These two directions are very well discussed by Davis, MacNeilage and Matyear (2002), who come to the conclusion, that the viewing points on early vocalizations are somehow based on Chomsky's aspects of either competence or performance.

The competence-related viewing point is held by the majority of the modern linguists. They try to explain the changes in the quality of infant vocalizations by an ongoing development of language as a grammatical system. This means that whenever the child starts to produce a new kind of vocalization, he or she has discovered a new aspect of the grammar of human language. The process of acquisition is thus, believed to be based on the innate knowledge, the Universal Grammar (UG), assumed by Chomsky (1986). The competence-related approach is therefore also called the "universalist" point of view. As the current work is based on a parametric framework for stress assignment, it can be understood as a universalist approach to explain the prosody of infant babbling.

The second theoretical direction is performance-related or in other words "functionalist" or "selectionist" after Darwin's theory of natural selection. It is a more biological approach, assuming, that language is a kind of behaviour that has come a long way in evolution. Selectionists, thus try to explain the change in articulatory output of infants as part of a more general biological process of maturing, which is determined by the genetic heritage in human beings (see Lieberman (1984), Kent & Bauer (1985) and Kent (1992)).

Although there was some kind of debate between researchers from both sides on how to account for a proper model of speech development in early infancy, today a tendency towards a unifying point of view has risen. In fact, there is to my mind no convincing reason to refute either of these two approaches, because neither of them is capable of explaining early language acquisition completely on its own. However, put together in a productive way, they serve perfectly as the fragments of the puzzle, researchers all over the world have tried to solve.

2.2   Timeline of infant vocalizations

Up to now we have had a look at the most popular theories in the field. However, we have not yet covered the facts, meaning the vocalizations of the infant during his or her early language development. Independently from the actual theoretical point of view it is clearly to be seen, that there are several different developmental stages throughout the infant's first three years of life. During these stages the speech sounds uttered by the infant appear to be specifically shaped in terms of their phonetic properties. Thus, the mile stones in the infant's language development will be characterised in this section.

2.2.1   Crying

The very first type of vocalization of an infant is a cry. That seems to be the way life uses to start for all of us. However, these early cry vocalizations are produced by a vocal tract, that in its anatomical shape differs from that of an adult in many respects. The most crucial differences in the newborn are a relatively short vocal tract caused by a higher placement of the larynx, a shorter pharyngeal cavity, a gradual instead of a right-angled bend in the oropharyngeal channel, and most importantly a larger and less manoeuvrable tongue, making it rather difficult to form adult like speech sounds in a precise way (see Kent (1992) and Kent & Miolo

(1995)). An important consequence of the high placement of the larynx is that it can be used to form a sealed airway by lifting it upwards into the nasopharynx. Hence, food can now flow from the mouth into the oesophagus, while the infant is still able to breath through the nose at the same time. Furthermore, infants at that age are obligatory nose breathers (see Laitman, Crelin & Conlogue (1977)). Additionally, the ribs of newborns are perpendicular to the spine. As a consequence, babies are not able to control their sub-glottal air pressure in the way adults can do and, thus cannot yet build speech-like breath groups (Lieberman (1985)).

The scientific field of cry analysis has a great tradition since the 1960s (see Michelsson (1986)). It has been used to determine potential impairments in newborns such as brain damages as well as endocrine or metabolic disturbances, deformation of lungs, larynx or oral cavities and diseases of the central nervous system. In most cases cries of impaired babies appear to have an extremely high F0 value, that can reach up to 2kHz (Wermke & Mende (1992)). In this respect cry analysis has proven to be a stable tool of clinical diagnosis.

Cry analysis is largely focussed on the intonational modulation of the vocalizations. Cries of healthy babies appear to have ups and downs of the F0 contour as well as the whole harmonic spectrum. This led cry analysts to the term of a "biological siren" to explain the basic social-communicational characteristics of infant cries (see Wermke & Mende (1992)). They understand the aim of crying as a means to "alarm" the parents, that care is needed. By using a wide modulation of the fundamental frequency it is ensured, that crying perceptually breaks through most other noises. In fact, Michelsson (1986) classifies cry melodies into the categories falling, rising-falling, rising, falling-rising and flat. Additionally, she encounters a contour, which she labels as "glottal role". This stands for a modulation with a very low pitched F0, that appears at the end of a complex cry phonation in healthy babies.

Cry vocalizations also develop over time. Starting with a basic cry containing a single intonational peak, Wermke and Mende (1992) have observed infants to enlarge their repertoires beginning at an age of around 0;2. Up to now, F0 movements have been bound to the expiration. Thus, a decline of pitch has by default appeared towards the end of an expiration. Now, the infant is, however, capable of uttering cries with up to four separate peaks within one expirational phase. Interestingly, cry development seems not to be linear. Instead, infants are reported to pass through a number of regression stages, before they acquire new intonational patterns. Wermke and Mende believe, that during these fall-backs processes of neural reorganization take place, increasing the infant's control over his or her F0 modulation.

The question whether there is any grammatical, especially prosodic, significance in crying itself, may not be a thought lying at hand, unless one takes into account, that a cry is a vocalization, which like speech itself is produced by the infant's vocal tract. This means, a cry has to share some of the acoustic properties, which also appear to determine prosody in the target language. Having said that, the question arises, how a cry is acoustically defined. What are the differences to the phones used in language? Crying forces the lungs to produce a strong air pressure throughout the whole vocal tract (Vetter (2000)), which in addition has to be fully opened and stiffly formed to allow the pass through of the air. This reveals some crucial differences to speech, as the latter makes use of precisely positioned articulators within the vocal tract In the case of a stop consonant, for example, one of the articulators is used to interrupt the air flow completely.

As most of the studies on crying are placed in the field of biology, results are not conclusive from a strictly linguistic point of view, as there have been no investigations on the abstract parameters of suprasegmental phonology such as word stress, foot-construction or intonational patterns. The only strictly linguistic analysis of crying so far comes from Vetter (2000), who did a case study on the female German-learning infant JR, who will be introduced later in chapter four as a subject for the current study. Vetter's results show a tendency in the data, that a prominental peak is placed at the very beginning of a cry utterance. However, there was no significant relationship between prominence and the duration of a cyclic modulation of F0, which would have indicated a notion of syllable-like weight or at least a comparable acoustic parameter in crying. Hence, Vetter concludes that these findings could mean that the prosodic parameter of [head directionality] is already set in crying. The question arises, however, in how far a "left-headedness" has to be seen as an articulatory must for this specific form of vocalic production. As far as Lieberman (1984) is concerned, a decline of acoustic parameters such as [frequency] and [intensity] at the end of an utterance is a universal tendency, which he suggests to be present from the earliest onset of crying. He argues that the end of an utterance is always the end of a breath group. Thus, all speech-like utterances are bound to this articulatory constraint, which is purely a matter of physiology.

2.2.2 Early non-cry sounds

Right from the earliest days of an infant's life, parallel to the ongoing development of crying, there are also other forms of vocalizations to be heard, which are of non-vegetative origin and

show more similarities to speech than to crying. Oller (2000) calls these vocalizations "proto-phones". However, they change crucially over time, as the infant grows older. Oller (1980) was one of the first to examine closely the acoustic properties of these sounds. He proposed a developmental model for protophones containing five different stages. This model has proven to be stable for several years now and still is the most popular approach in this field (see also Oller & Lynch (1992) and Oller (2000)). There are, however, comparable models like the one by Stark (1980), who independently discovered nearly the same developmental stages as Oller but labelled them in a slightly different fashion. Most researchers all over the world, however, have followed the model by Oller.

A third issue on this topic comes from Koopmans-van Beinum and van der Stelt (1986). Their model differs from the one by Oller (1980) in the way, prespeech sounds are looked at. Whilste Oller is particularly interested in the acoustic shape of infant vocalizations, to compare their phonetic properties such as syllable duration or formant transitions to those of mature language, Koopmans-van Beinum and van der Stelt in contrast concentrate on the articulatory and phonatory movements to be observed within the vocalizations. Thus, Oller's model is in first place based on acoustic phonetics, whereas the one by Koopmans-van Beinum and van der Stelt is based on articulatory phonetics. Nevertheless, the articulatory development in young infants is also closely observed by Oller (1980) to explain the change in the acoustic shape of prespeech sounds. Hence it can be stated that both approaches are not contradictory in describing the actual appearance of infant vocalizations.

Table 6: Different models of articulatory development in prespeech sounds by Oller (1980), Stark (1980) and Koopmans-van Beinum & van der Stelt (1986)

Oller (1980)	Stark (1980)	Koopmans-van Beinum & van der Stelt (1986)
Phonation stage 1st month	Reflexive 1 – 2 months	Uninterrupted phonation 1 – 2 months
Goo stage 2 – 4 months	Cooing 2 – 5 months	Interrupted phonation (no articulatory movement) 2 – 4 months
Expansion stage 4 – 7 months	Vocal play 5 – 8 months	Interrupted phonation (one articulatory movement) 4 – 6 months
Canonical babbling stage 7 – 10 months	Reduplicated babbling 8 – 10 months	Variations in the phonatory domain 6 – 9 months
Variagated babbling stage 10 – 12 months	Nonreduplicated babbling 10 – 14 months	Reduplicated articulatory movements 9 – 12 months

It should however be clarified here that the values for the actual age of the infants in these models are mean values, as most infants tend to show a certain amount of individuality in their prespeech development. Furthermore, the stages are not strictly separated from each other. There is at least some kind of overlapping to be observed (see Oller & Lynch (1992)). When a child has entered a particular stage, he or she is still likely to produce vocalization types of previous stages.

During the first stage observed by Oller (1980) an infant only produces centralized quasiresonant or quasivocalic sounds. There is phonation but not yet articulation. Air from the lungs is let through the infant's vocal tract, but none of the articulators influences or interrupts it. Thus, the lower frequencies of the infant's output show a higher energy level. Stage 1 ranges from birth up to an age of 0;2 and is referred to as Phonation Stage (Oller (1980)) or Reflexive Stage (Stark (1980)).

Articulation is achieved at stage 2, the so called Goo Stage (Oller (1980)) or Cooing Stage (Stark (1980) or Primitive Articulation Stage (Oller & Lynch (1992)), which usually lasts till 0;4. Now the supraglottal part of the vocal tract is used to establish more consonant-like variation. However, only the back of the vocal cavity is involved, which leads to a type of sounds reminding listeners of velar or uvular consonants. Vowels at the same time keep their uniform fashion and, thus, still appear as centralized. During this stage of articulatory development there is also an anatomic reorganization beginning to take place. The infant's vocal tract, which we've already found to show some crucial differences to that of an adult, is now re-modelled to fit the needs of the human bipedal physiology. Most importantly, the larynx is lowered to the position, where it is placed in the adult. At that age infants can hence breath either through their noses or mouths (see Laitman, Crelin & Conlogue (1977), Ingram (1989) and Kent (1992)). Additionally, the ribs are now becoming adult-shaped, too, as they become angled downward and outward (Lieberman (1985)). With this anatomic configuration, the infant can now control his or her respiration in the same way, as adults can do. It has to be mentioned once again here, that Wermke and Mende (1992) state, that at this point intonation is no longer linked to expiration. Furthermore, the emergence of laughter can be observed here.

At an age of about four months the infant enters the next stage known as Vocal Play in Stark's terms or Expansion Stage in Oller's ones. The infant now enlarges his or her inventory of vocalizations by a wide range of yells, growls, whispers, vibrants and for the first time full-resonant vowels. These show the infant's increasing articulatory control over acoustic parameters like intensity and fundamental frequency as a result of the ongoing dramatic anatomic restructuring around this age.

Furthermore, at this stage another type of protophones begins to be produced, which appears to be a sequence vowel-like and consonant-like sounds reminding of lengthened syllables, the Marginal Babbling (Oller & Lynch (1992)). According to Oller (1986), marginal babbles are untranscribable. This is the effect of several violations of well-formedness conditions of speech by the infant. These violations include a duration of the syllable exceeding 500ms, formant transitions longer than 120ms and the shape of the segmental material itself. Vowel-like elements, that form the intensity peak of a marginal syllable, appear to be rather unstable and therefore not definable even for phonetically trained listeners. Oller (1986) calls these afore-mentioned well-formedness conditions "metaphonological", as they define fundamental

properties of phonological units in human language. They have then been relabelled as "infra-phonological" some years later (see Oller & Lynch (1992)), as the new term seems more precise in explaining, that the infraphonological conditions form the necessary basis of phonology in mature language.

Throughout his work, Oller has emphasized the need for infraphonology as a standardized formalism, to describe the infant's prespeech vocalizations (see Oller (1986), Oller & Eilers (1988), Oller & Lynch (1992) and Oller (2000)). He argues that this kind of sound production has to be referred to in terms of fundamental conditions of well-formedness, which are not biased in a target-language specific way, but express the adult-likeness of prespeech sounds. The shape of segments and syllables in human language relies on a set of defined phonetic properties. However, these properties have still to be established during prespeech development. Thus, it is not possible - and would make no sense at all - to use any usual system of transcription like IPA for such vocalizations, which not yet adhere to the infraphonological well-formedness.

Observations on marginal babbles in the subjects of the current study confirm the findings by Oller (1980). For all the infants, it can be stated that within their marginal vocalizations the intensity peaks are filled with a rather complete opening of the vocal tract, whereas the syllable margins either consist of a glide-like part, which in most cases shares the same place of articulation as the vocalic peak-part, namely [ɑ] or [ɛ] or a voiced fricative-like sound built at the back part of the vocal tract. According to Kent and Miolo (1995) the most frequent vowel-like sounds here are [ʌ], [e] and [ɪ]. This shows that there appear gaps and peaks of sonority within an utterance even in this early stage of the acquisition process. The question remains, however, if these differences are articulatory musts or if they are the result of any kind of prosodic structure, that is underlying to Marginal Babbling.

At this age the child furthermore shows an explicit control over his or her intonational modulation (see Sander (1981), Lieberman (1984) and Peters (1997)). Infants are able to track the intonation contours of adults while copying the precise F0 values. This suggests, that the child is aware of how to manipulate his or her fundamental frequency in order to communicate with the environment. Whether this capability has been learned or is innate in human infants cannot be answered here.

Oller, Buder and Nathani (2003) report furthermore that all kinds of sounds which infants produce during Marginal Babbling can be observed to be used by the babies in order to interact with their environment. They state that there is clear evidence for a contextual flexibility in the infants' usage of sound categories. Hsu and Fogel (2001) come to a similar conclusion. They studied mother-infant-interactions in thirteen dyads, recording their subjects weekly at an age between 0;1 and 0;6. The major question of this study was, how different kinds of infant non-cry sounds change in particular communication situations. Results clearly indicate, that the number of vocalizations increased, when the infants are engaged in communicative interaction with their mothers. However, when the infants decided not to interact with their mothers, the amount of sounds decreased. These findings lead to the conclusion that babies at that age are very well aware of the fact that vocalizations and communicative interaction are tied together.

2.2.3   Canonical Babbling

By reaching the sixth month of life the child enters the next stage in his or her prespeech development, the Canonical Babbling (Oller (1980)). In Stark's terminology this stage is called Reduplicated Babbling. This is the time when parents notice the first adult-like syllables in their baby's vocalizations. Although the infant still doesn't use meaningful words as such, he or she articulates in a way being very close to speech in general (Davis & MacNeilage (1995)). Thus, many nursery terms have been adopted by parents all over the world, who imitated their infant's babbling. "Mama" and "baba" are among the most common ones (Zimmer (1986)).

What makes the Canonical Babbling so well-sounding for parents' ears is the fact, that the infant now adheres to all the infraphonological well-formedness conditions, he or she violated throughout the previous stages (Oller (1980) and (1986)). Syllables have now in most cases the same duration as in the target language and do not exceed a peak-to-peak range of maximally 500ms. They are filled with vowel-like and consonant-like part separated by quick formant transitions within a maximal value of 120ms. The vowel-like part is phonated in adult-like fashion and is thus full-resonant (Oller & Lynch (1992)). Such canonical syllables are furthermore grouped together to larger rhythmic units, that appear like phonological words or even complete intonational phrases to the listener. Hence, in Canonical Babbling the infant has found out about the building blocks of adult speech (Oller & Lynch (1992)).

In addition, it has been reported that not only the syllables become well-formed in this developmental stage. Davis, MacNeilage, Matyear and Powell (2000) state, that some of the acoustic correlates of adult word stress, namely F0, intensity and duration in vowels, are used by infants in a comparable way to adult utterances. Davis, MacNeilage, Matyear and Powell collected data from four English-learning infants. The recordings started at the emergence of canonical babbling and lasted maximally four months. The disyllabic babbles were compared against disyllabics uttered by native speakers of English. Results indicated that the infants constantly used all three acoustic properties of adult stress to differentiate the syllables in disyllabics. Only 48 of the 324 infant disyllabics appeared to be uniformly stressed. Nevertheless, a tendency towards the trochaic pattern of the ambient language English could not be found in the data. The current study actually deals with the question of whether the acoustic correlates of stress assignment are also used to express any notion of an adult-like prominence for syllables and prosodic feet.

In a different experiment, Lalevée and Vilain (2005) found, that their two French subjects showed explicit velar control as well as the orolaryngeal coordination abilities, which are two main features in adult speech production. Both subjects had complete velar control at 0;11. This finding was furthermore proven by the fact, that the proportions of nasal against oral consonants had reached the ones of the ambient language French. Concerning the orolaryngeal coordination in more detail, Lavelée and Vilain (2005) analysed the values for voice onset time in the consonants of their two subjects between 0;6 and 1;3. They found, that there were unvoiced as well as voiced sounds to be observed, the latter including even prevoiced consonants. However, prevoicing until 1;0 did not show the values it has in the target language French. Thus, Lavelée and Vilain conclude, that there is control over basic articulatory parameters of human speech during the stage of Canonical Babbling, although specific values of the infants' target language are finally achieved at the age of 1;0.

At around ten months the infant reaches the stage of Variagated Babbling (Oller (1980)). In Stark's terminology it is labelled as Non-reduplicated Babbling. Up to this point the infant has uttered well-formed syllables within reduplicated patterns of one and the same syllable, like [ba.ba.ba] or [da.da.da]. Sometimes these sequences can have up to 15 syllables (see figure 2).
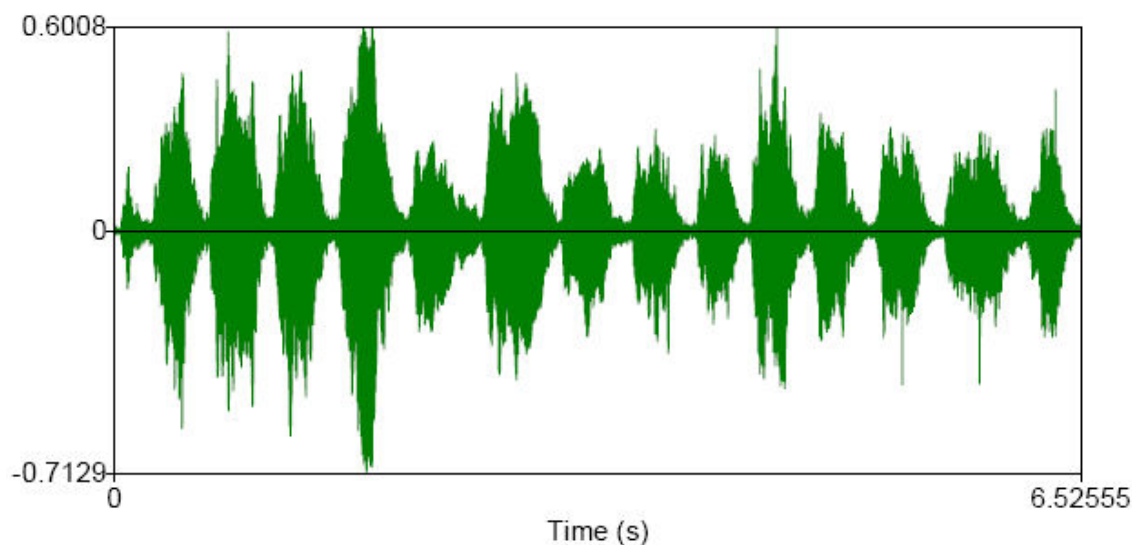
Figure 2: Reduplicated babbling utterance including 15 syllables by NB at an age of 0;9

In contrast, variagated babbles are built from a number of syllables including different seg-mental material such as [ba.da.ga]. They usually have two to four syllables and not more than six. Due to their larger segmental variation, variagated babbles are perceived as more adult-shaped. In earlier studies Reduplicated Babbling was claimed to emerge before the variagated vocalization type (Oller (1980), Stark (1980)). However, this point of view has lost its ground, as both kinds of protophones are reported to appear in parallel (see Davis & MacNeilage (1995) and Peters (1997)). This parallelity was also observed in the subjects of the current study. Hence, the two stages of canonical and variegated babbling are seen here as one, be-cause both cases fulfil the infraphonological well-formedness conditions (Oller & Lynch (1992)).

Now that the emergence of adult-like segments has taken place, Jakobson (1941) discovered, that in babbling utterances the infant is not limited to a restricted number of speech sounds. Instead he noticed the children to produce nearly all kinds of well-formed segments, even if they didn't belong to the phoneme inventory of the actual target language. All the subjects of the current study, for example, consistently uttered even such sounds, which are not used in their upcoming native language German, for example [ð], [ɲ] or [ʒ]. However, as this work in first place deals with stress assignment, no frequencies for single segments were measured. Vihman (1992) reports French infants frequently to produce [h]. Nevertheless, other investi-gators have shown that a number of restrictions occur in the actual choice of phones. Levitt and Utman (1992) reported that the two subjects of their study generally preferred stops

against all other types of consonants. One of their subjects acquired English, the other infant acquired French. Oller and Eilers (1982) discovered the same preference for stops in English- and Spanish-learning infants. Kent and Miolo (1995) claim the most frequent consonants in babbling to be [b], [d] and [m]. These findings are in line with the ones by Locke (1983), who additionally mentions [h] amongst the most favoured sounds. Oller, Wieman, Doyle and Ross (1976) transcribed the prespeech sounds of five infants from 0;6 to 0;8 as well as five infants at around 1;0. They analysed the frequencies of consonants in relation to their actual locations within the syllable as well as in clusters. The results showed that there is a continuity in the usage of specific phones and even segmental processes from babbling to meaningful speech.

Furthermore, it has been reported that some consonant-vowel-combinations are preferred over others. Vihman (1992) states the most common syllables produced by subjects of a cross-linguistic study to be [da], [ba], [va], [ha], [də] and [hə]. The ambient languages for these infants were English, French, Japanese and Swedish. Similar results were reported by Davis and MacNeilage (1995). Furthermore, Oller (1986) remarks that Jakobson may not have distinguished infraphonologically well-formed babbles from non-well-formed ones, what then has led to his assumption of a random choice of phones within babbling.

As the above mentioned examples of infants' favourite syllables in babbling suggest, the most common type of syllable structure in this stage of prespeech vocalizations to be CV. Many studies have confirmed this finding (Oller & Smith (1977), Locke (1983), Sendlmeier & Sendlmeier (1991), Vihman (1992), Lleó, El Mogharbel & Prinz (1994) and Davis & MacNeilage (1995)). The subjects of the current study also largely favoured the syllable shape CV over all others, as it can be seen under 4.3.5 in more detail.

Many researchers have tried to answer the question, what triggers the emergence of Canonical Babbling in the infant. Van der Stelt and Koopmans-van Beinum (1986) examined, whether the onset of babbling - as well as a number of other milestones in motor development like crawling, sitting, rolling and smiling - is related to the sex of the infant, his or her sleeping position (supine or prone), the difference between being breastfed or bottle-fed and between frequent or sporadic thumb sucking. Results, however, were not conclusive in many respects. None of the relations in question showed significance to babbling development. All of their 51 subjects, however, entered the Canonical Babbling stage at a mean age of around 0;7 and 0;8.

It has been observed that the infant is involved in a large amount of rhythmic behaviour, which has its peak at around 0;6 (Kent & Bauer (1985), van der Stelt & Koopmans-van Beinum (1986) and Kent (1992)). Obviously, Canonical Babbling has thus become viewed as an accomplishment of this behaviour. Davis, MacNeilage and Matyear (2002) claim it to be the effect of a mandibular cyclicity. They believe the opposition of consonants and vowels to have derived from the opposition of closed versus open mandible. Canonical Babbling is hence the articulatory aspect of an underlying motor development in the infant.

In his earlier work, MacNeilage (1986) pointed out that there is a strong relationship between babbling and the development of the manual system. He argues, that in most humans the preferred (right) hand is controlled by the same cerebral hemisphere as syntactic and semantic aspects of language, namely the left one. Thus, it is not surprising that the emergence of Canonical Babbling coincides with the beginning of manual activities. Indeed, a number of studies on the cooccurrence of infraphonologically well-formed syllables and rhythmic manual behaviours have shown, that the peak of the latter is around the time, when canonical babbling begins to appear (see Kent (1992) and Ejiri (1998)).

Nevertheless, motor development seems not to be the whole picture. Oller and Eilers (1988) found that there was a crucial difference in the vocalizations of normally hearing as opposed to deaf infants. They compared 21 hearing to nine deaf subjects. Results indicated that all of the hearing infants reached the Canonical Babbling stage between ages of 0;7 and 0;10. In contrast, none of their deaf subjects began uttering well-formed syllables that early. In fact, the onset of Canonical Babbling in the deaf infants lay between 0;11 and 2;1. Oller and Eilers (1988) hence concluded, that audition seems to play an important role in early vocal development (see also Oller (1986)).

Similar results were reported by Rvachew, Slawinski, Williams and Green (1999), who conducted a study on the influence of temporary hearing losses caused by otitis media in young infants. They collected babbling data from 18 babies, who were recorded at 0;6, 0;9, 1;0, 1;3 and 1;6 respectively. Half of the subjects were reported to have suffered from otitis media before their sixth month of life, while the others were developing normally. The results indicated that the children with temporal hearing losses produced less canonical babbles than the other infants in each of the recording sessions. Furthermore, the infants with early otits media never reached the ratio of well-formed syllable production, which was observed in the unimpaired subjects.

To examine more closely the actual influence of motor development and auditive capacities involved in the emergence of well-formed babbling, Ejiri (1998) conducted a study with 28 Japanese babies from 0;5 to 0;9. There were two different kinds of rattles placed in the subjects' hands, audible and inaudible ones. Each infant got the two rattles in a counterbalanced way in a number of experimental sessions. Results showed, that infants shook these rattles regardless of audibility, when canonical babbles emerged. However, just one month after this point in development, subjects preferred shaking the audible rattle and lost their interest in the inaudible one continuously during the next months. Furthermore, the peak of shaking behaviour coincided with the onset of canonical babbles. Ejiri (1998) hence concluded that auditory feedback is used during babbling to control vocal as well as motor activities.

It was mentioned earlier in this section, that crying can be used as a reliable indicator for physiological impairments in the newborn. Canonical babbles can also reveal information on the maturity of an infant. In a study on babbling frequency Oller, Eilers, Steffens, Lynch and Urbano (1994) compared preterm babies and infants of families with a low socio-economic status with those with a normal development. The group of preterm babies differed from the two others, as these subjects showed significantly less well-formed syllables than all of the full-term subjects. However, this difference only occurred when the premature infants were considered by their age after birth. As soon as the gestational age of these preterm babies were taken into account, similar results for both groups of subjects could be observed. On the other hand, infants of families with a low socioeconomic state appeared not to behave significantly different. Thus Oller, Eilers, Steffens, Lynch and Urbano (1994) concluded, that "this pattern of results bolsters an emerging perspective on the biological foundation of speech. It appears that infants come to produce well-formed speech-like units in a manner that is notably flexible under changing circumstances." (p. 54)

2.2.4 Influences by the ambient language in Canonical Babbling

Because canonical babbles are so adult-like in terms of their infraphonological structure, the question arose, as to whether it is possible to recognized any properties of the target language within the infant's utterances. There have been lots of studies on the segmental as well as the suprasegmental phonology in babbling over the past 25 years. Generally, these studies can be divided into two different types. On the one hand, there are studies based on transcripts or perceptual judgements of infant babbling by adult listeners. These studies therefore have a

more phonological point of view. On the other hand, linguists have conducted massive acoustic analyses to determine the phonetic properties of prespeech vocalizations. As will be explained in chapter 4, the current work combines both of these methods.

Stated with Levitt and Utman (1992) it has to be said, that "empirical investigations of language-specific influences have had somewhat mixed outcomes." (p. 20)

Starting with the first type of studies, Lleó, El Mogharbel and Prinz (1994), for example, compared four Spanish- against five German-learning infants at different ages during babbling and the early lexical stage. They transcribed their subjects' vocalizations with respect to sound inventories as well as syllable structure. In the data collected during the babbling stage they observed two kinds of differences in the two language groups, which indicated an influence by the corresponding environment. The Spanish infants produced slightly more fricatives and approximants than the Germans did. Lleó, El Mogharbel and Prinz concluded, that this result was caused by a particular process of segmental phonology in Spanish. This language has a rule of spirantization, which transforms stops into fricatives by spreading the feature [+continuant]. Furthermore, the German subjects uttered more closed syllables as did the Spanish babies. This finding actually reflects the higher frequencies of closed syllables in the German target language. Nevertheless, these two differences in the language groups seemed to be the only indicator for an actual influence by the ambient language. Hence Lleó, El Mogharbel and Prinz (1994) finally concluded that babbling "should be viewed as sound production in its universal state, reflecting the principals of UG, before setting the parameters to the values they have in the target language." (p. 191) Results like these made other linguists suggest that babbling is in deed largely universal but in some aspects drifts towards the target language. Especially Brown (1958) used the term "drift" to describe the appearence of babbling.

Oller and Eilers (1982) compared babbling data from eight English and eight Spanish infants living in the area around Miami. The mean age of the subjects was 1;0. The utterances were transcribed by two coders, one was a native speaker of English and the other of Spanish. Oller and Eilers found no significant differences between the English- and Spanish-learning babblers. Instead, the segments within the transcribed prespeech vocalizations appeared to be very similar in both groups of subjects and generally universal, although a small number of marked consonants did show up in the data.

In the above mentioned study presented by Vihman (1992), infants learning English, French, Japanese and Swedish were transcribed at an age from 0;9 onwards. One of the central questions was whether the four language groups showed noticeable differences in the repertoire of syllables. The results pointed to the fact, that there are syllables which seem to be common across all subjects, such as [da] and [ba]. However, some language-specific variation actually occurred in the frequencies of the vowels. French and Japanese infants preferred [a], whereas English and Swedish subjects often had [ə] and [i] in their data. Furthermore, alveolar stops were more frequent in the Swedish data than in all other language groups, while only the Japanese babies showed a tendency to combine velar stops and back vowels like [o]. A problem for this investigation was the fact, that there were two groups of English-learning subjects taking part in the study, who showed strong differences in their vocalizations when compared against each other. Vihman hence concluded, that "within-language differences seem to be as great as cross-language differences as far as the overall selection of practiced syllables is concerned." (p. 398)

Sendlmeier and Sendlmeier (1991) examined the consonantism of German-learning infants from 0;8 to 1;3 in terms of similarities to the target language's frequencies of places as well as manners of articulation. It was observed that the frequencies of places of articulation began matching those of German, when the subjects reached the age of 1;2. In contrast, the manners of articulation appeared in target-matching frequencies from 0;8 onwards and showed no further changes. Only liquids were found to be less frequent in the babbling data than in German.

A common experimental setup to examine the influences of the ambient language in babbling is to let adult listeners judge utterances by babbling infants. Dinger and Blom (1973), for example, compared Dutch against English babbling stimuli, which were presented to adults of both target languages. The stimuli matched the ages of 0;8, 0;10, 1;0, 1;2 and 1;4, which means that they were partially recorded during the transition to the lexical stage of language acquisition, which begins at 1;0. As a result, both groups of adults, the Dutch- as well as the English-speaking listeners, could identify the infants' target languages from 1;0 onwards. Dinger and Blom (1973) mentioned, however, that the material of the older infants may have contained early lexical items. This makes the outcome of their experiment somewhat questionable, at least for the data from the transitional period.

Some years later, Olney and Scholnick (1976) compared samples from English and Chinese infants, which were recorded at ages between 0;6 and 1;6. Adult listeners could not reliably distinguish the different language backgrounds of the babies.

De Boysson-Bardies, Sagart and Durand (1984) used babbling samples of French, Cantonese and Arabic infants at 0;8 and 0;10. The stimuli were presented to French adults, who were asked to identify such babbles, which were produced by a French infant. Results showed that listeners' judgements were reliable in the vast majority of the cases. Only when prosodic cues within the babbles were poor, adults failed to identify the ambient language correctly. Hence, these prosodic properties seemed to be specifically recognisable for the adult listeners.

Another experiment of this type was undertaken by Thevenin, Eilers, Oller and Lavoie (1985). They compared the ratings of monolingual English versus bilingual English and Spanish adult subjects, who were asked to distinguish stimuli by 14 infants acquiring either English or Spanish. The babbling sounds were recorded at the ages of 0;7 to 0;10 as well as 0;11 to 1;2. The results showed that adults were not able to identify the target language of these infants.

The second type of studies conducted into the influence of the ambient language in babbling can be characterized as having a more phonetic viewing point. These examinations have meanwhile become much more numerous due to the ongoing development in recording and computerized sampling techniques. Levitt and Utman (1992), for example, compared a French- against an English-learning infant from 0;5 onwards, using transcripts as well as acoustic analyses. They measured syllable duration and punctual F1- and F2-values at the amplitude peak within vowels. Additionally they conducted a massive analysis on the segmental inventories of their subjects. Results indicated that some parameters in the sound production of the two babies reflected universal patterns while others seemed to be influenced by the target language. The latter case was most obviously to be seen in syllable structure. "The English-learning infant produced more closed syllables, which is characteristic of English, than the French-learning infant. The French-learning infant tended to produce more regularly-timed non-final syllables and showed significantly more final syllable lengthening (both characteristics of French) than the English-learning infant." (p. 19) These findings point to the fact, that the specific type of rhythmic timing the two languages base on - stress timed for English and syllable timed for French (see Ramus, Nespor & Mehler (1999)) - were acquired by the two subjects at an age of 0;11. Further influences of the ambient language of both in-

fants was also found in the phonetic inventory. However, target-specific differences firstly occurred as late as 0;11. Both subjects showed a rather universal distribution of consonants and vowels at younger ages. Finally, the measurements of the punctual formant values for both subjects displayed a shift towards the values observed in the corresponding adult speech. This specific development was, however, not found before 1;2. Hence, it can be concluded from the study by Levitt and Utman (1992), that influences of the ambient languages appear in infant babbling, but they tend to emerge close to the end of the first year of life.

De Boysson-Bardies, Sagart, Hallé and Durand (1986) compared six French, six Cantonese and five Algerian Arabic ten-month-olds in terms of the spectral properties in vowels. They applied long term FFTs, to reveal the spectral properties of the infants' babbling sounds. Results indicated that there were clear differences for the three language groups. Whilste French and Cantonese subjects produced a spectrum with one peak at 825 Hz for French and 1200 Hz for Cantonese, Algerian infants showed two peaks at 830 Hz and 1600 Hz. Then de Boysson-Bardies, Sagart, Hallé and Durand (1986) compared their ten-month-old subjects to adult native speakers of the three corresponding languages. It could be clearly seen that the infants' spectral distributions matched those of the corresponding adults in a relative way, due to the different F0-values. Thus, there were clear target-specific acoustic properties in the infants' vowels to be seen as early as ten months of age.

In a further investigation de Boysson-Bardies, Sagart, Hallé and Durand (1989) compared French, English, Cantonese and Algerian Arabic infants in respect to their F1- and F2-values during vowel production. Subjects were recorded at an age of 0;10. The results showed that there were again significant differences between the formant frequency values of the language-groups. Additionally, the inter-language differences were higher than the intra-language differences of the individual infants. As in their previous experiment de Boysson-Bardies, Sagart, Hallé and Durand (1989) again compared the babbling data to that of adults of the same language backgrounds and found clear similarities in terms of the relationship of the actual formant values within each language-group. The results of both studies lead to the assumption, that the spectral properties in vowels appear in a target-shaped fashion in babbling infants at an age of 0;10. As Reetz (1999) states, formant frequencies are not a property of the vocal tract itself but depend on the configuration of the articulators. Any particular configuration results in specific resonance values. Hence, if infants show the same distribution of formant frequencies in vowels as adults do, then this means that they use their articulators to

express exactly such vocalic sounds, which are also present in their corresponding language environment.

Whalen, Levitt and Wang (1991) examined the intonation patterns of five English- and five French-learning infants. They conducted a perceptual as well as an acoustic analysis of reduplicative babbles containing two and three syllables. Their subjects were recorded weekly from 0;5 till 1;1 by their parents. As a first step all relevant utterances were classified by adult listeners into five categories (rising, falling, rise-fall, fall-rise and level). Additionally, the fundamental frequency for these vocalizations were acoustically measured. Whalen, Levitt and Wang (1991) found the majority (65%) of the intonation patterns in their subjects to be either falling or rising. These two patterns were, however, significantly different, as soon as the English infants were compared to the French. The English subjects produced 75% falling patterns, while the French showed no clear tendency towards either pattern. The researchers claimed that the falling intonation pattern is more frequent in English than in French. Thus, the infants showed an influence by the ambient language.

A special piece of interest in the acoustical studies lies on the phonological rule of Final Syllable Lengthening (FSL), which is operative in particular languages such as German and English. Oller and Smith (1977) measured vowel durations of utterance final syllables produced by six English-learning infants from 0;8 to 1;0 as well as six adults of the same linguistic background. To make the data as comparable as possible, the adult subjects were instructed to also utter reduplicated nonsense words with open final syllables. While in the adult data FSL was strongly present in all cases, the differences of final versus non-final vowel durations in the infant data showed no tendency towards FSL in babbling. Because FSL only occurs in particular languages, Oller and Smith (1977) concluded that this rule is actually learned at the end of the babbling stage.

Nathani, Oller and Cobo-Lewis (2003) conducted a study, in which eight normally hearing infants were compared to eight deaf infants during the first year of life. The purpose of this investigation was to determine, how FSL develops in these subjects. Syllable durations were acoustically measured for well-formed babbles. It was observed that FSL was present in the normally hearing infants throughout the study. However, it showed strongest effects in the earliest recordings and then decreased during the second half of the first year of life. In contrast, all deaf subjects showed a greater amount of FSL that didn't even change over time.

Hence, Nathani, Oller and Cobo-Lewis (2003) concluded, that FSL should be understood as a biological tendency to slow down motor activity towards the end of a vocalization.

2.2.5   The transition to the lexicon

Around their first birthday children enter a developmental stage, which in the following will be referred to as the Placeholder Stage. As the term suggests, children now begin to use particular combinations of speech sounds to express meanings. At the emergence of this stage there is, however, just one such placeholder, which is used to mark all kinds of deictic relationships. Hence it occurs, for example, in a situation, where the child would say "What is this?" or "I want to have that.". Usually it is combined with a gesture of pointing at something or someone (see Kühne (2003)). This indicates, that at this stage a sequence of speech sounds is used by the infant to describe a complex situation as a whole, instead of naming an object or an action (Nelson (1988)).

Having said this, it is not very surprising that in case of the subjects participating in the current study this specific placeholder strongly reminds of a deictic pronoun or an adverb in their ambient language German (see table 7). Only NB had a different phonological representation for it. It has furthermore to be remarked, that this placeholder is used with a wide variety of intonational modulations, as they would occur in different kinds of phrases such as questions or exclamations. This indicates that the child is very well aware of the specific correlation between semantics and suprasegmental intonation, he or she is about to utter.

Table 7: Deictic placeholders during the transition to the lexicon

JR	[dɑ]
NB	[bə]
LU	[dɑ]
TJ	[də]
DP	[dɑ]
SG	[dɑ]
LS	[dɛ]

When this placeholder emerges all subjects show decreasing overall numbers of babbles. Instead they tend to insert the placeholder in order to express themselves. Furthermore, meaningful babbles can be recognized by the listener. These babbles often appear as reduplications

of the syllables of a target word. It has to be noted however, that the semantic representations at that age are not yet fully specified. Meaningful babbles hence may cover a broader range of meaning. This demonstrates the child's tendency to use a particular sequence of speech sounds to express a rather broad semantic notion, which then will be specified later on.

One thing about the placeholders uttered by the subjects of this study is, that all of them appear as a monomoraic unit. This finding could point to the fact, that the children were aware of the existence of functional elements in the target language, which in many cases violate the conditions of the Minimal Word Constraint (MWC) formulated by Demuth (1996), as it is described in the following.

(3) Minimal Word Constraint (MWC):

Content words have to be binary at some level of analysis.

The monomoraic shape of the placeholder to my mind indicates that the children at this developmental stage already have encountered a fundamental term of organization in the mental lexicon, namely the difference between functional and content elements.

Just a few weeks after the emergence of the deictic placeholders parents will notice the beginning of the lexical stage in their children, who now combine meanings and patterns of speech sounds to build up their inventory of lexical entries (see Locke (1995)). From a semantic point of view, it has to be mentioned, that these first meaningful items have a very broad semantic content. For example, when a child at this stage produces a word such as "Wauwau", he or she need not necessarily have the picture of a dog in mind. Instead, he or she could appoint every kind of animal, which is "close to" or similar to a dog. It can be said, thus, that the child begins to acquire the lexicon by combining a sequence of phonemes with a semantic class. Later on the child develops combinations of phonemes and particular semantic units (see also Stern & Stern (1928)). Generally, placeholders are extensively used up to an age of 1;8, when the child usually has around fifty words stored in his or her mental lexicon. Then the child engages to learn more target words at a higher rate, namely about nine new words a day, which at first are, however, not available for active use. This point in lexical development is known as the Vocabulary Spurt (see Carey (1978)).

Jakobson (1941) postulated the appearance of a silent stage between babbling and the onset of the lexicon. For the subjects of the current study such a stage could not be observed. Nevertheless, the number of babbles tends to decrease. In fact, all subjects had a peak of babbling

frequency at a mean age of 0;9.14. Vihman, Macken, Miller, Simmons and Miller (1985) found that well-formed babbling still occurred in infants at ages from 0;9 to 1;4, while there was an ongoing process of lexical acquisition, without encountering any notion of a silent stage. Furthermore, babbling and early target words were built from the same segmental material, suggesting that there is continuity in these two types of vocalizations. Other researchers reported similar results (see Oller, Wieman, Doyle & Ross (1976), Oller & Eilers (1982), Locke (1983) and (1995), Sendlmeier & Sendlmeier (1991), Oller & Lynch (1992) and Vihman, De Paolis & Davis (1998)).

At an age of around 1;6 Hallé, de Boysson-Bardies and Vihman (1991) found that intonational patterns and processes such as FSL showed target-specific properties in their four French and four Japanese subjects. Whilste the French infants showed more rising F0 contours as well as a lengthening of the final syllable, the Japanese infants produced more falling F0 contours and appeared to have no durational differences in initial and final syllables. Hallé, de Boysson-Bardies and Vihman examined target words as well as late babbling disyllabics. These two types of vocalizations furthermore displayed no recognisable acoustic differences for both language backgrounds. According to Locke (1983) well-formed babbling finally disappears, when the child has reached the Vocabulary Spurt Phase.

2.2.6   The development of segmental phonology in early target words

From a phonological point of view, it is interesting to note that at this point in language acquisition infants seem to do a step in the wrong direction. When taking a closer look at the phonemic inventory of one year olds, it is possible to observe a sudden decrease in variation. Whilste having been able to produce a wide range of consonants and vowels throughout the Canonical Babbling stage, they now seem to lose these capabilities, and the majority of their sounds disappear (Jakobson (1941)). Hence, most theorists argue that upon the emergence of the lexical stage infants move over from a rather universal form of sound production to a much more target shaped one (see Lleó, El Mogharbel & Prinz (1994)). More on the question, what happens at this point in development will be discussed under 2.3.

In this new stage of the acquisition process, the phoneme inventory seems to be rebuilt from scratch. In Jakobson's (1941) view, the segmental development in child language is an establishment of phonetic counterparts. This means, that the child begins to build up his or her

phonological system by discovering maximal oppositions in the phonetic features of speech sounds. He claims, that the "first" – that is the first meaningful - syllable uttered by most of the children was [pɑ], because /p/ is the least open (complete closure of the vocal tract) and /ɑ/ is the most open speech sound in human language. What is so striking about this finding is the fact, that most parents try to stimulate their children to babble while building syllables like [bɑ]. It would thus seem as if parents are also "programmed" in the sense that they "know", what kind of linguistic input is required by their infants most importantly.

Then, after acquiring this fundamental stop-vowel-opposition, children move on by adding the maximal phonetic contrast within the vowel system to their inventory, namely the opposition of /ɑ/ and /i/, a low back and a high front vowel. This is followed by adding /u/, a high back vowel, which in addition is rounded. These three vowels /ɑ/, /i/ and /u/ build the basis of the minimal universal vowel inventory of the world's languages as well as the fundamental notion of the vowel triangle.

(4)

```
i ------- u
 \     /
  \   /
   \ /
    ɑ
```

Jakobson (1941) suggests a similar acquisition process also to appear in case of the consonant inventory. Hence, one of the earliest sounds is /m/, a nasal as opposed to the oral /p/. These two sounds are furthermore maximally contrastive in terms of the phonetic feature [continuant]. Now, for the non-continuant consonants a further distinction is established. The alveolar /t/ is added and builds up an opposition to the labial /p/, which is based on place of articulation. As a next step the velar plosive /k/ is introduced, resulting, thus, in a fundamental triad of place feature opposition.

(5)

```
                    k
                   / \
                  /   \
                 p ----- t
```

It is striking that these two triads of sounds require just two phonetic features, to be defined. For the vowel set these are [high/low] and [front/back]. For the first three consonants /p/, /m/ and /t/ these are [nasal] and [labial]. The child has hence established a minimal phoneme inventory, where phonetic features are used to define phonemes. Thus, features and phonemes are separated instances (see also Ramge (1993)).

Jakobson claims that the establishment of this phoneme inventory in the child is guided by language universals. He points out that the two sets of triads not only occur in the output by young children, but also are the minimal phoneme inventories of human language in general. No language has – let us say - the vowel /y/ without at the same time having /ɑ/, /i/ and /u/ as well. This fundamental constraint on the vowel system can be explained by the Subset Principle (SSP) formulated by Demuth and Fee (1995), which is given under (6).

(6) Subset Principle (SSP):

If a language has feature B, which is more complex than A, this languagealso has to have feature A.

Actually, the establishment of the phoneme inventory seems to strictly adhere to the SSP. The most universal speech sounds are acquired prior to those sounds, which are less common throughout the world's languages. Furthermore, the less universal a particular speech sound is, the later it is acquired by children. Hence, Ramge (1993) states, that the relatively rare fricative /θ/ emerges rather lately in English-learning children, namely as late as the third year of life (see also Locke (1983) and Ingram (1989)).

More recent work on the acquisition of the phoneme inventory during the lexical stage comes from Beers (1996). In her work she shows how the child acquires a contrastive system of phonetic features rather than phonemes as a combination of features, which is a somewhat compatible argumentation to the one introduced by Jakobson. Hence it can be concluded that

when children utter speech sounds, they use unspecified phonetic features, before the phonetic properties of the phonemes are sequentially acquired.

During the ongoing lexical development it can be observed that phonemes become modified by the child. Hence, the child's output does not match the target-shape in terms of the actual segmental content. Generally speaking, there are three different kinds of processes, which are frequently applied by young children in order to change segments or phonetic features within target words: harmony, substitution and reduction (see Berman (1977)).

In the case of harmony, children produce a target word while spreading a single phonetic feature onto all its segments. Levelt (1994) collected data from twelve Dutch-speaking children during the second year of life. The data indicates that the earliest lexical items appear in a completely harmonized fashion. Hence, all of the syllable's constituents share exactly the same phonetic features. Children then explore the constituents one after another, as they reduce the amount of spreading and allow separate features for the different branches of syllable.

Consonant harmony can either be progressive or regressive (see Penner, Fischer & Dietz (1999)). Some examples of consonant harmony by NB at an age of 1;7 are given below:

(7) Progressive harmony

    [fɛɐp]   Pferd [pfeɐt^h] horse

(8) Regressive harmony

    [dɪnt]   Kind [k^{h}ɪnt^h] child

It is interesting, that NB didn't produce harmonized forms in a constant fashion, even throughout one and the same recording session. The noun "Kind" [k^{h}ɪnt^h] appeared, for example, as [dɪnt] as well as [dɪŋk], the latter one with a partially progressive harmony. Furthermore, Penner, Fischer and Dietz (1999) give an interesting example of a partially progressive harmony by a child at an age of 2;0. The target noun was "Wasser" [ˈvasɐ], which the child transformed to [ˈsasa] and just one moment later to [ˈzaza], where the feature [+voiced] is spread progressively from the first onto the second syllable, while all place features are spread vice versa. It has been reported by other researchers that a child's output form of a particular

target word shows a certain amount of variation even throughout one single recording session (Ferguson & Farwell (1975)).

Other linguists have shown that consonant harmony is not restricted to the very early stages of the lexical development, but does still appears even at an age of 2;7 as it was illustrated by Berg (1992). He collected data of his German-speaking daughter from 2;7 till 2;11. He found, that the only kind of harmony in place features was [labial]. He furthermore found just one out of 65 harmonized forms to be progressive.

The second type of process occurring in the early consonantism is cluster reduction. It has been reported for different languages of the world that young children tend not to produce consonant clusters as a whole but leave out at least one of the consonants. Ohala (1999) shows that the omissions are not at random. Instead, they are strongly related to the actual amount of sonority of the corresponding consonants. In a number of experiments Ohala found that children between 1;1 and 3;2 reduced word initial clusters to the least sonorous consonant, whereas final clusters were reduced to the most sonorous one. This indicates, that the universal notion of the sonority hierarchy is already present in young children.

2.2.7 The development of syllable structure

Levelt, Schiller and Levelt (2000) show, that the constituental structure of the syllable itself develops in a predictable way. They suggest four particular stages, in which the syllables uttered by children appear in different shapes (see also Fikkert (1994)). These stages can be characterised as follows:

Table 8: Developmental stages of syllable types according to Levelt, Schiller & Levelt (2000)

Stage 1	CV
Stage 2	CV and CVC
Stage 3	V and VC
Stage 4	all syllable types

An interesting finding of this study is that in the two initial stages onsets seem to be obligatory. They begin to be optional at stage 3. This is striking, because Dutch is a language, which allows syllables without onsets. Stages 1 and 2, however, indicate that children acquiring Dutch at first do have obligatory onsets. This reflects the fact, that the parameter [syllable onset] is still unset and therefore in its default state. It is then set at the transition to stage 3. Furthermore, this is again an example for the presence of the SSP. There are languages, which are restricted to syllables with onsets, while others like Dutch, German and English allow syllables with and without onsets. However, there are no languages, which only have onsetless syllables. Thus, we again find that the process of language acquisition adheres to the SSP.

Another outcome of the investigation by Levelt, Schiller and Levelt (2000) is that closed syllables emerge prior to open syllables with long vowels. This points to the fact, that as a first step the rhyme branches into nucleus and coda, before the nucleus itself can branch any further. This is exactly what is also stated by Fikkert (1994). From a universalist point of view, this would again make sense.

A different approach on this topic comes from Demuth and Fee (1995), who examine English data but compare it cross-linguistically. However, their model combines predictions on syllable structure and the appearance of whole words in early child language and therefore has a somewhat different perspective. It basically consists of two developmental stages, where the second one is divided up into three sub-stages, as can be seen in table 9.

Table 9: Development of syllable structure and prosodic words by Demuth and Fee (1995)

Stage 1: Core syllables	CV
Stage 2: Minimal words	
Stage 2 a) Core syllable	(C)VCV
Stage 2 b) Closed syllables	(C)VC
Stage 2 c) Vowel length	(C)VV

I will discuss stages 1 and 2a in more detail under 2.2.8. For now, it is important to remark, that the two models by Levelt, Schiller and Levelt (2000) and Demuth and Fee (1995) show an interesting similarity. Both state that CVC syllables emerge prior to CVV ones. This finding indicates that children seem to acquire closed syllables earlier than the distinction of vowel quantity within the syllable. What is, however, most essential to the model by Demuth

and Fee (1995), is the assumption of a constraint on children's early words at stage 2 to be minimally and maximally bimoraic. Such a constraint was also suggested by Kehoe and Stoel-Gammon (2001), who examined the development of rhymes in 14 English-speaking children from 1;3 to 2;0. They found, that their subjects produced coda consonants more frequently after short vowels, pointing towards are bimoraic - or at least bipositional - restriction to children's rhymal structure.

Concerning the acquisition of codas versus the vowel length contrast Fikkert (1994), who collected data from twelve Dutch-speaking children, comes to the same conclusion as Demuth and Fee (1995). Thus, she suggests the following parameters for syllable structure, as they had also been discussed by Kaye (1989).

(9)   Branching rhyme parameter:

        Rhymes can branch into nucleus and coda: [no/yes]

    Branching nucleus parameter:

        Nuclei can be branching: [no/yes]

    Extrarhymal parameter:

        Final bipositional rhymes can be followed   [no/yes]

        by an extra consonant:

According to these parameters, Fikkert (1994) proposes a developmental model of syllable structure acquisition, that includes the following four stage (see table 10):

Table 10: Model of the acquisition of syllable structure by Fikkert (1994)

Stage 1: No parameter is set	CV
Stage 2: The branching rhyme parameter is set	CVC
Stage 3: The branching nucleus parameter is set	CVV and CVC
Stage 4: The extrarhymal parameter is set	CVVC

In contrast, Kehoe and Stoel-Gammon (2001) reported their English-speaking subjects to acquire coda consonants and the distinction of long versus short vowels at the same time. However, two of the subjects appeared to produce different vowel quantities before they began to use coda consonants. Kehoe and Stoel-Gammon (2001) emphasized, that there are crucial

differences in the way, the target languages Dutch and English treat vowel quantity in respect of syllable weight, what might actually cause the particular sequence of developmental stages in the acquisition of syllable structure.

2.2.8 The acquisition of word stress

Another point of central interest is the acquisition of stress assignment in target words. During the stage of lexical development children often tend to utter target words in a rather incomplete fashion. Sometimes they delete syllables while in other cases reduplicating one or more of them. Many linguists have shown that these processes do not occur at random. Instead, they are highly predictable even across languages, because they adhere to language universals. They can be characterised either as effects of incomplete output forms or as repair strategies, which occur during particular developmental stages (see Berman (1977), Gleitman & Wanner (1982), Ingram (1989), Fikkert (1994) and Demuth (1996)).

The assumption that young children do actually have complete underlying representations of lexical items, was firstly assumed by Jakobson (1941). He reported, that although a child at a particular age was not able to produce his or her output forms exactly target shaped, he or she, nevertheless, noticed very well, when adults attempted to imitate child language by using typical output constraints like truncation or reduplication. This, however, can only be the case, if the child already has complete underlying forms.

As Fee and Ingram (1982) state, the process of reduplication starts to appear in the output of children at an age of 1;1. Although not all of their subjects produce reduplicated forms equally often, they suggest, that reduplication has to be viewed as a general pattern to repair incomplete output forms of underlying representations. On one hand reduplication can achieve a multisyllabic output enabling the child to utter, thus, a surface form that actually has as many syllables as the intended target representation. As a second effect these children use more multisyllabic lexical items in their production and are hence faster in acquiring new words. However, reduplicated forms in most cases contain only open syllables. Thus, final consonants and clusters of the target representations are less present than in non-reduplicated forms (see also Schwartz, Leonard, Wilcox & Folger (1980)).

As Ingram (1989) suggests, there are developmental trends to be found in the production of target words by young children. These trends can be described in five different stages. In a

first stage only monosyllabic output occurs in the data. All unstressed syllables of the target words are deleted. Then at a second stage, disyllabics appear, which mostly are trochaic. In target disyllabics with final stress, the unstressed syllables are lost. Trisyllabic targets are, however, reduced to their main stressed syllable. At stage 3 trisyllabics now appear as disyllabics. During the next stage, initial unstressed syllables begin to be produced in target disyllabics, but not yet in trisyllabics. Finally, the child completely acquires target stress assignment at the last stage.

An outstanding work in this field comes from Fikkert (1994), who gathered data from twelve Dutch-learning children. Her major goal is to show, that the acquisition of stress is not achieved by lexical learning. Instead, it can be described as a sequence of developmental stages as also suggested by Ingram (1989), during which children produce predictable output patterns of target words. Each of these stages is characterised by a specific configuration of the parameters for stress assignment, as they are introduced in 1.2.4. Hence, children begin to walk through the acquisition process, whilste setting the parameter values one by one to their target language's configuration (see also Dresher & Kaye (1990), Fikkert (1995) and Fikkert & Penner (1999)).

The data presented by Fikkert indicate, that the acquisition of stress develops in six different stages, where the last stage stands for the completion of the target specific parameter setting. These stages, as they are labelled in Fikkert and Penner (1999), are shown in the following table:

Table 11: Developmental stages of the acquisition of word stress by Fikkert (1994)

Stage 1: Subminimal words	All words are reduced to one CV syllable, which appears to be subminimal in Dutch.
Stage 2: Quantity-insensitive trochees	Polysyllabics are reduced to a quantity-insensitive trochee containing the main stressed syllable.
Stage 3: Still quantity-insensitive trochees	In contrast to stage 2 children now over-generalise the quantity-insensitive trochee and hence produce a number of stress errors.
Stage 4: Level stress	Disyllabics, which are not trochaic, are uttered with equal stress on both syllables.
Stage 5: Initial stress	Polysyllabics are main stressed on their first syllable.
Stage 6: Main stress rule	All words are stressed correctly.

In Fikkert's proposal stage 1 is characterised by the fact that target words uttered by children consist of just one single syllable of the type CV. Thus, the output forms are actually sub-minimal. What is essential to them is that they include the target's main stressed syllable. Exactly the same findings are reported by Ingram (1989), Demuth and Fee (1995) as well as Locke (1995).

At stage 2, the children's output forms become bimoraic. They are built up out of two core syllables, thus constituting a quantity-insensitive trochee. Fikkert (1994) states that the main stressed syllable of the target word is included in the child's output. However, at this stage the child produces a prosodic foot, which is a trochee, as it is for Dutch. A bimoraic trochaic form is also predicted by Demuth and Fee's (1995) substage 2a for the acquisition of the minimal word as well as by Allen and Hawkins (1980) and Ingram (1989). Moreover, a trochee seems to be present in child speech across languages. Demuth (1996) compared the output of young children of four different languages (English, Dutch, Sesotho and Qiché) and found that in all these environments target words with more than two syllables are reduced to a bimoraic form, which in English, Dutch and Sesotho was a trochee. In Qiché target words were, however, reduced to a heavy syllable, as this language is underlyingly iambic. Still it shows bimoraic output forms in the subjects' speech production at that stage.

In Fikkert's third stage there are still quantity-insensitive trochees to be seen in the child's output. None of the parameter values for stress assignment is set at this point. However, the trochaic stress pattern now becomes over-generalised and hence is even used for such target disyllabics like the ones containing a first light and a final heavy syllable, that are actually not trochaic. Thus, the child at this stage produces a number of stress errors.

At stage 4, disyllabics can appear in two different shapes. There are still trochees for target trochaic patterns. Additionally there are now forms with two equally stressed syllables, the so called "level stress" pattern. These equally stressed disyllabics, however, only show up when children attempt to utter such words which end with a superheavy syllable and thus, do not have primary stress in a regular way. Fikkert (1994) therefore concludes that children at stage 4 have noticed that their target language is quantity-sensitive. Hence, syllable weight differences begin to be used to distinguish target disyllabics. Those output forms revealing stress errors at stage 3 are now reanalysed and parsed into a sequence of two equally stressed feet.

At stage 5, polysyllabics are uttered completely. There are no more omissions of initial un-stressed syllables on the surface. However, all these forms are stressed on their very first syllable, meaning that the child again produces stress errors. These errors actually result in the fact that the prosodic parameter [main stress rule] is still unset and therefore results in output patterns with initial stress, as this is the case in UG.

Finally, the child reaches the sixth stage, at which he or she has acquired the stress system of Dutch completely. Thus, all kinds of polysyllabic words are from now on uttered without any stress errors.

2.3   The continuity question

The question of how babbling and lexical development are actually related, is still not solved. Although these two developmental stages mentioned share a number of similarities, there are on the other hand crucial differences. Hence, the discussion of their relationship has led to the so called continuity debate. Here two major points of view have arisen, which have manifested themselves in two theoretical branches, namely the Discontinuity and the Continuity Theories. The latter furthermore distinguishes two kinds of interpretation, the so called "weak" as opposed to the "strong" continuity.

2.3.1   Discontinuity

The first researcher, who assumed a largely discontinuant relationship of babbling and language acquisition and, thus, initiated the continuity discussion, was Jakobson (1941). He believed that babbling and lexical development were completely separated instances, because in babbling children were able to produce an enormous amount of different phons, even such sounds, which were not part of the phoneme inventory of the children's ambient language. However, all these phones suddenly disappeared when they encountered word learning. At this point the phoneme inventory had to be rebuilt from scratch. Hence, children seemed to have forgotten, what they were able to produce only a few days before.

Even more surprisingly, at the transition to the lexical stage the prosodic system appears also to be reset. Although the child used to utter polysyllabic word-like forms during babbling, target words, however, are reduced to the core syllable CV (see Ingram (1989), Fikkert

(1994), Demuth & Fee (1995) and Locke (1995)). This would lead to the conclusion that babbling was mostly irrelevant to the later acquisition of the stress assignment rules of the target language.

Most importantly, the acquisition process during the lexical stage is characterized by the presence of language universals such as the minimal phoneme inventory or the core syllable, which seem to guide the infant's development. Jakobson (1941) claimed however that these universals seemed to be missing during the babbling stage. Vocalizations appeared in a rather chaotic fashion, or - so to speak - ungrammatical and not bound to the fundamental laws of human languages (see also Peters (1997)).

Thus, the theory of Discontinuity states that the process of language acquisition is not unique over time. It consists of several different stages, which are sequentially arranged but not necessarily connected to one another. That means, a child can behave in a particular way, which he or she won't need to do at a later age, when the end of the current developmental stage is reached.

2.3.2   Weak Continuity

The counterpart to the Discontinuity point of view is called Continuity. Generally speaking, the Continuity Theory states that the universals of human language are available right after birth. This implies, that all the prelexical stages of development are also tied to grammatical development and are, thus not different from lexical acquisition.

Indeed, many linguists have clearly shown that babbling indeed seems to have a great amount of universal fashion (see for example Oller, Wieman, Doyle & Ross (1976), Ingram (1989), Levitt & Utman (1992), Vihman (1992) and Lleó, El Mogharbel & Prinz (1994)). Oller and Eilers (1982) observed a number of characteristics in canonical babbles, which strongly indicate that language universals are present at this stage (see table 12).

Table 12: Characteristics of Canonical Babbling found by Oller & Eilers (1982)

1. Single consonants are more frequent than consonant clusters.
2. Consonants in onset position are more frequent than in coda position.
3. Stops and nasals are more frequent than fricatives and liquids.
4. Voiced stops in onset position are more frequent than voiceless ones.
5. Final obstruents usually are voiceless.

Other linguists come to similar conclusions. According to Locke (1983) there are clear prefer-ences in the usage of consonants by infants of different language backgrounds during Canoni-cal Babbling. Furthermore, Lleó, El Mogharbel and Prinz (1994) note that babbling "should be viewed as sound production in its universal state, reflecting the principals of UG, before setting the parameters to the values they have in the target language." (p. 191) Hence, they believe that the knowledge provided by UG is present during babbling. Moreover, canonical babbles and early target words have been shown to share very similar acoustic properties and phoneme inventories (see Oller, Wieman, Doyle & Ross (1976), Vihman, Macken, Miller, Simmons & Miller (1985), Sendlmeier & Sendlmeier (1991), Hallé, de Boysson-Bardies & Vihman (1991), Locke (1995) and Vihman, De Paolis & Davis (1998)). Consequently, there are many facts pointing towards a continuant development from babbling to lexical acquisi-tion.

2.3.3 Strong Continuity

A more straight forward interpretation of the Continuity Theory states that the child is in-volved in acquiring his or her ambient language since the earliest point in time. Consequently, the child does not interrupt this process at any time. If he or she reaches a new milestone in development, it will be impossible to fall back to a stage, which has already been passed through.

This "strong" interpretation of Continuity suggests that the infant has already started to ac-quire language before birth (see Zimmer (1986)). During pregnancy the infant's input mainly consists of the mother's voice (Locke (1993)). However, the speech signal recognized by the foetus at this stage has unique acoustic properties. Most importantly, the largest part of its

harmonic frequencies is suppressed by the amniotic fluid. What remains is the part of the sig-
nal, which is a) not – or the least - affected by any kind of lowpass filtering and b) produced
within the interior of the mother's body. Both conditions are met by her glottal frequency.

The foetus thus has access to the information provided by the mother's F0. This mainly covers
intonational modulation and voicing. The modulation of F0 provides the foetus with a basic
knowledge of the melodic contours in his or her target language. It might be imaginable in
particular, that the fundamental difference in tonal languages such as Chinese versus intona-
tional languages such as the Indoeuropean family could be acquired. Whether the foetus at
that stage is able to derive any notion of meaning from these contours remains unclear. It
might be possible, that a co-incidence of strong cardio-vascular activity - for example fast
heart beets - and particular F0 movements - contours expressing excitement for example - is
informative for the foetus.

On the other hand I suppose that the foetus might get information on the phonemic system of
the mother's language, mainly the consonantism, through the F0. In a language that mostly
has voiced consonants, like French, the contour of the F0 within a phrase will only be inter-
rupted by either stops or few voiceless fricatives. In a language like German with more voice-
less obstruents and segmental processes like Final Devoicing, the F0 contour will be inter-
rupted much more often. Hence, the foetus might benefit from this source information, before
he or she is born.

Whether the foetus is actually able to notice dynamic differences in the speech signal of his or
her mother remains unclear. Thus, the question of how much information on word prosody is
available at that stage has to be left open for now. Nevertheless, Papoušek (2001) claims that
newborn infants are able to recognize as well as differentiate tonal sequences and melodies.
She furthermore assumes that the infant's capabilities to process linguistic and musical input
are at that age organized in a comparable way.

Some researchers, for example de Boysson-Bardies, Sagart, Hallé and Durand (1986) and
(1989), have conducted a number of studies, which indicate, that during Canonical Babbling
there is a noticeable influence of the ambient language, when infants of different linguistic
backgrounds are compared cross-linguistically. They focussed mainly on the spectral proper-
ties of vowels and found, that the distribution of the F1 and F2 values in babbling infants were
the same as in adults of the corresponding ambient language. Nevertheless, the majority of

studies states language-specific influences to occur rather late in canonical babbles, mostly from 0;11 onwards (see Levitt & Utman (1992)).

2.3.4   The question of prosody in Canonical Babbling

The continuity question has become a central point of discussion in linguistic research on early language acquisition. Most researchers argue in favour of at least a "weak" kind of the Continuity hypothesis, as language universals can be found throughout the babbling stage, whereas specific features of the ambient language are more rarely.

As the current work is placed in the field of linguistics, it will also contribute to this controversy on continuity in an important way. The heart of the current work is an analysis of the canonical babbling data of German-learning infants. More precisely, the infants' utterances will be examined in terms of their prosodic properties. Up to now, there have so far been many investigations on babbling, all of them undertaken with a great amount of care, and the theorists have been able to draw much benefit from them. However, to my mind one fundamental question has never been asked: is there any kind of a prosodic organization of the well-formed, speech-like syllables in canonical babbles, that can be described by the framework of metrical phonology? Furthermore, if there actually is one, what does it look like?

The current work tries to fill this gap. Babbling data from seven German-learning infants between 0;5 and 1;0 will be analysed acoustically as well as perceptually in terms of stress assignment within word-like vocalizations. According to the continuity debate there could be three possible outcomes to this investigation:

a) There is no organization of any kind. Word stress is not predictable in the babbling data. This would point to a discontinuant behaviour of the subjects in terms of prosodic parameters.

b) There is a straight forward level of organization. Word tree dominance and head directionality are leftward in the vast majority of the utterances. This would suggest a universal pattern of the prosodic parametry, as it is provided by the UG, and would thus verify the theory of Weak Continuity.

c) There is a level of organization, which shifts at some time during the subjects' development. This would hint to some kind of prosodic parameter setting in the early prosody. It has then to be compared to the target prosody in order to find whether the shift can be ex-

plained as an influence by the ambient language. This finding could hence lead to the assumption, that there is a strong continuity of Canonical Babbling and the ambient language.

There are investigations on the perception of disyllabic stress patterns in young German-learning infants, which point to the fact, that at least the emergence of prosodic organization is to be seen at the onset of the canonical babbling stage. Weber, Hahne, Friedrich and Friederici (2004) measured event-related potentials of infants at 0;4 as well as 0;5 using a mismatch negativity paradigm. Results indicated that infants at an age of 0;4 did not significantly discriminate trochaic versus iambic diysyllabics they listened to. In contrast, at an age of 0;5 subjects showed a mismatch response to the trochaic stimuli. This leads to the conclusion that trochaic input forms are separated in the speech input at that age.

In a different kind of experimental setup, Höhle, Bijeljac-Babic, Nazzi, Herold and Weissenborn (submitted) demonstrated that German-learning infants at 0;6 do show a preference for the trochaic stress pattern, while French-learning subjects at the same age do not. They used the headturn preference paradigm offering trochaic as well as iambic stimuli. Results indicate that the German subjects do not show a particular preference for either stress pattern at 0;4. However, at 0;6 they clearly prefer trochees over iambs. In contrast, the French subjects at an age of 0;6 still do not show any preference.

Both of these studies lead to the assumption that a particular preference for the trochaic stress pattern is present in German-learning infants at an age of 0;5 onwards. It is thus the question, in how far this preference can be also observed in speech production during the stage of Canonical Babbling.

3 German Word Stress Revisited

In this chapter I will give an overview of the German stress system, its principles and its exceptions. Stress assignment will be analysed within the framework of Metrical Phonology and its hierarchically arranged units mora (µ), syllable (σ), prosodic foot (F) and phonological word (PWd) (see Liberman & Prince (1977), Selkirk (1980), Hyman (1985), Goldsmith (1990)). Thus, this chapter will present a purely phonological perspective without dealing with any phonetic problems such as tracing down an acoustic correlate of word stress.

The analysis is based on a parametric model of word stress assignment. The formalism contains the parameters [syllable weight], [quantity-sensitivity], [head directionality], [boundedness], [directionality of footing], [foot branching], [main stress rule] and [extrametricality], as they were introduced by Hayes (1980), Prince (1983), Halle & Vergnaud (1987) and Dresher & Kaye (1990). Special focus will furthermore be given to the role of the schwa vowel, which is assumed here to mark the right edge of a foot by default in this language.

In short, results lead to the following generalisations over the stress system of German: trochees are built starting from the right edge of the word. There are three different levels on the syllable weight hierarchy. CV syllables are considered as light (one mora) and therefore unstressable. A syllable of this kind will, thus, be parsed as the right edge of a foot regardless of its actual location within the word. CVV, CVC and CV syllables followed by an ambisyllabic consonant are heavy (two moras) as well as stressable and can hence be the left edge of a foot. CVVC, CVCC and larger syllables are superheavy (three moras). Superheaviness implies that syllables of this size are parsed into one single non-branching foot. A number of words with a minimum of two syllables show extrametricality of the ultimate syllable. These words are, however, marked in the lexicon as exceptions.

3.1   Introduction

The stress system of German has long been discussed in literature. It has so far led to a number of controversies on its nature, as it leaves the linguist with a somewhat mixed impression. There have been several approaches on it, and most of them come to conclusions, which in some aspects are contradictory to the findings of others (see Giegerich (1985), Hayes (1986), Eisenberg (1991), Vennemann (1992), Kaltenbacher (1994), Féry (1995) and (1998) and Wiese (1996)).

Giegerich (1985) and Vennemann (1992) were amongst the first phonologists to suggest that the location of stress in German monomorphematic words is determined by a set of prosodic rules, as they can be described by the formalism of metrical phonology (see Liberman & Prince (1977), Selkirk (1980) and Halle & Vergnaud (1987)). That means that German word stress is predictable when regarding the internal prosodic structure of any lexical item. Earlier studies in contrast preferred the claim that German behaved more like English, where stress depends largely on the morphosyntactic properties of the words, as it can be seen in the word

pair "to access" and "the access". In these two words the location of main stress is a consequence of the word class rather than of any prosodic facts distinguishing them from each other (see Roca & Johnson (1999) and Halle & Vergnaud (1987)). Giergerich as well as Vennemann, however, showed, that German has more in common with its Western Germanic relative Dutch in the sense that in both languages word stress is calculated by rule, while morphosyntactic information is not relevant, at least for monomorphematic words. Kager (1989) describes the Dutch stress system in detail, after there had been extensive studies on this language's prosody. Whilste stress assignment can clearly be predicted in this language, one crucial problem for Kager's analysis, however is that Dutch doesn't seem to fit into the universal typology of quantity-sensitivity, as it is characterised by Hayes (1995). This is due to the fact that this language has a vowel quantity contrast and in addition a tendency of projecting stress onto closed syllables, whereas open syllables with long vowels do not show this tendency. According to Hayes, in universal terms there are two kinds of quantity-sensitivity. In the first, long vowels are heavier than short vowels. In the second, closed syllables are heavier than open syllables, while a distinction of vowel quantity is irrelevant. Hence, the Dutch type of quantity-sensitivity can be viewed as being unusual (see Hyman (1985)).

3.1.1   Earlier accounts for German

As has been mentioned, there have been several approaches to explain the rules for stress assignment in German. Most of them, however, reveal significant differences in such important points like quantity-sensitivity or the syllable weight hierarchy as well as in the choice of the formalism for the notation of rules and generalisations. These differences mainly boil down to the fact that parts of the German lexical data can be accounted for in several different ways. Hence, some of the basic proposals of the literature on the stress system of this language will be covered in short here, to explain the difficulties the investigators have to deal with in this field.

For Wurzel (1980) native and non-native words are two separate instances and hence are also treated differently in prosodic terms. He claims only the non-native part of the German vocabulary to be quantity-sensitive. Hence, these words receive stress by rule, while all native words have main stress fixed to their first syllables no matter, how the internal structure of the word's syllables looks like. His syllable weight hierarchy (for non-native words) is CVVC,

CVCC, CVV, CVC > CV. Main stress is reported to fall on the last heavy syllable within a word. If there isn't any heavy syllable, then the initial syllable will be stressed.

In Wiese's (1988) and (1996) view German needs to have a minimal rhymal template of the shape VC under the strong branch of the foot. This template can either be filled by a long vowel or diphthong or by a short vowel in conjunction with a consonant, which can be ambi-syllabic. Wiese therefore claims German to be a quantity-insensitive language. He further-more proposes that the basic foot shape is a trochee. Feet are built from right to left, and main stress falls onto the right-most foot. However, Wiese's assumption of quantity-insensitivity leads to a number of problems for his analysis. Most importantly, many words have main stress on their final syllables, what Wiese considers as exceptional. These word-final syllables can, however, be explained as being "heavier", when taking quantity-sensitivity into account. It will be discussed in more detail later, why these word-final syllables should be treated dif-ferently during foot formation.

Wiese's findings are not in line with earlier studies like the one by Giegerich (1985), who demonstrates how the formalism of metrical phonology introduced by Liberman and Prince (1977) can be used for German. He assumes a universal type of quantity-sensitivity for this language. His syllable weight hierarchy is however, divided up into two sets of syllable tem-plates. Word-internal syllables are ordered in the sequence CVVC, CVCC, CVC, CVV > CV, while word-final syllables are claimed to have consonant extrametricality. Thus, the specific hierarchy for those syllables is CVV, CVVC, CVCC > CVC, CV. He furthermore states, that only non-native words can be used for an investigation on stress rules, as these are the only ones, which can consist of more than two syllables within the morphological stem. He even supposes that the rules projecting word stress onto the native vocabulary derive from the ones for the non-native vocabulary. Giegerich (1985) proposes the following principles on the placement of stress: the ultimate syllable is stressed if heavy. If it is light and the penultimate one is heavy, stress will fall on the penultimate syllable. If both final syllables are light, then the prepenultimate one will receive main stress, no matter if it is light or heavy (see also Hayes (1986) and Kaltenbacher (1994)).

Eisenberg (1991) points out that the interaction of prosody and morphology has to be taken into account when analysing the German stress system. He emphasises the fact that a number of derivational and inflectional affixes can either attract or dismiss main stress within a word, regardless of how these affixes are made up internally with respect to syllable weight. Thus,

morphologically complex words should be treated differently than simplex words. Eisenberg furthermore stresses the fact, that syllables can either be stressable or unstressable. He views schwa syllables as the only kind of syllables in German, which are unstressable. He then differentiates stress patterns from patterns of stressability, as he demonstrates that unstressable syllables dismiss main word stress, even if they appear in a position within the word, where they should receive stress by rule.

In Vennemann's (1992) proposal, syllable weight is differentiated in two ways. All closed syllables count as heavy, all open ones are light, resulting in the following picture: CVVC, CVCC, CVC > CVV, CV. Vennemann's account differs in one important aspect from all the others. He explains the vowel length distribution by the so called "syllable cut". In his view, there is no underlying vowel length contrast. Vowels become long or short on the surface depending on the kind of "cut" there is in the current syllable. All closed syllables are "abruptly cut" and thus get a short as well as lax vowel as nucleus. On the other hand, all open syllables are "smoothly cut" and get a long as well as tense vowel. This claim is somewhat problematic in the way, that there definitely are frequent minimal pairs throughout the German lexicon, that clearly do not fit into Vennemann's approach to vowel quantity, as they do have a long tense vowel as well as a coda in the same syllable. Concerning native versus non-native vocabulary Vennermann believes, that the nonnative words reflect the fundamental stress rules in a more efficient way than the native words do, because the non-native part of the lexicon has only gone through a relatively short period of phonological development in diachronic language change yet and is therefore less resistant against the prosodic rule system, that means less exceptional. Vennemann explains that main stress generally falls on the penultima, if it is heavy and the ultima is unstressable. If both final syllables are unstressable, the prepenultimate one will be stressed instead. However, main stress won't appear further left than on the prepenultimate syllable.

In contrast to Wiese's and also Kaltenbacher's (1994) work, Féry (1998) shows that German does differentiate syllable weight. However, the type of quantity-sensitivity she assumes is not compatible to the universal types postulated by Hayes (1995). Féry claims that long vowels are heavier than short vowels, what fits perfectly to the findings by Hayes. However, Féry also suggests that closed syllables with a short vowel are not heavier than open ones with a long vowel. Hence, her syllable weight hierarchy looks like the following: CVVC, CVCC > CVV, CVC, CV > Cə. The role of schwa as a marker for unstressability is emphasised. Féry's

investigation is based on a broad analysis of the German lexicon, thus differing from earlier studies, which mostly use a small set of examples. Finally, she uses Optimality Theory to account for the prediction of stress placement. Her resulting generalisations are that main stress falls on the penultimate syllable if the final one is light. In case of its heaviness the ultima is stressed instead. If in a trisyllabic word the medial syllable contains a schwa, then main stress will fall on the first syllable.

3.1.2   The current work

The present study is based on a parametric framework for stress assignment as it has been introduced in 1.2.4 (see Dresher & Kaye (1990) and Fikkert (1994)). Thus, it is supposed, that word stress relies on a universal set of parameters, that have to be put to specific values to express the prosodic system of a particular language. The following parameters will be used for the analysis.

(1)   a) Foot shape parameters

Headedness:	Feet are strong on the [left/right]
Quantity-sensitivity:	Feet are [quantity-sensitive/-insensitive]
Weight:	Feet are quantity-sensitive to [closed syllable/nucleus/rhyme]
Foot branching:	Feet must be branching [yes/no]
Boundedness:	Feet are [binary/unbounded]

b) Foot construction parameters

Directionality:	Feet are built from the [left/right]
Iterativity:	Feet are built iteratively [yes/no]

c) Word tree dominance parameters

Main stress rule:	The word tree is strong on the [left/right]
Extrametricality:	There is an extrametrical unit [yes/no]
Edge of extremetricality:	The extrametrical unit is on the [left/right]

To derive the values for the parameters in (1) the present study puts its focus mainly onto the stress patterns that can be observed in the German lexicon. This will lead to a typology of syllable combinations and the principles of how word stress is projected onto them. There will

also be a discussion of the shape of the prosodic foot and its influence on processes of prosodic morphology in German. It will be shown, what evidence can be found for the existence of the prosodic foot, as well as will be furthermore explained, what kinds of phonological rules are bound to this unit as a template to operate in.

The centre of the investigation of stress assignment will be monomorphematic nouns and adjectives, because only this part of the German lexicon actually represents rhythmic stress by a rule-driven stress assignment (see Hayes (1995)). Morphologically complex words on the other hand show a different kind of stress assignment, as stress is often fixed to or rejected by derivational and inflectional affixes. As an example, the two nominal suffixes /-ie/ and /-ei/ are always stressed wherever they appear, whereas /-heit/ and /-bar/ remain unstressed. The latter are, however, prosodically "heavier" (CVVC as opposed to VV) and should therefore attract stress (see Eisenberg (1991)).

The word "umfahren" is another famous example to explain the interference of stress assignment by morphology. This item is translated either as "drive around", when it is stressed on the verbal stem, or as "knock down", when the adverbial part receives main stress. Thus, the word appears with two different stress patterns, while in both cases the internal morphological parts "um" and "fahren" are exactly the same. The actual location of stress here depends on the specific kind of derivation. Hence, morphology highly influences stress assignment, so that morphologically complex words have to be claimed to receive morphological stress in this language (see Eisenberg (1991) and Hayes (1995)).

Monomorphematic words in German can have up to five syllables. The vast majority of such "long" words are loans from a wide variety of source languages such as Latin, Greek, English, French, Italian and a lot more, which all have quite different prosodic systems. Native German words on the other hand are mostly "short", that means, their stem morpheme is usually made up of one syllable. Additionally there can be another syllable, which either contains a schwa vowel or is, when analysed diachronically, a static suffix. Only very few native words have a disyllabic stem (see also Giegerich (1985)). It should be furthermore noted, that there are loan words which were morphologically complex in their source languages, but whose parts weren't borrowed as separate morphemes. Although their parts may hence not play a role in the morphological system of the loaning language, they might influence the domain of stress in a noticeable way. Thus, these words may show irregular stress on a basis of their original morphological complexity (see also Eisenberg (1991)).

An example for such a set of words are the terms for grammatical cases like Nominativ or Genitiv. As Vennemann (1992) states, each of them shows main stress on the first syllable no matter how many syllables it consists of and how these syllables are shaped with respect to their prosodic weight. Vennemann calls the stress assignment of these words a "paradigm accent", because each of the first syllables is contrasted to those ones of the other words within this group. Thus, all other syllables in these words reject main stress due to the fact, that the morphological content is the same and hence functions as if it was a derivational suffix (see also Wiese (1996)).

Also excluded from the analysis is a very small number of words, which show compound stress as a result of wrong etymological interpretation leading native-speakers towards the assumption, that these words were made up out of two nominal stems. This group of words consists of Ameise, Eidechse, Herberge, Hängematte and Abenteuer. They then appear to have pseudo-compound stress.

In contrast to the studies by Wurzel (1980) and Giegerich (1985) native and non-native vocabulary will be treated the same way in the following analysis. Names for places or human beings will, however, not be discussed here, as in most cases they show lexical, that is exceptional, stress as a cause of diachronic morphological complexity.

In 3.2 evidence for the existence of the prosodic foot in German will be collected in order to create a basis for the following discussion of the observable stress patterns in the language's lexicon. Thus, processes of segmental as well as suprasegmental phonology will be presented in order to demonstrate the way in which the unit of the prosodic foot is operable in them.

Then, as a second step of the examination, a typology of stress patterns is introduced in 3.3. These stress patterns serve for the discussion of possible stress rules and language specific parameter values in 3.4.

3.2 Evidence for the prosodic foot in German

Within the framework of metrical phonology, word stress is necessarily connected to the unit of the prosodic foot (see Selkirk (1980) and Hayes (1995)). The foot branches down towards a more prominent (strong) and a less prominent (weak) syllable, while at a higher level of the metrical tree structure one foot within a phonological word will receive main stress. The pre-

cise way in which syllables are grouped under feet and feet are grouped under the word is determined by the specific configuration of prosodic parameters. This implies that the main stressed syllable of a word must also be the prominent syllable within one foot of that word. Syllables which are not heads of feet can never get stressed on the word level, as it can be seen in the following arboreal structure. There, the third syllable receives main word stress.

Table 13: Example tree structure of a bipedal phonological word
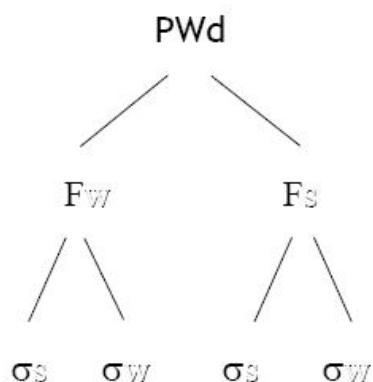
Thus, in order to investigate how word stress is fundamentally assigned, one first has to raise the question whether there is actually a foot as part of the prosodic system and the unit hierarchy of this language. One has thus, to find evidence in the form of phonological processes that can only be explained by the existence of the foot.

The majority of researchers have proposed the German foot to be trochaic, that means being strong on its left syllable (see Giegerich (1985), Grewendorf, Hamm & Sternefeld (1987), Eisenberg (1991), Vennemann (1992), Wiese (1996), Alber (1997) and Féry (1997) and (1998)). Indeed, there are a number of phonological processes occurring in a trochaic disyllabic pattern like schwa deletion (3.2.3), hypochoristic clipping (3.2.4) and schwa epenthesis (3.2.5), along with segmental phenomena such as the tense-lax-contrast in vowels (3.2.1), ambisyllabicity of medial consonants (3.2.2) and the appearance of the schwa vowel (3.2.3). These findings will be presented in the following.

3.2.1   The German vowel inventory

German distinguishes long and short vowels. A large number of minimal pairs clearly illustrates, that quantity is used to define a vowel phoneme. Additionally the quantity contrast is accompanied by a slightly different configuration of the vocal tract. Long vowels are pro-

duced phonetically tense, meaning that the tongue position is more accurate with respect to the aimed place of articulation. Short vowels instead appear to be phonetically lax, that is more centralised (see Anderson (1984) and Ramers (2001)). The complete vowel inventory of German is shown below in separated charts for each vowel set.
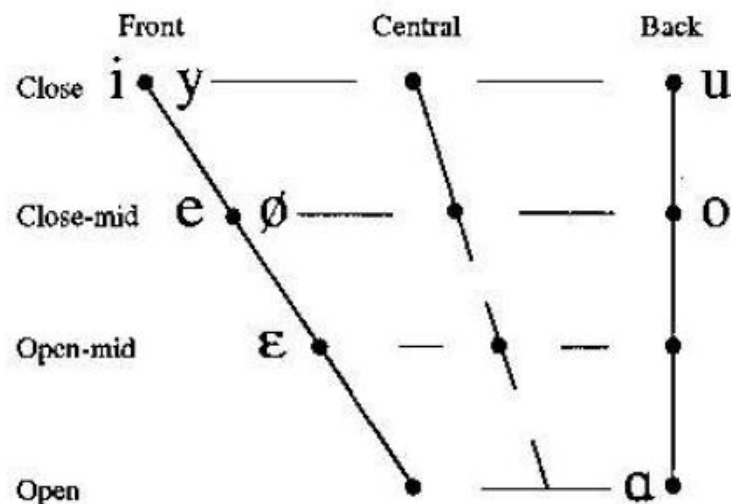
Figure 3: Tense vowel set of German
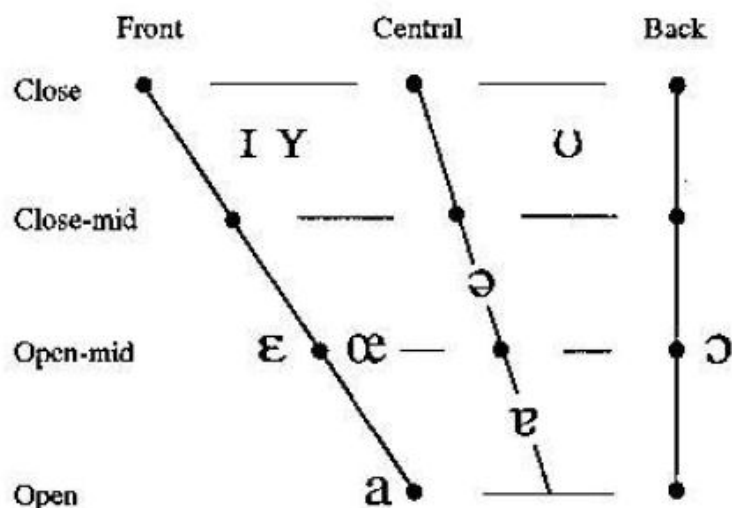
Figure 4: Lax vowel set of German

Amongst the lax vowels are [ɐ], which appears as a result of a vocalization process of the phoneme /r/ when occurring in coda position, and /ə/. Note also that the vowel [ɛ] appears to be long and short and therefore has a tense as well as a lax variant.

It has been discussed in literature, that the tense-lax-opposition not only appears as articulatory feature corresponding to quantity, but is also distinguished in the underlying representation, because one very important observation about the tense vowels can be made. Although they seem to represent phonological length, they need, however, not necessarily be phonetically long on the surface as well (see Kager (1989). In fact, tense vowels show up as long when stressed but short when unstressed. They keep their tense tongue position, even when they are short (see Alber (1997)). Lax vowels on the other hand are always short. Hence, the majority of authors have come to the conclusion, that the two sets of vowels should be viewed as separate sets of phonemes instead of allophones.

Still there is a fundamental contrast in quantity in the two sets of vowels. Tense vowels can occur phonetically long as well as short, while lax vowels never appear as phonetically long. Hence, tense vowels are supposed to be underlyingly long, while lax ones are short (see Wiese (1988), Giegerich (1992), Ramers (1992) and (2001), Féry (1995) and (1998) and Alber (1997)). This finding furthermore leads to the conclusion that tense vowels indicate by their quantity on the surface, whether they stand in a head of a foot or not.

3.2.2 Ambisyllabicity

The term "ambisyllabicity" refers to the fact that an open syllable is closed by the onset of the syllable immediately following. This results in a consonant, which at the same time functions as onset as well as coda. Researchers such as Ramers (1992), Giegerich (1986) and (1992), Vennemann (1992) and Féry (1998) have claimed ambisyllabicity to occur for medial consonants in German, if the syllable to their left is open, the left edge of a foot and its nucleus is filled with an underlying lax vowel. What is hence essential for the existence of the prosodic foot in German is that ambisyllabic consonants can only appear in foot-medial position.

Ramers (1992) argues, that there are slips of the tongue uttered by German native speakers, that exchange consonants of onset as well as coda position with consonants in medial position, where ambisyllabicity is claimed to be operative. This leads to the point, that medial consonants seem to be treated psycholinguistically as if they were placed in coda as well as onset position. In fact, other researchers including Cutler, Mehler, Norris and Segui (1986) as well as Zwitserlood, Schriefers, Lahiri and van Donselaar (1993) have proven the existence of ambisyllabic consonants in English and Dutch by a number of psycholinguistic experiments.

The present study is in line with the point of view, that ambisyllabicity is part of the underlying representations of the German vocabulary. This argumentation is also supposed by Vennemann (1992), who suggests that ambisyllabicity has not to be understood as a synchronic rule of word prosody in German as well as in English or Dutch. Instead it should be explained diachronically for all the Western Germanic languages as a relict of a process of gemination as well as a shift of the syllable peak. As Braune and Eggers (1987) explain, the syllable accent in early Germanic was on the whole rhyme. Thus, medial consonants in disyllabics belonged to the first syllable and not to the second one, as it is the case in the modern Germanic languages. The syllable accent was then shifted towards the nucleus, however, as a result of the changing stress type from the Indo-European tonal accent to the later Germanic dynamic accent. Ambisyllabicity is hence a relict of the fact that a medial consonant had once belonged to the syllable on its left. Furthermore, especially in Old High German, an additional gemination took place after short vowels in the left edge of a foot as part of the Second Consonant Shift (see Krahe & Meid (1985) and Schweikle (1986)). Some dialects of German, especially the ones spoken in Austria and Switzerland, have maintained these geminates up to the present day, while Standard German changed them to ambisyllabic single consonants.

3.2.3   Schwa distribution

A crucial characteristic of the phonotactics of German is that the central vowel schwa is restricted to particular positions within the phonological word. Unlike other languages, for example Dutch, where a schwa can be the only vowel in stem morphemes, German schwas are bound to unstressed syllables. Thus, one can conclude that a schwa only shows up in the right edge of the prosodic foot (see Wiese (1986), Eisenberg (1991), Féry (1998) and Penner, Krügel, Gross & Hesse (2006)).

Furthermore, there are some phonological processes, that are connected to the vowel schwa and therefore supposedly to the right edge of a foot. For example, schwa will be deleted on the surface, if it is followed by a sonorant within the same syllable. This, however, only happens within word final syllables. As a result, the remaining sonorant becomes [+syllabic] and thus the nucleus of the syllable. If it's /n/ it will be assimilated in place of articulation to the onset of the syllable (see Wiese (1986)). These processes can be formulated as follows:

Table 14: Phonological processes related to schwa

Schwa deletion	/ə/ -> Ø / __ [+sonorant] #		
Syllabification	[+sonorant] -> [+syllabic] / [+consonantal] __ #		
Assimilation of /n/	/n/ -> [α anterior] [β coronal] / [χ back]	[α anterior] [β coronal] [χ back]	__ #

It can be concluded from these processes, that syllabic sonorants only occur under weak nodes of prosodic feet.

3.2.4   Clipping

German provides a mechanism to form hypochoristic words or nicknames, which I will refer to as "clipping". This process can be understood as a rule of prosodic morphology (see Mac-Carthy & Prince (1986)). It is most frequently addressed to names but can also be operative in other nouns and even adjectives or verbs in order to simplify them (Féry (1997)). From a pro-sodic point of view, this process works as follows: the segmental material of the input form is connected to a disyllabic trochaic template, where the nucleus of the second syllable is by default filled with /i/ or alternatively with /ə/. This means that input forms with more than two syllables will be truncated, hence the term clipping.

The process can however, function in two different ways. The so called "left edge clipping" assigns the disyllabic output template to the first syllable of the input form. This results in a stress shift, whenever the input form does not show initial stress. In contrast the "main stress clipping" takes the main stressed syllable as the starting point for the projection of the tem-plate (Fischer (1996)). Thus, the main stressed syllables are always kept in the output form. In the following I will provide some examples for both types.

(2) Left edge clipping:

Constantin	[ˈkʰɔnsdanˌtʰin]	->	Coni	[ˈkʰɔni]
Susanne	[ˌzuˈzanə]	->	Susi	[ˈzuːzi]
Andreas	[ˌʔanˈdʁeːas]	->	Andi	[ˈandi]
Elisabeth	[ʔɛˈliːzaˌbɛtʰ]	->	Elli	[ˈʔɛli]

(3) Main stress clipping

| Ramona | [ˌʁaˈmoːnɑ] | -> | Moni | [ˈmoːni] |
| Charlotte | [ˌʃaɐ̯ˈlɔtʰə] | -> | Lotti | [ˈlɔtʰi] |

It is striking that the output forms produced by both versions of the clipping process are always the same shape, namely a disyllabic trochee, while the corresponding input forms can be different not only with respect to the number of syllables but also to the location of main stress. Féry (1997) hence states that "the result of the derivation must be a syllabic trochee." (p. 461) Obviously, clipping is a stress-sensitive process, which produces a specified output stress pattern. The fact that this pattern is trochaic can be seen as a strong cue towards the assumption, that this kind of stress pattern is actually operative within the phonological system of German. As there is no process within prosodic morphology in German which produces an iambic output, it can hence, be concluded, that the prosodic foot is trochaic.

3.2.5   Schwa epenthesis

In some dialects of German, especially the slang spoken in Berlin, there can be found a rule of a schwa epenthesis. It inserts a schwa vowel at the end of a word, which either is monosyllabic or disyllabic and of a non-trochaic shape on the surface. Some examples are given below.

(4)

| Det [dɪtʰ] this | -> | dette [ˈdɪtʰə] |
| Musik [muˈziːkʰ] Music | -> | Musike [ˌmuˈziːkʰə] |

What this rule actually does, is to transform non-trochaic patterns into trochaic ones. The epenthesis, however, neither appears in cases, where the input form already is trochaic, nor does it insert a schwa to the left of a non-trochaic pattern in order to build an iamb. This points to the fact that this rule is not only sensitive to the stress pattern of the input form, but also serves to produce output forms of a very special, that is the trochaic, stress pattern. Hence, one can conclude that the trochee appears as the default foot shape in German and has therefore to be viewed as underlying.

3.3   German stress patterns

As the second part of the current analysis I will present examples for stress assignment in German monomorphematic words. The aim of this presentation is to provide all observable combinations of syllable types in conjunction with their actual stress patterns, to be compared to each other in the discussion and to find evidence for the underlying stress rules of the language.

The listings include IPA surface transcripts with diacritics for primary and secondary stress, ambisyllabicity, vowel length, aspiration and syllabicity in sonorants as well as a CV template of the underlying representation for each example. In the latter ambisyllabic consonants will be underlined. The words are sorted according in first place to the location of main stress (1st, 2nd, 3rd syllable and so on) as well as in second place to the internal make up of their syllables, which appear in the following sequence: CV, CVC (ambisyllabic, where C is serving as coda), CVV, CVC, CVVC and CVCC.

3.3.1   Examples of disyllabic words

Within this group of words we find a large number of trochaic forms. The vast majority of them carry a schwa in the second syllable, but there are also numerous forms with either a full vowel or a more complex rhymal structure.

(5) Type **CVC** + CV

Tasse	[ˈtʰasə]	CVCV	cup
Kasse	[ˈkʰasə]	CVCV	till
Mitte	[ˈmɪtʰə]	CVCV	middle
Decke	[ˈdɛkʰə]	CVCV	lid
Hecke	[ˈhɛkʰə]	CVCV	hedge
Kappe	[ˈkʰapʰə]	CVCV	cap

These words have a CV-syllable in the beginning, which is closed by an ambisyllabic consonant. The second syllable does also have a short vowel in nucleus position. Words of this kind are quiet numerous. A few more examples are: Kanne, Watte, Wanne, Bitte, Elle, Welle, Kelle,

Motte, Ecke, Pappe, Hacke, Schnecke, Masse, Klasse, Trasse, Rinne, Spinne, Rolle, Mücke, Klemme, Ebbe, Stimme. There are many more.

(6) Type **CV<u>C</u>** + <u>C</u>VV

Kaffee	[ˈkʰafe̝]	CV<u>C</u>VV	cofe
Lasso	[ˈlaso̝]	CV<u>C</u>VV	lasso
Villa	[ˈvɪlɑ]	CV<u>C</u>VV	villa
Echo	[ˈʔɛço]	V<u>C</u>VV	echo
Komma	[ˈkʰɔmɑ]	CV<u>C</u>VV	comma
Sakko	[ˈzakʰo̝]	CV<u>C</u>VV	lounge jacket

Words of this shape are numerous because a specific process of prosodic morphology in German can produce such output forms, namely clipping as it is described under 2.2.4.

(7) Type **CV<u>C</u>** + <u>C</u>VC

Futter	[ˈfʊtʰɐ]	CV<u>C</u>VC	fodder
Himmel	[ˈhɪml̩]	CV<u>C</u>VC	sky
Wasser	[ˈvasɐ̝]	CV<u>C</u>VC	water
Natter	[ˈnatʰɐ]	CV<u>C</u>VC	adder
Schoppen	[ˈʃɔpʰm̩]	CV<u>C</u>VC	half a pint
Brocken	[ˈbʁɔkʰŋ̩]	CCV<u>C</u>VC	scrap

Words in this category have a first syllable with an ambisyllabic coda and a second syllable, which is closed. There are a lot more forms of this kind like Schuppen, Paddel, Butter, Rassel, Sessel, Kessel, lecker, bitter. Most of these words have a schwa in the second syllable, which is deleted on the surface, but there are also a few words with a different lax vowel in that syllable, which I will list below.

Pudding	[ˈpʰʊdɪŋ]	CVC̱VC	blancmange
Kuckuck	[ˈkʰʊkʰʊkʰ]	CVC̱VC	cuckoo
Rettich	[ˈʀɛtʰɪç]	CVC̱VC	radish
Messing	[ˈmɛsɪŋ]	CVC̱VC	brass
Teppich	[ˈtʰɛpʰɪç]	CVC̱VC	carpet
Mammut	[ˈmamʊtʰ]	CVC̱VC	mammoth

There are only a few more words of this kind, namely Sittich, Bottich, Fittich, Essig and Amok.

(8) Type **CVV** + CV

Schale	[ˈʃɑːlə]	CVV.CV	peel
Kehle	[ˈkʰeːlə]	CVV.CV	throat
Kohle	[ˈkʰoːlə]	CVV.CV	coal
Traube	[ˈtʰʀaʊbə]	CCVV.CV	grape
Eiche	[ˈʔaɪçə]	VV.CV	oak
Trage	[ˈtʰʀɑːgə]	CCVV.CV	hand cart

These words start with an open syllable of the shape CVV. The second syllable has a short vowel instead. More words of this kind are: Soße, Nase, Ähre, Röhre, Taube, Scheibe, Eibe, Eile, Weile, Wiese, Riese, Bohne, Blüte, Auge, Haube, Sohle, Ruhe, Buche, Stube, Wabe, Bühne, Biene, leise, böse, müde, spröde.

(9) Type **CVV** + CVV

Auto	[ˈʔaʊtʰo]	VV.CVV	car
Trauma	[ˈtʰʀaʊma]	CCVV.CVV	trauma
Lama	[ˈlɑːma]	CVV.CVV	llama
Kino	[ˈkʰiːno]	CVV.CVV	cinema
Cobra	[ˈkʰoːbʀa]	CVV.CCVV	cobra
Rheuma	[ˈʀɔɪma]	CVV.CVV	rheumatism

Like the words in (7), these words are numerous. They have an open CVV-syllable with main stress in the beginning, which is followed by another syllable of the same internal structure. This shape is also an output of clipping (see under 2.2.4). Other examples (non-clipped forms) are: Zebra, Puma, Khoma, Soda, Soja, Klima, Aula, Aura, Efeu.

(10) Type **CVV** + CVC

Haken	[ˈhɑːkʰn̩]	CVV.CVC	hook
Regen	[ˈʁeːgn̩]	CVV.CVC	rain
Segel	[ˈzeːgl̩]	CVV.CVC	sail
Vogel	[ˈfoːgl̩]	CVV.CVC	bird
Bruder	[ˈbʁuːdɐ]	CCVV.CVC	brother
Moder	[ˈmoːdɐ]	CVV.CVC	mould

These are words with an open and a following closed syllable with a short vowel, showing initial stress. More examples are: Kugel, Siegel, Spiegel, Kegel, Haken, Laken, Segen, Makel, Hagel, Boden, Fohlen, Reigen, Haufen, Schauder, Zauber, heiter, lauter, heiser and lots more. Like the word type in (7) these forms mostly have a schwa in the second syllable. Words with a different lax vowel are the following.

Slalom	[ˈslɑːlɔm]	CCVV.CVC	slalom
König	[ˈkʰøːnɪç]	CVV.CVC	king
Status	[ˈʃtɑːtʰʊs]	CCVV.CVC	state
Hering	[ˈheːʁɪŋ]	CVV.CVC	herring
Krokus	[ˈkʰʁoːkʰʊs]	CCVV.CVC	crocus
Käfig	[ˈkʰɛːfɪç]	CVV.CVC	cage

There are a few more examples of this kind, like Pathos, Radon, Bison, Panik, Sirup, Kanon, Fazit, Kranich, Honig, Gulasch.

(11) Type **CVV** + CVVC

Platin	[ˈpʰlaːtʰin]	CCVV.CVVC	platinum
Demut	[ˈdeːmutʰ]	CVV.CVVC	humility
Fakir	[ˈfaːkʰiɐ]	CVV.CVVC	fakir
Monat	[ˈmoːnɑtʰ]	CVV.CVVC	month

(12) Type **CVV** + CVCC

Abend	[ˈʔaːbəntʰ]	VV.CVCC	evening
Kobalt	[ˈkʰoːbaltʰ]	CVV.CVCC	cobalt
Wisent	[ˈviːzɛntʰ]	CVV.CVCC	bison
Elend	[ˈʔeːlɛntʰ]	VV.CVCC	misery
Joghurt	[ˈjoːgʊɐtʰ]	CVV.CVCC	yoghourt
Napalm	[ˈnɑːpʰalm]	CVV.CVCC	napalm

The words in this category share an open first syllable with a long vowel and a final one with a short vowel as well as two closing consonants. There are a few more items of this kind, like Habicht, Herold, Ahorn or Kobold.

(13) Type **CVC** + CV

Ende	[ˈʔɛndə]	VC.CV	end
Espe	[ˈʔɛspʰə]	VC.CV	asp
Wolke	[ˈvɔlkʰə]	CVC.CV	cloud
Linde	[ˈlɪndə]	CVC.CV	lime-tree
Liste	[ˈlɪstʰə]	CVC.CV	list
Kiste	[ˈkʰɪstʰə]	CVC.CV	box

The words in (13) have a closed syllable in first place and a CV one in the end. The first syllable recieves main stress. These words are numerous, too. Some more of them are the following: Kante, Lunte, Tinte, Torte, Karte, Sünde, Paste, Wespe, Winde, Rinde, Molke, Tulpe, Ranke, sachte.

(14) Type **CVC** + CVV

Tempo	[ˈtʰɛmpʰo]	CVC.CVV	tempo
Mensa	[ˈmɛnza]	CVC.CVV	cafeteria
Kombi	[ˈkʰɔmbi]	CVC.CVV	estate car
Konto	[ˈkʰɔntʰo]	CVC.CVV	account
Tundra	[ˈtʰʊndʁa]	CVC.CCVV	tundra

Although there are not many words of the type in (14), a large number of clipping forms appears with this stress pattern.

(15) Type **CVC** + CVC

Balken	[ˈbalkʰŋ]	CVC.CVC	rafter
Falter	[ˈfaltʰɐ]	CVC.CVC	butterfly
Kordel	[ˈkʰɔɐdl]	CVC.CVC	string
Mistel	[ˈmɪstʰl]	CVC.CVC	mistletoe
Wunder	[ˈvʊndɐ]	CVC.CVC	miracle
Mandel	[ˈmandl]	CVC.CVC	almond

These words consist of two closed syllables. They are less numerous than all types listed so far. Some more examples are Zunder, Windel, Spindel, Klafter, munter. Like in (7) and (10) I will list examples with a different vowel than schwa in the second syllable seperately.

Kaktus	[ˈkʰakʰtʰʊs]	CVC.CVC	cactus
Argon	[ˈʔaɐgɔn]	VC.CVC	argon
Picknick	[ˈpʰɪkʰnɪkʰ]	CVC.CVC	picnic
Tandem	[ˈtʰandɛm]	CVC.CVC	tandem
Rhythmus	[ˈʁʏtʰmʊs]	CVC.CVC	rhythm
Album	[ˈʔalbʊm]	VC.CVC	album

Other examples are: Iltis, Taktik, Sperling, Scharlach, Zirkus, Mustang, Kürbis, Atlas, Herpes, Kompaß, Scharlach, Pfirsich, Amboss, Imbiss, Marschall, Harnisch.

(16) Type **CVC** + CVVC

Sultan	[ˈzʊltʰɑn]	CVC.CVVC	sultan
Herzog	[ˈhɛɐ̯tsokʰ]	CVC.CVVC	duke
Nektar	[ˈnɛkʰ.tʰɑɐ̯]	CVC.CVVC	nectar
Turban	[ˈtʰʊɐ̯ban]	CVC.CVVC	turban
Balsam	[ˈbalzɑm]	CVC.CVVC	balsam
Arbeit	[ˈʔaɐ̯baɪtʰ]	VC.CVVC	work

A number of disyllabics show main stress on the last syllable. These are shaped in the following ways.

(17) Type CV + **CVV**

Büro	[byˈʁoː]	CV.CVV	office
Depot	[deˈpʰo]	CV.CVV	depot
Café	[kʰaˈfeː]	CV.CVV	café
Allee	[ʔaˈleː]	V.CVV	avenue
Trikot	[tʰʁɪˈkʰoː]	CCV.CVV	tricot
Niveau	[nɪˈvoː]	CV.CVV	level

Words of this type have a short vowel in the first and a long vowel in the second syllable. There are other examples, like Idee or Milieu, but the vast majority of them are of French origin.

(18) Type CV + **CVC**

Sonett	[zoˈnɛtʰ]	CV.CVC	sonnet
Skelett	[skʰeˈlɛtʰ]	CCV.CVC	skeleton
Hotel	[hɔˈtʰɛl]	CV.CVC	hotel
Metall	[mɛˈtʰal]	CV.CVC	metal
Tablett	[tʰaˈblɛtʰ]	CV.CCVC	tray
Schafott	[ʃaˈfɔtʰ]	CV.CVC	scaffold

The words in (15) are built with a CV-syllable in first position plus a closed one with a single coda in second place. Some more examples are Brikett, Fagott, Krawall, Koloss, Atoll, Tyrann, Barock, Vasall, Katarrh, Idyll, adrett and kaputt.

(19) Type CV + **CVVC**

Salat	[zaˈlaːtʰ]	CV.CVVC	salad
Klavier	[kʰlaˈviːɐ]	CCV.CVVC	piano
Kanal	[kʰaˈnaːl]	CV.CVVC	channel
Kamin	[kʰaˈmiːn]	CV.CVVC	fire place
Kamel	[kʰaˈmeːl]	CV.CVVC	camel
Atom	[ʔaˈtʰoːm]	V.CVVC	atom

Words of this shape consist of a CV and a CVVC syllable. Other words of this type are: Spinat, Spagat, Varan, Signal, Labor, Pirat, Pokal, Elan, Regal, Tarif, Juwel, Idol, Problem, Figur, Moral, Paket, Komet, Schakal, Likör, Granit, Quadrat, Despot, Profit, Basar, Baron, immun, banal.

(20) Type CV + **CVCC**

Palast	[pʰaˈlastʰ]	CV.CVCC	palace
Gigant	[gɪˈgantʰ]	CV.CVCC	giant
Ballast	[baˈlastʰ]	CV.CVCC	ballast
Tumult	[tʰʊˈmʊltʰ]	CV.CVCC	riot
Trabant	[tʰʁaˈbantʰ]	CV.CVCC	satellite

(21) Type CVV + **CVVC**

Eunuch	[ʔɔɪˈnuːx]	VV.CVVC	eunuch

(22) Type CVC + **CVC**

Kartell	[kʰaɐˈtʰɛl]	CVC.CVC	cartel
Parkett	[pʰaɐˈkʰɛtʰ]	CVC.CVC	parquet
Skalpell	[skʰalˈpʰɛl]	CCVC.CVC	scalpel
Kompott	[kʰɔmˈpʰɔtʰ]	CVC.CVC	stewed fruit
Komplott	[kʰɔmˈpʰlɔtʰ]	CVC.CCVC	conspiracy
Bankett	[baŋˈkʰɛtʰ]	CVC.CVC	banquet

These words have exactly the same CV-template like the ones in (15). However, they are stressed on the last syllable. More examples are Rondell and Bankrott.

(23) Type CVC + **CVVC**

Balkon	[balˈkʰɔn]	CVC.CVVC	balcony
Arsen	[ʔaɐˈzen]	VC.CVVC	arsenic
Ventil	[vɛnˈtʰiːl]	CVC.CVVC	valve
Vulkan	[vʊlˈkʰaːn]	CVC.CVVC	vulcano
Kalkül	[kʰalˈkʰyːl]	CVC.CVVC	calculation
Portal	[pʰɔɐˈtʰaːl]	CVC.CVVC	portal

These words have a closed syllable with a short vowel in the beginning, followed by a CVVC one, which receives main stress. Other words of this type are: Diktat, Skandal, Benzin, Parfüm, Karbon, Bandit, Phantom, Orkan, Reptil, Person, Altar, Scharnier, Emblem, Archiv, Aspik, Vampir, Skorpion, Kumpan.

(24) Type CVC + **CVCC**

Asphalt	[ʔasˈfaltʰ]	VC.CVCC	asphalt
Impuls	[ʔɪmˈpʰʊls]	VC.CVCC	impuls
Kompost	[kʰɔmˈpʰɔstʰ]	CVC.CVCC	compost

3.3.2 Examples of trisyllabic words

A number of words with three syllables have primary stress. They are, however, not numerous.

(25) Type **CV<u>C</u>** + <u>C</u>V + CVV

Paprika	[ˈpʰapˈʁɪˌkʰɑ]	CV<u>C</u>CV.CVV	paprika
Sellerie	[ˈzɛlɐˌʁi]	CV<u>C</u>V.CVV	celery
Matinee	[ˈmatʰˌɪne]	CV<u>C</u>V.CVV	matinée

(26) Type **CV<u>C</u>** + <u>C</u>V + CVC

Ananas	[ˈʔanaˌnas]	V<u>C</u>V.CVC	pine-apple
Syphilis	[ˈzʏfɪˌlɪs]	CV<u>C</u>V.CVC	syphilis
Tacheles	[ˈtʰaxəˌlɛs]	CV<u>C</u>V.CVC	
Bariton	[ˈbaʁɪˌtʰɔn]	CV<u>C</u>V.CVC	baritone
Marathon	[ˈmaʁaˌtʰɔn]	CV<u>C</u>V.CVC	marathon
Ischias	[ˈʔɪʃɪˌjas]	V<u>C</u>V.VC	

(27) Type **CV<u>C</u>** + <u>C</u>V + CVVC

Telefon	[ˈtʰɛləˌfon]	CV<u>C</u>V.CVVC	telefone
Dromedar	[ˈdʁɔməˌdaɐ]	CV<u>C</u>V.CVVC	dromedary
Januar	[ˈjanʊˌaɐ]	CV<u>C</u>V.VVC	january

(28) Type **CV<u>C</u>** + <u>C</u>VC + CVVC

| Attentat | [ˈʔatˌʔənˌtʰotʰ] | V<u>C</u>VC.CVVC | assassination |

(29) Type **CVV** + CV + CVV

Domino	[ˈdoːmɪˌno]	CVV.CV.CVV	domino
Risiko	[ˈʁiːzɪˌkʰo]	CVV.CV.CVV	risk
Kolibri	[ˈkʰoːliˌbʁi]	CVV.CV.CCVV	humming-bird
Alibi	[ˈʔaːliˌbiː]	VV.CV.CVV	alibi
Cholera	[ˈkʰoːleˌʁa]	CVV.CV.CVV	cholera
Gigolo	[ˈdʒiːɡɔˌlo]	CVV.CV.CVV	gigolo

(30) Type **CVV** + CV + CVC

| Karies | [ˈkʰaːʁiˌɛs] | CVV.CV.VC | caries |
| Bumerang | [ˈbuːmeˌʁaŋ] | CVV.CV.CVC | boomerang |

(31) Type **CVV** + CV + CVVC

Pelikan	[ˈpʰeːliˌkʰan]	CVV.CV.CVVC	pelican
Thymian	[ˈtʰyːmiˌan]	CVV.CV.VVC	thyme
Jaguar	[ˈjaːɡʊˌaɐ]	CVV.CV.VVC	jaguar

(32) Type **CVC** + CV + CVV

Tombola	[ˈtʰɔmbɔˌla]	CVC.CV.CVV	raffle
Eskimo	[ˈʔɛsˌkʰɪˌmo]	VC.CV.CVV	Eskimo
Bungalow	[ˈbʊŋɡaˌlo]	CVC.CV.CVV	bungalow
Embryo	[ˈʔɛmˌbʁɪo]	VC.CCV.CV	embryo
Chembalo	[ˈtʃɛmbaˌlo]	CVC.CV.CVV	chembalo

(33) Type **CVC** + CV + CVC

| Nachtigall | [ˈnaxtʰɪˌɡal] | CVC.CV.CVC | nightingale |
| Karneval | [ˈkʰaɐnəˌval] | CVC.CV.CVC | carnival |

(34) Type **CVC** + CV + CVVC

Kormoran	[ˈkʰɔɐ̯moˌʁɑn]	CVC.CV.CVVC	cormorant
Pinguin	[ˈpʰɪŋɡʊˌin]	CVC.CV.VVC	penguin
Alkohol	[ˈʔalkʰɔˌhol]	VC.CV.CVVC	alcohol
Harlekin	[ˈhaɐ̯ləˌkʰin]	CVC.CV.CVVC	harlequin

The following words show main stress on their second syllable. These outnumber the ones with primary stress by far.

(35) Type CV + **CV<u>C</u>** + <u>C</u>V

Tablette	[ˌtʰaˈblɛtʰə]	CV.CCV<u>C</u>V	tablet
Gitarre	[ˌɡɪˈtʰaʁə]	CV.CV<u>C</u>V	guitar
Stafette	[ˌʃtaˈfɛtʰə]	CCV.CV<u>C</u>V	courier
Karotte	[ˌkʰaˈʁɔtʰə]	CV.CV<u>C</u>V	carrot
Gazelle	[ˌɡaˈtsɛlə]	CV.CV<u>C</u>V	gazelle
Forelle	[ˌfoˈʁɛlə]	CV.CV<u>C</u>V	trout

The words of this kind are numerous. They have three syllables with short vowels. The second one is stressed and closed by ambisyllabicity. More examples are the following: Koralle, Gazette, Giraffe, Karaffe, Bazille, Eklipse, Krawatte, Libelle, Debatte, Cassette, Pipette, Attacke, Atrappe, Pupille, Krokette, Baracke, Epoche, Karosse, Finesse, Matratze, Kapelle, Matritze, Fregatte, Plakette, Lakritze, Sawanne, Kamille, Idylle, Lamelle, Limette, Schabracke, Grimasse, Morelle, Etappe.

(36) Type CV + **CV<u>C</u>** + <u>C</u>VV

Lametta	[ˌlaˈmɛtʰa]	CV.CV<u>C</u>VV	tinsel
Spaghetti	[ˌʃpaˈɡɛtʰi]	CCV.CV<u>C</u>VV	spaghetti
Gorilla	[ˌɡoˈʁɪla]	CV.CV<u>C</u>VV	gorilla
Dilemma	[ˌdɪˈlɛma]	CV.CV<u>C</u>VV	dilemma
Regatta	[ˌʁɛˈɡatʰa]	CV.CV<u>C</u>VV	regatta

(37) Type CV + **CV<u>C</u>** + <u>C</u>VC

Schlamassel	[ˌʃlaˈmasl̩]	CCV.CV<u>C</u>VC	mess
Falafel	[ˌfaˈlafl̩]	CV.CV<u>C</u>VC	falafel
Kapitel	[kʰaˈpʰɪtʰl̩]	CV.CV<u>C</u>VC	chapter

(38) Type CV + **CVV** + CV

Tapete	[ˌtʰaˈpʰeːtʰə]	CV.CVV.CV	wallpaper
Kajüte	[ˌkʰaˈjyːtʰə]	CV.CVV.CV	cabin
Banane	[ˌbaˈnɑːnə]	CV.CVV.CV	banana
Minute	[ˌmiˈnuːtʰə]	CV.CVV.CV	minute
Tomate	[ˌtʰɔˈmɑːtʰə]	CV.CVV.CV	tomato
Zitrone	[ˌʦɪˈtʰʁoːnə]	CV.CCVV.CV	lemmon

This type contains lots of examples, like Machete, Granate, Trophäe, Patrone, Sonate, Spirale, Kapuze, Ballade, Kanone, Posaune, Rakete, Banause, Maschine, Schikane, Rosine, Amöbe, Kojote, Hyäne, Methode, Misere, Mimose, Querele, Affäre, Migräne, Reklame, Allüre, Olive, Parole, Muräne, Rabauke, Fassade, Brigade, Vitrine, Melone, Lawine, Latrine, Ruine, Lagune and marode. They have a CV-syllable in first position followed by an open one with a long vowel and another CV-syllable. Main stress falls onto the second syllable.

(39) Type CV + **CVV** + CVV

Mikado	[ˌmɪˈkʰɑːdo]	CV.CVV.CVV	micado
Aroma	[ˌʔaˈʁoːmɑ]	V.CVV.CVV	fragrance
Bikini	[ˌbɪˈkʰiːni]	CV.CVV.CVV	bicini
Salami	[ˌzaˈlɑːmi]	CV.CVV.CVV	salami
Kasino	[ˌkʰaˈziːno]	CV.CVV.CVV	casino
Paroli	[ˌpʰaˈʁoːli]	CV.CVV.CVV	to defy

Words like these end in two CVV-syllables with main stress on the penultimate one. There are, however, not many more known examples, only Safari.

(40) Type CV + **CVV** + CVC

Hiatus	[ˌhiˈɑːtʰʊs]	CV.VV.CVC	hiatus
Botanik	[ˌbɔtˈʔɑːnɪkʰ]	CV.CVV.CVC	botany
Keramik	[ˌkʰɛˈʁɑːmɪkʰ]	CV.CVV.CVC	pottery
Debakel	[ˌdɛˈbɑːkʰl]	CV.CVV.CVC	debacle
Pullover	[ˌpʰʊˈloːvɐ]	CV.CVV.CVC	sweater
Parabel	[ˌpʰaˈʁɑːbl]	CV.CVV.CVC	parabola

In these words the medial syllable receives main stress. It is open and has a long vowel as nucleus. The first syllable is light, while the final one has a short vowel and a consonant in coda position. There are only a few more examples, like Orakel or penibel.

(41) Type CV + **CVC** + CV

Sekunde	[ˌzɛˈkʰʊndə]	CV.CVC.CV	second
Orange	[ˌʔɔˈʁaŋʒə]	V.CVC.CV	orange
Medallie	[ˌmɛˈdaljə]	CV.CVC.CV	medal
Spelunke	[ˌʃpɛˈlʊŋkʰə]	CCV.CVC.CV	dive
Halunke	[haˈlʊŋkʰə]	CV.CVC.CV	scoundrel

(42) Type CV + **CVC** + CVV

Komando	[ˌkʰɔˈmando]	CV.CVC.CVV	command
Agenda	[ˌʔaˈgɛndɑ]	V.CVC.CVV	agenda
Veranda	[ˌvɛˈʁandɑ]	CV.CVC.CVV	veranda
Flamingo	[ˌflaˈmɪŋgo]	CCV.CVC.CVV	flamingo
Marimba	[ˌmaˈʁɪmbɑ]	CV.CVC.CVV	marimba
Fiasko	[fɪˈjaskʰo]	CCV.CVC.CVV	fiasco

(43) Type CV + **CVC** + CVC

Kanister	[ˌkʰaˈnɪstʰɐ]	CV.CVC.CVC	container
Rhabarber	[ˌʁaˈbaɐbɐ]	CV.CVC.CVC	rhubarb
Kalender	[ˌkʰaˈlɛndɐ]	CV.CVC.CVC	calendar
Lavendel	[ˌlaˈvɛndl̩]	CV.CVC.CVC	lavender
Minuskel	[ˌmɪˈnʊskʰl̩]	CV.CVC.CVC	minuscule
Hibiskus	[ˌhɪˈbɪskʰʊs]	CV.CVC.CVC	hibiscus

Words of this type have an initial open syllable with a short vowel followed by two closed syllables with the same vowel quantity. The second syllable receives main stress. Other examples are: Zylinder, November, Holunder, Revolver, Meniskus, Polunder, Wacholder.

(44) Type CVV + **CVC** + CV

| Toilette | [ˌtʰɔɪˈlɛtʰə] | CVC.CVCV | toilet |
| Haubitze | [ˌhaʊˈbɪtsə] | CVC.CVCV | howitzer |

(45) Type CVC + **CVC** + CV

Antenne	[ˌʔanˈtʰɛnə]	VC.CVCV	aerial
Serviette	[ˌzɛɐˈvjɛtʰə]	CVC.CCVCV	napkin
Manschette	[ˌmanˈʃɛtʰə]	CVC.CVCV	cuffs
Hornisse	[hɔɐˈnɪsə]	CVC.CVCV	hornet
Pinzette	[ˌpʰɪnˈtsɛtʰə]	CVC.CVCV	tweezers
Kandare	[ˌkʰanˈdaʁə]	CVC.CVCV	curb

Words of this kind begin in a closed syllable with a short vowel, which is then followed by a syllable with another short vowel and an ambisyllabic consonant. The final syllable is light. One more example is Narzisse.

(46) Type CVC + **CVC** + CVV

| Konfetti | [ˌkʰɔnˈfɛtʰi] | CVC.CVCVV | confetti |

(47) Type CVC + **CV<u>C</u>** + <u>C</u>VC

Kartoffel	[ˌkʰaɛˈtʰɔfl̩]	CVC.CV<u>C</u>VC	potato
Scharmützel	[ˌʃaɛˈmʏʦl̩]	CVC.CV<u>C</u>VC	skirmish
Pantoffel	[ˌpʰanˈtʰɔfl̩]	CVC.CV<u>C</u>VC	slipper

(48) Type CVC + **CVV** + CV

Trompete	[ˌtʰʁɔmˈpʰeːtʰə]	CVC.CVV.CV	trumpet
Sandale	[ˌzanˈdɑːlə]	CVC.CVV.CV	sandal
Kombüse	[kʰɔmˈbyːzə]	CVC.CVV.CV	caboose
Pistole	[ˌpʰɪsˈtʰoːlə]	CVC.CVV.CV	pistol
Argave	[ˌʔaɛˈgɑːvə]	VC.CVV.CV	
Fontäne	[fɔnˈtʰɛːnə]	CVC.CVV.CV	fountain

In these words the first syllable is closed and has a short vowel as nucleus, while the second one is open and contains a long vowel. It receives main stress. Other examples include: Alraune, Turbine, Gardine, Sardine, Garnele, Oktave, Narkose, Randale.

(49) Type CVC + **CVV** + CVV

Angina	[ˌʔaŋˈgiːnɑ]	VC.CVV.CVV	angina
Torpedo	[tʰɔɛˈpʰeːdo]	CVC.CVV.CVV	torpedo
Armada	[ˌʔaɛˈmɑːdɑ]	CV.CVV.CVV	armada
Tornado	[tʰɔɛˈnɑːdo]	CVC.CVV.CVV	tornado

(50) Type CVC + **CVV** + CVC

Tentakel	[tʰɛnˈtʰɑːkl̩]	CVC.CVV.CVC	tentacle
Spektakel	[ˌʃpɛkˈtʰɑːkl̩]	CCVC.CVV.CVC	spectacle
Oktober	[ˌʔɔkˈtʰoːbɐ]	VC.CVV.CVC	october
Computer	[kʰɔmˈpʰjuːtʰɐ]	CVC.CCVV.CVC	computer
Bronchitis	[ˌbʁɔnˈçiːtʰɪs]	CCVC.CVV.CVC	bronchitis

(51) Type CVC + **CVC** + CV

| Girlande | [ˌgʁeˈlan.də] | CVC.CVC.CV | garland |
| Schimpanse | [ˌʃɪmˈpʰan.zə] | CVC.CVC.CV | chimpanzee |

(52) Type CVC + **CVC** + CVV

| Inferno | [ˌʔɪnˈfɛɐ.no] | VC.CVC.CVV | inferno |
| Embargo | [ˌʔɛmˈbaɐ.go] | VC.CVC.CVV | embargo |

(53) Type CVC + **CVC** + CVC

Gymnastik	[ˌgʏmˈnas.tʰɪkʰ]	CVC.CVC.CVC	gymnastics
Silvester	[ˌzɪlˈvɛs.tʰɐ]	CVC.CVC.CVC	New Year's Eve
Orgasmus	[ˌʔɔɐˈgas.mʊs]	VC.CVC.CVC	orgasm

There are also trisyllabic words with a main-stressed final syllable. Examples are the following:

(54) Type CV + CV + **CVV**

| Papagei | [ˌpʰaˌpʰaˈgaɪ] | CV.CV.CVV | parrot |

(55) Type CV + CV + **CVC**

Karussell	[ˌkʰaˌʁʊˈsɛl]	CV.CV.CVC	merry-go-round
Etikett	[ˌʔɛˌtʰɪˈkʰɛtʰ]	V.CV.CVC	label
Kabinett	[ˌkʰaˌbɪˈnɛtʰ]	CV.CV.CVC	cabinet

(56) Type CV(V) + CV(V) + **CVVC**

Paraffin	[ˌpʰaˈʁaˈfiːn]	CV.CV.CVVC	paraffin
Krokodil	[ˌkʰʁɔkʰoˈdiːl]	CV.CVV.CVVC	crocodile
Molekül	[ˌmoˌləkʰyːl]	CVV.CV.CVVC	molecule
Paradies	[ˌpʰaˈʁaˈdiːs]	CV.CV.CVVC	paradise
Kapitän	[ˌkʰaˈpʰɪtʰɛn]	CV.CV.CVVC	captain
Partisan	[ˌpʰaʁtʰiˈzɑːn]	CVC.CV.CVVC	partisan

One more example of this kind is Elixier.

(57) Type CV + CV + **CVCC**

Elefant	[ˌʔɛləˈfantʰ]	V.CV.CVCC	elephant
Vagabund	[ˌvaɡaˈbʊntʰ]	CV.CV.CVCC	vagabond
Katapult	[ˌkʰatʰaˈpʰʊltʰ]	CV.CV.CVCC	catapult
Katafalk	[ˌkʰatʰaˈfalkʰ]	CV.CV.CVCC	catafalque
Manifest	[ˌmaniˈfɛstʰ]	CV.CV.CVCC	manifesto
Horizont	[ˌhɔʁiˈtsɔntʰ]	CV.CV.CVCC	horizon

(58) Type CV + CVC + **CVVC**

| Amalgam | [ˌʔaˌmalˈɡɑːm] | V.CVC.CVVC | amalgam |

(59) Type CVV + CV + **CVCC**

| Obelisk | [ˌʔoˌbəˈlɪskʰ] | VV.CV.CVCC | obelisk |
| Diamant | [ˌdiaˈmantʰ] | CVV.V.CVCC | diamond |

(60) Type CVC + CV + **CVCC**

| Firmament | [ˌfʁɛmaˈmɛntʰ] | CVC.CV.CVCC | sky |

3.3.3 Words with more than three syllables

In this category there are monomorphematic words with either four or five syllables. Very few quadrisyllabics show prepenultimate main stress. These will be listed in the following.

(61) Type CV + **CVV** + CV + CVC

| Chamäleon | [kʰaˈmɛləˌjɔn] | CV.CVC.CV.CVC | chameleon |
| Rhinozeros | [ʁiˈnoːtseˌʁɔs] | CV.CVC.CV.CVC | rhinoceros |

A large number of polysyllabics with more than three syllables show penultimate stress. Examples are given below.

(62) Type CV + CV + **CV<u>C</u>** + <u>C</u>V

Etikette	[ˌʔɛtʰɪkʰˈɛtʰə]	V.CV.CV<u>C</u>V	convention
Mirabelle	[ˌmɪʁaˈbɛlə]	CV.CV.CV<u>C</u>V	yellow plum
Zigarette	[ˌtsɪgaˈʁɛtʰə]	CV.CV.CV<u>C</u>V	cigarette
Zitadelle	[ˌtsɪtʰaˈdɛlə]	CV.CV.CV<u>C</u>V	citadel
Frikadelle	[fʁɪkʰaˈdɛlə]	CCV.CV.CV<u>C</u>V	rissole
Karamelle	[kʰaʁaˈmɛlə]	CV.CV.CV<u>C</u>V	caramel

The words of this shape have four syllables with short vowels. The penultimate one is, however, closed by ambisyllabicity. More examples of this kind are Klarinette, Silouette, Pirouette and Bagatelle.

(63) Type CV + CV + **CV<u>C</u>** + <u>C</u>VC

| Amaryllis | [ˌʔamaˈʁɪlɪs] | V.CV.CV<u>C</u>VC | amaryllis |

(64) Type CV(V) + CV + **CVC** + CV

| Katakombe | [kʰatʰaˈkʰɔmbə] | CV.CV.CVC.CV | catacomb |
| Hyazinthe | [hyˌjaˈtsɪntʰə] | CVV.CV.CVC.CV | hyacinth |

(65) Type CV + CV + **CVV** + CV

Anemone	[ˌʔa.nəˈmoːnə]	V.CV.CVV.CV	anemone
Mayonnaise	[ˌma.jɔˈneːzə]	CV.CV.CVV.CV	mayonnaise
Pyramide	[ˌpʰʏˈʁaˈmiːdə]	CV.CV.CVV.CV	pyramid
Aprikose	[ˌʔa.pʰʁɪˈkʰoːzə]	V.CCV.CVV.CV	apricot
Kapriole	[ˌkʰa.pʰʁɪˈoːlə]	CV.CV.VV.CV	escapade
Limonade	[ˌlɪmɔˈnɑːdə]	CV.CV.CVV.CV	lemonade

The words in (65) contain four open syllables. The penultimate one has a long vowel as nucleus, while all the others have short vowels in this position. Some more examples are Kathedrale, Kalorie, Remoulade, Palisade, Synagoge, Schokolade, Gelatine, Galeone, Polonese, Serenade, Karawane, Barrikade, Barriere, Karaoke and Limosine.

(66) Type CV + CV + **CVV** + CVV

Avokado	[ˌʔa.vɔˈkʰaːdo]	V.CV.CVV.CVV	avocado
Makkaroni	[ˌmakʰaˈʁoːni]	CV.CV.CVV.CVV	macaroni
Panorama	[ˌpʰanɔˈʁɑːma]	CV.CV.CVV.CVV	panorama
Barrakuda	[ˌbaʁaˈkʰuːda]	CV.CV.CVV.CVV	barracuda
Balalaika	[ˌbala.laɪkʰa]	CV.CV.CVV.CVV	balalaikea
Ballerina	[ˌbaleˈʁiːna]	CV.CV.CVV.CVV	ballerina

These words have four open syllables. The first two have a short vowel as nucleus, whereas the others contain a long vowel. One more example of this kind is Maracuja.

(67) Type CV + CVC + **CVV** + CV

Quarantäne	[ˌkʰa.ʁanˈtʰɛnə]	CV.CVC.CVV.CV	quarantine
Katastrophe	[ˌkʰatʰasˈtʰʁoːfə]	CV.CVC.CCVV.CV	catastrophy
Anamnese	[ˌʔanamˈneːzə]	V.CVC.CVV.CV	anamnesis
Anekdote	[ˌʔanɛkʰˈdoːtʰə]	V.CVC.CVV.CV	anecdote
Chrysantheme	[ˌkʰʁʏzanˈtʰeːmə]	CV.CVC.CVV.CV	chrysanthemum

(68) Type CV + CV + **CVC** + CVV

| Propaganda | [ˌpʰʁɔpʰaˈɡanɖɑ] | CV.CV.CVC.CVV | propaganda |
| Anaconda | [ˌʔanaˈkʰɔnɖɑ] | V.CV.CVC.CVV | anaconda |

(69) Type CV(V) + CV + **CVC** + CVC

Helikopter	[hɛlɪˈkʰɔpˌtʰɐ]	CV.CV.CVC.CVC	helicopter
Eukalyptus	[ˌʔɔʏkʰaˈlʏpˌtʰʊs]	VV.CV.CVC.CVC	eucalyptus
Salamander	[ˌzalaˈmanɖɐ]	CV.CV.CVC.CVC	salamander
Rhododendron	[ˌʁɔdoˈdɛnɖʁɔn]	CV.CV.CVC.CVC	rhododendron
Koriander	[kʰɔʁɪˈjanɖɐ]	CV.CV.CVC.CVC	coriander
Oleander	[ˌʔɔleˈanɖɐ]	V.CV.VC.CVC	oleander

(70) Type CVC + CV + **CV<u>C</u>** + <u>C</u>V

| Salmonelle | [ˌzalmɔˈnɛlə] | CVC.CV.CV<u>C</u>V | salmonella |
| Streptokokke | [ˌʃtʁɛpˌtʰɔˈkʰɔkˌʰə] | CCVC.CVV.CV<u>C</u>V | streptococcus |

(71) Type CVC + CV + **CVV** + CV

Marmelade	[ˌmaʁməˈlɑːdə]	CVC.CV.CVV.CV	jam
Garderobe	[ˌɡaʁdeˈʁoːbə]	CVC.CV.CVV.CV	cloak-room
Mandarine	[ˌmandaˈʁiːnə]	CVC.CV.CVV.CV	nectarine
Nektarine	[nɛkˌtʰaˈʁiːnə]	CVC.CV.CVV.CV	tangerine
Pantomime	[ˌpʰantʰɔˈmiːmə]	CVC.CV.CVV.CV	pantomime
Amplitude	[ˌʔamplʰɪtʰuːdə]	CVC.CCV.CVV.CV	amplitude

There are some more words with this stress pattern, Orchidee, Mandoline, Eskapade, Anti-lope, Margerite and Margarine.

(72) Type CVC + CVC + **CVV** + CV

| Pampelmuse | [ˌpʰamplˈmuːzə] | CVC.CVC.CVV.CV | grapefruit |
| Serpentine | [zɛʁpʰənˈtʰiːnə] | CVC.CVC.CVV.CV | winding road |

(73) Type CVC + CVV + **CVC** + CVC

Portamento   [ˌpʰɔɐ̯tʰaˈmɛn̩tʰo] CVC.CV.CVC.CVV   portamento

Furthermore some polysyllabics have main stress on their final syllable. These are the following.

(74) Type CV + CV + CV + **CVVC**

Katamaran   [kʰatʰamaˈʁɑn] CV.CV.CV.CVVC   catamaran

(75) Type CVC + CVC + CV + **CVVC**

Testosteron   [tʰɛs.tʰɔs.tʰeˈʁɑn] CVC.CVV.CCV.CVVC   testosterone

There are also few monomorphematic words with five syllables. The ones with penultimate stress are listed below.

(76) Type CV + CV + CV + **CV<u>C</u>** + <u>C</u>V

Apokalypse   [ˌʔapʰɔkʰaˈlʏpʰsə]V.CV.CV.CV<u>CC</u>V   apocalypse

(77) Type CV + CV + CV + **CVV** + CV

Lokomotive   [ˌlɔkʰɔmoˈtʰiːvə]   CV.CV.CV.CVV.CV   engine
Hypothenuse   [ˌhʏpʰɔtʰəˈnuːzə]   CV.CV.CV.CVV.CV   hypotenuse
Ephemeride   [ˌʔɛfɛmeˈʁiːdə]   V.CV.CV.CVV.CV   ephemeris

3.4   Discussion

The question now is which conclusions can be drawn from the typology of stress patterns as well as from the phonological processes mentioned earlier. In the following section, all stress patterns will be listed in short again and discussed in derail with the aim of examining each of the language-specific parameter values for German.

3.4.1   Disyllabic stress patterns

As a starting point I will discuss the inventory of observable disyllabic stress templates in German.

(78)   a) Patterns with initial stress:

CVC + CV	**CVC** + CVV	**CVC** + CVC
CVV + CV	**CVV** + CVV	**CVV** + CVC
CVV + CVVC	**CVV** + CVCC	**CVC** + CV
CVC + CVV	**CVC** + CVC	**CVC** + CVVC

b) Patterns with final stress:

CV + **CVV**	CV + **CVC**	CV + **CVVC**
CV + **CVCC**	CVV + **CVVC**	CVC + **CVC**
CVC + **CVVC**	CVC + **CVCC**	

Altogether there are 20 different patterns of disyllabics. 12 of them have primary stress, and the other eight have final stress.

The first observation is that patterns with initial stress are more numerous than the ones with final stress. Secondly it is obvious that syllables of the kind CV never appear as being stress-bearing. There are also no patterns with two CV-syllables. It is hence to be suspected that a CV-syllable rejects main stress regardless of its position.

In such patterns with two syllables of the type CVV or CVC there is a clear majority of six cases against one for the trochaic pattern. This finding points towards the assumption that the trochee should be viewed as the preferred foot type in German.

According to the lexical items, these disyllabic patterns belong to, the CELEX-database by Baayen, Piepenbrock and van Rijn (1993) gives the following numbers (see Féry (1998)).

Table 15: German lexical items with disyllabic pattern as listed in CELEX

Schwa trochees	56%
Full vowel trochees	17%
Light + superheavy	21%
Heavy + superheavy	1%
Light + heavy	5%

There is also a clear majority for the trochaic pattern with a total of 73% against 27% of the cases. These numbers are related to a total of 3425 disyllabics listed in CELEX. They strengthen the hypothesis that the trochee serves as the underlying foot type in German.

Within the minority group of iambic words there is, however, a large number of items displaying a final syllable of the type CVVC or CVCC. In fact, 22% of all the disyllabics are iambic and do have such a syllable. Furthermore, when examining all the items with a CVVC/CVCC-syllable in final position there is again a clear majority of cases in which this final syllable is stressed, namely as Féry (1998) states 723 words with final stress as against 88 of those with initial stress, or five against three CV-patterns. It would thus seem to be the case that a syllable of such a type shows a strong tendency to attract main stress.

What can be concluded from the disyllabic patterns at this point is that a) CV-syllables reject stress, b) CVVC/CVCC-syllables attract stress and c) patterns with two equally sized syllables such as CVV or CVC tend to be trochaic. This indicates that in contrast to the assumptions by Kaltenbacher (1994) and Wiese (1996), German appears to operate as a quantity-sensitive system, which treats syllable weight in three different ways. Firstly, CV-syllables are always unstressable, can, however be footed together with a larger syllable to their left. Secondly, CVV- and CVC-syllables can be footed together with another syllable plus can be stress bearing. Finally, CVVC- and CVCC-syllables appear to be foot-forming on their own. The contrast of stressability and unstressability observed here also fits perfectly to the formulation of Vennemann's (1988) Weight Law:

(79) Weight Law (WL):

In stress accent languages an accented syllable is the more preferred, the closer its syllable weight is to two moras, and an unaccented syllable is the more preferred, the closer its weight is to one mora.

Following this, a three-level syllable weight hierarchy is formulated as CVVC, CVCC >
CVV, CVC > CV. Thus, quantity-sensitivity actually regards the whole rhyme. Finally, the
bounded trochee is suspected to be the underlying prosodic foot, as it is also claimed by all
other researchers including Giegerich (1985), Grewendorf, Hamm and Sternefeld (1987),
Eisenberg (1991), Vennemann (1992), Wiese (1996), Alber (1997) and Féry (1997) and
(1998). The iambic patterns with a final CVV/CVC-syllable as well as those with initial stress
and a final CVVC/CVCC-syllable will be discussed in 3.4.4.

All the mentioned findings now lead us to conclude the following language specific parameter
values:
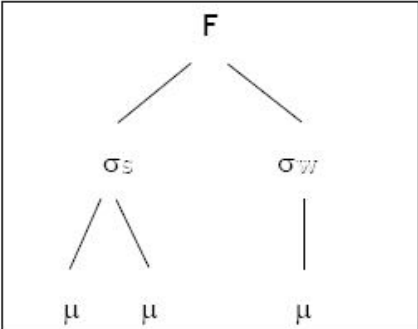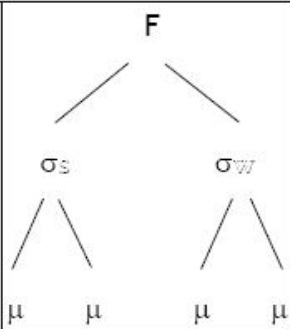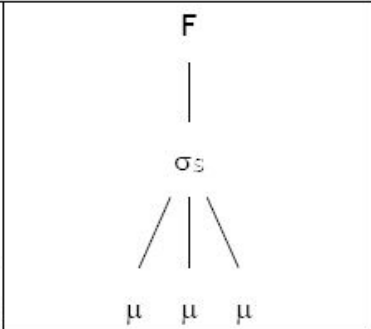
(80)   Foot shape parameters

Headedness:	Feet are strong on the [left/right]
Quantity-sensitivity:	Feet are [quantity-sensitive/-insensitive]
Weight:	Feet are quantity-sensitive to [closed syllable/nucleus/rhyme]
Foot branching:	Feet must be branching [yes/no]
Boundedness:	Feet are [binary/unbounded]

These conclusions are furthermore strongly confirmed by the phonological processes pre-
sented under 3.2, like clipping, schwa epenthesis and schwa deletion, as they all rely on a di-
syllabic trochaic template to operate in (see Fischer (1996) and Féry (1997)).

This configuration of the foot shape parameters in conjunction with the illustrated three-level
syllable weight hierarchy results in the following possible appearances of the prosodic foot
(F) in German.

Table 16: Foot typology in German

| Branching trochee (1 heavy + 1 light syllable) | Branching trochee (2 heavy syllables) | Nonbranching trochee (1 superheavy syllable) |

In the following figures I will illustrate a number of example patterns together with their prosodic structure in arboreal notation in order to clarify just how stress is projected onto them with respect to the units of the prosodic hierarchy.

Table 17: Disyllabic patterns with metrical trees
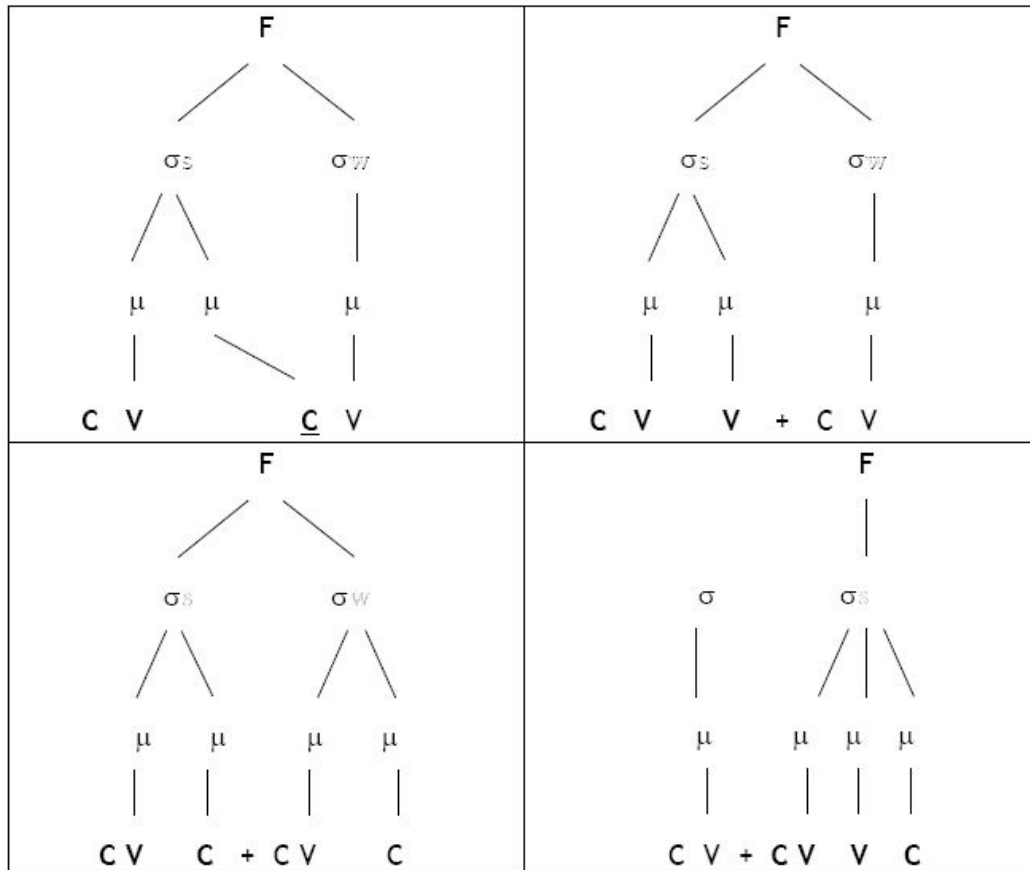
These findings also reveal, why patterns like CV + **CVV** or CV + **CVC** have to have final stress. As a CV-syllable cannot be the head of a foot it is skipped to serve as weak edge of a foot. However, there is no syllable to its left, so it cannot be included into any foot and goes stray. Thus, the second syllable of the word has to receive main stress, as it then represents a degenerate foot (see Hayes (1995)).

Table 18: Metrical tree for the stress pattern CV + **CVC**
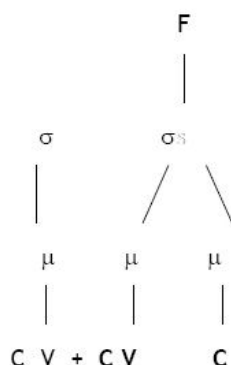
3.4.2   Trisyllabic stress patterns

As the foot shape and syllable weight values have already been examined, the question is now whether the trisyllabic patterns confirm these values and furthermore, what they tell us about the parameters for foot construction and word tree dominance.

(81)   a) Patterns with initial stress:

CVC + **C**V + CVV	**CVC** + **C**V + CVC	**CVC** + **C**VC + CVVC
CVC + **C**V + CVVC	**CVV** + CV + CVV	**CVV** + CV + CVC
CVV + CV + CVVC	**CVC** + CV + CVV	**CVC** + CV + CVC
CVC + CV + CVVC		

b) Patterns with medial stress

CV + **CVC** + **C**V	CV + **CVC** + **C**VV	CV + **CVC** + **C**VC
CV + **CVV** + CV	CV + **CVV** + CVV	CV + **CVV** + CVC
CV + **CVC** + CV	CV + **CVC** + CVV	CV + **CVC** + CVC
CVV + **CVC** + **C**V	CVC + **CVC** + **C**V	CVC + **CVC** + **C**VV
CVC + **CVC** + **C**VC	CVC + **CVV** + CV	CVC + **CVV** + CVV
CVC + **CVV** + CVC	CVC + **CVC** + CV	CVC + **CVC** + CVV
CVC + **CVC** + CVC		

c) Patterns with final stress:

CV + CV + **CVV**	CV + CV + **CVC**	CV + CV + **CVVC**
CV + CV + **CVCC**	CV + CVC + **CVVC**	CVV + CV + **CVVC**
CVV + CV + **CVCC**	CVC + CV + **CVCC**	

There are 37 trisyllabic patterns in German. Ten of them have initial stress. The majority of 19 trisyllabic patterns show medial (penultimate) stress. Another eight have main stress on their last syllable. According to Féry (1998), the distribution of lexical items with three syllables in CELEX is as follows. Compared to a total of 1312 trisyllabic words, there are 255 with initial stress (19%), 664 ones with medial stress (51%) and 393 ones with final stress (30%).

Again it can be stated that CV-syllables never receive stress regardless of their position within the template. All of the 18 patterns, which have a syllable of the type CVV or CVC in second place also appear to have main stress placed on exactly this syllable, that means in other words on their medial position. Here, those words made up of three syllables of exactly the same weight are the most important ones. As they all have medial stress, it can be concluded from them, that the prosodic parameter [directionality of footing] is set to the value "right". As the basic foot is bounded and left-headed, the main stressed medial syllable of these trisyllabic forms must thus be footed together with its neighbour to the right, while the initial syllable remains unfooted. Therefore, feet are built from the right edge of the word. Otherwise there would not be 18 patterns with medial stress compared to only nine with initial stress.

Furthermore, a number of trisyllabic patterns with final stress appear to end in a syllable of the kind CVVC or CVCC. Four of them show initial stress. These will be discussed in more detail in 3.4.4. The other six have a strong final syllable. None of them however, have medial stress, which leads to the conclusion that the final syllable seems not to be footed together with the medial one because the basic foot, as we have already learned from the disyllabics, is trochaic and bounded. Thus, if the final syllable were in one foot with its neighbour to the left, then the medial syllable should receive main stress. It can therefore be concluded that there is a foot with just a single CVVC/CVCC syllable under its non-branching node.

The trisyllabic patterns tell us three important things. Firstly, the footing starts from the right edge of the word. Secondly, in such patterns, where there could theoretically be two prosodic feet, namely CVV/CVC + CV + CVVC/CVCC, main stress falls onto the final syllable. This means that the main stress assignment is also right-headed. Thus, we can conclude two more prosodic parameter settings from the trisyllabics.

(82)   Foot construction parameters

         Directionality: Feet are built from the [left/<u>right</u>]

      Word tree dominance parameters

         Main stress rule: The word tree is strong on the [left/<u>right</u>]

The third finding is that syllables of the kind CV never recieve main stress, even if they show up in a position, which would cause such a syllable to be the left and the thus strong edge of a prosodic foot. A pattern of this kind is CVV/CVC + CV + CVV/CVC. Here, the two right-most syllables could theoretically be arranged together into one foot, which then had to be stressed on its left edge, the word's medial CV-syllable. However, this is not what we find in the data (see Ramers (2001)). In such patterns the first syllable receives main stress. Hence we can conclude that the medial CV syllable turns out to become a right edge of a foot together with its left neighbour. Thus, a syllable of the type CV can be claimed to be unable of being stressed in any event.

The following figure shows a number of metrical trees to illustrates the internal structure of the trisyllabics established in this work.

Table 19: Trisyllabic stress patterns with metrical trees
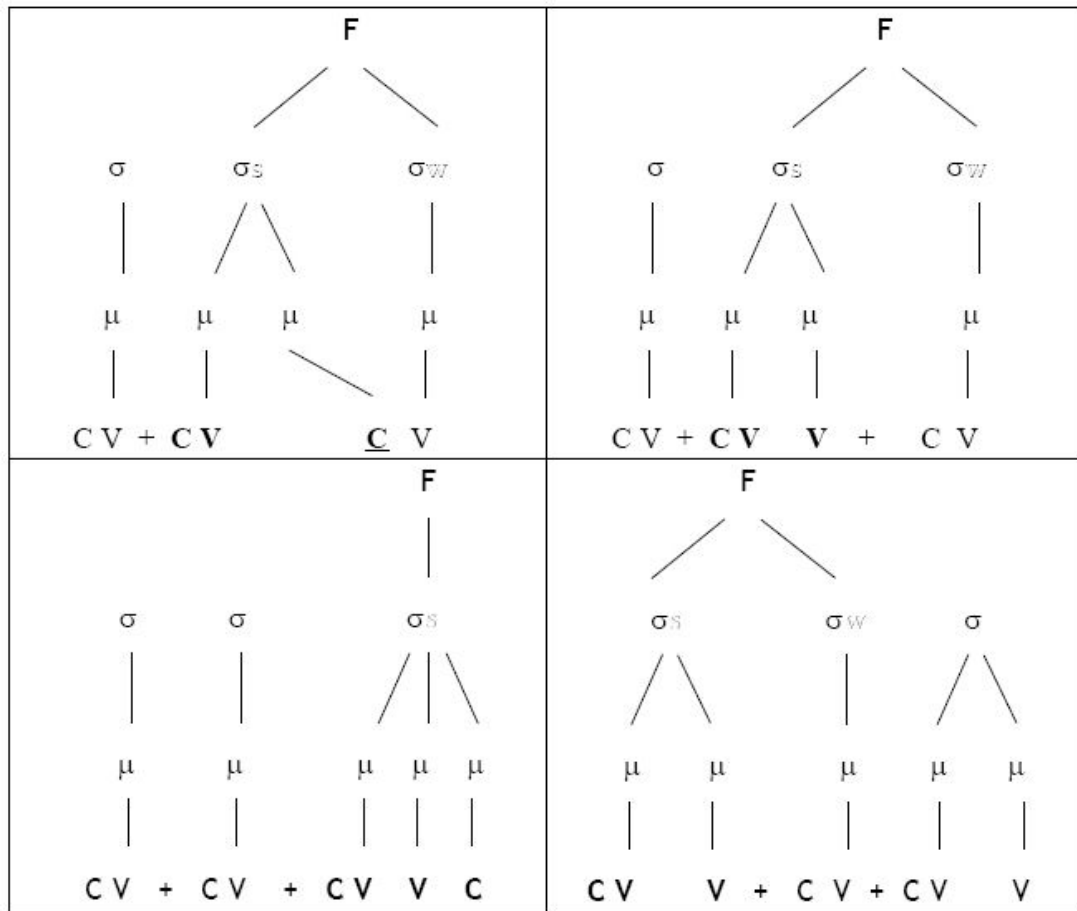
In such patterns with two CV-syllables and a final CVV/CVC one the first two syllables are again unable to recieve main stress. Therefor it has to fall on the ultima, although this syllable has to form a degenerate foot on its own.

Table 20: Arboreal structure of trisyllabic stress patterns with two initial CV-syllables
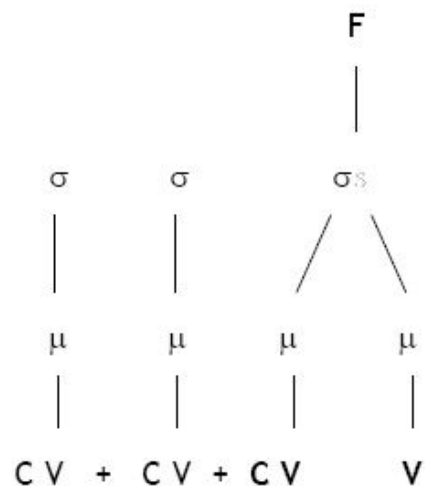
3.4.3   Patterns with more than three syllables

It remains to examine the patterns with more than three syllables to be looked at in order to clarify the values for the remaining parameters of foot construction.

(83)   a) Patterns with four syllables and prepenultimate stress

        CV + **CVV** + CV + CVC

    b) Patterns with four syllables and penultimate stress

CV + CV + **CV<u>C</u>** + <u>C</u>V	CV + CV + **CV<u>C</u>** + <u>C</u>VC
CV(V) + CV + **CVC** + CV	CV + CV + **CVV** + CV
CV + CV + **CVV** + CVV	CV + CVC + **CVV** + CV
CV + CV + **CVC** + CVV	CV(V) + CV + **CVC** + CVC
CVC + CV + **CV<u>C</u>** + <u>C</u>V	CVC + CV + **CVV** + CV
CVC + CVC + **CVV** + CV	CVC + CV + **CVC** + CVV

    c) Patterns with five syllables and penultimate stress

        CV + CV + CV + **CV<u>C</u>** + <u>C</u>V   CV + CV + CV + **CVV** + CV

    d) Patterns with four syllables and final stress

        CV + CV + CV + **CVVC**   **CVC** + **CVC** + **CV** + **CVVC**

There are 15 patterns with four syllables and two ones with five syllables altogether in this category. The majority of twelve quadrisyllabics has a main stressed penultimate syllable, whilste there are two patterns with final and one with prepenultimate stress. The forms with final stress again show that a syllable of the type CVVC or CVCC attracts main stress. Furthermore, such a syllable seems not to be footed together with another syllable, as it can occur word-finally and is still stressed, although the underlying foot shape is left-headed. Thus, syllables of the type CVVC/CVCC must be viewed as foot-forming.

On the other hand, CV-syllables again reject stress but can be footed together with larger syllables, to be the right edge of a trochee.

The two patterns with five syllables all have their main stress on the penultimate syllable, something fitting perfectly to the parameter settings for directionality of footing and the main stress rule. However, in all these cases, secondary stress seems to be fixed to the first syllable, although it should fall on the second, because the underlying prosodic foot in German is maximally disyllabic. Hence, the second and the third syllable in these forms should be grouped together to form a second trochaic foot as the left neighbour to the main stressed foot in the right edge of these words. This, however seems not to be the case. Exactly the same situation can be observed in patterns with four syllables and a CVVC/CVCC syllable in the final position. Again, secondary stress is expected to fall on the second syllable. Actually, however, it is found on the initial one.

We can conclude from the patterns with four or five syllables that all the parameter values derived so far, still function properly here. Additionally, secondary stress in forms with five syllables and penultimate main stress falls on the first syllable, which, however, means that there seems to be no foot iterativity in polysyllabic words, which will be discussed in more detail in 3.6.1. Thus, the following parameter setting can be derived.

(84)   Foot construction parameters

        Iterativity: Feet are built iteratively [yes/<u>no</u>]

In the following figure it will be again demonstrated that a penultimate CV-syllable leads to prepenultimate stress in quadrisyllabics, because a CV-syllable cannot be the left edge of a foot and, thus, has to be grouped together with the syllable to its left. The final syllable of the corresponding words remains unfooted.

Table 21: Metrical tree for a quadrisyllabic with a penultimate CV-syllable
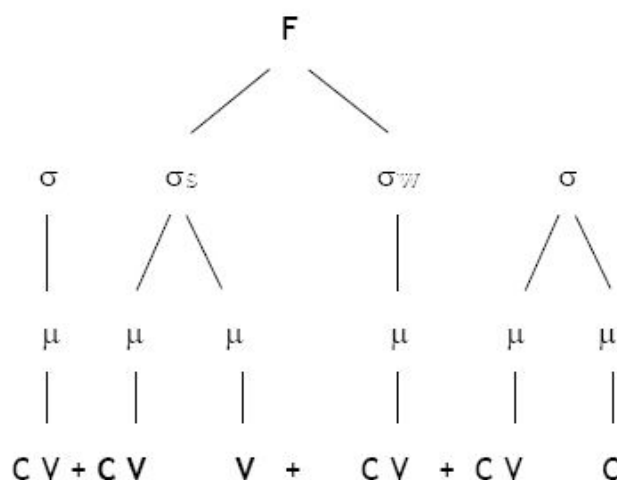
3.4.4 Conflicting stress patterns

There are, however a number of patterns which produce problems when analysed by the metrical stress rules established so far. In fact, such patterns occur with different or even contradictory stress assignment. For example, in disyllabics we find the template of the size CVC + CVC, which once shows up as trochaic like with the words in (15) and in other cases as iambic like with the words in (22). There are basically two kinds of problematic patterns, which will be listed and discussed in the following section

(84)   a) Disyllabics with two heavy syllables and final stress

b) Patterns with a final superheavy syllable, which does not receive main stress

The question is then, which of the (competing) stress patterns is the underlying one for a particular CV-template, and can there be observed any prosodic facts leading to those stress patterns which otherwise seem to present an exception. The two different kinds of problematic patterns listed above will now be discussed in detail.

a) Disyllabics with two heavy syllables and final stress

In this pattern main stress is expected always to fall on the first syllable, as both heavy ones can be combined under a trochaic foot node. However, this is not what we find in the data. Actually some of the corresponding words are iambic.

(86) CVC + **CVC**

First of all, if one takes a look at the relative amount of the lexical items connected to this rhythmic pattern, as was done by Féry (1998), one obtains the following picture. In 73% of all disyllabics there is either a syllable of the type CV, CVV or CVC in the final position and the trochaic pattern is present. These forms thus clearly outnumber the iambs of the same CV-templates, which only occur in 5% of the disyllabic cases. This points to an underlyingly trochaic foot shape, as it has already been proposed by other investigators throughout the literature (see Giegerich (1985), Grewendorf, Hamm & Sternefeld (1987), Eisenberg (1991), Vennemann (1992), Wiese (1996), Alber (1997) and Féry (1997) and (1998)).

There have been different proposals to account for the remaining iambic disyllabics. Grewendorf, Hamm and Sternefeld (1987) suggest that all words ending in /-ell/, /-ett/ and the like should be treated as morphologically complex and thus cannot be accounted for by prosodic rules. The suffixes would then be stress-attracting in the sense of Eisenberg (1991).

Giegerich (1985) on the other hand, has argued that these words end in an underlying geminate represented by a double consonant in spelling. Hence, according to his syllable weight hierarchy these words would have a final heavy syllable and therefor be stressed on their ultima. However, as Hayes (1986) points out, Giegerich's assumption of a word final geminate is based on orthographic properties and cannot be proven by any phonological means. Furthermore, there are a number of words which fit into the iambic stress pattern, but are not spelt with a double consonant, whilste others which do have a double consonant in orthography, yet appear to be stressed in a trochaic manner. Hence, Giegerich's approach runs into trouble here (see also Ramers (1992) and Kaltenbacher (1994)).

To my mind, the analysis by Grewendorf, Hamm and Sternefeld (1987) is more plausible. All the lexical items of the shape CVC + **CVC** collected under (22) can be said to be morphologically complex, as soon as their internal structure within their source languages is taken into account. As long as there is not a single purely phonological circumstance causing their actual iambic stress pattern, there can only be a morphological one for it. And as German stress as-

signment can be interfered by the morphological structure, the assumption of complexity for the mentioned words seems plausible.

b) Patterns with a final superheavy syllable, which does not receive main stress

In a number of patterns a syllable of the type CVVC or CVCC occurs in final position, which is not stressed, although it should be, as it is expected to build a nonbranching foot on its one, which then would be the rightmost foot within the prosodic word.

(87)   a) Disyllabic patterns

CVV + CVVC   **CVV** + CVCC   **CVC** + CVVC

b) Trisyllabic patterns

CV<u>C</u> + <u>C</u>VC + CVVC   **CV<u>C</u>** + <u>C</u>V + CVVC   **CVV** + CV + CVVC
CVC + CV + CVVC

Féry (1995) found 801 disyllabics in the CELEX database, which have a superheavy syllable in final position. 723 of these disyllabics show final stress, while only 88 appear to be stressed on their first syllable. In her study in 1998 she furthermore demonstrates that only 44 trisyllabic words with a final superheavy syllable are not stressed on their ultimas, which makes 13% of all trisyllabics with a final CVVC/CVCC-syllable. In these forms, it seems to be the case that the final syllable or the prosodic foot connected to it was omitted during stress assignment. Trisyllabic patterns of this kind all show main stress on their first syllable instead and in three of four cases a CV-syllable in medial position. This would appear as if though there were a complete prosodic foot on the left of the CVVC/CVCC-syllable.

Therefore an extrametrical unit is assumed on the basis of these findings. A superheavy syllable in final position may be blocked from footing, if the word is marked for extrametricality. This conclusion, however, is problematic insofar as extrametricality has to be stored in lexicon for all those words it occurs in.

(88)   Word tree dominance parameters

Extrametricality: There is an extrametrical unit [<u>yes</u>/no]
Edge of extrametricality: The extrametrical unit is on the [left/<u>right</u>]

These values result in the following arboreal structures for the words exhibiting extrametricality.

Table 22: Metrical trees for stress patterns with an extrametrical superheavy syllable
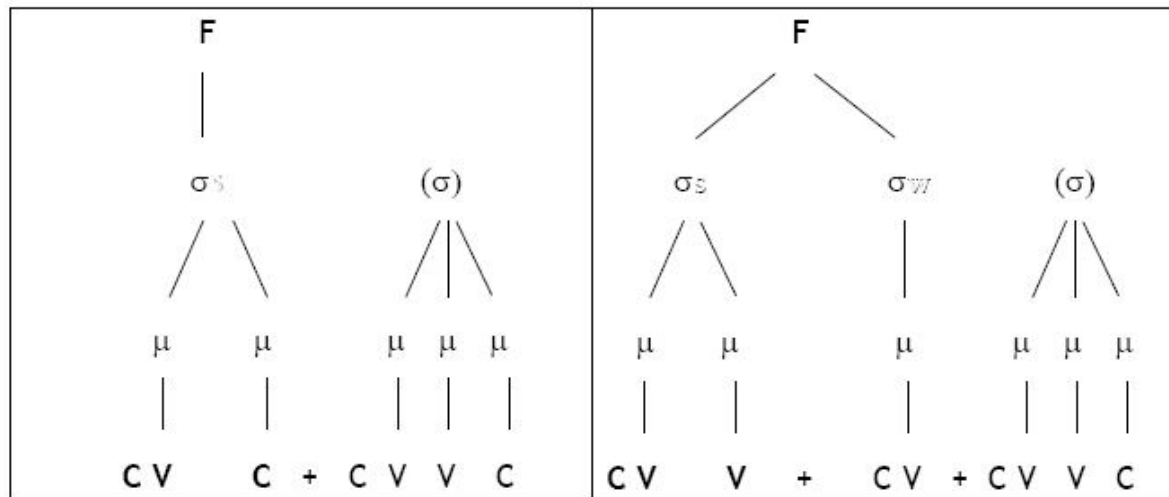
3.5 Conclusion

The discussion of the present study on German stress patterns finally leads to the following language specific values of the prosodic parameters.

3.5.1 Syllable weight

German has been observed here to be quantity-sensitive. Its syllable weight distinction is organized in a three-way fashion. Syllables can be light, heavy or superheavy. They appear to be shaped as follows:

Table 23: Syllable weight hierarchy in German

Light	CV	1 mora
Heavy	CVV or CVC	2 moras
Superheavy	VVC, CVCC	3 moras

The reason for proposing a three-level-hierarchy of syllable weight is that each of these three types of syllables is treated differently under the foot node. Light syllables can never be

stressed in any event. They also can neither be left edges of feet nor can they build minimal words on their own. Heavy syllables on the other hand can receive stress and therefore build a monosyllabic word, which then is made up of a degenerate foot. Finally, superheavy syllables build full (non-degenerate) feet on their own even in polysyllabic words. This sequence – foot-forming (CVVC, CVCC) > stressable (CVV, CVC) > unstressable (CV) - has to be spelled out in terms of moraic representation, because it is crucial to the stress system of this language.

3.5.2 Parameter setting for German

The foot shape of German can be described in the following way. The basic foot is strong on the left, as for example the disyllabic words with initial stress clearly outnumber the ones that seem to be iambic. The underlying system of foot-formation is thus trochaic.

Feet are bounded and hence can either be mono- or disyllabic. Monosyllabic feet consist of a superheavy syllable. Disyllabic feet are built of at least two light syllables in conjunction with ambisyllabicity of the medial consonant. This makes a total of three moras as the minimum for the foot formation in both cases. This trimoraic principle will be illustrated in the following table.

Table 24: The minimally trimoraic foot shape of German

This trimoraic foot size is essential to the language's prosodic system. It is also reflected in the formulation of the Weight Law by Vennemann (1988). It has furthermore to be emphasized in this respect, that the principle of the trimoraic foot is strongly demonstrated by the appearance of the schwa vowel. It can only occur in unstressed position and therefore in potentially right

edges of prosodic feet. Thus, it signals the lightness of the weak branch of a foot in contrast to the strong one, which has to be heavy.

Concerning the foot construction and word tree parameters, the findings lead to the following conclusions. Feet are built from right to left. Thus, syllables on the left edge of the word can remain unfooted. In a – supposedly - polypedal word main stress falls on the rightmost foot. There are, however, a number of facts leading to the conclusion, that words in German maximally have one single foot, whereas all other syllables remain unfooted. All monomorphematic words with more than three syllables have for example secondary stress fixed to their left edge. The problem of determining the value for the parameter [foot iterativity] in German will be further illustrated in 3.6.1.

A number of polysyllabic words show extrametricality. I assume here, that this parameter has to be marked in the lexicon for every item it occurs in. However, extrametricality produces the same effect for every word which it is marked. That is, it prevents the final syllable of a word from being branched towards the foot tier.

Thus, as a result of the present investigation, the complete parameter setting for German stress assignment can now be characterized as in (89), where UG-default settings are marked with small capitals and language-specific settings are underlined.

(89) a) Foot shape parameters

      Headedness: Feet are strong on the [<u>left</u>/right]

      Quantity-sensitivity: Feet are [<u>quantity-sensitive</u>/-insensitive]

      Weight: Feet are quantity-sensitive to
                                      [closed syllable/nucleus/<u>rhyme</u>]

      Foot branching: Feet must be branching [yes/<u>no</u>]

      Boundedness: Feet are [<u>binary</u>/unbounded]

    b) Foot construction parameters

      Directionality: Feet are built from the [left/<u>right</u>]

      Iterativity: Feet are built iteratively [yes/<u>no</u>]

    c) Word tree dominance parameters

      Main stress rule: The word tree is strong on the [left/<u>right</u>]

      Extrametricality: There is an extrametrical unit [<u>yes</u>/no]

      Edge of extrametricality: The extrametrical unit is on the [left/<u>right</u>]

3.6   Prospective

At this point it can be said that not all of the theoretical problems in German word stress assignment are satisfactorily solved, something however, that applies to all previous studies on this specific field, itself the result of misleading data in the lexicon of this language. Especially the problem of foot iterativity will be presented here once again.

Far more importantly, however is the need to realize how the speech learning infant can benefit from the clues provided by the language-specific parametry. If any language sets the prosodic parameters to particular values which are marked in the sense of UG, then native speakers must be able to derive these values from the input. Otherwise they would not be able to acquire the language-specific stress system properly. As German uses marked values for particular parameters, it is necessary to illustrated just how it makes these specific values available to the learning infant.

3.6.1   Foot iterativity

German has a large number of words, which can be analysed as polypedal. All trisyllabics with a final superheavy syllable, all quadrisyllabics and even words longer than that. Thus with these words fitting perfectly into a polypedal scheme, why is it necessary to pose the question of whether this language has foot iterativity?

The answer is very simple: because these words do not fit in perfectly. Some facts about them are striking.

a) Consonants that are medial in feet in the left edge of the word are never ambisyllabic. This means, that if there were feet in the left edge, they would not be three-moraic.

b) All polysyllabic words with more than three syllables display secondary stress on the initial syllable, even if they have an odd number of syllables, where the second syllable would be expected to be more prominent, because it should be the head of a left edge foot. However, secondary stress seems not to be calculated by rules but fixed to the left edge of these words instead. This would mean that left edge feet are not used for stress assignment at all.

c) There are no words consisting of an unstressed superheavy syllable in the left edge, except compounds. Hence, foot iterativity would be restricted to disyllabic feet, but as it can be seen in a), these are not the right size.

d) All words which should be polypedal appear to be loan words. No inherited word ever has more than one foot. That could mean that the underlying system of foot formation is restricted to one foot per word.

3.6.2   Clues to acquire the German stress system

Although it has already been clearly stated that a number of German stress patterns introduced earlier in this work are misleading or even contradictory when regarding very basic parameter values, the German system of stress assignment offers important and quite obvious hints to its learners, to simplify the derivation of the underlying parameter setting. These clues will be presented in the following section.

a) The differences between stressable (heavy, bimoraic) and unstressable (light, unimoraic) syllables illustrate the way in which disyllabic prosodic feet are shaped. As light syllables can never be left (strong) edges of feet, it is demonstrated to the learner that any kind of a heavy syllable is needed for the head of the foot. Thus, feet have to be trimoraic as a minimum.

b) The differences between stressed and unstressed syllables (even if the latter ones might be heavy) is emphasized by phonotactic means. The schwa vowel can only occur in an unstressed position. However, schwa syllables are highly frequent (see Féry (1998)) and hence provide a stable clue that they differ fundamentally from stressed syllables in terms of their segmental material as well as their prosodic properties such as prosodic weight.

c) The underlying trochaic foot shape is demonstrated in a number of processes within prosodic morphology. Thus, it is demonstrated to the learner that the disyllabic trochee is a unit, which is centrally operable in the prosodic system. The processes under 3.2 enlarge the number of input trochees to the learning infant and furthermore facilitate the recognition of morphological boundaries.

4   Prosodic development during Canonical Babbling

In this chapter I will present an examination of the canonical babbles uttered by seven German-learning infants between 0;5 and 1;0. The focus of the investigation lies on the prosodic organization of multisyllabic utterances. Three questions will be asked. a) Do the subjects show predictable stress patterns in a quantity-insensitive manner? b) Do syllables larger than (C)V show a tendency to attract stress? c) If syllable weight is discriminated by the subjects, do they hence produce stress patterns predictably in a quantity-sensitive fashion?

All well-formed vocalizations are classified by a number of perceptual and acoustic analyses including measurements of intensity, fundamental frequency and spectral tilt, to trace phonological properties like word stress and syllable weight. Subjects were recorded every two weeks from the onset of Canonical Babbling.

The results indicate that there is a weak tendency towards the trochaic stress pattern in disyllabic babbles. This tendency is however, only predictable by two of the five analysis parameters. In polysyllabic vocalizations the location of main stress appears not to be predictable by any analysis. It can nevertheless, be stated, that CVV syllables tend to attract stress significantly. These results point to the fact, that the parameters of word stress assignment are not yet completely set during Canonical Babbling. Instead, only those for foot shape and quantity-sensitivity appear to be set in a fashion reflecting an influence of the subjects' ambient language, German.

4.1   Hypothesis

The current work addresses the question of whether it is possible to observe a recognizable development of adult-like stress assignment in babbling infants during the second half of the first year of life, when the stage of infraphonologically well-formed babbling is reached. At this stage, children utter adult-like syllables (Oller (1980) and (1986) and Stark (1980)), which occur in breath groups similar to prosodic words (Oller & Lynch (1992)). They are furthermore not equally stressed (see Davis, MacNeilage, Matyear & Powell (2000)). This means that there are syllables, which appear to be more prominent than others within the same word-like utterance. Hence the current study will examine whether babbling syllables can be

found to be arranged into higher-level units such as prosodic feet, which, according to the principles of metrical phonology, then receive stress in a predictable way (see Liberman & Prince (1977), Selkirk (1980) and Hayes (1995)).

4.1.1   Possible outcomes of the investigation

As it was mentioned earlier under 2.3, there are basically three possible outcomes of an investigation on babbling prosody. Each of these outcomes points towards one of the three theoretical approaches within the continuity debate.

a) Babbling prosody and later prosodic development are discontinuant: This would result in the absence of any organization of stress assignment. Stress would hence not be predictable at all, because the infant has not yet gained access to the universals of human mature language.

b) Prosody of babbling and lexical stage are continuant in the way proposed by the "weak" interpretation of the continuity hypothesis: This would suggest a straight-forward organization of stress assignment during babbling. The default parameter setting of UG would be available, but there would be no indications to suggest an influence by the ambient language German. Hence, parameters like [main stress rule] and [head directionality] would be leftward in the majority of the subjects' utterances. However, a number of characteristics of the ambient language might emerge towards the end of the subjects' first year of life.

c) Babbling prosody is largely influenced by the ambient language, as it is suggested by the "strong" interpretation of the continuity hypothesis. This would hence result in a setup for the parameters dealing with stress assignment, which differs significantly from that provided by UG, because German needs to set crucial parameters such as [main stress rule] in a non-default fashion. Additionally, it is conceivable that some of the parameters change during canonical babbling, hinting at a process of switching these particular parameter to the actual target value.

4.2   Method

For this study, babbling data produced by seven German-learning infants were gathered starting with the emergence of the first infraphonologically well-formed babbles till the transition to the lexicon.

4.2.1   The subjects

The subjects participating in this study were recruted in two different locations. Three of the seven infants were recorded in the South-western part of Germany. The remaining four infants were participants in the German Language Acquisition Development Study (GLAD) at the Kinderklinik Lindenhof in Berlin, funded by grant of the DFG and the Max-Planck-Institut Leipzig. Babbling research within GLAD was led by PD Dr. Zvi Penner and Prof. Dr. Kathleen Wermke at the Charité hospital (see also Weissenborn (2001)).

The first three subjects are NB, LU and JR. That makes one male and two female babies. All of them lived in the South-western part of Germany, namely Baden-Württemberg, or in Thurgau, Northern Switzerland. All of them had a normal birth at term and no physical impairments. The actual educational level of all their parents was relatively high.

NB is the female first born of two German native speakers. She gained a brother, when she was two years old. Although her family lives in Northern Switzerland, her parents' speech is accent-free Standard German. Her mother studied linguistics and also worked on language acquisition as a student of Dr. Paula Fikkert. NB was furthermore recorded up to an age of 2;8, to provide an ongoing investigation of the child's development. Unfortunately, for various reasons her babbling data is limited to a three month time slot at around 0;9.

LU is also the male first born of two native speakers. His mother also studied linguistics. Although he started to produce canonical babbles at the relatively early age of 0;5, he uttered no target words up to around 1;8. His further development was however, unimpaired.

JR is the female first born of two native speakers. She took part in Vetter's (2000) study on Crying and was therefore recorded before the emergence of canonical babbling, which took place at an age of 0;8.

The other four babies were recorded in their homes in Berlin or Brandenburg and were subjects of the German Language Acquisition Development Study (see Weissenborn (2001)). All of these subjects are children of German-speaking parents. The strongest criterion for participation in the current study was the amount of babbling utterances which these babies produced. For mainly statistical reasons it was of interest to have individual numbers of babbles, which are comparable throughout all the subjects. Usually, babbling data for the GLAD study was gathered monthly. There was however, the possibility of handing a DAT-recorder to a number of parents, in order to increase the actual amount of analysable data. These subjects were hence included in the current study.

This group of subjects is made up of TJ, DP, SG and LS. That makes three females and one male. All these infants had a normal birth at term and no physical impairments. The educational level of their parents was altogether lower than for the first group.

TJ is the third child of two German native speakers living in Brandenburg, close to Berlin. All her siblings are brothers. The educational level of her mother is high.

DP is the second female child of two native speakers again. Her mother reached the highest graduation in the German school system. DP passed through the Canonical Babbling stage incredibly fast, as her first deictic placeholders appeared at an age of 0;9.

SG is the female first born of two German-speaking parents of middle-class level.

LS is the second child of again two middle-class native speakers. His sister is very active in all situations of life, what might be the reason why LS himself is actually a bit calmer when compared to the other subjects.

As table 1 indicates, the emergence of canonical babbling for all seven subjects is in line with the predictions of earlier studies on this topic, as they state, that well-formed babbling should be established in a normally developing infant before 0;10 (see for example van der Stelt & Koopmans-van Beinum (1986), Oller & Eilers (1988) and Ejiri (1998)). The subjects were furthermore reported as showing a normally ongoing process of language acquisition concerning phonological as well as lexical and syntactic development.

Table 25: Onset of canonical babbling

NB	0;8
JR	0;7,14
LU	0;5,14
TJ	0;6,14
DP	0;7
SG	0;6,14
LS	0;6,14

4.2.2 Data gathering

The recording sessions for this study were aimed at documenting the spontaneous canonical babbling of the subjects. All infants were recorded in their homes accompanied by either their mother or father.

All empirical studies on prespeech vocalizations share the same problems in case of gathering the data. Oller, Wieman, Doyle and Ross (1976) stated for example: "As the reader can imagine, some children went to sleep, some fussed, some cried and some remained largely silent - apparently fascinated with the novel laboratory surroundings and people." (p. 2) Davis, MacNeilage, Matyear and Powell (2000) furthermore noted: "Because data were spontaneous productions collected in a nonlaboratory setting in each child's home, background noise and competing voices were frequently present and greatly reduced the number of tokens accessible for acoustic analysis." (p.1261)

In order to minimize this problem, the data for the current study was collected in two different ways. On the one hand, all infants were visited monthly in their homes by an experimenter and recorded in a situation of playing, accompanied by at least one of their parents. Additionally, parents were given a DAT-recorder, in order to be able to conduct recordings in between the monthly sessions. Thus, they could spontaneously start recording, whenever the infant was engaged in babbling behaviour.

In order to keep the individual amount of data statistically comparable, all utterances made within a time frame of two weeks were taken together as one session. Thus, there are data for ages like 0;7, 0;7,14 or 0;8, but none in between.

As a starting point for the recordings of the first three subjects I used the time at which parents reported the onset of canonical babbling in their infants, meaning the emergence of the first well-formed syllables. In all three families there was at least one close relative to the subject, who actually had a strong linguistic background. In NB's and LU's case this was the mother. Thus, they were sufficiently trained to recognize the differences of the types of pre-speech sounds. The four remaining subjects were initially recorded at an age of 0;3.

Only canonical babbling utterances were used for the analyses. The relevant vocalizations were selected perceptually. The criteria for labelling a babble as "canonical" were those provided by Oller and Eilers (1988). An utterance had to a) have at least one full resonant nucleus resulting in a vowel with an identifiable quality, b) one consonantal margin other than a glottal, c) duration of syllables within the range of the adult syllable and d) normal phonation and pitch range. These infraphonological aspects are claimed by Oller and Eilers (1988) to be easily identifiable for phonetically trained listeners. Hence, Oller, Eilers, Steffens, Lynch and Urbano (1994) state that their "experience indicates that trainees quickly learn to bring to conscious awareness their tacit ability to judge well-formedness of transitions between consonants and vowels." (p. 40) Oller, Eilers, Neal and Schwartz (1999) formulate the point even more drastically: "If a parent could not recognize such sounds [canonical syllables] (indeed, if any grownup could not recognize such sounds), then that individual would not be able to tell the difference between speech and other kinds of less well-formed vocalizations." (p. 230)

All vocalizations, which failed to meet the infraphonological properties of canonicity, were not included in any of the further analyses. Furthermore, all kinds of coughs, sneezes, laughters, hick-ups, cries and growls were left aside.

4.2.3   Equipment

The data were recorded using a Sony TCD-D100 portable DAT-recorders in combination with a Sony ECM-MS957 microphone. As a first step, all the relevant vocalizations were captured using KAY Elemetrics CSL Modell 4300B or the newer Modell 4400 with the corresponding software. Each vocalization was digitized at a sampling rate of 44.1 kHz and a resolution of

16 bits. The sound material was passed in through an analogue connection with the Sony DATs and normalized manually before capturing. Only such digitized babbles were used in this study, which were totally free of background noise or talking. For further acoustic analyses, all the sounds captured were stored in AIFF format with 44.1 kHz and 16 bits and handed over to the Signalyze software package. Thus, an overall reliable audio quality achieved by the CSL interface was combined with a flexible hardware-independent analysis solution.

4.2.4   Perceptual analyses

In order to examine the ongoing prosodic development of each subject, several different perceptual as well as acoustic analyses were applied. These were aimed at deriving possible values of the parameters dealing with stress assignment at the different recording sessions. The perceptual analyses will be introduced first.

As a basis for all of the following analyses each babble was rated by three phonetically trained adult listeners. Two of them were monolingual native speakers of German, whereas the third was a bilingual native speaker of German and Vietnamese. They had to rate every vocalization with respect to its quality, to ensure, that there were no babbles included, which were interrupted by background noise or parents' speech.

As a second step, they had to classify each vocalization in terms of the actual number of syllables. This judgement was conducted independently by each listener, without knowing what the others found. After this, I listened to all of the data once again, to compare the three independent ratings and combine them in the following ways: in cases in which all three listeners agreed on a babble, their rating was noted down and used for further analysis. When only two listeners made the same judgement on a particular babble, I had to listen to it again and decide whether I agreed with the two listeners, which hence meant, that their rating was used, or not to agree and exclude the babble from the analyzable data. In cases in which all three listeners came to a different rating, the corresponding babble was excluded immediately. In that case I had no chance to overrule the judgements in order to keep the item within the analyses.

Additionally, the three adult listeners were asked to note down specific properties of the babbles such as the occurrence of closing consonants or clusters. After that I transcribed a CV template for each babble. Here, VV represented long vowels. This transcriptional analysis was conducted in order to answer the question, whether the subjects distinguish syllables with

long vowels or codas from syllables with short vowels. The major point of interest herein is, whether there is any rhythmic organization in respect of timedness to be seen in infant babbling. As Ramus, Nespor and Mehler (1999) point out, German is a stress-timed language. In a language of this rhythmic type, the stressed syllable in a word is increased in duration as opposed to syllable-timed languages like the Romance family, where all syllables are equally long regardless of their actual prominence.

Furthermore, the three adult listeners were asked to note down their subjective impression of the location of main stress in each of the babbles. They could, however, leave a vocalization unspecified. Hence, a disyllabic could, for example be classified as being stressed on the first syllable (trochaic), on the last syllable (iambic), on both syllables equally (level stress) or as undecidable (see also Vihman, De Paolis & Davis (1998)).

4.2.5 Acoustic analyses

After that a number of acoustic analyses were conducted. Herein the focus lay on word stress and its acoustic correlates. A phonetic investigation on this abstract phonological phenomenon is not trivial, because as Hayes (1995) states, word stress is "parasitic" and furthermore "relative", as Ramers (2001) points out. This means that there seems neither to be a single acoustic correlate of stress in the speech signal, nor can stress be measured in absolute values. Hence, different acoustic properties of the speech signal were analysed here (see Pompino-Marschall (1995)).

An F0-contour was plotted by the Signalyze software. Here, an autocorrelation algorithm within a frequency range of 200-400 Hz was calculated for every 10ms of the babbling sound. The autocorrelation algorithm was used because it offers reliable robustness in case of noise level. Then the edit cursor was moved to the peak within the syllable. The actual value in Hz was noted.

As Reetz (1999) points out, the measurement of F0 is more complex than that of the other acoustic properties of the speech signal. The algorithm to derive the fundamental frequency of any sound needs a clear and uninterrupted signal as input. Interfering noise might cause the algorithm to encounter an underlying periodicity, which actually does not belong to the phonation of the subject's vocal cords. Unfortunately, the measurement of F0 is also problematic, whenever a human speaker produces breathy vowels. In such cases it can occur that the algo-

rithm doesn't provide a robust value. Hence, measurement errors in case of the parameter F0 also occurred in the current study.

The type of stress in all the Germanic languages is generally characterized as a dynamic rather than a pitch accent (see Krahe & Meid (1985) and Braune & Eggers (1987)). It was thus, assumed throughout the literature, that an intensity contour might be helpful to find the syllable, which bears main stress within a word. More recent work on German as well as Dutch adult data has however, suggested, that the spectral tilt, which can be described as a measurement of energy-loss in the higher formants in unstressed syllables, is much more important in these languages. In particular, the parameter skewness, indicating the actual abruptness of the glottal closure, is claimed to be most reliable (see Sluijter (1995) and Claßen, Dogil, Jessen, Marasek & Wokurek (1998)). As intensity was also used in earlier studies on babbling data like in Davis, MacNeilage, Matyear and Powell (2000), both properties, spectral tilt as well as intensity will be taken into account for this study.

An intensity scale was drawn for every babbling sound using the Signalyze software for calculating an RMS amplitude chart on the basis of a 15ms time window. The syllable boundaries were herein estimated by separating the syllables in the oscillogramme with linked cursors in the intensity window. It was then noted which of the sound's syllables contained the highest peak on the intensity scale. Peaks had to have a minimal difference of 1,5db. Differences below this range were treated as equally dynamic.

In order to determine the spectral tilt the skewness parameter was measured around the peak of syllable intensity. To examine it, an FFT as well as an LPC spectrum were plotted by the Signalyze software. The FFT was calculated on the basis of a 50ms time window with inverted filtering. The window size for the LPC was 15ms. The value for the spectral tilt of the syllable was calculated by using the formula $x=H1-A2$, where H1 stands for the amplitude of the first harmonic in the FFT and A2 for the amplitude of F2 in the LPC, as it was proposed by Sluijter (1995). Hence, a lower value for x means, that the corresponding syllable is more prominent than one with a higher value for x within the same word-like babbling utterance.

Syllable duration was not measured for this study for two reasons. Firstly, offsets of final syllables are hardly determinable when recording vocalizations in a home environment. Here too many reflections cause final syllables to appear much longer in the oscillogramme than have actually been uttered by the subjects. Secondly, the rule of Final Syllable Lengthening (FSL)

might significantly distort an examination of syllable duration in terms of stress assignment (see Nathani, Oller & Cobo-Lewis (2003)). In a trochaic disyllabic the initial syllable would be expected to be longer than the final one. However, if there was FSL, the relational differences between both syllables would be unclear.

4.2.6 Statistical analysis

The investigation is composed of three steps. First, a more universal point of view is taken by examining the frequencies of stress patterns in the data. Here, the location of the main stressed syllable for the perceptual and acoustical analyses is of interest, whereas syllable weight is not yet taken into account. Hence, stress patterns of canonical babbles are examined in a quantity-insensitive environment.

As a second step, specific syllable types are counted with respect to the question, whether they are stressed or remain unstressed by the subjects. Again, all the parameters of the acoustic analyses as well as the perceptual rating by the adult listeners is compared with each other.

The final step of the investigation then combines both previous steps. Here a particular setting of the prosodic parameters for word stress assignment is suggested and hence compared to the subjects' data in order to find out the actual degree of influence exerted by the ambient language. This specific parameter setting is quantity-sensitive. Hence, syllables larger than CV will be treated as prosodically heavier and thus are expected to attract word stress. In a disyllabic of the shape CVV + CVV it will be assumed that stress has to fall on the final syllable, as both syllables are arranged each under separate non-branching feet. The parameter [main stress rule] is assumed at the value "right", as it is also the case in the ambient language German.

In order to interpret the data statistically, the sign test is chosen here as the most robust means for analyzing frequency values (see Siegel (2001)). The formula for this test can be seen in (1). Basically, values above a particular level are labelled with "+", the ones below as "-". Then, the amount of the "+" signs is weight against the "-" signs, whilste values at exactly the medium level are left out of the analysis. Additionally, the values for the recording session, where a particular type of vocalization did not occur, have also to be excluded by definition.

(1)

$$z = \frac{\left(N_{pos} - \dfrac{N_{pos}}{2}\right)}{\sqrt{\left(N_{pos} + N_{min}\right)}}$$

The sign test was chosen here, as it is the only method with which the current data can be analysed with any reliably. As babbling utterances are spontaneous speech, frequencies of particular vocalization types vary from one recording session to the next. Thus, the data is not scalable by intervals. Furthermore, the actual amount of vocalization types can be very small for a particular recording session. The sign test as a nonparametric procedure derives the most stable results under these circumstances.

The value for α is set to 0,1, as it is proposed by Bortz and Lienert (2003) for studies including less than 25 subjects, as such studies are of an explorative design. Lleó, El Mogharbel and Prinz (1994) also used this value for their investigation on babbling data. Hence, a value of $\leq$ 0.1 for p counts indicates significance.

4.3   Results

Before presenting the results of the analyses, I will introduce the data in plain numbers throughout the paragraphs 4.3.1 to 4.3.3. After that, the results of the three steps of statistical analysis will be presented in the paragraphs 4.3.4 to 4.3.6.

4.3.1   Individual numbers of canonical utterances per subject

The following table provides an overview of the numbers of canonical babbling utterances produced by each subject during each recording session. A "-" indicates that no recording took place at this particular age. In total there were 1113 babbling vocalizations classified as canonical and therefore taken into account here.

Table 26: Numbers of canonical utterances per subject and age

	NB	JR	LU	TJ	DP	SG	LS
0;5,14	-	-	38	0	0	0	0
0;6	-	-	7	0	0	0	0
0;6,14	-	-	1	1	0	6	1
0;7	-	-	21	4	1	0	7
0;7,14	-	5	26	5	9	8	2
0;8	-	19	21	15	4	7	14
0;8,14	10	34	31	15	4	10	0
0;9	83	1	14	20	28	2	18
0;9,14	47	10	122	7	7	15	2
0;10	22	4	72	8	9	2	30
0;10,14	-	-	-	-	8	40	-
0;11	-	55	4	19	16	4	19
0;11,14	-	12	19	-	8	17	-

4.3.2   Syllable numbers in the subjects' vocalizations

In this section, I will list the syllable numbers in the vocalizations of each subject. Additionally, the percentage of agreement of the three adult listeners (see 4.2.4) will be noted for the corresponding recording sessions. A value of 100% means that all three listeners agreed on the number of syllables for all utterances within the recording session. Items listed under "excluded" were rated differently by each of the listeners. In the following there will be two separate tables for each subject, one listing listener agreement and related values, and the other showing syllable numbers.

Table 27: Listener agreement on the vocalizations by NB

Age	Total utterances	Percentage of listener agreement	Items excluded	Analysable items
0;8,14	10	100%	0	10
0;9	83	63,86%	2	81
0;9,14	47	61,7%	5	42
0;10	22	59,09%	2	20

Table 28: Number of syllables in the vocalizations by NB

Age	Items	1 syll.	2 syll.	3 syll.	4 syll.	5 syll.	> 5 syll.
0;8,14	10	6	3	1	0	0	0
0;9	81	24	33	12	7	2	3
0;9,14	42	8	17	13	3	1	0
0;10	20	5	7	4	2	0	1

Table 29: Listener agreement on the vocalizations by JR

Age	Total utterances	Percentage of listener agreement	Items excluded	Analysable items
0;7,14	5	80%	0	5
0;8	19	89,47%	0	19
0;8,14	34	64,71%	1	33
0;9	1	100%	0	1
0;9,14	10	40%	1	9
0;10	4	50%	0	4
0;11	55	72,73%	1	54
0;11,14	12	91,67%	0	12

Table 30: Number of syllables in the vocalizations by JR

Age	Items	1 syll.	2 syll.	3 syll.	4 syll.	5 syll.	> 5 syll.
0;7,14	5	4	1	0	0	0	0
0;8	19	8	2	3	3	1	2
0;8,14	33	7	11	4	5	5	1
0;9	1	0	0	0	1	0	0
0;9,14	9	2	2	1	2	1	1
0;10	4	3	1	0	0	0	0
0;11	54	34	13	4	0	1	2
0;11,14	12	5	3	1	2	0	1

Table 31: Listener agreement on the vocalizations by LU

Age	Total utterances	Percentage of listener agreement	Items exclu-ded	Analysable items
0;5,14	38	76,32%	0	38
0;6	7	71,43%	0	7
0;6,14	1	0%	0	1
0;7	21	71,43%	1	20
0;7,14	26	88,46%	0	26
0;8	21	66,67%	0	21
0;8,14	31	61,29%	0	31
0;9	14	64,29%	1	13
0;9,14	122	77,05%	2	120
0;10	72	63,89%	1	71
0;11	4	50%	0	4
0;11,14	19	84,21%	0	19

Table 32: Number of syllables in the vocalizations by LU

Age	Items	1 syll.	2 syll.	3 syll.	4 syll.	5 syll.	> 5 syll.
0;5,14	38	9	13	5	1	0	0
0;6	7	3	3	1	0	0	0
0;6,14	1	1	0	0	0	0	0
0;7	20	1	2	3	4	3	7
0;7,14	26	9	9	2	2	1	3
0;8	21	3	7	8	2	1	0
0;8,14	31	1	6	4	4	6	10
0;9	13	0	5	3	2	1	2
0;9,14	120	27	36	26	12	10	9
0;10	71	11	32	13	7	3	5
0;11	4	1	1	1	1	0	0
0;11,14	19	0	5	7	5	2	0

Table 33: Listener agreement on the vocalizations by TJ

Age	Total utterances	Percentage of listener agreement	Items exclu-ded	Analysable items
0;6,14	1	100%	0	1
0;7	4	100%	0	4
0;7,14	5	60%	0	5
0;8	15	93,33%	0	15
0;8,14	15	93,33%	1	14
0;9	20	100%	0	20
0;9,14	7	100%	0	7
0;10	8	75%	1	7
0;11	19	94,74%	0	19

Table 34: Number of syllables in the vocalizations by TJ

Age	Items	1 syll.	2 syll.	3 syll.	4 syll.	5 syll.	> 5 syll.
0;6,14	1	1	0	0	0	0	0
0;7	4	3	0	1	0	0	0
0;7,14	5	4	1	0	0	0	0
0;8	15	11	4	0	0	0	0
0;8,14	14	5	6	2	1	0	0
0;9	20	17	3	0	0	0	0
0;9,14	7	7	0	0	0	0	0
0;10	7	4	2	1	0	0	0
0;11	19	16	2	1	0	0	0

Table 35: Listener agreement on the vocalizations by DP

Age	Total utterances	Percentage of listener agreement	Items exclu- ded	Analysable items
0;7	1	0%	0	1
0;7,14	9	100%	0	9
0;8	4	50%	0	4
0;8,14	4	100%	0	4
0;9	28	85,71%	0	28
0;9,14	7	100%	0	7
0;10	9	77,78%	0	9
0;10,14	8	75%	0	8
0;11	16	81,25%	0	16
0;11,14	8	100%	0	8

Table 36: Number of syllables in the vocalizations by DP

Age	Items	1 syll.	2 syll.	3 syll.	4 syll.	5 syll.	> 5 syll.
0;7	1	0	1	0	0	0	0
0;7,14	9	2	2	3	1	0	1
0;8	4	0	2	2	0	0	0
0;8,14	4	0	3	1	0	0	0
0;9	28	16	12	0	0	0	0
0;9,14	7	1	2	4	0	0	0
0;10	9	5	4	0	0	0	0
0;10,14	8	3	3	1	0	1	0
0;11	16	13	2	1	0	0	0
0;11,14	8	3	5	0	0	0	0

Table 37: Listener agreement on the vocalizations by SG

Age	Total utterances	Percentage of listener agreement	Items excluded	Analysable items
0;6,14	6	66,67%	0	6
0;7,14	8	75%	0	8
0;8	7	57,14%	0	7
0;8,14	10	70%	0	10
0;9	2	50%	0	2
0;9,14	15	53,33%	0	15
0;10	2	100%	0	2
0;10,14	40	85%	1	39
0;11	4	100%	0	4
0;11,14	17	76,47%	0	17

Table 38: Number of syllables in the vocalizations by SG

Age	Items	1 syll.	2 syll.	3 syll.	4 syll.	5 syll.	> 5 syll.
0;6,14	6	0	2	3	1	0	0
0;7,14	8	0	3	1	2	1	1
0;8	7	0	6	1	0	0	0
0;8,14	10	3	5	0	1	1	0
0;9	2	0	1	1	0	0	0
0;9,14	15	2	6	4	2	0	1
0;10	2	1	1	0	0	0	0
0;10,14	39	1	9	3	5	8	13
0;11	4	0	3	0	0	0	1
0;11,14	17	2	8	4	3	0	0

Table 39: Listener agreement on the vocalizations by LS

Age	Total utterances	Percentage of listener agreement	Items excluded	Analysable items
0;6,14	1	100%	0	1
0;7	7	42,86%	0	7
0;7,14	2	100%	0	2
0;8	14	85,71%	0	14
0;9	18	88,89%	0	18
0;9,14	2	100%	0	2
0;10	30	93,33%	0	30
0;11	19	73,68%	2	17

Table 40: Number of syllables in the vocalizations by LS

Age	Items	1 syll.	2 syll.	3 syll.	4 syll.	5 syll.	> 5 syll.
0;6,14	1	0	0	0	1	0	0
0;7	7	0	3	1	3	0	0
0;7,14	2	0	0	0	0	1	1
0;8	14	8	4	1	1	0	0
0;9	18	3	13	1	1	0	0
0;9,14	2	0	2	0	0	0	0
0;10	30	20	8	1	1	0	0
0;11	17	4	7	2	1	2	1

As these tables indicate, complete disagreement in the ratings of the three listeners was extremely rare. To be precise, there were only 21 out of 1113 babbles for which the listeners were unable to find a reliable judgement. Hence, this results in a percentage of 1,9% exclusion caused by listener disagreement, which is affordably low.

447 of the remaining 1092 babbling utterances were not taken into account statistically. Firstly, all monosyllabics (381 babbles) remained uninvestigated for obvious reasons, because any word stress matters are inconclusive in monosyllabics. Secondly, items with more than five syllables (66 babbles) were left also aside because as described under 3.3.3 such words do not exist monomorphematically in the target language German. Thus, 645 items were left for further investigations.

4.3.3   Comparison of the analysis parameters

Now the results of each of the analyses were compared to give an answer to the question, which combination of the perceptual and acoustic analysis parameters showed the greatest degree of overlapping results. Thus, all of the 645 polysyllabic items were counted out in order to find out which of the different analyses gave the same results to the question, which of the syllables is the most prominent one.

Table 41: Number of overlapping analysis results for the 645 polysyllabics

	Perceptual	Intensity	H1	A2	Spec. tilt	F0
Perceptual	-	411	309	275	222	252
Intensity	411	-	308	278	199	219
H1	309	308	-	232	97	191
A2	275	278	232	-	393	177
Spec. tilt	222	199	97	393	-	152
F0	252	219	191	177	152	-

Table 42: Parameters with the greatest degree of overlapping results

Analyses	Items	Percentage
Perceptual + Intensity	411	63,72%
A2 + Spectral tilt	393	60,93%
Perceptual + H1	309	47,91%
Intensity + H1	308	47,75%

As tables 41 and 42 suggest, there are two pairs of parameters, which result in an degree of overlapping larger than 50%. These are on one hand, the perceptual analysis conducted by the three adult listeners in combination with the intensity calculation and on the other, the value for A2 compared to the spectral tilt. Furthermore, in both cases, the parameter of the H1 measurement shows overlapping results for the perceptual analysis as well as the energy calculation with values larger than 45%. Hence, the H1 values will be included in the further presentation of the results.

4.3.4   Step 1: Location of main stress in a quantity-insensitive setting

Step 1 of the investigation is to examine the location of the main stressed syllable for every babbling vocalization. Here, two particular types of stress patterns are of central interest. Firstly, in a universal parameter setting, the main stressed syllable is expected to be the initial one in a majority of babbles. Secondly, in a more target-specific parameter setting, main stress is expected to fall on the penultimate syllable for most of the babbles. Disyllabics are of particular interest, as they appear to take the shape of a prosodic foot. The assumed parameter setting for the universal type of stress assignment is presented in (2)

(2) a) Foot shape parameters

      Headedness: Feet are strong on the [<u>left</u>/right]

      Quantity-sensitivity: Feet are [quantity-sensitive/-<u>insensitive</u>]

      Foot branching: Feet must be branching [<u>yes</u>/no]

      Boundedness: Feet are [<u>binary</u>/unbounded]

b) Foot construction parameters

      Directionality: Feet are built from the [<u>left</u>/right]

      Iterativity: Feet are built iteratively [yes/<u>no</u>]

c) Word tree dominance parameters

      Main stress rule: The word tree is strong on the [<u>left</u>/right]

In case of the more target-specific assumption, the following parameters are set to different values.

(3) b) Foot construction parameters

      Directionality: Feet are built from the [left/<u>right</u>]

c) Word tree dominance parameters

      Main stress rule: The word tree is strong on the [left/<u>right</u>]

For each of the five analysis parameters (perceptual, intensity, H1, spectral tilt and F0), two charts will be presented separately in order to illustrate babbles with two as well as with more than two syllables. These charts will show the percentage of stress location in the y-axis and the absolute values within the charts. Below the charts there will be tables showing the statistical results. These tables are separated into disyllabics, polysyllabcs and initial stress and polysyllabics and penultimate stress.

In the case of disyllabics, initially stressed babbles will appear with a blue-green gradient. Level stressed disyllabics will be marked black.

In babbles with more than two syllables, all stress locations other than initial or penultimate will be marked grey. Initially stressed items will be marked green, whereas such items with a target-specific penultimate stress will be blue.

4.3.4.1 Perceptual analysis
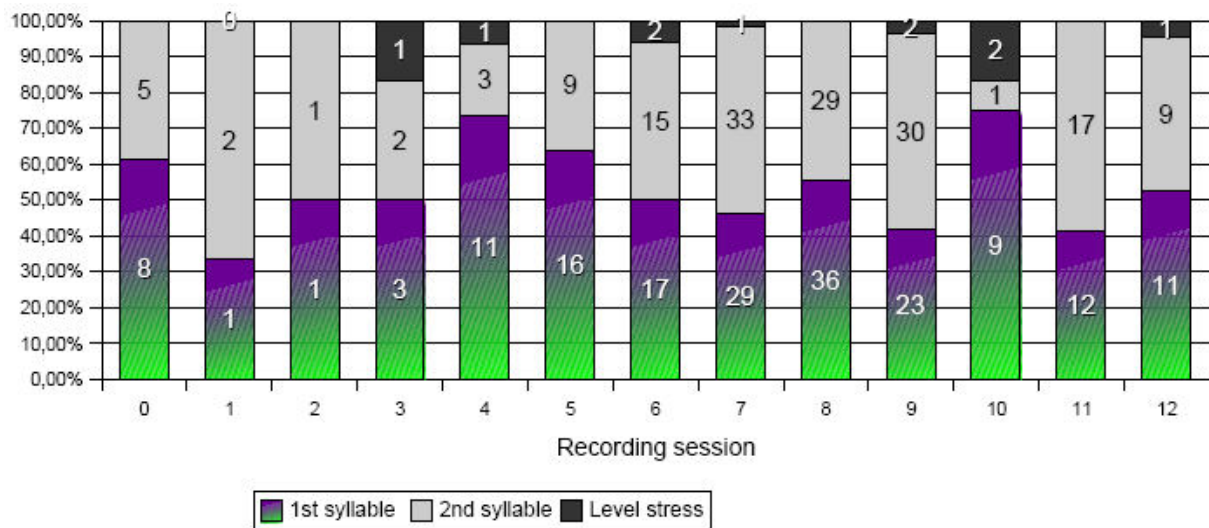
Disyllabics
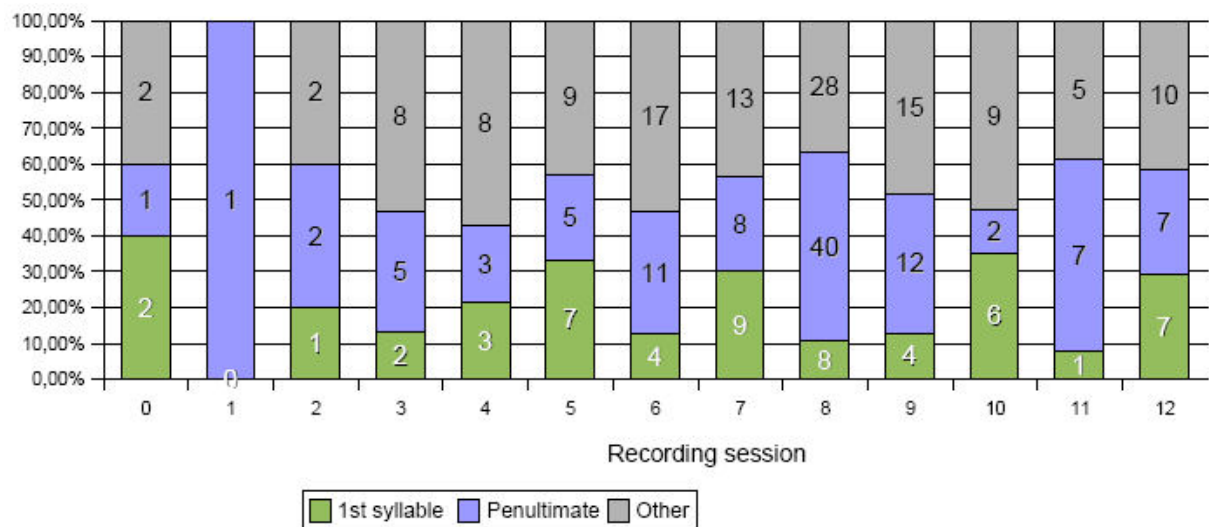
Polysyllabics

Table 43: Statistical results of the perceptual analysis for disyllabics

$N_{pos} = 6$	$N_{min} = 4$	$z = \dfrac{\left(6 - \dfrac{6}{2}\right)}{\sqrt{(6+4)}}$	$z = 0.9487$
$N_{equ} = 3$	$N_0 = 0$		$\Phi_{0;1(z)} = 0.8264$
			$p = 0.1736$

Table 44: Statistical results of the perceptual analysis for polysyllabics and initial stress

$N_{pos} = 0$ $N_{min} = 13$	$z = \dfrac{\left(0 - \dfrac{0}{2}\right)}{\sqrt{(0+13)}}$	$z = 0$
$N_{equ} = 0$ $N_0 = 0$		$\Phi_{0;1(z)} = 0.5$
		$p = 0.5$

Table 45: Statistical results of the perceptual analysis for polysyllabics and penultimate stress

$N_{pos} = 3$ $N_{min} = 10$	$z = \dfrac{\left(3 - \dfrac{3}{2}\right)}{\sqrt{(3+10)}}$	$z = 0.416$
$N_{equ} = 0$ $N_0 = 0$		$\Phi_{0;1(z)} = 0.6591$
		$p = 0.3409$

4.3.4.2 Intensity measurement

Disyllabics

Polysyllabics

Table 46: Statistical results of the intensity measurement for disyllabics

N_{pos} = 4 N_{min} = 7	$z=\dfrac{(4-\dfrac{4}{2})}{\sqrt{(4+7)}}$	z = 0.4152
N_{equ} = 2 N_0 = 0		$\Phi_{0;1(z)}$ = 0.6591
		p = 0.3409

Table 47: Statistical results of the intensity measurement for polysyllabics and initial stress

N_{pos} = 1 N_{min} = 12	$z=\dfrac{(1-\dfrac{1}{2})}{\sqrt{(1+12)}}$	z = 0.1387
N_{equ} = 0 N_0 = 0		$\Phi_{0;1(z)}$ = 0.5517
		p = 0.4483

Table 48: Statistical resuls of the intensity measurement for polysyllabics and penultimate stress

N_{pos} = 0 N_{min} = 12	$z=\dfrac{(0-\dfrac{0}{2})}{\sqrt{(0+12)}}$	z = 0
N_{equ} = 1 N_0 = 0		$\Phi_{0;1(z)}$ = 0.5
		p = 0.5

4.3.4.3 H1 measurement

Disyllabics
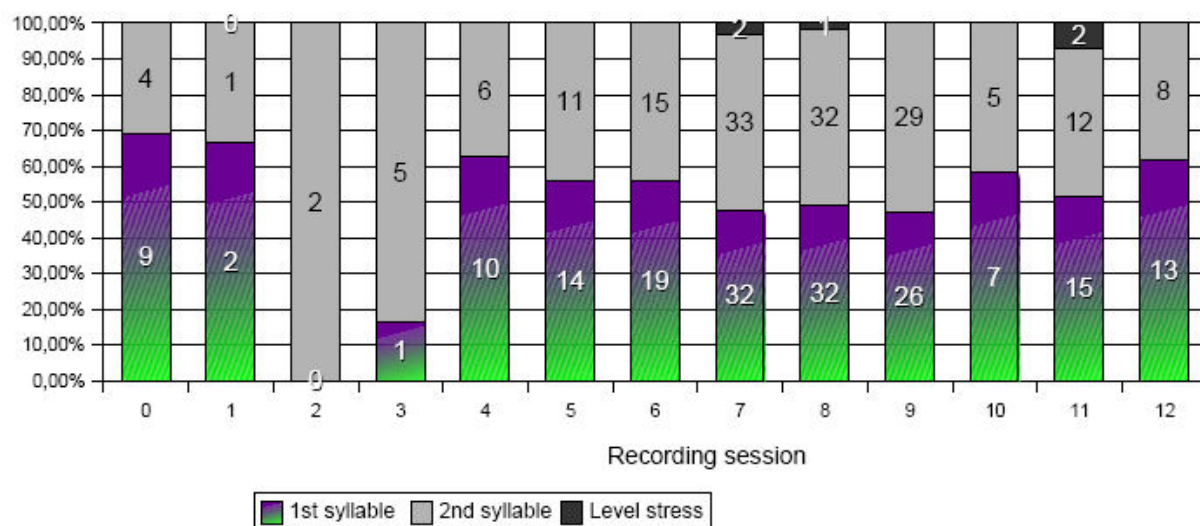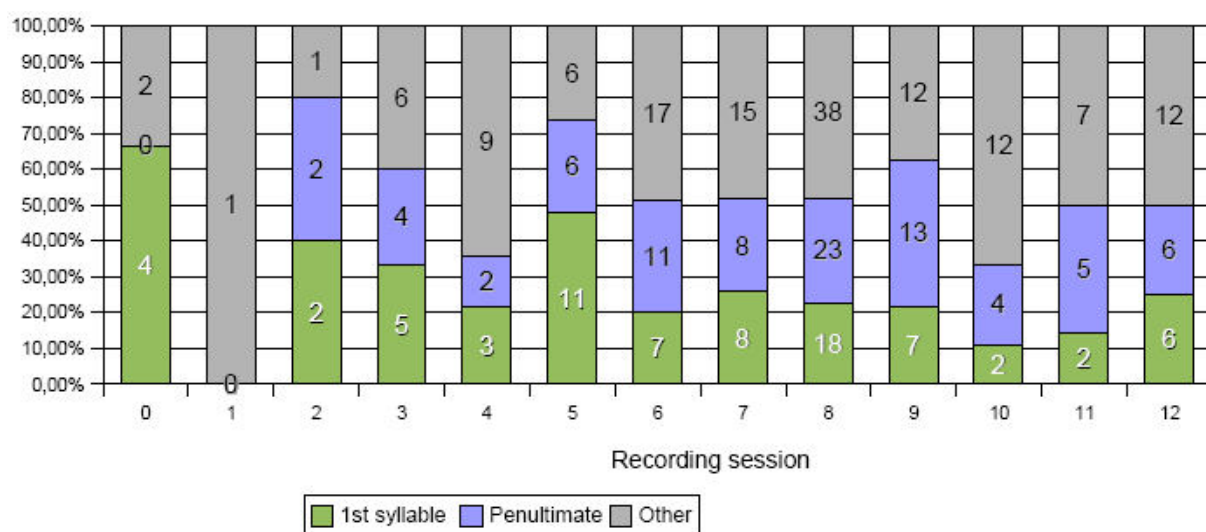
Polysyllabics

Table 49: Statistical results of the H1 measurement for disyllabics

$N_{pos} = 8$	$N_{min} = 5$		
$N_{equ} = 0$	$N_0 = 0$	$z = \dfrac{\left(8 - \dfrac{8}{2}\right)}{\sqrt{(8+5)}}$	$z = 1.1094$
			$\Phi_{0;1(z)} = 0.8643$
			$p = 0.1357$

Table 50: Statistical results of the H1 measurement for polysyllabics and initial stress

$N_{pos} = 1$ $\quad$ $N_{min} = 12$ $N_{equ} = 0$ $\quad$ $N_0 = 0$		$z = \dfrac{(1 - \frac{1}{2})}{\sqrt{(1+12)}}$	$z = 0.1387$ $\Phi_{0;1(z)} = 0.5517$ $p = 0.4483$

Table 51: Statistical results of the H1 measurement for polysyllabics and penultimate stress

$N_{pos} = 0$ $\quad$ $N_{min} = 13$ $N_{equ} = 0$ $\quad$ $N_0 = 0$		$z = \dfrac{(0 - \frac{0}{2})}{\sqrt{(0+13)}}$	$z = 0$ $\Phi_{0;1(z)} = 0.5$ $p = 0.5$

4.3.4.4 Spectral tilt calculation
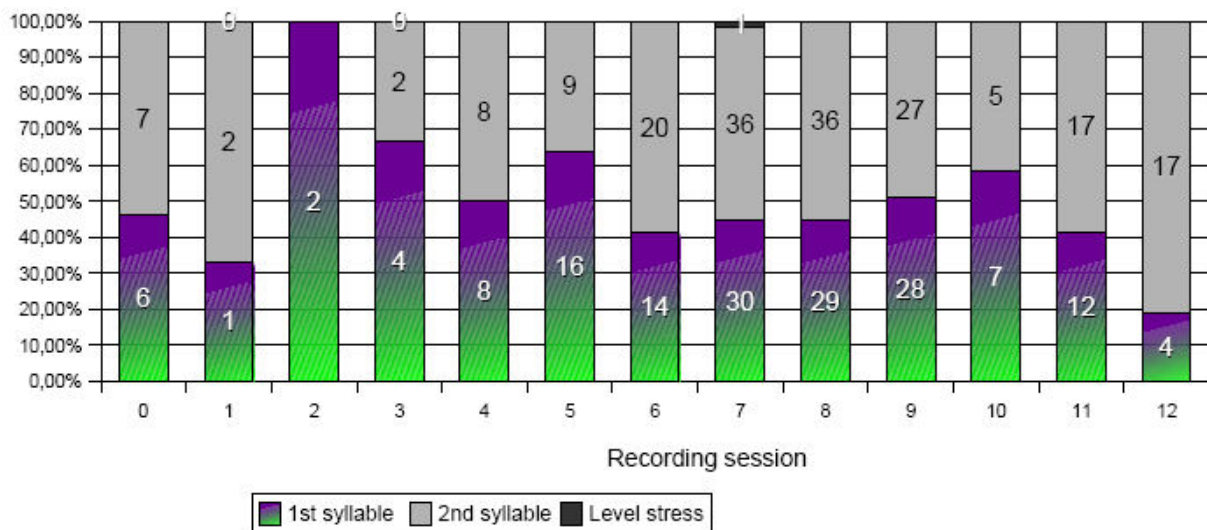
Disyllabics
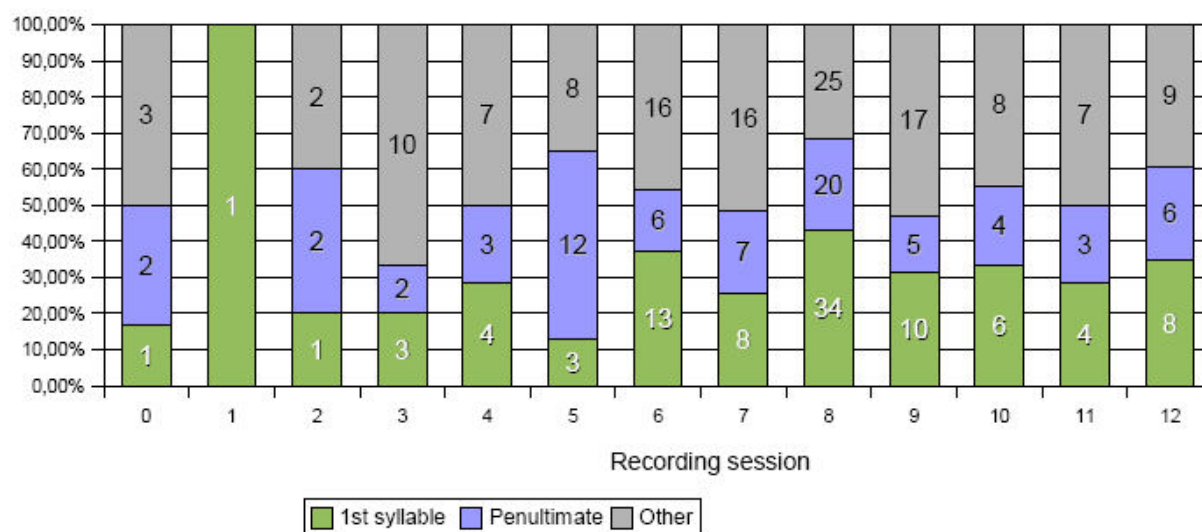
Polysyllabics

Table 52: Statistical results of the spectral tilt calculation for disyllabics

N_{pos} = 5 N_{min} = 7 N_{equ} = 1 N_0 = 0	$z = \dfrac{(5 - \frac{5}{2})}{\sqrt{(5+7)}}$	$z = 0.7217$ $\Phi_{0;1(z)} = 0.7642$ $p = 0.2358$

Table 53: Statistical results of the spectral tilt calculation for polysyllabics and initial stress

N_{pos} = 1 N_{min} = 12 N_{equ} = 0 N_0 = 0	$z = \dfrac{(1 - \frac{1}{2})}{\sqrt{(1+12)}}$	$z = 0.1387$ $\Phi_{0;1(z)} = 0.5517$ $p = 0.4483$

Table 54: Statistical results of the spectral tilt calculation for polysyllabics and penultimate stress

N_{pos} = 1 N_{min} = 12 N_{equ} = 0 N_0 = 0	$z = \dfrac{(1 - \frac{1}{2})}{\sqrt{(1+12)}}$	$z = 0.1387$ $\Phi_{0;1(z)} = 0.5517$ $p = 0.4483$

4.3.4.5 F0 measurement

Disyllabics
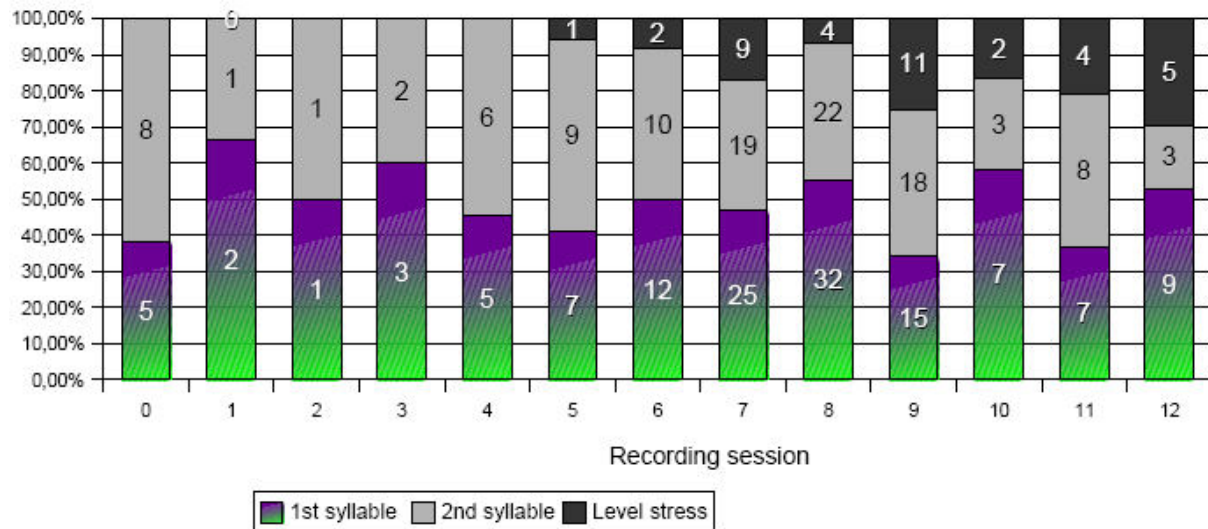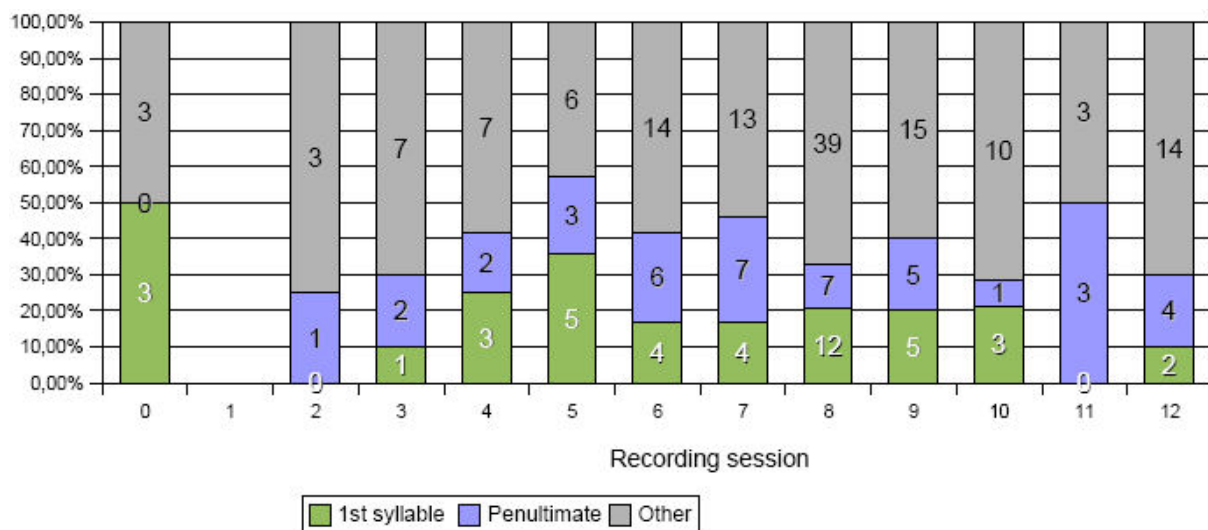
Polysyllabics

Table 55: Statistical results of the F0 measurement for disyllabics

N_{pos} = 5	N_{min} = 6	$z = \dfrac{\left(5 - \dfrac{5}{2}\right)}{\sqrt{(5+6)}}$	z = 0.7538
N_{equ} = 2	N_0 = 0		$\Phi_{0;1(z)}$ = 0.7734
			p = 0.2266

Table 56: Statistical results of the F0 measurement for polysyllabics and initial stress

$N_{pos} = 0$ $N_{min} = 11$	$z = \dfrac{(0 - \frac{0}{2})}{\sqrt{(0+11)}}$	$z = 0$
$N_{equ} = 1$ $N_0 = 1$		$\Phi_{0;1(z)} = 0.5$
		$p = 0.5$

Table 57: Statistical results of the F0 measurement for polysyllabics and penultimate stress

$N_{pos} = 0$ $N_{min} = 11$	$z = \dfrac{(0 - \frac{0}{2})}{\sqrt{(0+11)}}$	$z = 0$
$N_{equ} = 1$ $N_0 = 1$		$\Phi_{0;1(z)} = 0.5$
		$p = 0.5$

As these results clearly indicate, the location of main stress is not significantly predictable. There is a weak tendency exhibited by the perceptual analysis and the H1 measurement to-wards predictability of stress in disyllabics. Furthermore, these results contain no evidence for a development over time.

4.3.5   Step 2: Syllable weight

Step 2 of the investigation is to answer the question, as to whether syllables larger than CV or V are treated differently by the subjects. As part of the perceptual analysis a CV-template was transcribed for each babble. Hence, the different types of syllable structures can be examined for each recording session. The following table lists the frequencies for every syllable shapes observed in the 645 polysyllabic vocalizations, which were used for the further perceptual and acoustic analyses.

Table 58: Syllable types per recording session for all seven subjects

Age	V	CV	VV	CVV	VC	CVC	VVC	CVVC	VCC	CVCC
0;5.14	6	30	1	4	1	3	0	0	0	0
0;6	4	5	0	0	0	0	0	0	0	0
0;6.14	4	11	0	6	0	0	0	0	0	0
0;7	11	44	3	10	0	1	0	0	1	0
0;7.14	11	62	3	6	0	4	0	0	0	0
0;8	18	82	1	20	2	5	0	0	0	1
0;8.14	35	148	1	19	1	4	0	0	0	0
0;9	55	135	8	36	0	9	1	0	0	0
0;9.14	37	294	8	71	0	10	0	0	0	0
0;10	53	142	4	19	1	13	0	0	0	0
0;10.14	13	76	7	3	0	2	0	0	0	0
0;11	18	68	4	13	0	5	0	0	0	0
0;11.14	20	88	9	10	0	1	0	0	0	0

Although syllables of the types CV and V are observed most frequently in the data, larger syllables do appear. Hence, the question can be asked, as to whether these larger syllables attract main stress, regardless of their actual position within a babble.

The following charts show the results for the perceptual analyses as well as for the acoustic parameters intensity, H1, spectral tilt and F0. There will be separate charts for the syllable types (C)VV and (C)VC. Larger patterns were too rare to be taken into account statistically. Here, these syllable types are distinguished in three ways. They can be main stressed (s = "stressed"). On the other hand they can be unstressed, whilste a light syllable (C)V bears main stress (uli = "unstressed compared to a light syllable") or another larger syllable within the babble (uhe = "unstressed compared to a heavy syllable").

4.3.5.1 Perceptual analysis

CVV syllables
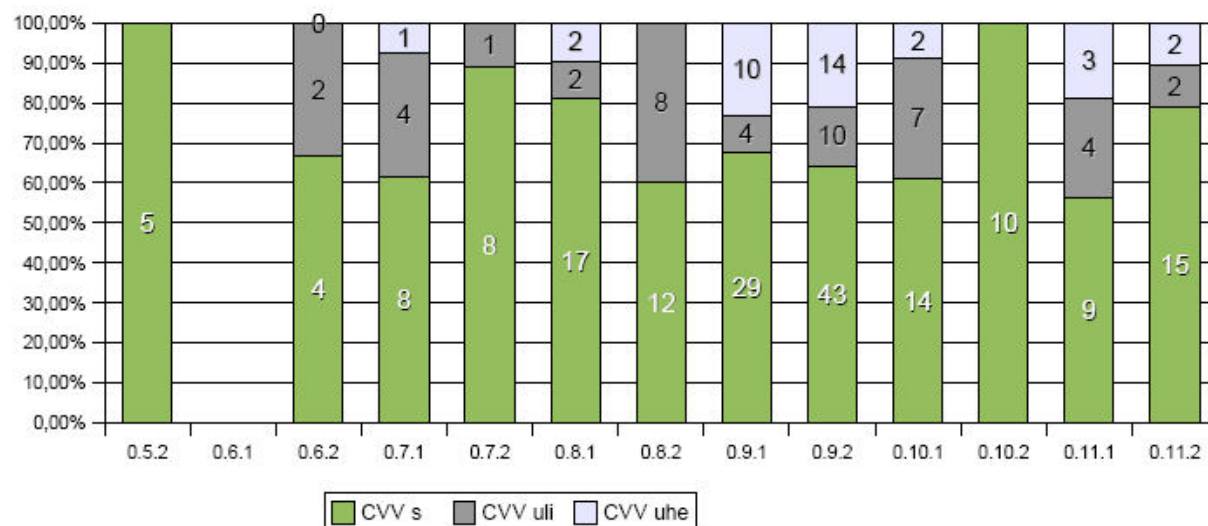
CVC syllables
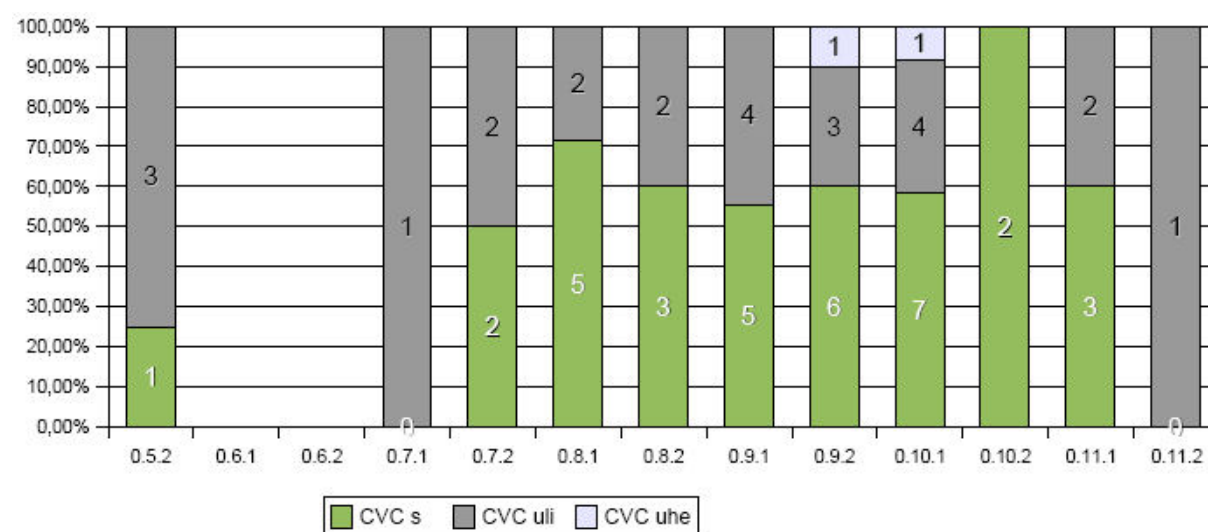
Table 59: Statistical results of the perceptual analysis for CVV syllables

$$N_{pos} = 12 \qquad N_{min} = 0$$

$$N_{equ} = 0 \qquad N_{0} = 1$$

$$z = \frac{(12 - \frac{12}{2})}{\sqrt{(12+0)}}$$

$$z = 1.732$$

$$\Phi_{0;1(z)} = 0.9581$$

$$p^{*} = 0.0419$$

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Table 60: Statistical results of the perceptual analysis for CVC syllables

$N_{pos} = 7 \quad N_{min} = 3$	$z = \dfrac{\left(7 - \dfrac{7}{2}\right)}{\sqrt{(7+3)}}$	$z = 1.1068$
$N_{equ} = 1 \quad N_0 = 2$		$\Phi_{0;1(z)} = 0.8643$
		$p = 0.1357$

4.3.5.2 Intensity measurement

CVV syllables
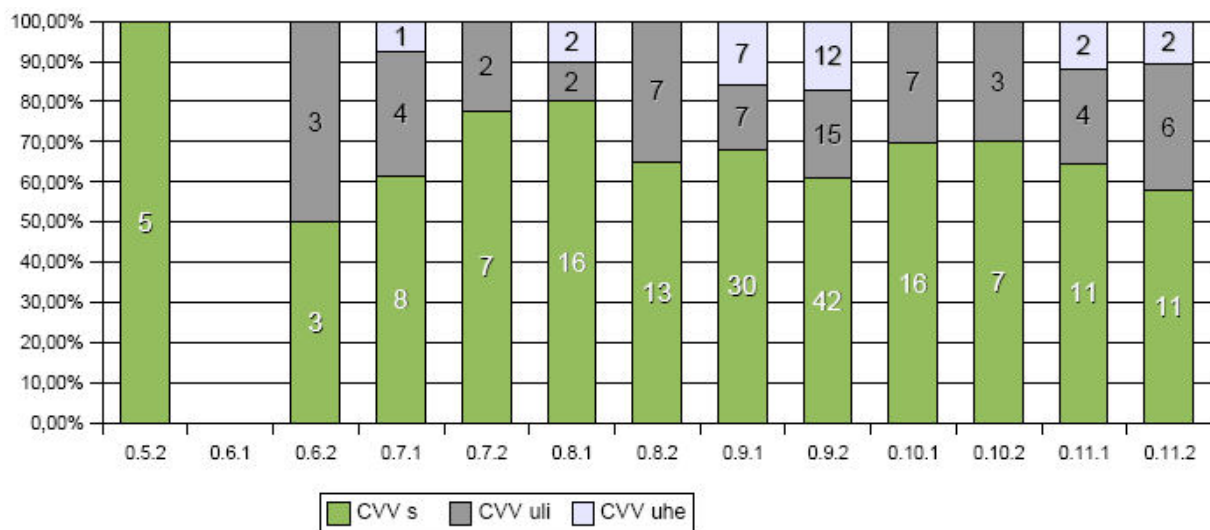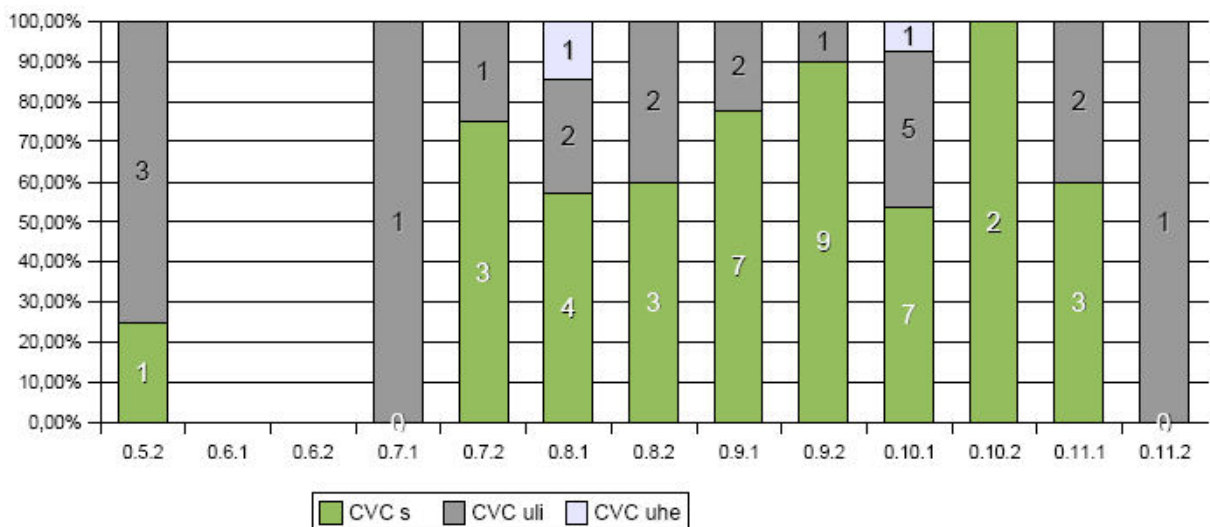
CVC syllables

Table 61: Statistical results of the intensity measurement for CVV syllables

$N_{pos} = 11$ $N_{min} = 0$ $N_{equ} = 1$ $N_0 = 1$	$z = \dfrac{(11 - \dfrac{11}{2})}{\sqrt{(11+0)}}$	$z = 1.6583$ $\Phi_{0;1(z)} = 0.9505$ $p^* = 0.0495$

Table 62: Statistical results of the intensity measurement for CVC syllables

$N_{pos} = 8$ $N_{min} = 3$ $N_{equ} = 0$ $N_0 = 2$	$z = \dfrac{(8 - \dfrac{8}{2})}{\sqrt{(8+3)}}$	$z = 1.206$ $\Phi_{0;1(z)} = 0.8849$ $p = 0.1151$

4.3.5.3 H1 measurement

CVV syllables
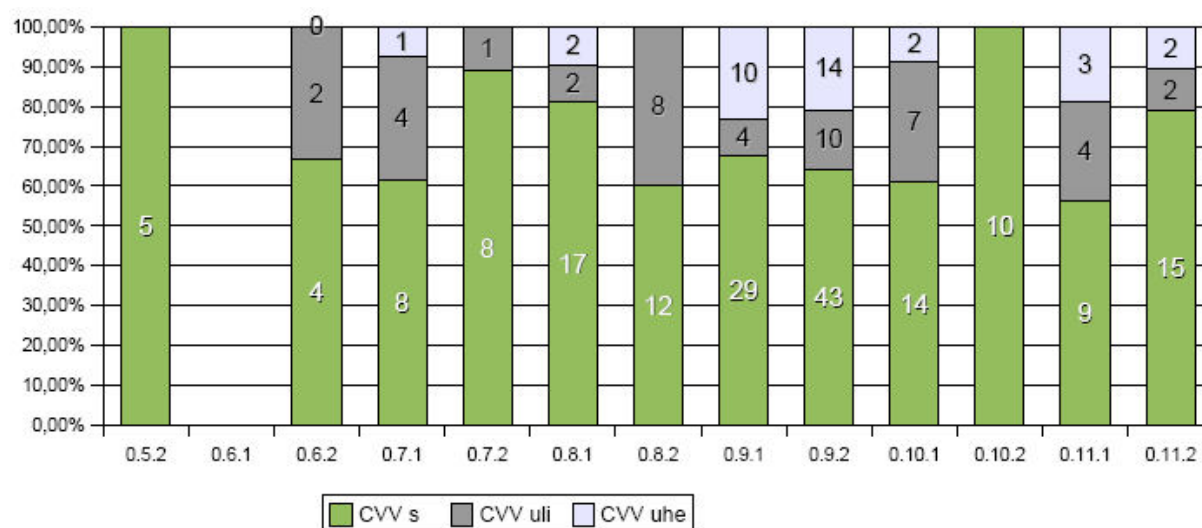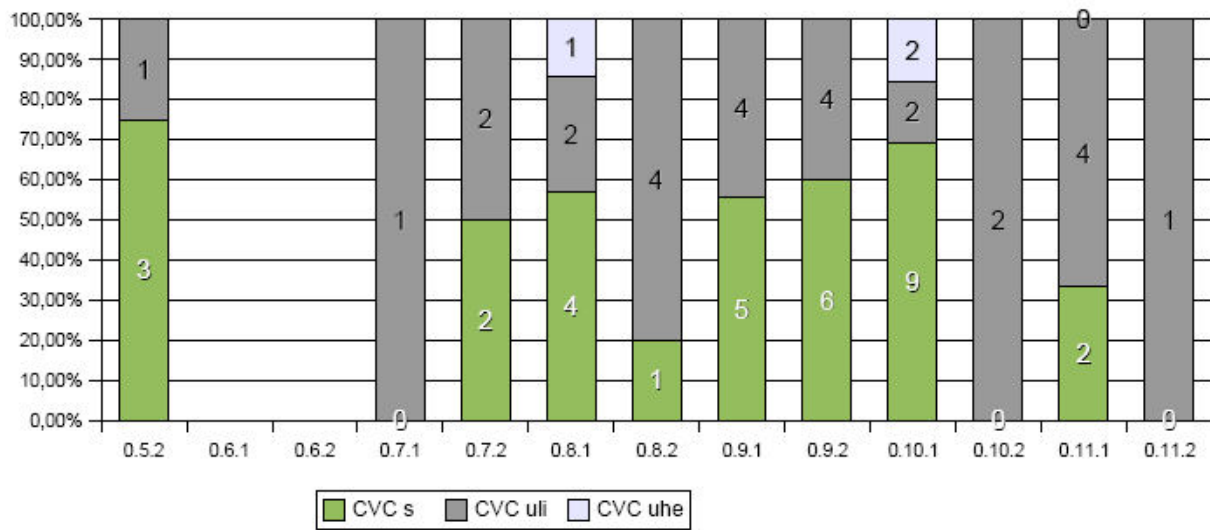
CVC syllables

Table 63: Statistical results of the H1 measurement for CVV syllables

$N_{pos} = 12$ $N_{equ} = 0$	$N_{min} = 0$ $N_0 = 1$	$z = \dfrac{(12 - \dfrac{12}{2})}{\sqrt{(12 + 0)}}$	$z = 1.732$ $\Phi_{0;1(z)} = 0.9581$ $p^* = 0.0419$

Table 64: Statistical results of the H1 measurement for CVC syllables

$N_{pos} = 5$ $N_{equ} = 1$	$N_{min} = 5$ $N_0 = 2$	$z = \dfrac{(5 - \dfrac{5}{2})}{\sqrt{(5 + 5)}}$	$z = 0.79$ $\Phi_{0;1(z)} = 0.7852$ $p = 0.2148$

4.3.5.4 Spectral tilt calculation

CVV syllables
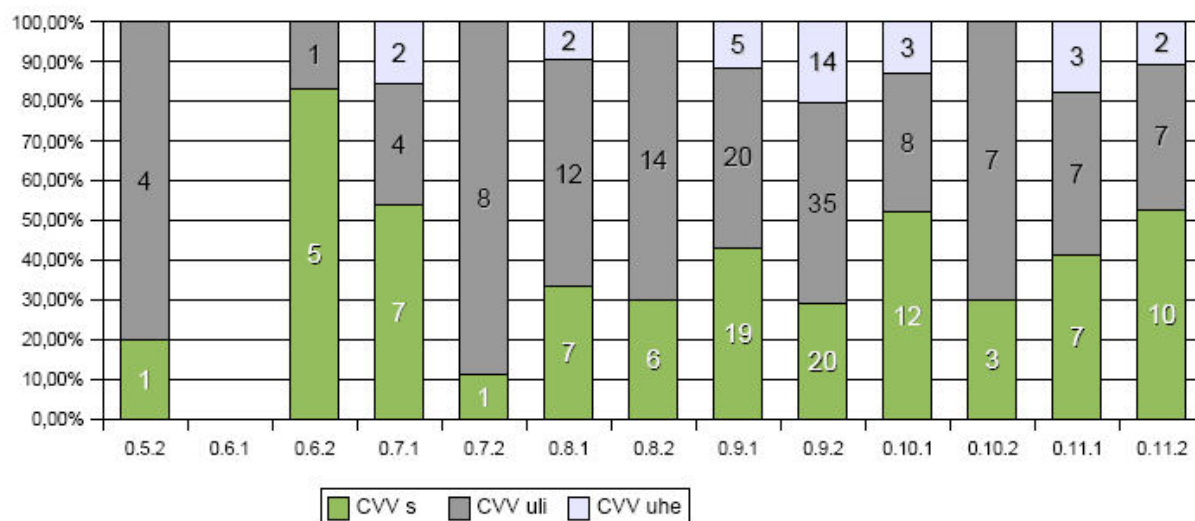
CVC syllables
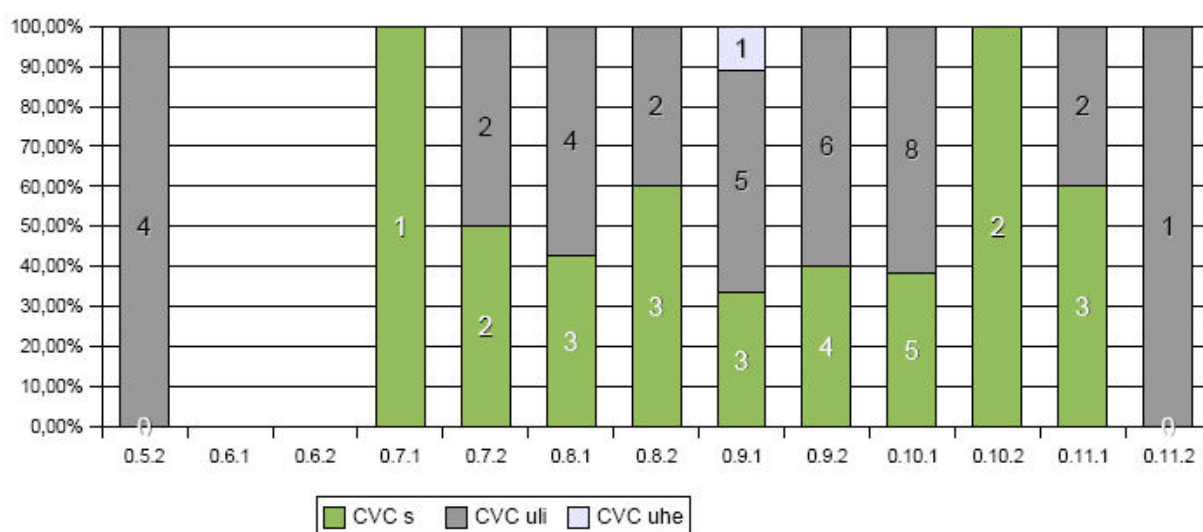
Table 65: Statistical results of the spectral tilt calculation for CVV syllables

$N_{pos} = 4$ $N_{min} = 8$ $N_{equ} = 0$ $N_0 = 1$		$z = \dfrac{\left(4 - \dfrac{4}{2}\right)}{\sqrt{(4+8)}}$	$z = 0.5773$ $\Phi_{0;1(z)} = 0.7157$ $p = 0.2843$

Table 66: Statistical results of the spectral tilt calculation for CVC syllables

$N_{pos} = 4$ $N_{min} = 6$	$z = \dfrac{\left(4-\dfrac{4}{2}\right)}{\sqrt{(4+6)}}$	$z = 0.6324$
$N_{equ} = 1$ $N_0 = 2$		$\Phi_{0;1(z)} = 0.7356$
		$p = 0.2644$

4.3.5.5 F0 measurement

CVV syllables
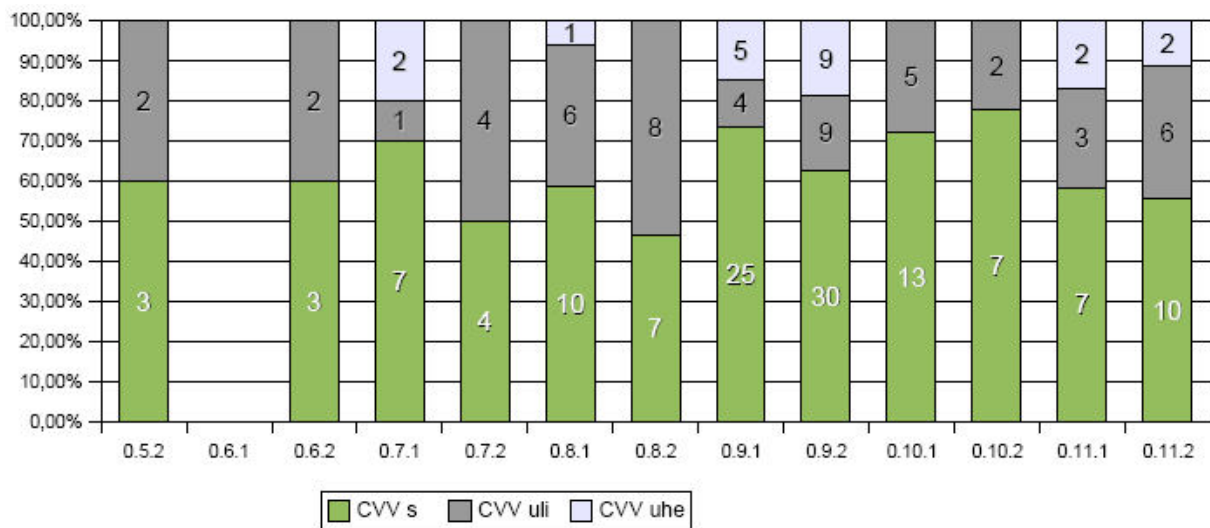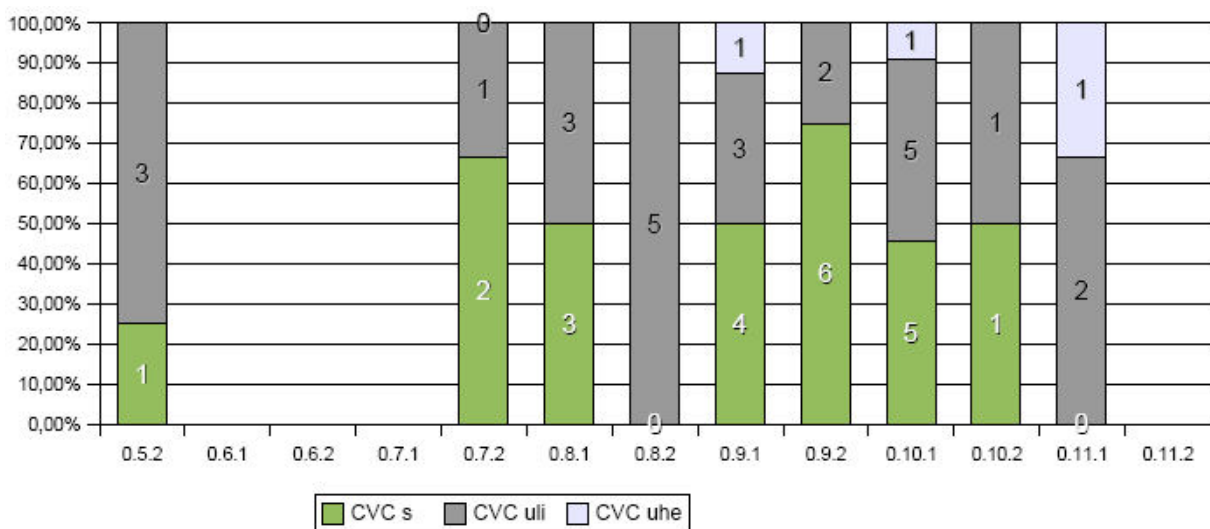
CVC syllables

Table 67: Statistical results of the F0 measurement for CVV syllables

$N_{pos} = 10$ $N_{min} = 1$ $\quad$ $N_{equ} = 1$ $N_0 = 1$	$z = \dfrac{\left(10 - \dfrac{10}{2}\right)}{\sqrt{(10+1)}}$	$z = 1.5075$ $\Phi_{0;1(z)} = 0.9332$ $p^* = 0.0668$

Table 68: Statistical results of the F0 measurement for CVC syllables

$N_{pos} = 2$ $N_{min} = 4$ $\quad$ $N_{equ} = 3$ $N_0 = 4$	$z = \dfrac{\left(2 - \dfrac{2}{2}\right)}{\sqrt{(2+4)}}$	$z = 0.4082$ $\Phi_{0;1(z)} = 0.6554$ $p = 0.3446$

The placement of stress on CVV syllables can be predicted by both the perceptual analysis as well as the acoustical measurements of intensity, H1 and F0. The calculation of the spectral tilt, however appears to be inconclusive. Stress on CVC syllables is unpredictable. There appears to be no development over time in the data, meaning that predictability doesn't increase towards the later recording sessions.

4.3.6   Step 3: Location of main stress in a quantity-sensitive setting

As was observed in step 2 syllables larger than (C)V show a tendency to attract stress. Thus, in step 3 syllable weight and stress patterns are observed in combination. Here, a setting of the prosodic parameters is assumed, which is closer to that of the target language German. In particular [directionality of footing] is set to "right" and [quantity-sensitivity] is assumed to distinguish heavy and light syllables. Extrametricality is not taken into account here. The complete setting can be seen in (4).

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(4)   a) Foot shape parameters

        Headedness: Feet are strong on the [left/right]

        Quantity-sensitivity: Feet are [quantity-sensitive/-insensitive]

        Weight: Feet are quantity-sensitive to
[closed syllable/nucleus/rhyme]

        Foot branching: Feet must be branching [yes/no]

        Boundedness: Feet are [binary/unbounded]

   b) Foot construction parameters

        Directionality: Feet are built from the [left/right]

        Iterativity: Feet are built iteratively [yes/no]

   c) Word tree dominance parameters

        Main stress rule: The word tree is strong on the [left/right]

4.3.6.1 Perceptual analysis
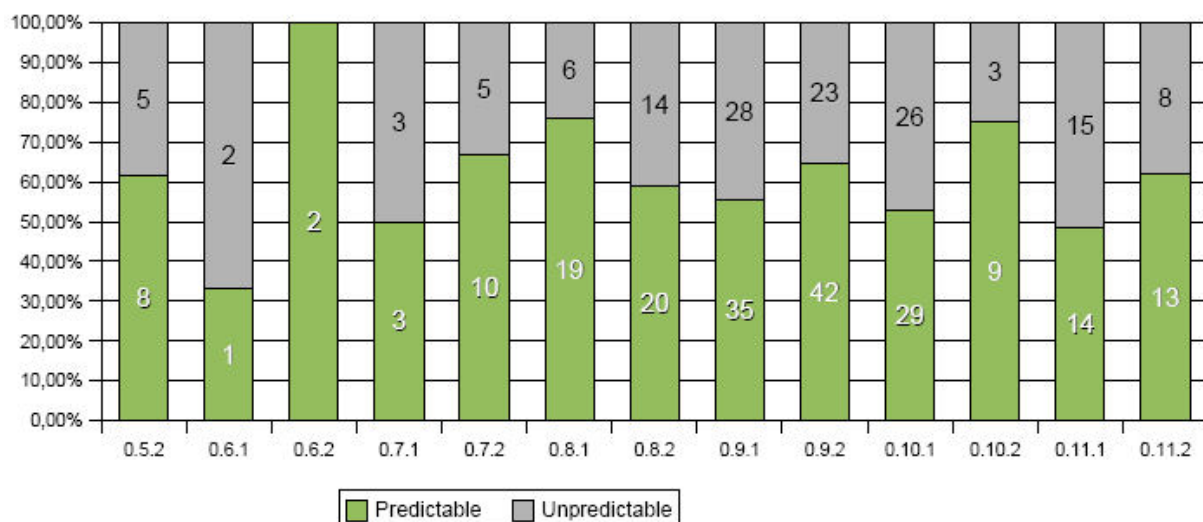
Disyllabics
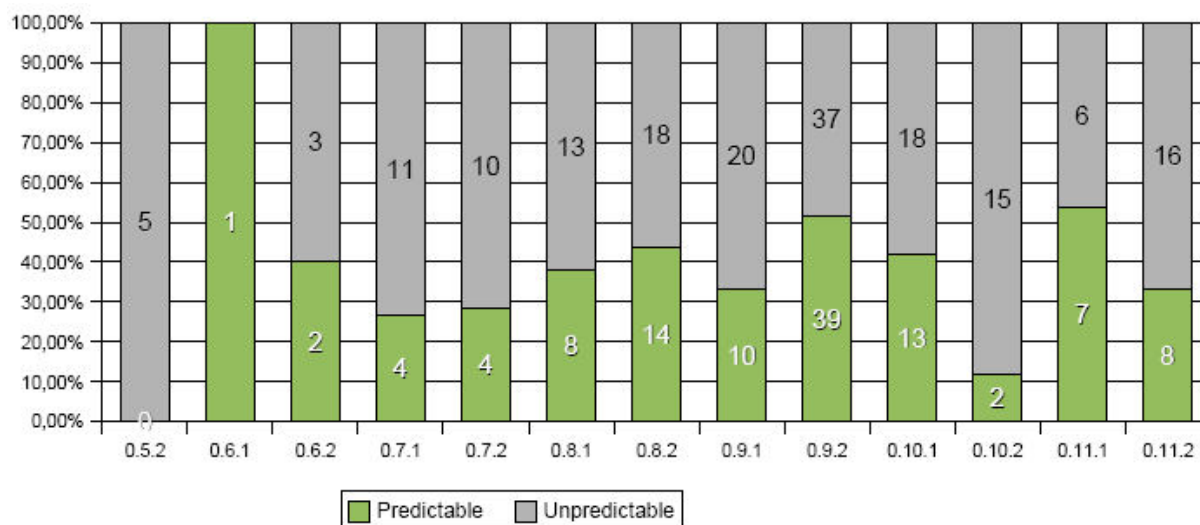
Polysyllabics

Table 69: Statistical results of the perceptual analysis for disyllabics

N_{pos} = 10 N_{equ} = 1	N_{min} = 2 N_0 = 0	$z = \dfrac{(10 - \frac{10}{2})}{\sqrt{(10+2)}}$	z = 1.4434 $\Phi_{0;1(z)}$ = 0.9251 p* = 0.0749

Table 70: Statistical results of the perceptual analysis for polysyllabics

N_{pos} = 3 N_{equ} = 0	N_{min} = 10 N_0 = 0	$z = \dfrac{(3 - \frac{3}{2})}{\sqrt{(3+10)}}$	z = 0.416 $\Phi_{0;1(z)}$ = 0.6591 p = 0.3409

4.3.6.2 Intensity measurement
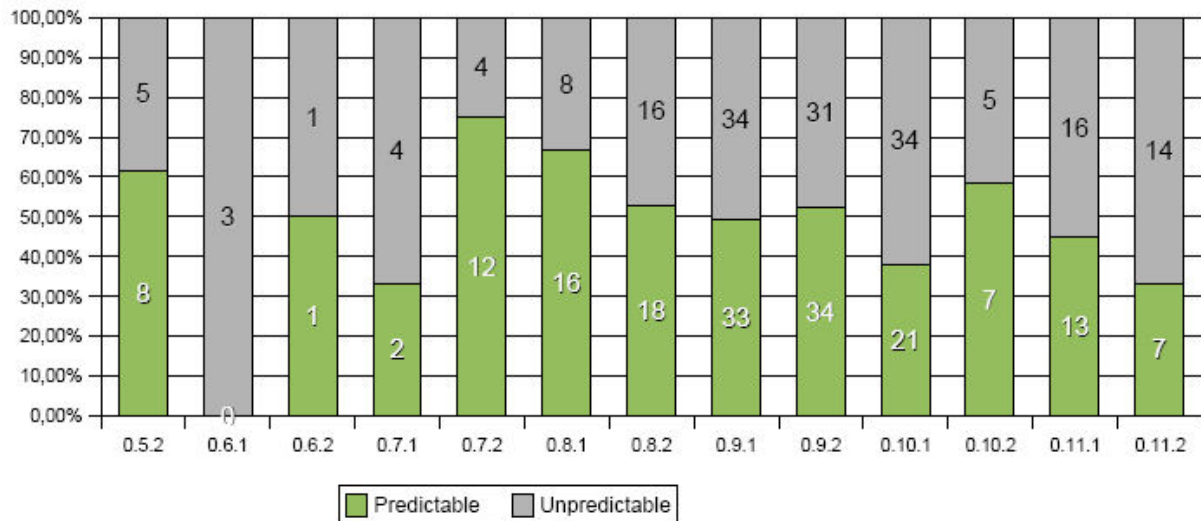
Disyllabics

Polysyllabics

Table 71: Statisctical results of the intensity measurement for disyllabics

$N_{pos} = 6$	$N_{min} = 6$	$z = \dfrac{(6 - \dfrac{6}{2})}{\sqrt{(6+6)}}$	$z = 0.866$
$N_{equ} = 1$	$N_0 = 0$		$\Phi_{0;1(z)} = 0.8051$
			$p = 0.1949$

Table 72: Statistical results of the intensity measurement for polysyllaics

$N_{pos} = 0$ $N_{min} = 12$	$z = \dfrac{\left(0 - \dfrac{0}{2}\right)}{\sqrt{(0+12)}}$	$z = 0$
$N_{equ} = 1$ $N_0 = 0$		$\Phi_{0;1(z)} = 0.5$
		$p = 0.5$

4.3.6.3 H1 measurement

Disyllabics
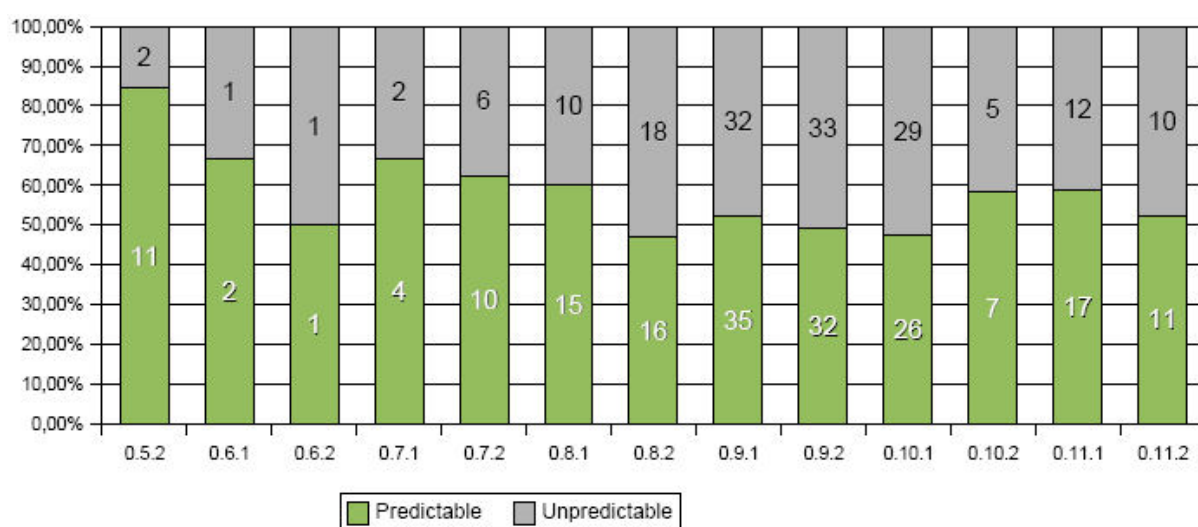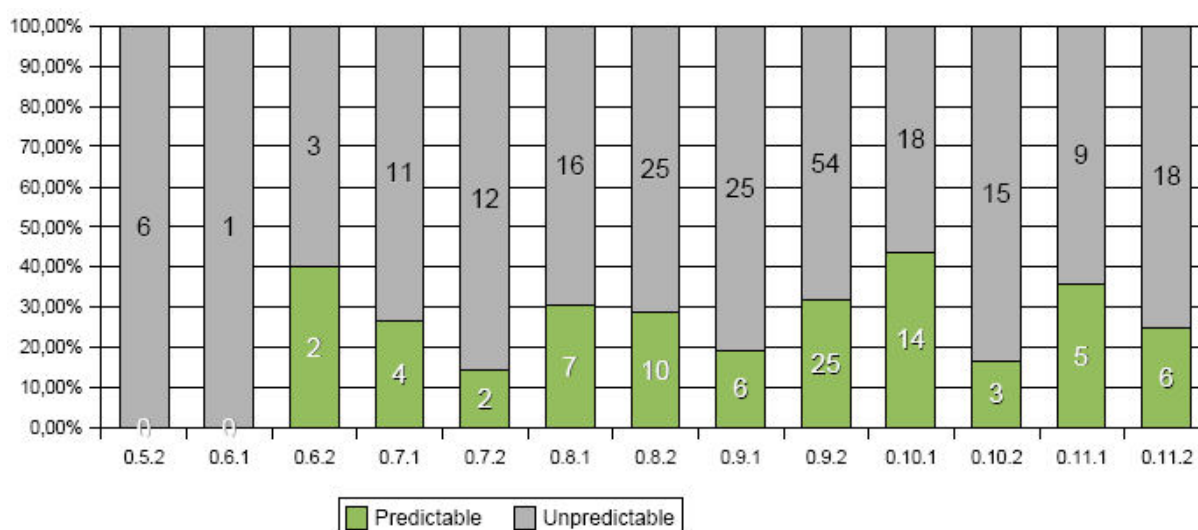
Polysyllabics

Table 73: Statisctical results of the H1 measurement for disyllabics

$N_{pos} = 9$ $N_{min} = 3$ $N_{equ} = 1$ $N_0 = 0$	$z = \dfrac{\left(9 - \dfrac{9}{2}\right)}{\sqrt{(9+3)}}$	$z = 1.299$ $\Phi_{0;1(z)} = 0.9015$ $p^* = 0.0985$

Table 74: Statistical results of the H1 measurement for polysyllabics

$N_{pos} = 0$ $N_{min} = 13$ $N_{equ} = 0$ $N_0 = 0$	$z = \dfrac{\left(0 - \dfrac{0}{2}\right)}{\sqrt{(0+13)}}$	$z = 0$ $\Phi_{0;1(z)} = 0.5$ $p = 0.5$

4.3.6.4 Spectral tilt calculation
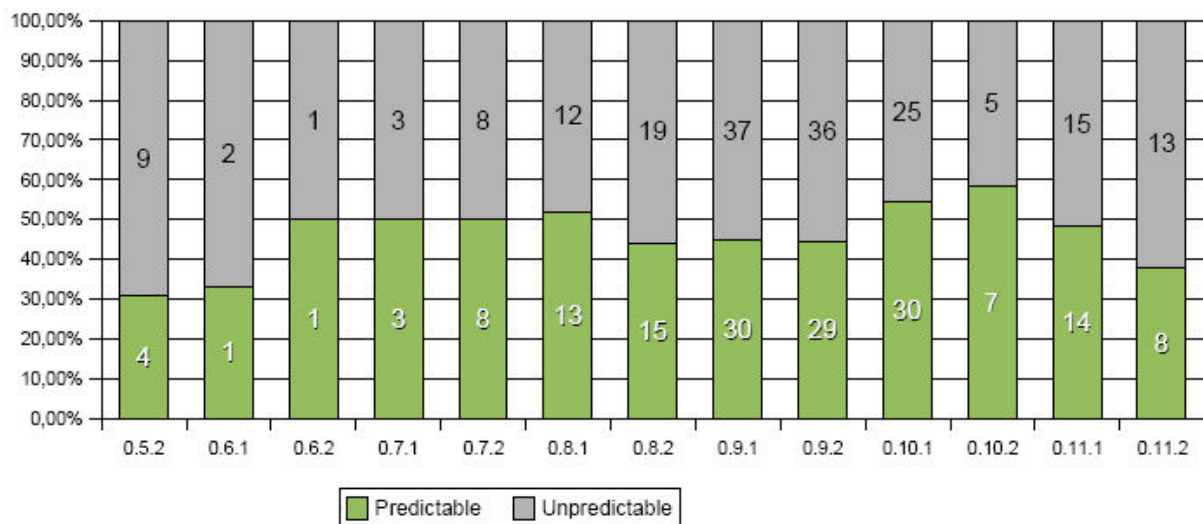
Disyllabics
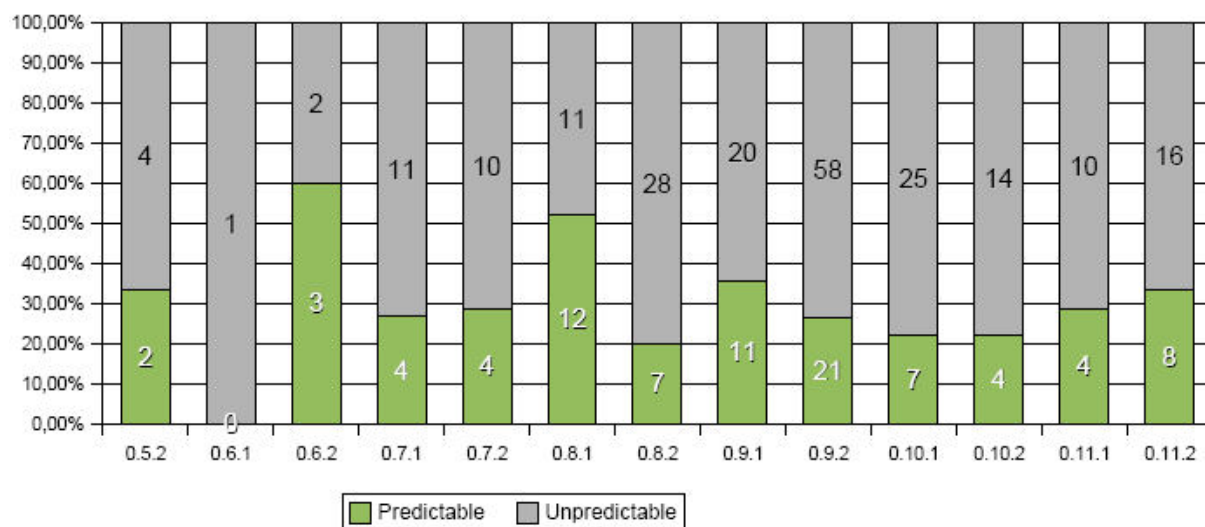
Polysyllabics

Table 75: Statistical results of the spectral tilt calculation for disyllabics

N_{pos} = 3 N_{min} = 7	$z=\dfrac{(3-\frac{3}{2})}{\sqrt{(3+7)}}$	z = 0.4743
N_{equ} = 3 N_0 = 0		$\Phi_{0;1(z)}$ = 0.6808
		p = 0.3192

Table 76: Statistical results of the spectral tilt calculation for polysyllabics

N_{pos} = 2 N_{min} = 11	$z=\dfrac{(2-\frac{2}{2})}{\sqrt{(2+11)}}$	z = 0.2773
N_{equ} = 0 N_0 = 0		$\Phi_{0;1(z)}$ = 0.6064
		p = 0.3936

4.3.6.5 F0 measurement

Disyllabics
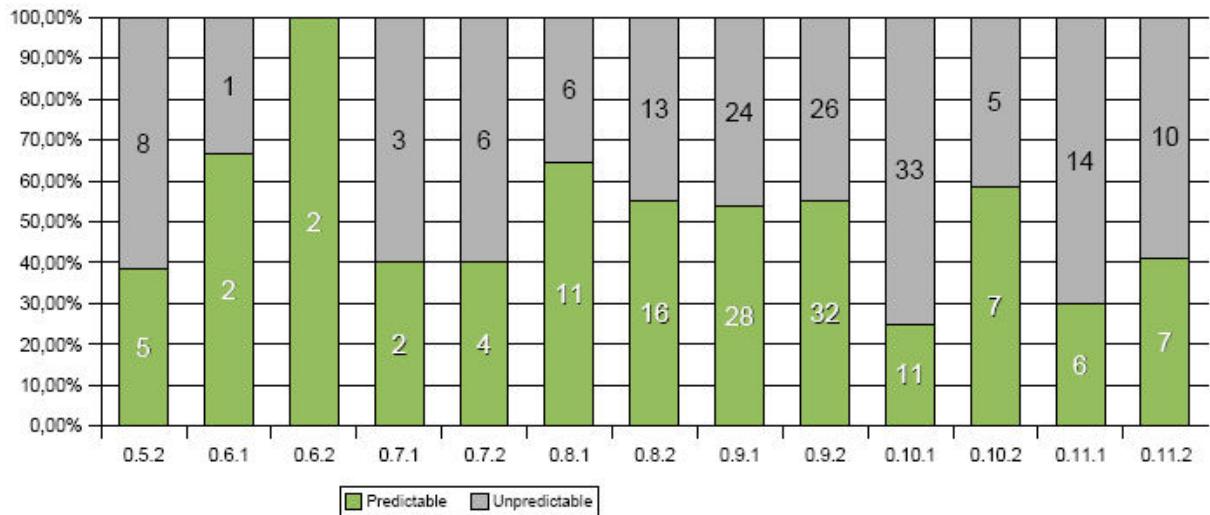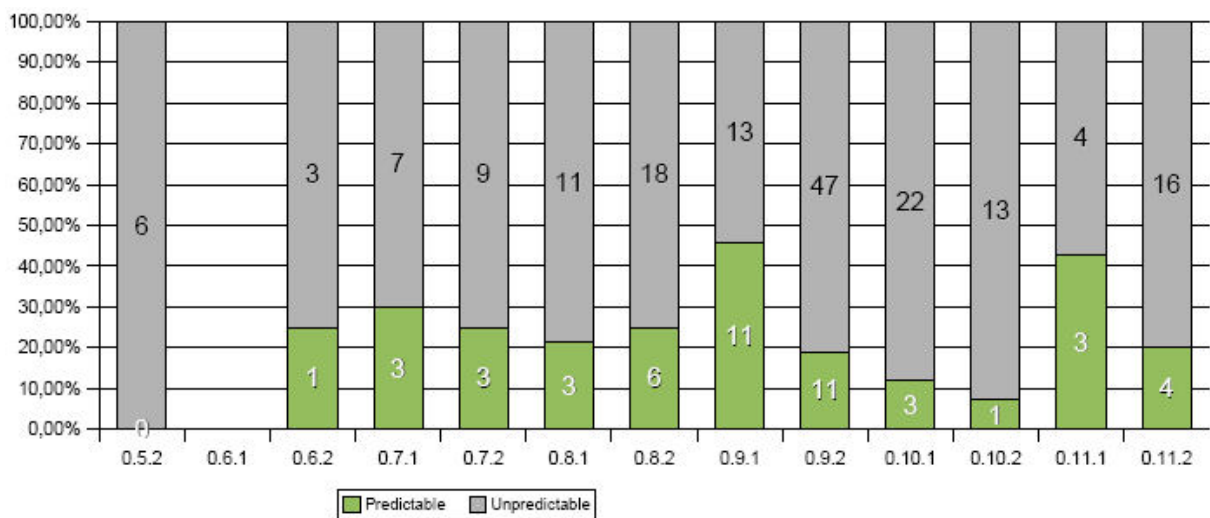
Polysyllabics

Table 77: Statistical results of the F0 measurement for disyllabics

$N_{pos} = 7$	$N_{min} = 6$	$z = \dfrac{(7 - \frac{7}{2})}{\sqrt{(7+6)}}$	$z = 0.9707$
$N_{equ} = 0$	$N_0 = 0$		$\Phi_{0;1(z)} = 0.834$
			$p = 0.166$

Table 78: Statisctical results of the F0 measurement for polysyllabics

$N_{pos} = 0$ $N_{min} = 12$ $N_{equ} = 0$ $N_0 = 1$	$z = \dfrac{(0 - \frac{0}{2})}{\sqrt{(0+12)}}$	$z = 0$ $\Phi_{0;1(z)} = 0.5$ $p = 0.5$

These results show that stress assignment with the mentioned parametry is predictable in di-syllabics in the case of the perceptual analysis as well as the H1 measurement. Neither intensity nor spectral tilt appear to be significant. For polysyllabics, none of the analyses indicate predictability of main stress. Again, any kind of a development over time is not to be found in these results.

4.4   Discussion

This work tries to provide an answer to the question as to whether there is any prosodic organisation during the developmental stage of Canonical Babbling. To reach this aim, babbling data from 0;5 to 1;0 by seven German-learning infants were collected and perceptually as well as acoustically analysed. The results indicate that there appears to be no significant tendency, when data is analysed by the strictly universal parameter setting (4.3.4). In a quantity-sensitive environment the perceptual analysis as well as the measurement of H1 appear to give significant results for disyllabics, indicating a tendency towards a trochaic structure, but it has to be clearly emphasised that this tendency is weak.. In the case of polysyllabics, it is impossible to find any tendency (4.3.6). Hence it can be said, that when taking syllable weight into account, subjects seem to move towards the settings of the target language for disyllabics. In babbles with more than two syllables, results actually indicate, that word stress assignment seems not to be predictable. Neither is there a noticeable bias towards a universally initial stress, nor does the target-specific placement onto the penultimate syllable appear to be significant. The latter case was also combined with the assumption of quantity-sensitivity, but again there was no robust tendency to be found in the data (4.3.4 and 4.3.6). There is, however, a clear tendency towards main stress being placed on syllables larger than (C)V, which is significant for CVV but not for CVC syllables (4.3.5).

The results also display no recognisable development of any stress pattern throughout the babbling stage. It is not the case that a particular pattern becomes more frequent in the later recording sessions or vice versa.

4.4.1   Methodological discussion

One of the most important goals in this study was to provide reliable results. Hence, the actual amount of measurement parameters was large. An attempt was made to compare these parameters against each other. As mentioned in 4.3.3, three of them showed greatest degrees in overlapping results, the perceptual analysis, the intensity measurement and the H1 parameter, which was originally intended to serve for the spectral tilt calculation, but due to its overlapping with the perceptual analysis was then taken into account separately.

Table 79: Amounts of overlapping results for the parameters perceptual, intensity and H1

Analyses	Items	Percentage
Perceptual + Intensity	411	63,72%
Perceptual + H1	309	47,91%
Intensity + H1	308	47,75%

Of major importance is the fact that the intensity as well as the H1 parameter are in line with the impression of the three adult listeners. It can be assumed then, that both of these acoustical properties reflect most closely the actual phonetic correlate of main stress in the current data. In contrast, F0, A2 and the spectral tilt seem not to give such ratios of overlapping with the perceptual analysis.

In the case of the F0 measurement, this may have different reasons. Firstly, this parameter is the most unstable due to technical reasons (see Reetz (1999)). Secondly, the modulation of the fundamental frequency is used in the target language German to express the prosodic property of intonation. In particular, the use of F0 as a means of expressing intonation was confirmed by a number of studies on early infant vocalizations, such as those by Sander (1981), Peters (1997), Hsu and Fogel (2001) and Oller, Buder and Nathani (2003). It seems, that during babbling F0 is preferred for communicative rather than purely phonological usage.

The results of the current study show that the location of stress in a quantity-sensitive setting can be predicted by the impression of the three adult listeners as well as one of the two acous-

tic analyses, which show the largest amount of overlapping results, namely the H1 measurement. Furthermore, the perceptual analysis is in line with both the intensity as well as the H1 measurement in the investigation of the placement of stress on CVV syllables.

Hence, it can be noted that on the basis of the current data, the H1 and intensity parameters seem to correlate most closely to the impression of the three adult listeners. This does not necessarily imply, that intensity and H1 are good correlates of word stress in general, as the goal of this study is not the identification of phonetic correlates of stress. They should not however be overlooked, when analysing stress. Especially the H1 measurement is worthy of further investigation in subsequent studies on infant babbling.

A methodological problem common to all studies in the field of infant babbling is the fact that the subjects cannot be influenced in to utter certain types or amounts of vocalizations (see Oller, Wieman, Doyle & Ross (1976) and. Davis, MacNeilage, Matyear & Powell (2000)). As babbling data is spontanous speech, there appears to be no kind of experimental design that could ensure a certain type of output. The lack of such a standardised setup hence results in varying numbers of data, not only per subject but also per recording session. This makes it more difficult to analyse the data statistically, as it severely restricts the number of suitable procedures available (see Siegel (2001)).

4.4.2   Comparison to other studies

The findings of the current study are, however, largely in line with the results discussed throughout the literature. Davis, MacNeilage, Matyear and Powell (2000) investigated the acoustic properties of disyllabic babbles of American infants. They measured intensity, F0 and vowel duration for each syllable. Although English is – like German, as it was explained in chapter 3 – a trochaic language, the subjects did not exhibit a target-specific bias towards this stress pattern in babbling. Trochaic and iambic stress patterns seemed to be equally frequent in their data, whereas level stressed babbles appeared to be rare (in 48 of 324 disyllabics). The current study presents a comparable scenario in German-learning infants. The number of equally stressed disyllabics is also low. There are 10 level stresses for the perceptual analysis, 31 for intensity measurement, 5 for H1 measurement, one for the spectral tilt calculation and 38 for F0 measurement at a total of 348 disyllabic vocalizations. For the seven German-

learning subjects introduced in the current study, there is, however, at least a weak tendency towards observing the trochee in babbles with two syllables.

Vihman, De Paolis and Davis (1998) asked the question, if young children are biased towards a trochaic stress pattern during babbling as well as in early target words. Their results also indicated that the proportions of trochees and iambs uttered by their English-learning subjects were nearly equal.

Both studies, Vihman, De Paolis and Davis (1998) as well as Davis, MacNeilage, Matyear and Powell (2000), concluded that the well-balanced numbers for trochees and iambs in their babbling data can be explained by the fact that English shows an opposition of trochaic simplicia and on the other hand quasi-iambic phrases constructed by an article and a monosyllabic noun. Hence, English-learning infants are confronted with these two kinds of contradictory input. In this respect it is of interest that German behaves in a fashion similar to English, when phrasal stress is considered. As Wiese (2000) states, the main stressed element within a phrase is located at its right edge. Hence, an acquiring infant has to cope with trochaic patterns of lexical items as against iambic patterns in phrases. Particularly German indefinite articles can be reduced to only a syllabic nasal on the surface. This emphasizes, that phrases appear to be completely contradictory to lexical items, when stress patterns are concerned.

There are, however, two more assumptions, why stress might not be predictable in infant babbling. One particular feature of German is the specific use of the schwa vowel to mark unstressed syllables, as it has been stated in more detail under 3.2.3 (see also Wiese (1986), Féry (1998) and Penner, Krügel, Gross & Hesse (2006)). The schwa vowel is extremely frequent in adult speech and shows up in unstressed syllables within trochaic disyllabics. Hence, the language German distinguishes stressed and unstressed syllables not only by acoustic properties expressing word stress, but also by the quality of vowels. Canonical babbles in contrast are mostly of a reduplicative nature. Vowel quality usually does not tend to show drastic changes from one to another syllable within one vocalization (see Vihman (1992) and Oller & Lynch (1992)). Hence, there is a difference in the way vowel quality is treated in adult speech and infant babbling. It might be the case, that this difference contributes to the fact, that the placement of stress in infant babbling appears to be less predictable.

Furthermore, studies by Ingram (1989), Fikkert (1994) as well as Demuth and Fee (1995) showed that stress assignment in target words has to be acquired from 1;0 onwards, where

children start to utter target words while using a minimal output template of only one single core syllable (see also Levelt, Schiller & Levelt (2000) and Kehoe & Stoel-Gammon (2001)). According to these studies, children at 1;0 still do not have a quantity-sensitive trochaic foot. Consequently, one has to ask, why they should have an even more complex parameter adjustment at a younger age. Either the children loose these early parameter settings during the babbling stage as soon as children enter the lexical stage, or prosodic parameters are not set before the emergence of the lexical stage. In the latter case, Canonical Babbling and language have to be understood as two different instances (see also Jakobson (1941) and Peters (1997)).

4.4.3 Influence of the ambient language

The distribution of stress patterns in the babbling data of the current study shows that in case of stress placement there is little noticeable influence exerted by the target language. In fact, only disyllabics tend to fit into the trochaic foot shape which is the underlying foot form in German. On the other hand, trochaic babbling output could be caused by a UG-like configuration of the corresponding prosodic parameters. In polysyllabics, the characteristic penultimate stress of German target words of the same size is not the predominant pattern to be observed. In contrast, the distribution of syllable shapes offers a different picture. On one hand, syllables larger than (C)V attract stress significantly more often than (C)V syllables, which leads to the assumption, that quantity-sensitivity is operable in babbling. On the other, the characteristic stress-attracting superheavy syllables of the target language only show up very rarely in the data. There are just three syllables that count as three-moraic in the German syllable weight hierarchy.

The fact that syllable weight can be shown to play a role in stress assignment also is reflected by the results by Lleó, El Mogharbel and Prinz (1994). They found that their German subjects uttered significantly more closed syllables than their Spanish counterparts. They concluded that this effect was caused by the frequencies of syllable types in the two target languages and hence understand the occurrence of closed syllables in the German infants as an influence of the ambient language. A similar result for English babbling data comes from Levitt and Utman (1992). In this respect it can be concluded that the attraction of stress by a particular type of syllables is likely to be caused by the target language.

The assumption of a quantity-sensitive scenario in babbling raises the question, as to what exactly happens to the syllable weight distinction at the onset to the lexicon, as many studies have already shown that young children start to acquire syllable structure from scratch (see Fikkert (1994), Levelt, Schiller & Levelt (2000) and Kehoe & Stoel-Gammon (2001)). This problem can however, only be solved by further investigations into the transition period from babbling towards the emergence of the lexicon.

Of further interest is the fact that the spectral tilt calculation doesn't supply conclusive results for the babbling data. This points to the fact that this rather language-specific property – as it was convincingly proposed by Claßen, Dogil, Jessen, Marasek and Wokurek (1998) - has not yet been acquired by the subjects of the current study. This leads to a more universal view of babbling phonetics.

As a final remark it has to be emphasized, that earlier studies into the influence of the target language – and here the focus particularly lies on German – found a rather similar picture, as it has already been discussed in 2.2.4. There definitely are phenomena within babbling phonology, which can be clearly explained by an influence of the surrounding language, whilste others are not (see for example Sendlmeier & Sendlmeier (1991) and Lleó, El Mogharbel & Prinz (1994)). It seems, hence, that the term "babbling drift" introduced by Brown (1958) still has not lost its justification. Furthermore, it has to be kept in mind, that the majority of studies claim language-specific influences to occur rather late in canonical babbling stage, mostly from 0;11 onwards (see Levitt & Utman (1992)). In case of perception, it has to be mentioned that the trochaic stress pattern is already recognized by German-learning infants at the age of 0;5, as it is shown in the studies by Weber, Hahne, Friedrich and Friederici (2004), who measured event-related potentials, as well as Höhle, Bijeljac-Babic, Nazzi, Herold and Weissenborn (submitted), who used the headturn preference paradigm. Although infants thus seem to have the trochaic shape available they only exhibit a tendency towards using it in their output during the stage of Canonical Babbling.

4.4.4 Comparison to early target words

The studies by Vihman, De Paolis and Davis (1998) as well as by Hallé, de Boysson-Bardies and Vihman (1991) analysed babbling as well as target words and found that there seems to be no significant difference in the way young children at an age of about 1;6 treat these two types

of vocalizations in terms of their phonetic properties. Hence, it will be asked in the following section, whether a number of example target words uttered by NB exhibit similar stress patterns as her babbling. As has been mentioned under 4.2.1 NB was recorded up to an age of 2;8. Therefore words appearing at different ages are of specific interest here, as they may show a certain development of their stress patterns.

The three nouns "Affe", "Auto" and "Wauwau" will be analysed the same way, as it has been done to the babbling data of NB in the previous sections. These words were chosen here, because NB consistently uttered them in two or more recording sessions, so that a notion of a development over time can be seen. Additionally three more disyllabic targets from varying recording sessions were included in order to get more data. On the other hand, NB didn't utter any target polysyllabics larger than disyllabics. She produced, however, a few compounds as the only type of output containing more than two syllables. In one recording session at an age of 2;1 she also uttered the adjective "kaputt", which will be analysed here as well as being an example for an iambic target pattern. It appears, however, as being level stressed, as it is displayed in the following figure.
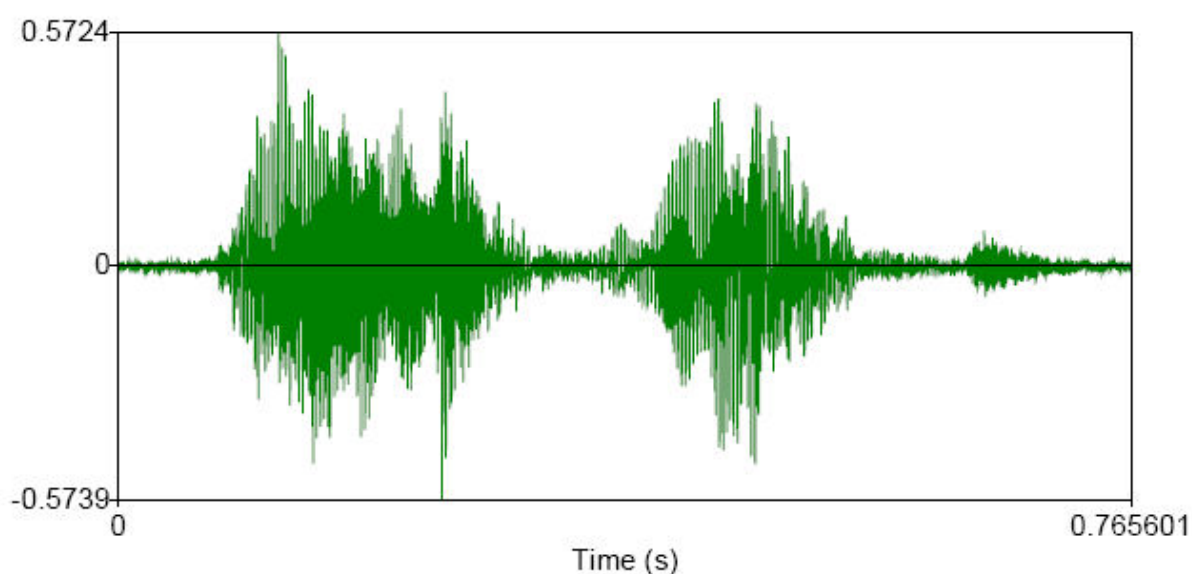
Figure 5: The adjective "kaputt" uttered as level stress by NB at an age of 2;1

The target words mentioned are analysed by measurements of intensity, H1 and A2, as it has been done for the babbling data. The spectral tilt is also calculated form the H1 and A2 values. The following table shows the results.

Table 80: Results of the acoustical analyses of the lexical items uttered by NB

Target	Age	Intensity	H1	Spectral tilt
Affe	1;9	1st	2nd	1st
Affe	2;1	1st	1st	1st
Affe	2;5	1st	1st	1st
Auto	1;8	1st	2nd	1st
Auto	1;9	1st	2nd	1st
Auto	1;11	1st	1st	2nd
Auto	2;5	1st	1st	1st
Wauwau	1;7	1st	1st	2nd
Wauwau	1;11	1st	1st	2nd
Wauwau	2;1	1st	1st	2nd
Hase	1;9	1st	1st	2nd
Katze	1;11	1st	2nd	1st
Tasse	2;6	1st	2nd	1st
kaputt	2;1	level	1st	2nd

This data shows that in NB's target words there is a clear preference for placing main stress on the first syllable of a disyllabic. Each of the 13 trochaic targets shows intensity on the initial syllable. For the H1 parameter as well as for the spectral tilt calculation there are eight of the 13 target trochees appearing to have a dominant first syllable. This indicates that in the case of the intensity measurement, NB produced target-specific output. For H1 and the spectral tilt there is a tendency towards target values. Compared to NB's babbling data, the situation for the spectral tilt in her target words seems to be more target-oriented, which would suggest that this particularly language-specific acoustic property is not yet available during the babbling stage. Hence it has to be acquired at the emergence of the lexicon. The only target word with final stress "kaputt" is inconclusive and has therefore to be treated as being level stressed here.

Of course, an appropriate conclusion cannot be derived from this small amount of data. An over all investigation of NB's lexical items in conjunction with her babbling utterances seems to be interesting.

4.5 Conclusion

The current work addresses the question, whether an underlying rule system for prosodic organisation can be observed during the developmental stage of Canonical Babbling, when infants gain access to the building blocks of mature language, the syllables (Oller & Lynch (1992)). This means that the question has been posed as to whether the placement of stress is predictable. To answer this question, acoustic as well as perceptual analyses were undertaken in order to ensure the most reliable outcome. The results indicate that different levels of the prosodic hierarchy are treated in rather specific ways.

As has been mentioned earlier, the question of prosody in babbling also contributes to the continuity discussion. Generally, three possible scenarios were expected for the current study, which will be repeated here in short.

a) Babbling prosody and later prosodic development are discontinuant. This would result in the absence of any organization of stress assignment.

b) Prosody of babbling and lexical stage are continuant in the way proposed by the "weak" interpretation of the Continuity hypothesis. This would suggest a straight-forward level of organization of stress assignment during babbling.

c) Babbling prosody is largely influenced by the ambient language, as it is suggested by the "strong" interpretation of the Continuity hypothesis.

The results lead to the conclusion, that none of these three scenarios exist solely during babbling. In contrast, it seems that prosodic units of different sizes are treated in a rather particular way. Syllables are distinguished by their weight, which would point to scenario c). Disyllabics exhibit a predictable stress assignment in a quantity-sensitive setting for two of the analysis parameters. There is also a tendency towards the trochaic stress pattern to be observed in disyllabics. As the basic prosodic foot is also maximally disyllabic as well as trochaic, this finding again points to scenario c). The location of main stress in polysyllabics is, however, unpredictable, which fits best to scenario a). It can, hence be concluded that babbling prosody affects the units of moras, syllables and (disyllabic) feet, but seems ineffective for the prosodic word as such. This finding is illustrated in (5).

(5) Prosodic hierarchy in Canonical Babbling

Prosodic Foot (F)
|
Syllable (σ)
|
Mora (μ)

Thus, a minimum of continuity can be observed for the development of the units below the prosodic word. The results of this study show that the syllable weight hierarchy in babbling distinguishes light ((C)V) and heavy ((C)VV, (C)VC) syllables. The latter show a strong tendency towards attracting stress within a word-like babbling utterance. The following table reflects the type of quantity-sensitivity in babbling.

Table 81: Syllable weight hierarchy for the babbling data of the current study

Light	CV	1 mora
Heavy	Larger than CV	2 moras

Quantity-sensitivity is a parameter, which is not yet set in UG and thus target-specific (see Fikkert (1994)). However, as has been shown in 3.5.1, the target-language German distinguishes between three types of syllable sizes. It has to be concluded, that the babbling prosody of the subjects for the current study is not yet exactly target-specific. It seems to have chosen the direction towards the particular parametry of the ambient language, but will certainly require further developmental phases to reach the target setting (see Brown (1958)). Continuity can thus be said to be recognizable, whilste affecting not all levels of the prosodic hierarchy at the same time. The classical Discontinuity approach by Jakobson (1941) as well as a strictly universal setup, which is claimed by the weak Continuity proposal, has to be rejected.

Concerning parametric theory the current results lead to the following settings for Canonical Babbling. There are parameters, which are set to target-specific values. These are listed in (6).

(6)   a) Foot shape parameters

        Quantity-sensitivity: Feet are [<u>quantity-sensitive</u>/-insensitive]

        Weight: Feet are quantity-sensitive to

                [closed syllable/nucleus/<u>rhyme</u>]

        Foot branching: Feet must be branching [yes/<u>no</u>]

The parameter for [foot branching] is set to the value "no" because main stress can fall onto the final syllable of disyllabics, if it is heavy. As there is a tendency towards the trochee as the underlying foot shape, a main stressed final syllable results in a monosyllabic foot.

On the other hand, there are parameters, which can either be set or still remain in their UG-driven default configuration. These ones are given in (7).

(7)   a) Foot shape parameters

        Headedness: Feet are strong on the [left/right]

The tendency towards the trochaic stress pattern is however, rather weak. This can be explained by the misleading opposition of monomorphematic words and phrases, where the latter appear as an iambic unit (see Vihman, De Paolis & Davis (1998), Davis, MacNeilage, Matyear & Powell (2000) and Wiese (2000)).

The configuration of all other parameters – especially the ones for foot construction and word tree dominance, that require a non-UG-like setting - remains unclear and is likely to be set during the later developmental stages of prosody (see Ingram (1989), Fikkert (1994) and Demuth & Fee (1995)).

Generally speaking, the results of the current study emphasize the claim by Levitt and Utman (1992) that "empirical investigations of language-specific influences have had somewhat mixed outcomes." (p. 20) Further investigations in the field of babbling as well as the transition to the lexical stage are needed in order to understand fully, what actually happens to the

prosodic parameters, which are particularly language-specific, when infants leave the babbling stage and begin to acquire their first meaningful words.

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Appendix

A. IPA Symbols

THE INTERNATIONAL PHONETIC ALPHABET (revised to 1993)

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	N		
Trill	ʙ			r					R		
Tap or Flap				ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	L			

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

CONSONANTS (NON-PULMONIC)

Clicks		Voiced implosives		Ejectives	
				'	
ʘ	Bilabial	ɓ	Bilabial		as in:
ǀ	Dental	ɗ	Dental/alveolar	p'	Bilabial
ǃ	(Post)alveolar	ʄ	Palatal	t'	Dental/alveolar
ǂ	Palatoalveolar	ɠ	Velar	k'	Velar
ǁ	Alveolar lateral	ʛ	Uvular	s'	Alveolar fricative

VOWELS

Front   Central   Back

Close   i • y ——————— ɨ • ʉ ——————— ɯ • u
              ɪ Y   ʊ
Close-mid   e • ø ———— ɘ • ɵ ———— ɤ • o
                              ə
Open-mid   ɛ • œ — ɜ • ɞ — ʌ • ɔ
                  æ   ɐ
Open   a • ɶ ————————— ɑ • ɒ

Where symbols appear in pairs, the one to the right represents a rounded vowel.

OTHER SYMBOLS

ʍ Voiceless labial-velar fricative
w Voiced labial-velar approximant
ɥ Voiced labial-palatal approximant
ʜ Voiceless epiglottal fricative
ʢ Voiced epiglottal fricative
ʡ Epiglottal plosive

ɕ ʑ Alveolo-palatal fricatives
ɺ Alveolar lateral flap
ɧ Simultaneous ʃ and x

Affricates and double articulations can be represented by two symbols joined by a tie bar if necessary.

k͡p t͡s

SUPRASEGMENTALS

ˈ	Primary stress	ˌfoʊnəˈtɪʃən
ˌ	Secondary stress	
ː	Long	eː
ˑ	Half-long	eˑ
̆	Extra-short	ĕ
.	Syllable break	ɹi.ækt
ǀ	Minor (foot) group	
‖	Major (intonation) group	
‿	Linking (absence of a break)	

TONES & WORD ACCENTS

LEVEL			CONTOUR		
e̋ or ꜛ	Extra high		ě or ꜛ	Rising	
é ꜓	High		ê ꜔	Falling	
ē ꜕	Mid		e᷄ ꜓	High rising	
è ꜖	Low		e᷅ ꜕	Low rising	
ȅ ꜔	Extra low		e᷈ ꜔	Rising-falling	
↓	Downstep		↗	Global rise	etc.
↑	Upstep		↘	Global fall	

DIACRITICS   Diacritics may be placed above a symbol with a descender, e.g. ŋ̊

̥	Voiceless	n̥ d̥	̤	Breathy voiced	b̤ a̤	̪	Dental	t̪ d̪
̬	Voiced	s̬ t̬	̰	Creaky voiced	b̰ a̰	̺	Apical	t̺ d̺
ʰ	Aspirated	tʰ dʰ	̼	Linguolabial	t̼ d̼	̻	Laminal	t̻ d̻
̹	More rounded	ɔ̹	ʷ	Labialized	tʷ dʷ	̃	Nasalized	ẽ
̜	Less rounded	ɔ̜	ʲ	Palatalized	tʲ dʲ	ⁿ	Nasal release	dⁿ
̟	Advanced	u̟	ˠ	Velarized	tˠ dˠ	ˡ	Lateral release	dˡ
̠	Retracted	i̠	ˤ	Pharyngealized	tˤ dˤ	̚	No audible release	d̚
̈	Centralized	ë	̴	Velarized or pharyngealized	ɫ			
̽	Mid-centralized	e̽	̝	Raised	ɹ̝ (ɹ̝ = voiced alveolar fricative)			
̩	Syllabic	l̩	̞	Lowered	e̞ (β̞ = voiced bilabial approximant)			
̯	Non-syllabic	e̯	̘	Advanced Tongue Root	e̘			
˞	Rhoticity	ə˞	̙	Retracted Tongue Root	e̙			

B. Listing of data

Sub	Age	File	Syl	Template	Agree	Perc	Intens	H1	A2	SpecT	F0
DP	0.7.1	k01	2	cvv.cvv	2	1	1	2	1	1	1
DP	0.7.2	k04	2	v.ccvv	3	2	1	2	1	1	1
DP	0.7.2	k07	3	cv.cv.cv	3	3	3	3	3	3	1
DP	0.7.2	k12	4	cv.cv.cv.cc	3	3	3	3	3	3	-
DP	0.7.2	k14	3	v.cv.cvv	3	3	3	3	1	1	3
DP	0.7.2	k17	2	cv.cc	3	1	1	1	1	1	1
DP	0.7.2	k19u04	3	v.v.cv	3	3	3	3	1	1	3
DP	0.8.1	k05u01	2	v.cvv	3	2	2	2	1	1	2
DP	0.8.1	k06u02	2	vc.cv	3	1	1	1	|	2	1
DP	0.8.1	k07u02	3	v.cv.cv	2	?	2	1	2	2	2
DP	0.8.1	k10u04	3	c.cvv.cvc	2	1	2	2	|	3	1
DP	0.8.2	k02	2	cv.cvv	3	2	2	1	1	1	2
DP	0.8.2	k03	2	cv.cvc	3	2	2	1	2	2	1
DP	0.8.2	k04u01	2	v.cv	3	2	1	2	2	2	|
DP	0.8.2	k06	3	cv.cv.cv	3	2	2	2	2	3	|
DP	0.9.1	k02	2	v.cvv	3	2	2	2	2	2	|
DP	0.9.1	k04u01	2	v.cvv	3	2	2	2	2	1	1
DP	0.9.1	k05u01	2	v.cv	3	2	2	2	1	1	1
DP	0.9.1	k13	2	cvv.cv	3	1	1	1	2	2	-
DP	0.9.1	k18	2	v.cv	3	2	2	1	2	2	1
DP	0.9.1	k20u05	2	cvv.cv	3	1	1	1	1	1	1
DP	0.9.1	k21	2	cv.cv	3	1	1	2	1	1	|
DP	0.9.1	k24	2	v.cv	3	2	1	2	1	1	|
DP	0.9.1	k43	2	v.cv	3	2	2	2	2	1	2
DP	0.9.1	k46u07	2	v.cv	3	2	2	1	2	2	-
DP	0.9.1	k51u08	2	v.cv	2	2	2	2	2	1	-
DP	0.9.1	k55	2	v.cv	3	2	2	1	1	1	-
DP	0.9.2	m03	3	cvv.cv.cv	3	1	1	3	2	2	|
DP	0.9.2	m06u01	3	cv.cvv.cv	3	2	2	2	3	3	1
DP	0.9.2	m14u03	3	cv.cvv.cv	3	2	1	2	1	1	|
DP	0.9.2	m15u03	2	cv.cvv	3	2	2	2	2	1	2
DP	0.9.2	m17	3	cvv.cv.cv	3	3	3	1	1	2	|
DP	0.9.2	m18	2	cv.cv	3	1	1	2	1	1	2
DP	0.10.1	k03	2	v.cv	3	2	2	2	2	2	|
DP	0.10.1	k05	2	cv.cv	3	2	2	2	|	1	|
DP	0.10.1	k07	2	vc.cvv	3	2	2	2	2	2	-

DP	0.10.1	k09u02	2	cv.cvv	3	2	1	1			2	1
DP	0.10.2	k02	2	v.cv	3	2			2	1	1	2
DP	0.10.2	k11	5	cv.cv.cv.cv.cv	2	?			2	3	5		
DP	0.10.2	k13	2	v.cv	3	1	1	2	1	1	1
DP	0.10.2	k14	3	v.cv.cv	3	1	3	3	2	2	2
DP	0.10.2	k15	2	v.cv	3	1			1			2		
DP	0.11.1	k10	2	vv.cv	2	1	1			1	1	2
DP	0.11.1	k15u07	3	cv.cvv.cv	3	2	2	2	1	1	-
DP	0.11.1	k25	2	v.cvv	3	1	1	1	2	2		
DP	0.11.2	k02	2	v.cv	3	1			1			2	2
DP	0.11.2	k04	2	cv.cvv	3	2	2	1	2	2		
DP	0.11.2	k05	2	cv.cv	3	1	1	2	2	2	1
DP	0.11.2	k08	2	v.cv	3	2	2	2	1	1	-
DP	0.11.2	k09u05	2	cv.cv	3	2	2	1	2	2	2
JR	0.7.2	09-05-bab3	2	cv.cv	3	?	1	2	1	1	-
JR	0.8.1	17-05-bab5	3	cv.cvv.cv	3	3	2	1	1	2	1
JR	0.8.1	17-05-bab9	4	cv.cv.cv.cv	3	1	2	1	2	2	-
JR	0.8.1	17-05-bab11	3	cvv.cv.cv	3	1			1	3	2	2
JR	0.8.1	17-05-bab12	2	cv.cv	3	1	1	1	1	1	-
JR	0.8.1	17-05-bab13	4	cv.cvv.cv.cv	3	2	2	1	1	3	4
JR	0.8.1	17-05-bab14	3	v.cvv.cv	3	2	1	1	1	1	-
JR	0.8.1	17-05-bab16	2	cvv.cvv	3	1	1	1	1	1	2
JR	0.8.1	17-05-bab17	4	v.cv.cv.cvv	3	4	4	2	4	4	-
JR	0.8.1	17-05-bab19	5	cv.cv.cv.cv.cv	2	?	5	1	4	4	-
JR	0.8.2	06-bab2	2	cv.cv	2	1	1	1	1	2	1
JR	0.8.2	06-bab4	2	cv.c	3	1	1	1	1	2	1
JR	0.8.2	06-bab5	2	cv.cv	3	1	1	1	2	2	1
JR	0.8.2	06-bab6	2	cv.cv	3	1	1	1	1	2	1
JR	0.8.2	06-bab7	3	cv.cv.cvc	3	3			2	3	3	2
JR	0.8.2	06-bab8	2	cv.c	2	1	1	1	1	2	-
JR	0.8.2	06-bab9	2	cv.c	3	1	1	1	1	2	1
JR	0.8.2	06-bab10	2	cv.cv	3	1			2			1	-
JR	0.8.2	06-bab11	4	v.cv.cv.cvc	2	4	4	4	4	1	1
JR	0.8.2	06-bab14	2	v.cv	3	2	2	2	1	1	2
JR	0.8.2	04-06-bab1	3	cv.cvv.cv	3	2	2	2	3	3	3
JR	0.8.2	05-06-bab1	5	v.cv.cv.cv.cvv	2	3	3	4	4	1	5
JR	0.8.2	05-06-bab2	3	v.cv.cv	3	2			2	2	1	2
JR	0.8.2	05-06-bab3	4	v.cv.c.c	2	4	1	1	1	2	-
JR	0.8.2	05-06-bab4	3	v.cv.cv	3	?			1	1	2	3
JR	0.8.2	05-06-bab7	5	cv.cv.cv.cv.cv	2	2	5	2	4	4	-

JR	0.8.2	05-06-bab8	2	cv.cv	3	1	2	2	2	1	-
JR	0.8.2	05-06-bab9	4	cvv.cv.cv.cv	3	4	|	2	4	4	2
JR	0.8.2	05-06-bab10	5	v.cv.cv.cv.cv	2	?	3	2	5	5	|
JR	0.8.2	05-06-bab11	2	cv.cvc	2	1	1	1	1	2	1
JR	0.8.2	05-06-bab12	4	v.cv.cv.cv	2	2	2	3	2	1	3
JR	0.8.2	05-06-bab13	2	cv.cvv	3	2	2	2	2	1	2
JR	0.8.2	05-06-bab14	5	cv.cv.c.cvv.cv	2	4	4	4	|	1	-
JR	0.8.2	05-06-bab15	5	cv.cv.cv.cv.c	3	1	1	1	1	5	|
JR	0.8.2	05-06-bab16	4	cv.cv.cv.cv	3	2	1	2	2	1	2
JR	0.9.1	20-06-bab1	4	cvv.cv.cv.cv	3	4	4	4	1	1	4
JR	0.9.2	07-07-bab1	2	cv.cv	3	1	1	1	1	1	1
JR	0.9.2	07-07-bab2	2	cv.cv	3	2	2	2	1	1	1
JR	0.9.2	11-07-bab1	5	v.cv.cv.cv.cvv	2	2	|	5	2	2	|
JR	0.9.2	11-07-bab2	4	cv.cv.cv.cv	2	?	1	1	2	3	1
JR	0.9.2	11-07-bab3	3	v.cv.cvc	2	3	3	3	3	1	|
JR	0.9.2	11-07-bab5	4	vv.cv.cv.cv	2	1	1	1	2	3	-
JR	0.10.1	20-07-bab3	2	cv.cvv	3	1	|	1	2	2	-
JR	0.11.1	15-08-bab1	2	cv.cv	3	2	1	1	1	1	2
JR	0.11.1	15-08-bab6	2	v.cv	2	2	2	|	2	2	-
JR	0.11.1	15-08-bab9	2	v.cv	3	2	2	1	1	2	2
JR	0.11.1	15-08-bab10a	2	v.cvv	2	2	2	2	1	1	2
JR	0.11.1	15-08-bab10b	2	v.cvv	2	2	2	2	1	1	2
JR	0.11.1	15-08-bab12	2	v.cv	3	2	2	2	|	1	2
JR	0.11.1	15-08-bab22	2	c.cv	2	2	2	2	2	2	-
JR	0.11.1	15-08-bab25	5	vv.cv.cv.cv.cv	2	?	|	1	5	5	|
JR	0.11.1	15-08-bab26	3	v.cvv.cv	2	2	2	2	3	3	-
JR	0.11.1	15-08-bab28	2	v.cv	3	2	1	1	2	2	-
JR	0.11.1	15-08-bab29	2	v.cv	3	1	1	1	1	2	1
JR	0.11.1	31-08-bab2	2	cv.cv	2	2	2	1	2	2	-
JR	0.11.1	31-08-bab3	3	cvv.cvv.cvv	3	3	3	2	3	3	3
JR	0.11.1	31-08-bab5	3	cv.cv.cv	3	|	2	3	1	1	-
JR	0.11.1	31-08-bab7	2	v.cv	3	2	2	1	2	2	-
JR	0.11.1	31-08-bab8	2	cv.cvv	3	2	2	2	2	2	-
JR	0.11.1	31-08-bab10	2	cv.cv	3	1	2	1	2	2	1
JR	0.11.1	31-08-bab12	2	cvv.cv	3	2	2	1	2	2	-
JR	0.11.1	31-08-bab15	3	v.cv.cv	3	2	|	|	2	2	-
JR	0.11.2	03-09-bab1	2	v.cv	3	2	2	1	2	2	-
JR	0.11.2	03-09-bab2	2	cv.cv	3	1	2	2	2	2	1
JR	0.11.2	03-09-bab6	4	cv.cv.cv.cv	3	3	4	4	3	3	3
JR	0.11.2	03-09-bab7	3	cv.cv.cv	3	2	2	1	3	3	|

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JR	0.11.2	03-09-bab8	4	cv.cv.cvc.cv	3	1	1	4	1	1	-
JR	0.11.2	03-09-bab10	2	v.cv	3	2	2	2	2	2	-
LS	0.6.2	k01	4	cv.cvv.cv.cv	3	2	2	3	2	2	-
LS	0.7.1	k01u04	4	v.cv.cv.cvv	2	2	2	1	4	4	-
LS	0.7.1	k02u04	2	vv.cvv	2					2	1	1	1
LS	0.7.1	k03	4	v.cv.cc.cv	2	2	2	1	2	2	-
LS	0.7.1	k04	3	vv.cv.ccv	3	1			2			1	1
LS	0.7.1	k05u06	4	v.cvv.cv.cvv	3	2	2	2			3		
LS	0.7.1	m08k	2	v.cv	3	1	1	1	1	2	-
LS	0.7.1	m21k	2	vcc.cv	2	2	2	2	2	1	2
LS	0.7.2	k04	5	cv.cv.cvv.cv.cv	3					3	2	2		
LS	0.8.1	k01	2	cv.cv	3	1	2	1	1	1	2
LS	0.8.1	k02u01	2	v.cv	3	1	1	2	1	1	1
LS	0.8.1	k03	2	cv.cv	3	1	2	1	1	1	2
LS	0.8.1	k08u02	3	cvv.ccvv.cv	2	2	2	2	3	3	3
LS	0.8.1	k15	2	vv.cv	3	1	1	1	1	1	-
LS	0.8.1	k16	4	cv.cvv.cv.cv	3	2	3	2	3	3		
LS	0.9.1	k02u02	2	v.cv	3	1	2	2	1	1	1
LS	0.9.1	k03u02	2	cvv.cv	3	1	1	1	1	2	1
LS	0.9.1	k04	2	cv.cv	3	1	2	1			2	1
LS	0.9.1	k05	2	v.cv	3	2	2	2			1		
LS	0.9.1	k06	2	v.cv	3	2	2	1	2	2		
LS	0.9.1	k07	2	v.cv	3	2	2	1	2	2	2
LS	0.9.1	k08	4	v.cv.cv.cv	3	2			2			4	2
LS	0.9.1	k10u03	2	v.cv	3	2	2	2			1	1
LS	0.9.1	k11u03	2	v.cv	3	2	2	1	2	2	1
LS	0.9.1	k12	2	vv.cv	3	1	1	1	1	1	1
LS	0.9.1	k13	2	v.cv	3	1	1	1	1	2	1
LS	0.9.1	k14	2	cvv.cv	3	1	1	1			2	1
LS	0.9.1	k17u04	3	cv.cv.cvv	2	3			3	2	1	3
LS	0.9.1	k18	2	vv.cv	3	2	2	1	2	2		
LS	0.9.1	k19	2	v.cv	3	2	2	2			1	2
LS	0.9.2	k01	2	v.cv	3	2	2	2	1	1	-
LS	0.9.2	k03	2	cv.cv	3	1			1			2	2
LS	0.10.1	k06	3	v.cv.cv	3					2	1	1	3
LS	0.10.1	k07	2	cv.cv	3	1	1	1	1	2	1
LS	0.10.1	k08	2	cvc.cv	3	1			1	1	1	1
LS	0.10.1	k09	2	v.cv	3	2	2	2	2	1	2
LS	0.10.1	k14	2	cv.cv	3			1	2	1	1		
LS	0.10.1	k17	2	v.cv	3	2	2	1	1	1	2

LS	0.10.1	k20	2	cv.cv	3	1	1	1	2	2	1
LS	0.10.1	k24u04	2	v.cv	3	2	2	2	1	1	2
LS	0.10.1	k31u05	4	cv.cv.cv.cv	4	|	1	4	2	2	|
LS	0.10.1	k34	2	v.cv	3	2	2	2	2	1	2
LS	0.11.1	k03	4	cv.cv.cv.cv	3	3	3	3	1	4	3
LS	0.11.1	k08	3	cv.cv.cvc	2	2	|	3	1	1	2
LS	0.11.1	k09u01	2	cv.cvc	2	1	1	1	|	2	1
LS	0.11.1	k10u01	2	cv.cv	3	1	1	2	|	1	1
LS	0.11.1	k12	2	cv.cv	3	1	1	1	1	2	-
LS	0.11.1	k14	3	cv.cv.cv	3	1	1	1	3	3	-
LS	0.11.1	k18	2	cv.cvc	3	2	2	1	|	2	-
LS	0.11.1	k21	2	cv.cv	3	1	1	2	1	1	|
LS	0.11.1	k25	2	cv.cv	3	1	2	2	2	1	1
LS	0.11.1	k26	5	v.cv.cv.cv.cvc	3	|	4	2	5	3	-
LS	0.11.1	k29	5	c.cv.cv.cv.cv	3	5	5	5	|	1	-
LS	0.11.1	k31	2	vv.cvc	3	2	|	2	2	2	1
LU	0.5.2	16-04-bab1	3	v.cv.cv	3	3	3	1	2	3	|
LU	0.5.2	17-04-bab2	4	v.cv.cv.cv	3	4	4	2	2	4	1
LU	0.5.2	17-04-bab4	2	cvv.cv	3	1	1	2	2	1	2
LU	0.5.2	17-04-bab6	3	cv.cv.cv	3	?	3	3	3	3	3
LU	0.5.2	17-04-bab7	2	cv.cv	3	1	1	1	1	2	2
LU	0.5.2	17-04-bab8	3	v.cv.cvc	2	2	2	1	1	1	1
LU	0.5.2	27-04-bab1	2	cv.cv	3	1	1	2	1	1	1
LU	0.5.2	27-04-bab2	2	v.cv	3	2	2	1	1	1	2
LU	0.5.2	27-04-bab5	2	v.cv	3	2	3	1	1	1	2
LU	0.5.2	27-04-bab7	2	cv.cv	3	1	1	1	2	2	1
LU	0.5.2	28-04-bab1	3	cvv.cv.cv	2	1	1	1	2	2	3
LU	0.5.2	28-04-bab2	2	cv.cvc	3	2	2	2	2	1	2
LU	0.5.2	28-04-bab3	2	cv.cvc	3	1	1	2	1	1	1
LU	0.5.2	28-04-bab4	2	cvv.cv	3	1	1	1	1	2	1
LU	0.5.2	28-04-bab6	2	ccv.cv	3	1	1	1	2	2	2
LU	0.5.2	28-04-bab10	3	vv.cv.cv	3	1	1	1	1	2	1
LU	0.5.2	30-04-bab1	2	vc.cv	3	2	2	1	2	2	2
LU	0.5.2	30-04-bab2	2	v.cv	3	2	|	1	2	2	2
LU	0.5.2	30-04-bab3	2	cvv.cv	3	1	1	1	2	2	1
LU	0.6.1	06-05-bab1	2	c.cv	3	2	2	1	1	2	1
LU	0.6.1	06-05-bab2	2	v.cv	3	1	2	2	|	1	1
LU	0.6.1	11-05-bab1	3	v.cv.cv	2	2	3	3	2	1	-
LU	0.6.1	11-05-bab2	2	v.cv	3	2	2	1	1	2	2
LU	0.7.1	07-06-bab2	5	v.cv.cv.cv.cv	3	4	4	1	5	5	5

LU	0.7.1	07-06-bab3	2	ccv.cvv	2	2	2	2	2	2	2
LU	0.7.1	07-06-bab4	4	ccv.cv.cv.cv	3	|	4	4	4	4	2
LU	0.7.1	07-06-bab5	5	v.cv.cv.cv.cv	3	4	5	4	1	5	4
LU	0.7.1	07-06-bab7	3	cv.cvv.cv	3	2	2	1	3	3	3
LU	0.7.1	07-06-bab8	2	cv.cv	3	1	|	2	1	1	1
LU	0.7.1	07-06-bab11	4	v.cv.cv.cv	3	2	2	|	3	3	|
LU	0.7.1	07-06-bab12	4	v.cv.cv.cvc	3	3	3	2	4	4	-
LU	0.7.1	07-06-bab13	4	v.cv.cv.cv	3	2	|	3	4	4	3
LU	0.7.1	07-06-bab15	3	vv.cv.cv	3	1	1	3	1	1	-
LU	0.7.1	07-06-bab16	5	v.cv.cv.cv.cv	3	5	5	1	5	5	5
LU	0.7.1	07-06-bab17	3	v.cv.cvv	2	3	|	2	3	3	3
LU	0.7.2	25-06-bab4	4	vv.cv.cv.cv	2	|	|	2	4	4	|
LU	0.7.2	25-06-bab5	3	vv.cv.cv	3	2	|	3	2	2	2
LU	0.7.2	28-06-bab2	5	v.cv.cv.cv.cv	2	|	|	2	|	5	|
LU	0.7.2	28-06-bab4	2	v.cv	3	2	2	2	2	2	2
LU	0.7.2	28-06-bab5	2	v.cv	3	1	1	2	1	1	-
LU	0.7.2	28-06-bab8	2	v.cv	3	1	1	1	1	1	-
LU	0.7.2	28-06-bab9	2	cv.cv	3	1	1	1	1	2	1
LU	0.7.2	28-06-bab10	2	v.cvc	3	1	2	2	2	1	2
LU	0.7.2	28-06-bab11	2	v.cvc	3	1	1	1	2	2	-
LU	0.7.2	28-06-bab12	2	cv.cv	3	1	1	1	1	2	2
LU	0.7.2	28-06-bab14	2	cvc.cv	3	1	1	1	2	2	|
LU	0.7.2	28-06-bab17	4	cv.cv.cvv.cv	3	3	3	4	1	1	1
LU	0.7.2	28-06-bab20	2	cv.cv	3	1	1	2	1	1	2
LU	0.7.2	28-06-bab21	3	cv.cv.cv	3	1	2	1	2	2	1
LU	0.8.1	05-07-bab3	2	cv.cvc	2	1	1	2	1	1	1
LU	0.8.1	05-07-bab4	2	v.cv	3	1	2	2	2	2	-
LU	0.8.1	05-07-bab5	3	vc.cv.cv	3	1	3	2	2	2	1
LU	0.8.1	05-07-bab6	2	v.cv	3	1	1	1	2	2	1
LU	0.8.1	09-07-bab1	3	cv.cvv.cv	3	2	2	3	1	1	2
LU	0.8.1	09-07-bab2	4	v.cv.cv.cv	3	|	|	2	4	1	|
LU	0.8.1	09-07-bab3	3	cv.cvv.cv	2	2	|	2	3	3	-
LU	0.8.1	09-07-bab4	3	ccv.cv.cv	3	1	|	1	3	3	1
LU	0.8.1	09-07-bab5	3	v.cv.cv	3	1	1	1	2	2	1
LU	0.8.1	09-07-bab6	2	cvc.cv	3	1	1	1	1	1	2
LU	0.8.1	09-07-bab7	5	v.cv.cv.cv.cv	3	|	1	|	|	4	-
LU	0.8.1	09-07-bab8	2	v.cv	3	1	1	2	1	1	-
LU	0.8.1	13-07-bab1	3	v.cv.cvcc	2	3	|	3	2	2	|
LU	0.8.1	13-07-bab2	3	v.cv.cv	2	2	2	2	3	3	-
LU	0.8.1	13-07-bab3	2	cv.cv	3	2	1	1	2	2	2

LU	0.8.1	13-07-bab4	3	cv.cv.cv	3	3	3	1	2	2	-
LU	0.8.1	13-07-bab5	4	v.cv.cv.cv	3	2	2	3	|	4	|
LU	0.8.1	13-07-bab6	2	v.cvc	3	2	2	1	|	2	2
LU	0.8.2	15-07-bab1	5	v.cv.cv.cv.cv	3	3	|	2	2	1	2
LU	0.8.2	20-07-bab1	3	v.cv.ccv	3	1	|	1	1	3	1
LU	0.8.2	20-07-bab2	4	c.cv.cvv.cv	2	3	3	2	3	3	1
LU	0.8.2	20-07-bab3	2	v.cv	3	2	2	1	1	1	2
LU	0.8.2	20-07-bab4	5	v.cv.cv.cv.cv	3	4	4	3	5	2	-
LU	0.8.2	20-07-bab5	3	v.cvv.cv	2	2	2	3	3	1	-
LU	0.8.2	20-07-bab6	2	v.cv	3	1	1	1	2	2	1
LU	0.8.2	20-07-bab8	2	vc.cv	3	2	2	2	2	2	2
LU	0.8.2	20-07-bab9	3	ccvv.cv.cv	2	2	2	2	1	3	2
LU	0.8.2	21-07-bab1	2	v.cv	3	2	2	1	|	2	2
LU	0.8.2	21-07-bab4	3	cv.cv.cv	3	1	2	2	3	3	2
LU	0.8.2	21-07-bab5	4	cvv.cv.cv.cv	3	3	3	1	3	3	|
LU	0.8.2	21-07-bab7	2	ccvv.cv	2	|	|	2	2	2	2
LU	0.8.2	21-07-bab9	5	v.cv.cv.cv.cv	3	|	4	1	1	1	|
LU	0.8.2	21-07-bab12	4	v.cv.cv.cv	3	2	2	2	4	4	3
LU	0.8.2	21-07-bab15	5	v.cv.cv.cv.cv	2	3	3	3	2	2	2
LU	0.8.2	21-07-bab16	2	v.cv	3	2	2	2	2	1	-
LU	0.8.2	21-07-bab17	4	v.cv.cv.cvv	3	2	|	3	1	4	-
LU	0.8.2	25-07-bab1	5	cv.cv.cv.cvv.cv	2	4	3	2	5	5	-
LU	0.8.2	25-07-bab3	5	cv.cv.cv.cv.cv	2	5	5	5	1	1	-
LU	0.9.1	01-08-bab1	3	v.cv.ccv	2	2	2	2	1	1	-
LU	0.9.1	01-08-bab5	5	cv.cv.cv.cv.cv	3	1	1	1	1	2	4
LU	0.9.1	01-08-bab3	3	cv.cv.cvv	3	3	|	1	1	2	3
LU	0.9.1	01-08-bab4	2	vvc.cv	2	1	1	2	1	1	1
LU	0.9.1	01-08-bab5	2	v.cvc	3	2	|	1	1	2	2
LU	0.9.1	01-08-bab7	4	cv.cv.cv.cv	3	3	1	1	2	4	4
LU	0.9.1	02-08-bab2	2	v.cv	3	2	2	2	2	2	2
LU	0.9.1	02-08-bab3	2	v.cv	3	1	1	1	|	2	2
LU	0.9.1	02-08-bab4	4	cv.cv.cv.cv	2	1	|	2	3	3	-
LU	0.9.1	02-08-bab6	2	c.cv	3	1	1	1	2	2	-
LU	0.9.1	02-08-bab7	3	cv.cv.cv	3	1	1	3	3	1	3
LU	0.9.2	18-08-bab1	2	vv.cv	3	1	1	1	1	2	2
LU	0.9.2	18-08-bab2	2	v.cvc	3	2	2	2	1	1	2
LU	0.9.2	18-08-bab3	4	v.cv.cv.cvv	2	4	4	2	1	1	-
LU	0.9.2	18-08-bab4	4	cv.cv.cv.cv	2	4	4	4	3	3	|
LU	0.9.2	18-08-bab5	3	v.cv.cv	3	2	|	2	2	1	2
LU	0.9.2	18-08-bab6	3	cv.cv.cv	3	1	1	1	2	3	1

LU	0.9.2	18-08-bab7	3	cv.cvv.cvv	3	2	2	2	2	1	2
LU	0.9.2	18-08-bab8	2	cv.cv	3	1	1	2	2	1	2
LU	0.9.2	18-08-bab9	2	cvv.cv	3	1	2	1	1	1	1
LU	0.9.2	18-08-bab10	3	cv.cv.cv	3	2	2	2	2	1	1
LU	0.9.2	18-08-bab11	2	cv.cv	3	1	2	1	2	2	2
LU	0.9.2	18-08-bab12	2	cv.cv	3	1	2	2	2	2	1
LU	0.9.2	18-08-bab13	3	cv.cv.cv	3	2	2	2	3	3	2
LU	0.9.2	18-08-bab14	2	cv.cvc	3	2	2	2	2	2	1
LU	0.9.2	18-08-bab15	5	cv.cv.cv.cv.cv	2			2	2	4	5	-
LU	0.9.2	18-08-bab16	5	cv.cv.cv.cvv.cv	3	4	4	3	2	2	-
LU	0.9.2	18-08-bab17	4	cv.ccv.cvv.cv	2	3	2	1	4	3	-
LU	0.9.2	18-08-bab18	3	v.cv.cv	3	2	2	1	2	2	-
LU	0.9.2	21-08-bab1	3	v.ccv.cv	3	3			2	1	1	3
LU	0.9.2	21-08-bab3	2	cv.cv	3	1	1	2	2	1	2
LU	0.9.2	21-08-bab5	2	cv.cv	3	1	1	1	2	2	1
LU	0.9.2	21-08-bab6	3	cvv.cv.cv	3	1			3	3	1		
LU	0.9.2	21-08-bab9	3	v.cvv.cvc	3	2	3	3	1	1	3
LU	0.9.2	21-08-bab11	5	ccv.cv.cv.cv.cv	2			1	5	2	2		
LU	0.9.2	21-08-bab12	2	cv.cv	2	2	2	1	2	2	2
LU	0.9.2	21-08-bab13	2	cv.cv	3	2	2	2	2	2	1
LU	0.9.2	21-08-bab14	2	cv.cv	3	1			1	1	2	1
LU	0.9.2	21-08-bab15	4	v.cv.cv.cvc	2	2	1	2	4	4	-
LU	0.9.2	21-08-bab16	5	cv.cv.cv.cv.cvv	3	2	2	2	3	3	-
LU	0.9.2	21-08-bab19	5	cv.cv.cv.cv.cv	3	5	3	1	3	3	5
LU	0.9.2	21-08-bab20	4	cv.cv.ccvv.cv	3					4	1	2		
LU	0.9.2	21-08-bab21	5	cc.cv.cv.cv.cvv	2	5	5	2	3	3	-
LU	0.9.2	21-08-bab22	3	cv.cv.cvc	3	3	3	2	1	1	3
LU	0.9.2	21-08-bab23	2	ccvv.cv	2	1	2	2	2	1	1
LU	0.9.2	21-08-bab24	2	cv.cvv	3	2	1	1	1	2	2
LU	0.9.2	21-08-bab26	4	cv.cv.cv.cv	3					1	3	3	1
LU	0.9.2	21-08-bab27	5	cv.cv.cv.cv.cv	3	3	2	2	1	3	-
LU	0.9.2	21-08-bab29	5	cv.cv.cv.cv.cv	3	4	1	2	5	5	5
LU	0.9.2	21-08-bab30	2	cv.cv	3	1	2	2	1	1	1
LU	0.9.2	22-08-bab5	3	cc.cv.cv	3	2	3	2	1	1		
LU	0.9.2	22-08-bab6	2	cv.cvv	3	2	2	1	1	1	2
LU	0.9.2	22-08-bab7	3	cv.cvv.cv	3	2	2	3	3	1		
LU	0.9.2	22-08-bab8	3	ccv.cv.cv	3	2	1	2	1	1		
LU	0.9.2	22-08-bab9	3	cv.cvv.cv	3	2	2	2	1	1	2
LU	0.9.2	22-08-bab10	3	cvv.cvv.cv	3	1			2	2	2	1
LU	0.9.2	22-08-bab11	4	cv.cv.cvv.cv	2	2			4	3	3	-

LU	0.9.2	22-08-bab12	2	cv.cv	3	1	1			2	2	1
LU	0.9.2	22-08-bab13	5	cv.cvv.cv.cv.cv	3	2	2	3	2	1		
LU	0.9.2	22-08-bab15	2	cv.cv	3	2			1	2	2	1
LU	0.9.2	22-08-bab17	2	v.cv	3	1			2	1	1	2
LU	0.9.2	22-08-bab18	2	cv.cv	3	2	2	2	2	2	-
LU	0.9.2	22-08-bab19	3	cv.cv.cv	3	3	3	1	1	1	3
LU	0.9.2	22-08-bab23	2	cv.cv	3	2	1	2	1	1	1
LU	0.9.2	22-08-bab27	2	cv.cv	3	1			1	2	1	1
LU	0.9.2	22-08-bab29	2	cv.cv	3	1	1	2	1	1	-
LU	0.9.2	22-08-bab31	3	v.cv.cv	3	2	2	2	2	1	-
LU	0.9.2	22-08-bab32	2	cv.cv	3	1	1	2	1	1	1
LU	0.9.2	22-08-bab33	2	cv.cv	3	2	2	2	2	1	2
LU	0.9.2	22-08-bab34	2	cv.cv	3	1	1	1	1	2	-
LU	0.9.2	22-08-bab36	5	cv.cv.cv.cv.cv	3	2	3	2	2	2		
LU	0.9.2	22-08-bab37	3	v.cv.cvv	2	2	2	1	1	2	3
LU	0.9.2	30-08-bab1	3	v.cvv.cv	3	2	2	1	2	2	1
LU	0.9.2	30-08-bab3	3	cv.cv.cvv	3	3	3	3	3	2	3
LU	0.9.2	30-08-bab4	3	v.cvv.cv	3	2	2	2	2	3	3
LU	0.9.2	30-08-bab5	4	cv.cv.cv.cv	3	3			4	2	2		
LU	0.9.2	30-08-bab9	3	cv.cv.cv	3	1	2	1	2	2		
LU	0.9.2	30-08-bab10	4	v.cv.cv.cv	2	3	3	3	4	4	2
LU	0.9.2	30-08-bab11	2	cv.cv	3	2	2	2	2	2	2
LU	0.9.2	30-08-bab12	2	cv.cv	3	1			2	2	2	1
LU	0.9.2	30-08-bab13	2	cv.cv	3	1	1	2	1	1	1
LU	0.9.2	30-08-bab14	3	cv.cv.cv	3	2			3	1	1		
LU	0.9.2	30-08-bab15	2	cv.cvc	3	1	1	2	1	1	1
LU	0.9.2	30-08-bab16	2	cv.cv	3	1	1	1	1	1	1
LU	0.9.2	30-08-bab18	2	cv.cv	3	2	2	2	2	2	2
LU	0.9.2	30-08-bab20	2	v.cv	3	1	1	1	1	1	1
LU	0.9.2	30-08-bab21	2	c.cv	2	2	2	2	2	2	2
LU	0.9.2	30-08-bab22	4	cv.cv.cv.cvc	2	3			3	2	4		
LU	0.9.2	30-08-bab23	2	cv.cvc	2	2	2	1	1	1	2
LU	0.9.2	30-08-bab24	3	cv.cv.cv	3	2	2	2	2	2	-
LU	0.9.2	30-08-bab25	3	cc.cv.cv	2	2	2	3	3	1	-
LU	0.9.2	30-08-bab27	3	cv.cv.cv	3	2	2	1	1	1		
LU	0.9.2	30-08-bab29	4	cvv.cvv.cv.cv	3	3			1	3	2	1
LU	0.9.2	31-08-bab1	2	v.cv	3	2	2	1	1	2	2
LU	0.9.2	31-08-bab2	4	v.cv.v.cvv	3	4	4	4	3	1	-
LU	0.10.1	01-09-bab2	2	cvv.cvv	3	2			2	1	1		
LU	0.10.1	01-09-bab3	2	cv.cv	3	2	2	1	2	2	2

LU	0.10.1	01-09-bab4	3	v.cv.cv	3	3	3	2	3	3	-
LU	0.10.1	01-09-bab5	3	v.cv.cvv	2	3	2	2	3	3	-
LU	0.10.1	01-09-bab6	2	ccv.cvv	2	2	2	1	2	2	1
LU	0.10.1	01-09-bab7	2	ccv.cv	2	1	1	1	2	2	|
LU	0.10.1	01-09-bab8	3	v.cv.cv	3	3	3	2	3	1	-
LU	0.10.1	01-09-bab9	3	v.cv.cv	3	3	3	3	3	2	1
LU	0.10.1	01-09-bab10	2	v.cv	3	2	2	1	2	2	2
LU	0.10.1	01-09-bab11	2	vv.cv	2	1	2	2	1	1	1
LU	0.10.1	01-09-bab12	3	v.cv.cv	3	2	3	2	3	3	|
LU	0.10.1	01-09-bab14	3	cv.cv.cv	3	2	3	|	3	2	1
LU	0.10.1	01-09-bab15	4	v.cv.cv.cv	3	3	|	2	1	4	|
LU	0.10.1	06-09-bab4	4	cv.cv.ccv.cv	3	3	3	2	1	3	1
LU	0.10.1	06-09-bab5	2	cvv.cvc	3	1	1	1	1	2	1
LU	0.10.1	06-09-bab6	2	v.cvc	2	2	2	2	1	1	-
LU	0.10.1	06-09-bab8	2	v.cv	3	2	2	1	2	2	1
LU	0.10.1	06-09-bab9	2	cv.cv	3	1	2	1	1	2	1
LU	0.10.1	06-09-bab10	2	v.cv	3	2	2	1	2	2	-
LU	0.10.1	06-09-bab12	2	cv.cv	2	|	2	1	2	2	|
LU	0.10.1	06-09-bab13	2	c.cv	2	2	2	2	2	2	-
LU	0.10.1	06-09-bab15	2	v.cv	2	2	2	2	2	1	|
LU	0.10.1	06-09-bab16	5	cv.cv.cv.cv.cv	2	4	4	4	3	3	-
LU	0.10.1	06-09-bab17	2	v.cv	3	1	2	2	2	1	|
LU	0.10.1	06-09-bab18	4	cvc.cv.cv.cvc	2	2	2	1	3	2	3
LU	0.10.1	06-09-bab19	5	v.cv.cv.cv.cv	3	|	|	3	2	5	5
LU	0.10.1	06-09-bab20	2	v.cv	3	2	2	2	2	1	-
LU	0.10.1	06-09-bab21	3	cv.cv.cv	3	2	2	1	3	3	3
LU	0.10.1	10-09-bab2	2	v.cv	3	2	2	1	1	1	|
LU	0.10.1	10-09-bab3	2	v.cvv	2	2	2	1	2	2	-
LU	0.10.1	10-09-bab4	2	v.cv	3	2	2	1	2	2	2
LU	0.10.1	10-09-bab5	3	v.cvc.cv	3	2	2	2	|	1	|
LU	0.10.1	10-09-bab7	4	v.cvv.cvv.cv	3	2	|	4	3	1	|
LU	0.10.1	10-09-bab9	4	v.cv.cvv.v	2	2	1	3	1	1	|
LU	0.10.1	10-09-bab10	4	v.cvv.cv.cv	2	4	3	2	3	4	-
LU	0.10.1	10-09-bab11	3	c.cv.cv	2	|	3	3	3	3	-
LU	0.10.1	12-09-bab1	2	cv.cv	2	1	1	1	2	2	|
LU	0.10.1	12-09-bab2	5	cv.cv.cvv.cv.cv	3	3	2	1	5	3	|
LU	0.10.1	12-09-bab4	2	cv.cv	3	1	1	2	2	2	-
LU	0.10.1	12-09-bab6	3	v.cv.cv	3	2	2	2	3	1	2
LU	0.10.1	12-09-bab7	2	cv.cv	3	1	|	2	2	1	2
LU	0.10.1	12-09-bab9	2	cv.cv	3	1	1	2	1	1	2

LU	0.10.1	12-09-bab10	4	ccv.cv.cv.cv	2	1	2	3	4	4	4
LU	0.10.1	12-09-bab11	2	cv.cv	3	2	2	2	1	1	2
LU	0.10.1	12-09-bab12	3	cv.cvv.cv	3	2	2	2	1	1	3
LU	0.10.1	12-09-bab13	2	ccv.cv	2	1	1	2	1	1	2
LU	0.10.1	12-09-bab14	2	cv.cv	3	2	2	1	2	2	2
LU	0.10.1	12-09-bab15	2	v.cv	3	2	2	1	|	2	2
LU	0.10.1	12-09-bab16	3	v.cv.cv	3	2	3	2	3	3	2
LU	0.10.1	12-09-bab17	3	v.cv.cv	3	3	3	2	1	1	2
LU	0.10.1	12-09-bab18	2	cv.cv	3	1	2	2	2	2	2
LU	0.10.1	12-09-bab19	2	ccv.cv	3	1	1	1	2	2	1
LU	0.10.1	12-09-bab20	2	v.cv	3	2	2	2	|	1	2
LU	0.10.1	12-09-bab21	2	cv.cv	3	1	1	2	1	1	2
LU	0.10.1	12-09-bab22	2	cv.cv	3	1	1	2	1	1	|
LU	0.11.1	05-10-bab1	2	c.cv	3	2	2	2	2	2	2
LU	0.11.1	05-10-bab2b	4	ccv.cv.cv.cv	2	4	4	4	2	2	2
LU	0.11.1	05-10-bab3	3	cv.cvv.cv	3	2	2	3	2	2	2
LU	0.11.2	08-11-bab1	2	vv.cv	3	1	|	1	1	2	1
LU	0.11.2	08-11-bab2	3	vv.cv.cv	3	1	|	3	2	2	2
LU	0.11.2	08-11-bab3	4	vv.cv.cv.cv	2	|	2	3	1	1	|
LU	0.11.2	08-11-bab4	3	v.cv.cv	3	1	|	1	|	3	|
LU	0.11.2	08-11-bab5	3	v.cvv.cv	2	2	2	3	2	2	1
LU	0.11.2	08-11-bab6	5	v.cv.cv.cv.cv	3	4	2	2	3	3	4
LU	0.11.2	08-11-bab7	4	v.ccv.cv.cv	3	2	|	4	1	1	3
LU	0.11.2	08-11-bab8	3	vv.cvv.cv	2	2	|	1	1	2	|
LU	0.11.2	08-11-bab9	2	vv.cvv	3	2	2	1	2	2	1
LU	0.11.2	08-11-bab10	2	cv.cv	3	1	|	2	2	1	|
LU	0.11.2	08-11-bab11	2	v.cv	3	1	|	1	|	2	1
LU	0.11.2	08-11-bab12	4	vv.cv.cv.cv	3	2	|	4	3	3	2
LU	0.11.2	08-11-bab13	3	vv.cv.cv	3	|	2	2	1	1	|
LU	0.11.2	08-11-bab14	2	vv.cv	3	|	2	1	1	2	1
LU	0.11.2	08-11-bab15	4	v.cv.cv.cv	3	3	3	4	4	4	|
LU	0.11.2	08-11-bab16	5	v.cv.cv.cv.cv	3	|	|	4	1	1	3
LU	0.11.2	09-11-bab1	4	v.cv.cv.cvv	3	4	4	2	4	4	|
LU	0.11.2	09-11-bab2	3	v.cv.cv	3	3	3	3	1	2	3
LU	0.11.2	09-11-bab3	3	vv.cv.cv	3	1	2	2	1	1	3
NB	0.8.2	14-10-bab1	3	v.cvv.cvv	3	1	|	3	2	1	1
NB	0.8.2	14-10-nein	2	cvv.cv	2	1	1	1	1	1	1
NB	0.8.2	20-10-bab2	2	cv.cv	3	2	|	2	1	1	|
NB	0.8.2	20-10-bab3	2	cv.cv	3	1	1	1	2	2	1
NB	0.9.1	28-10-bab1	2	v.cv	3	1	1	1	1	2	-

NB	0.9.1	28-10-bab2	2	cv.cvc	2	1	1	2	1	1	-
NB	0.9.1	02-11-bab1	2	v.cv	3	2	2	|	2	2	-
NB	0.9.1	02-11-bab2	4	v.cvv.cvv.cv	3	2	2	4	4	4	|
NB	0.9.1	03-11-bab1	2	v.cv	3	2	2	2	2	2	-
NB	0.9.1	03-11-bab2	3	cvv.cv.cv	3	1	1	1	1	1	1
NB	0.9.1	03-11-bab3	2	v.cvv	2	2	2	1	2	2	2
NB	0.9.1	03-11-bab5	4	v.cv.cv.cvc	3	2	|	2	2	1	4
NB	0.9.1	03-11-bab6	3	v.cv.cvc	3	1	2	2	1	1	2
NB	0.9.1	03-11-bab8	5	v.cv.cv.cv.cv	3	4	4	4	3	3	4
NB	0.9.1	03-11-bab9	3	cv.cv.cv	3	3	3	2	3	3	-
NB	0.9.1	03-11-bab10	2	cvv.cv	3	1	1	|	1	1	1
NB	0.9.1	03-11-bab11	3	cvv.cvv.cv	3	2	2	|	3	3	-
NB	0.9.1	03-11-bab12c	2	v.cv	3	2	2	2	2	2	2
NB	0.9.1	03-11-bab12d	3	v.cv.cv	2	2	|	3	2	2	2
NB	0.9.1	03-11-bab12e	2	v.cvv	3	2	|	1	2	2	2
NB	0.9.1	03-11-bab12f	2	v.cvv	3	2	2	2	|	1	2
NB	0.9.1	03-11-bab13	2	vv.cvc	3	2	2	2	1	1	1
NB	0.9.1	03-11-bab14	4	v.cvv.cv.cv	2	4	4	2	2	4	|
NB	0.9.1	03-11-bab15	2	v.cv	3	1	1	2	1	1	1
NB	0.9.1	03-11-bab16	2	v.cv	3	1	1	2	2	1	-
NB	0.9.1	03-11-bab17	2	cv.cv	3	1	1	1	1	1	|
NB	0.9.1	03-11-bab19a	2	cv.cvc	3	1	|	2	|	1	1
NB	0.9.1	03-11-bab20	5	v.cvv.cvv.cvv.cv	3	4	|	1	5	5	-
NB	0.9.1	04-11-bab2a	2	v.cv	2	2	2	1	2	2	2
NB	0.9.1	04-11-bab2b	2	v.cv	2	?	2	2	1	1	1
NB	0.9.1	04-11-bab4c	2	v.cv	2	?	2	2	2	2	2
NB	0.9.1	05-11-bab1a	3	v.cv.cv	3	1	3	1	3	2	1
NB	0.9.1	05-11-bab1b	3	v.cvv.cvv	3	2	|	1	3	3	3
NB	0.9.1	05-11-bab1c	2	vv.cv	2	1	|	1	1	2	2
NB	0.9.1	05-11-bab1d	2	cvv.cvv	3	1	1	1	2	2	2
NB	0.9.1	05-11-bab1e	2	vv.cv	2	1	1	2	1	1	2
NB	0.9.1	05-11-bab3	2	v.cv	3	2	2	2	2	2	|
NB	0.9.1	05-11-bab4	2	v.cvv	3	2	2	2	2	|	-
NB	0.9.1	05-11-bab5	3	vv.cvv.cv	3	1	2	1	2	2	1
NB	0.9.1	05-11-bab7a	3	v.cvv.cvv	3	2	|	3	3	3	2
NB	0.9.1	05-11-bab7b	4	v.cv.cv.cv	3	2	|	4	2	2	2
NB	0.9.1	05-11-bab7c	4	v.cv.cvv.cv	3	2	2	2	3	3	-
NB	0.9.1	05-11-bab7d	2	cv.cv	3	2	1	2	1	1	|
NB	0.9.1	05-11-bab8	3	cv.cv.cv	3	1	|	3	1	2	2
NB	0.9.1	06-11-bab1	4	v.cv.cv.cv	3	2	|	3	4	4	3

NB	0.9.1	06-11-bab2	2	vv.cv	2	1	1	1	2	2	1
NB	0.9.1	06-11-bab4	4	cvv.cv.cv.cv	3	?	2	2	1	1	-
NB	0.9.1	06-11-bab5	2	cvv.v	3	1	1	1	1	2	1
NB	0.9.1	06-11-bab8	3	v.cv.cvv	2	3	2	2	3	3	3
NB	0.9.1	06-11-bab10	2	cv.cv	3	1	1	1	1	2	1
NB	0.9.1	06-11-bab11	2	cv.cv	3	1	1	1	2	2	1
NB	0.9.1	06-11-bab12	2	cvc.cv	3	1	1	1	2	2	1
NB	0.9.1	06-11-bab14b	3	vv.cv.cvv	2	1	1	2	1	3	3
NB	0.9.1	06-11-bab14c	2	cv.cv	3	2	1	1	2	2	2
NB	0.9.1	06-11-bab14d	2	cv.cv	3	?	1	1			2	2
NB	0.9.1	06-11-bab14e	2	cv.cv	3	1	1	2	1	1	1
NB	0.9.1	06-11-bab14f	2	cv.cv	3	?			2			1	1
NB	0.9.1	06-11-bab15	2	v.cvc	2	2	2	2	2	2	2
NB	0.9.2	07-11-bab1	3	cv.cv.cv	3	3			3	3	1	3
NB	0.9.2	07-11-bab2	3	v.cv.cv	3	2			3	2	1	-
NB	0.9.2	07-11-bab4	4	v.cv.cv.cv	3	?	1	3	1	1	3
NB	0.9.2	07-11-bab6a	2	vv.cv	2	1	2	1	1	2	1
NB	0.9.2	07-11-bab7	3	cv.cv.cv	3	2			3	2	2	1
NB	0.9.2	10-11-bab2	3	cv.cv.cv	3	2			1	3	3		
NB	0.9.2	10-11-bab3	3	cv.cv.cv	3	2	2	3	1	1		
NB	0.9.2	10-11-bab4	2	cv.cc	3	1	1	1	1	2	1
NB	0.9.2	10-11-bab5	3	c.cv.cv	2	3	2	2	3	3	3
NB	0.9.2	10-11-bab7	2	cv.cv	3	1	1	1	1	2	1
NB	0.9.2	10-11-bab8	3	v.cv.cvv	2	2	2	3	3	1	2
NB	0.9.2	10-11-bab9	2	v.cv	3	2	1	1	2	2		
NB	0.9.2	10-11-bab10	2	cvv.cvv	3	2	2	1	1	1	1
NB	0.9.2	10-11-bab11	2	cvv.cv	3	2	2	2	1	1	2
NB	0.9.2	10-11-bab12	2	cvv.cv	2	1	1	1	2	2	1
NB	0.9.2	10-11-bab13	2	cv.cv	2	1	1	1	1	2	-
NB	0.9.2	10-11-bab14	3	v.cvv.cvv	3	2	2	3	2	1	-
NB	0.9.2	10-11-bab15	4	vv.cvv.cvv.cvv	3	3	4	3	4	4	-
NB	0.9.2	10-11-bab16	4	cv.cv.cv.cv	3	3			2	3	3	3
NB	0.9.2	10-11-bab17	2	ccv.cv	3	1	1	1			2	1
NB	0.9.2	10-11-bab18	2	cv.cvv	2	2	2	2	2	2	1
NB	0.9.2	10-11-bab19	3	v.cvv.cvv	2	3	3	2	1	1	3
NB	0.9.2	10-11-bab20	3	v.cvv.cvv	2	?	2	2			1	-
NB	0.9.2	10-11-bab21	2	cv.cv	3	1	1	1	1	2	1
NB	0.9.2	10-11-bab24	2	cv.cv	3	1	1	1	2	2	1
NB	0.9.2	10-11-bab26	2	v.cv	3	2	3	3			1		
NB	0.9.2	10-11-bab27	2	v.cvc	3	2	2	2	2	2	-

NB	0.9.2	10-11-bab30	3	vv.cvv.cv	3	2	|	2	2	1	|
NB	0.9.2	10-11-bab33	2	vv.cvv	3	1	2	1	2	2	-
NB	0.9.2	10-11-bab34	3	cvv.cvv.cv	2	2	2	3	1	1	1
NB	0.9.2	10-11-bab35	5	v.cvv.cvv.cvv.cvv	3	|	1	5	4	4	5
NB	0.9.2	10-11-bab36	3	vv.cvv.cvv	3	1	|	3	1	1	-
NB	0.9.2	10-11-bab37	2	vv.cvv	2	1	1	1	1	2	1
NB	0.9.2	10-11-bab38	2	cc.cv	3	2	|	2	2	1	1
NB	0.10.1	11-11-bab3	3	c.cv.cvc	2	2	2	1	2	3	|
NB	0.10.1	11-11-bab5	3	v.cv.cvc	3	3	3	3	1	1	2
NB	0.10.1	11-11-bab6	2	v.cvc	3	1	1	1	1	2	1
NB	0.10.1	11-11-bab7	2	v.cc	2	2	2	1	1	1	-
NB	0.10.1	11-11-bab8	3	v.cv.cvv	3	1	1	1	3	3	1
NB	0.10.1	11-11-bab9	2	cvc.cv	3	1	1	1	1	1	1
NB	0.10.1	11-11-bab10	4	cc.cv.cv.cvc	2	?	|	4	4	3	|
NB	0.10.1	11-11-bab11	3	cv.cv.cv	3	1	1	1	|	2	-
NB	0.10.1	11-11-bab12	4	vv.cvv.cv.cv	3	3	|	4	1	1	|
NB	0.10.1	11-11-bab15	2	v.cvc	3	2	2	2	2	1	-
NB	0.10.1	11-11-bab16	2	vv.cv	2	1	1	2	2	2	1
NB	0.10.1	11-11-bab19	2	v.cvc	3	2	1	2	1	1	1
NB	0.10.1	11-11-bab22	2	cv.cv	3	1	1	1	1	2	-
SG	0.6.2	k14	2	v.cvv	2	2	2	2	|	1	2
SG	0.6.2	k33u11	4	v.cv.cv.cvv	3	1	1	1	4	4	|
SG	0.6.2	k35u11	3	cv.cvv.cv	3	2	1	1	2	2	|
SG	0.6.2	k57u17	3	cvv.cv.cv	2	3	1	2	1	1	2
SG	0.6.2	k69	3	v.cvv.cv	3	2	3	3	3	2	3
SG	0.6.2	k70u19	2	c.cv	3	1	2	2	2	1	1
SG	0.7.2	k01u02	4	v.cv.cv.cv	3	1	1	1	2	4	3
SG	0.7.2	k02	2	cv.cvc	3	|	2	1	|	2	1
SG	0.7.2	k03u04	3	cv.cv.cvv	2	|	1	2	3	3	1
SG	0.7.2	k04	4	vv.cv.cv.cv	3	1	1	1	3	4	-
SG	0.7.2	k05	2	cv.cv	2	1	1	1	|	2	-
SG	0.7.2	k06	5	cv.cv.cv.cv.cv	3	2	3	3	1	1	|
SG	0.7.2	k09	2	cv.cv	3	2	2	1	1	1	2
SG	0.8.1	k03	2	cvv.cv	3	1	1	2	2	1	1
SG	0.8.1	k06u02	2	c.cvv	3	2	2	2	2	1	-
SG	0.8.1	k07u02	3	ccv.cv.cv	2	1	1	1	|	2	-
SG	0.8.1	k12	2	ccvc.cc	2	1	1	1	1	2	-
SG	0.8.1	k15	2	cvv.cv	2	1	-	2	1	1	1
SG	0.8.1	k17	2	cv.cvv	3	2	2	2	1	1	2
SG	0.8.1	k21	2	cv.cvv	3	2	2	1	1	2	2

SG	0.8.2	k01	5	cv.cv.cv.cv.cv	3	2	3	3	5	2		
SG	0.8.2	k04	2	v.cv	3	2			2	1	1	2
SG	0.8.2	k05	2	c.cv	3	2			2			1	1
SG	0.8.2	k06u02	2	vv.cv	2			2	2			1	1
SG	0.8.2	k09u03	4	v.cv.cv.cvv	3	2	1	1	3	3	-
SG	0.8.2	k10u03	2	v.cvv	2	2	1	1	2	2	1
SG	0.8.2	k11u04	2	cvv.cv	3	1	1	2	1	1	1
SG	0.9.1	k04u10	2	v.cv	3	2	2	2	2	2	-
SG	0.9.1	k05u10	3	cv.cv.cvc	2	3	3	2	3	3	1
SG	0.9.2	k07	4	cv.cv.cv.cv	3			4	4			2	1
SG	0.9.2	k08	3	v.cvv.cv	3	2	2	3			1	1
SG	0.9.2	k09	4	v.cv.cv.cv	2	2			4	3	1	2
SG	0.9.2	k10	2	cv.cv	3	2	1	2	1	1		
SG	0.9.2	k11	2	cv.cv	3	1	1	1	1	2		
SG	0.9.2	k12	2	cv.cv	3	1			1			2	2
SG	0.9.2	k14	3	cv.cv.cv	2	1	1	1	1	3	-
SG	0.9.2	k15	3	ccvv.cv.cv	2	2	2	1	2	2		
SG	0.9.2	k16	2	ccv.cv	2	2	2	1	2	2	1
SG	0.9.2	k19u02	2	v.cv	3	2	2	2	2	2	2
SG	0.9.2	k20u02	3	v.cvv.cv	2	2	2	1	1	2		
SG	0.9.2	k21u02	2	v.cv	3	2	2	2	1	1	2
SG	0.10.1	u01b	2	vv.cv	2	1	1	2	1	1	1
SG	0.10.2	k01	5	v.cv.cv.cvc.cv	3	4			6	5	4		
SG	0.10.2	k02	4	vv.cv.cv.cv	3	1	1	1	2	4		
SG	0.10.2	k05u01	3	cv.cvc.cv	3	2	2	3	2	2	3
SG	0.10.2	k06	2	v.cv	3	1	1	1	2	2	1
SG	0.10.2	k07u02	5	v.cv.cv.cv.cv	3	2	3	4	2	5	-
SG	0.10.2	k09	4	cvv.cv.cv.cv	3	1	1	1			2	1
SG	0.10.2	k11	4	cvv.cv.cv.cv	3	1	2	2	1	1		
SG	0.10.2	k12	5	ccv.cv.cv.cv.cv	2			4	2			1		
SG	0.10.2	k15u04	5	cv.cv.cv.cv.cvv	3			4	4	1	1	2
SG	0.10.2	k16	5	cv.cv.cv.cv.cv	3	2	2	2	2	1	-
SG	0.10.2	k17	2	vv.cv	3			2	2	1	1	1
SG	0.10.2	k19	2	v.cv	3	1	2	1	1	1	2
SG	0.10.2	k30u07	5	vv.cv.cv.cv.cv	3			1	5	4	4	-
SG	0.10.2	k33	2	vv.cv	3	1	1	1	1	2	2
SG	0.10.2	k37	5	ccv.cv.cv.cv.cv	3	2	2	2			1		
SG	0.10.2	k39	3	v.cv.cv	3	1	1	2	2	3	3
SG	0.10.2	k44u10	3	cv.cv.cv	3	1	3	3	3	3	1
SG	0.10.2	k45	2	vv.cv	3	1	1	1	1	2	1

SG	0.10.2	k46	4	v.cv.cv.cv	3	2	2	2	2	4	1
SG	0.10.2	k48	2	cv.cv	3			2	2	1	1	1
SG	0.10.2	k49	4	v.cv.cv.cv	3	4	4	4	1	1	-
SG	0.10.2	k51u13	2	vv.cv	3	1	1	1	1	2	1
SG	0.10.2	k53	5	v.cv.cv.cv.cv	3	5	2	4	2	2		
SG	0.10.2	k56u15	2	v.cv	3	1	1	1	1	1		
SG	0.10.2	k58u16	2	vv.cv	3	1	1	2	1	1	1
SG	0.11.1	k01	2	ccv.cv	3	1	1	1			2		
SG	0.11.1	k02	2	v.cv	3	1	1	1	1	1		
SG	0.11.1	k03	2	vv.cv	3	2	2	1	1	1	2
SG	0.11.2	k02u01	2	cv.cv	2	1	1	1			2	1
SG	0.11.2	k05	3	cv.cv.cv	3	1	2	1			3		
SG	0.11.2	k07u10	2	v.cv	3	2	2	2			1		
SG	0.11.2	k08	2	cvv.cv	3	1	2	1	1	2	2
SG	0.11.2	k09	3	v.cv.cv	3	2			2			3		
SG	0.11.2	k10u12	2	cv.cvv	2	1	1	1	2	2	1
SG	0.11.2	k11u12	3	cv.cv.cv	3	1			1			3		
SG	0.11.2	k13u13	4	cvv.cv.cv.cv	3			1	1	1	3	-
SG	0.11.2	k14u14	2	ccvv.cv	2	1	1	1			2	1
SG	0.11.2	k15u14	2	cv.c	3	1	1	1	1	2	-
SG	0.11.2	k16u15	2	cv.cv	3	2	2	2	1	1		
SG	0.11.2	k17u15	3	ccv.cv.cv	3	1	3	3	3	1	1
SG	0.11.2	k19	4	v.cv.cv.cv	2	2	3	3	3	1	-
SG	0.11.2	k20	4	v.cv.cv.c	3	2	2	2	2	4	-
SG	0.11.2	m08u04	2	v.cvv	3	2	2	2	2	2		
TJ	0.7.1	m27	3	cv.cv.cvv	3	2	1	3	1	1	-
TJ	0.7.2	k01u01	2	cvv.cv	3	1	1	1	1	2	2
TJ	0.8.1	k11u04	2	cvv.cv	3	1	1	1	2	2	1
TJ	0.8.1	k14u06	2	cv.ccv	2	2	2	2	2	1		
TJ	0.8.1	k17u07	2	c.cv	3	2	2	1	2	2	-
TJ	0.8.1	k18u07	2	cv.cv	3	2	2	2	1	1	-
TJ	0.8.2	k04u02	3	cv.cv.cv	3	3	3	3			1	3
TJ	0.8.2	k05	3	cv.cv.cv	3	2	2	2	2	3	-
TJ	0.8.2	k07u05	2	cv.cv	3	1	1	1	2	2	1
TJ	0.8.2	k12u07	4	cv.v.cv.cv	3	?	1	2	2	3	-
TJ	0.8.2	k26	2	cv.cv	3	2	1	1	2	2	2
TJ	0.8.2	k32	2	cv.cv	3	2	2	2	2	1	-
TJ	0.8.2	k33u15	2	cv.cv	3	1	1	1	1	2	1
TJ	0.8.2	k34u15	2	cv.cv	3	1			2	2	2	1
TJ	0.8.2	k35	2	cv.cv	3	1	1	1			2	2

TJ	0.9.1	k01	2	cv.cv	3	2	2	2	2	1	2
TJ	0.9.1	k18u05	2	cv.cvv	3	|	1	1	1	1	-
TJ	0.9.1	k21u06	2	v.cv	3	1	2	2	|	1	-
TJ	0.10.1	k02	3	cv.cvv.cv	2	1	1	1	1	3	1
TJ	0.10.1	k06u05	2	cv.cvv	3	2	2	2	2	1	2
TJ	0.10.1	k08	2	v.cv	3	2	2	2	|	1	2
TJ	0.11.1	k06	2	v.cv	3	2	2	2	1	1	2
TJ	0.11.1	k15	3	c.cvv.cv	3	2	2	2	2	2	-
TJ	0.11.1	k22	2	cv.cvv	2	1	1	2	1	1	1

Declaration

Hiermit erkläre ich, Andreas Fischer, an Eides statt, dass ich die vorliegende Dissertation "Prosodic organization in the babbling of German-learning infants between the age of six and twelve months" selbstständig verfasst habe und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt wurden.

Sämtliche wissentlich verwendete Textausschnitte, Zitate oder Inhalte anderer Verfasser wurden ausdrücklich als solche gekennzeichnet.

Andreas Fischer