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# **Syllables and schwa: normal and impaired first language acquisition**

Dümig, Sascha

Frank, Andreas

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## **Abstract**

In dem vorliegenden Artikel werden die Sprechdaten eines deutschen Kindes mit einer expressiven spezifischen Sprachentwicklungsstörung (SSES) in Hinsicht auf zwei Themengebiete analysiert. Das erste Themengebiet beinhaltet die Analyse der vom Kind produzierten Silbenstrukturen, das zweite fokussiert die Entwicklung der Prosodie. Bei letzterer steht die Realisierung des Schwa im Vordergrund. Für beide Gebiete wird die Frage aufgeworfen, ob sie eine Erklärung für die Sprachstörung des Kindes liefern können. Die Entwicklung des phonetischen und phonemischen Inventars wird in diesem Artikel nicht berücksichtigt, weil die Analyse auf die Silbenstruktur und das Schwa beschränkt wird.

Schlüsselwörter: Prosodische Entwicklung, Silbenstruktur, Sonorität, Markiertheit, Schwa-Realisierung, Sprachentwicklungsstörung

## **Abstract**

The present article analyses the speech data of a German child with expressive specific language impairment (SLI-E) in regard to two topics. One focuses on the analysis of the child's syllable structures. The other topic is related to the child's prosodic development where we focus on his schwa realization. Both topics are questioned whether they could provide an explanation of the child's language impairment.

What we do not discuss in the present article are issues concerning the development of the child's phonetic and phonemic inventory. We restrict our analysis to syllable structure and schwa.

**Keywords:** Prosodic development, syllable structure, sonority, markedness, schwa realization, language impairment

# 1 **Introduction**

Syllable structure has been one of the topics in studies about delayed and deviant phonological development and revealed that children with expressive specific language impairment (SLI-E) showed simpler syllable structures compared to typically developing children (cf. Paul & Jennings 1992, Thal et al. 1995, Pharr et al. 2000). They produced earlier developing syllable shapes, i.e. only few consonant clusters and predominantly CV, VC, and CVC-syllable shapes. Additionally, these studies list up the children's phonetic inventory separately. Interestingly, it is only stated that simple syllable structures occur but nothing is said about whether the children face problems to produce certain sounds in certain syllable positions but not other. In the present article we will show that the production of certain sound classes may be dependent on whether the syllable is marked as regards to sonority.

Another point recently discussed in studies about prosodic development and in the explanation of language impairment is schwa which is considered a possible marker for delayed and deviant language development. Therefore we extend the data analysis by looking at the child's schwa realisation.

Before analysing and discussing the speech data we will present theoretical issues concerning syllable structure and sonority and cite recent work in the study of the development of syllables and schwa development in children.

## 2 **Theoretical issues concerning syllable structure**

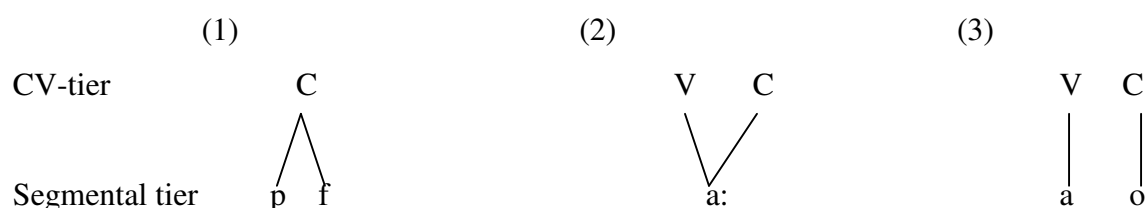
### 2.1 **Syllable models**

There are three important models of the syllable: The flat CV-model, the mora-model and the onset-rhyme-model.

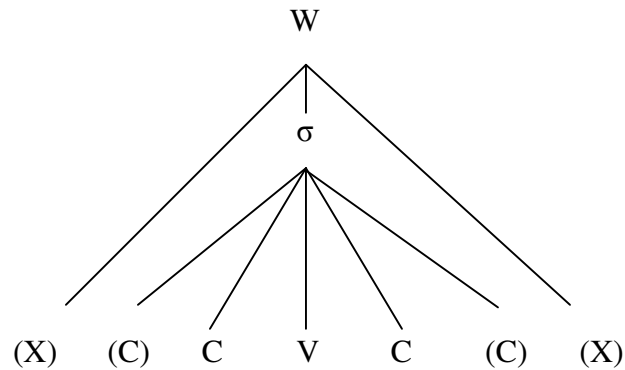
In the CV-model a CV-tier is placed between the syllable and the segmental tier. C and V do not only represent consonants and vowels, in the sense of opening and closing phases of the articulatory tract, but also represent the duration of segments.

There is a 1:1 association of short vowels with V and simple consonants with C.

Complex segments like affricates (1), long segments (2) and diphthongs (3) are represented by a different quantity structure:



There is a limitation for possible associations between the tiers in the form of canonical minimal and maximal syllable positions of a language. According to Wiese (1996: 38) in German the canonical structure, called template, looks like the following:



The minimal syllable of German has a CVC-structure, the CCVCC-structure constitutes the maximal syllable. There can be in some cases extra-syllabic elements or appendices. Some sequences of segments like *Sklave* (*slave*), *Spruch* (*slogan*), *Skelett* (*skeleton*) or *Herbst* (*autumn*) violate the ordering of syllable structure defined by sonority and are directly associated with the w(ord)-node. Selkirk (1984: 116) formulated the following generalization:

“Sonority Sequencing Generalization

In any syllable, there is a segment constituting a sonority peak that is preceded and / or followed by a sequence of segments with progressively decreasing sonority values.”

There is no consensus among phonologists how sonority can be exactly defined. Some authors use a definition in terms of perception (e.g. Jespersen 1913), others in terms of articulation (e.g. Sievers 1901).

The sonority hierarchy for German adopted from Wiese (1988: 91):



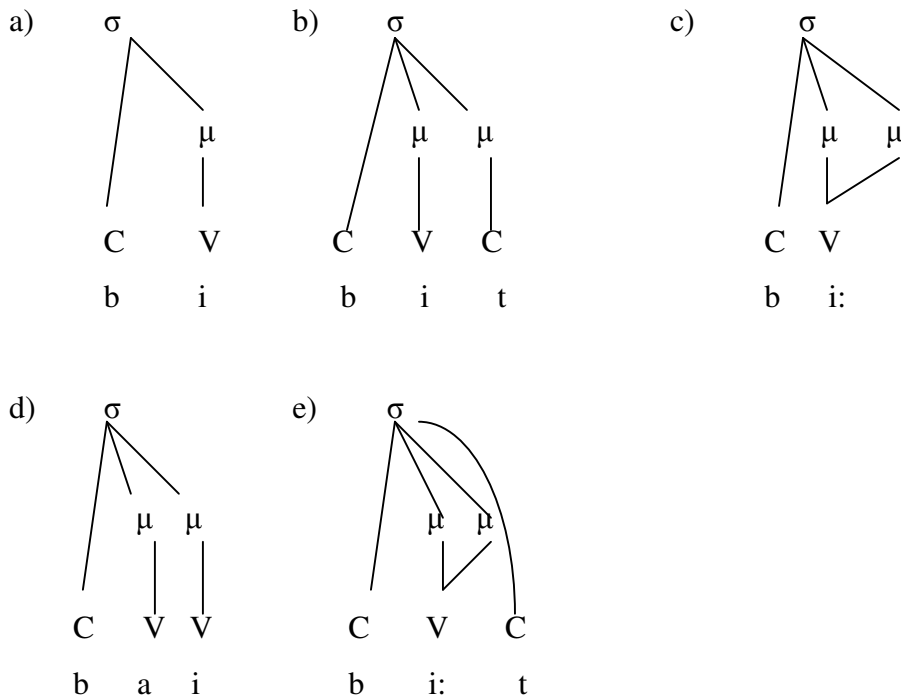
A description of the syllable as a carrier of prosodic attributes, like accent, is given more adequately by other models to be discussed:

The mora-model postulates one tier between segmental and syllable tier. A mora is a timing-unit that defines the syllable weight. A syllable is light with one mora (one segment), heavy with two moras (two segments, long vowel, diphthong) in the syllable rhyme. In quantity sensi-

tive languages (e.g. Arabian, Japanese, Latin) the word-accent is assigned to the heavy syllables. Vennemann (1988:30) has captured this phenomenon in the “Weight Law”:

“In stress accent languages an accented syllable is 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. (The optimal stressed syllable is bimoraic, the optimal unstressed syllable is unimoric.)”

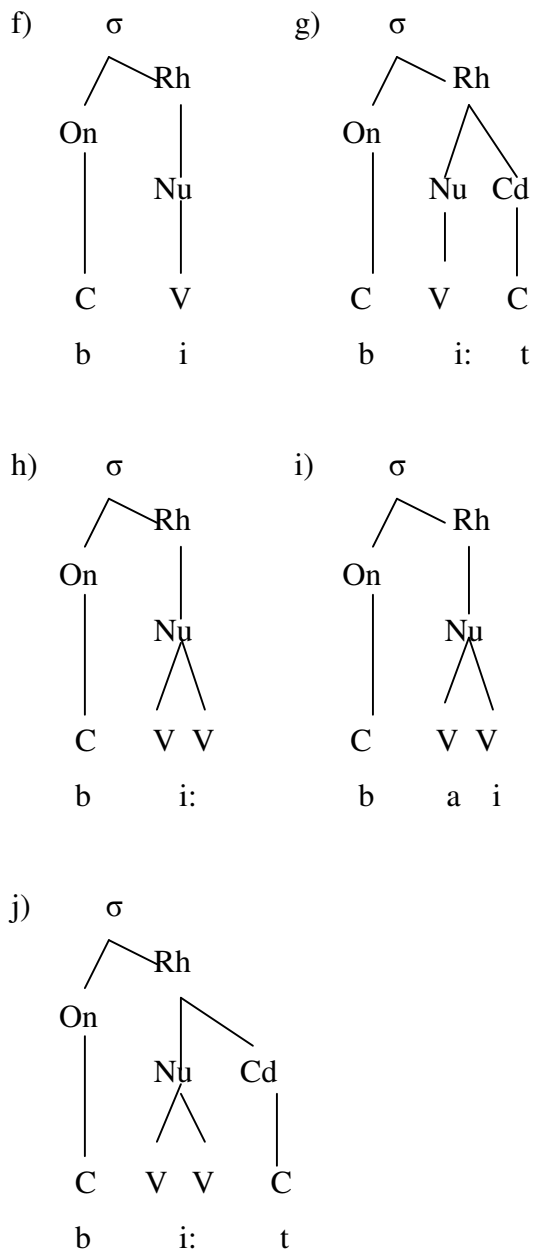
Kehoe & Stoel-Gammon (2001: 396) summarize the moraic representation of syllables in English in the following way:



Only the rhyme of the syllable contributes to syllable weight. The differentiation of syllabic sub-constituents is mainly given in the onset-rhyme-model. The syllable-node branches binarily into onset and rhyme.

The rhyme itself also branches, viz. into nucleus and coda. These sub-constituents, onset, nucleus and coda, are associated with the CV-tier. In this model syllable weight is represented by the number of branching nodes.

Heavy syllables (g, h, i, j) are in contrast with light syllables (f) with a binary rhyme or nucleus:



Kehoe & Stoel-Gammon (2001: 397)

The mora-model and the onset-rhyme-model are frequently used in studies of syllable acquisition. Therefore these models are important to adequately describe the differences of vowel length- and syllable weight.

## 2.2 Sonority and markedness (Clements 1990)

According to Clements (1990), the complexity of a syllable can be defined in terms of sonority. In this theory, sonority is not phonetically measurable but is rather explained in terms of major-classes as the SPE-model (Chomsky & Halle 1968) defined it.

“I will suggest that sonority is not a single, multivalued property of segments, but is derived from more basic categories, identical to the major class features of standard phonological theory (Chomsky & Halle 1968) supplemented with the feature ‘approximant’.” (Clements 1990: 284)

O	<	N	<	L	<	V	
+		+		+		+	syllabic
-		-		-		+	vocoid
-		-		+		+	approximant
-		+		+		+	sonorant
1		2		3		4	rank

Four major classes (obstruents, nasals, liquids and glides/vowels) are defined by the three major class features [+vocoid], [+approximant] and [+sonorant].

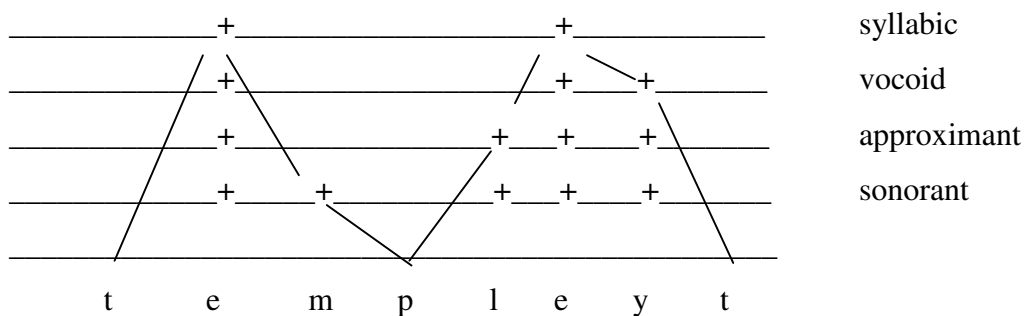
The feature [+syllabic] is based on the associations of segments with C-roots and V-roots of the CV-skeleton, therefore the feature “syllabic can be interpreted as referring to the prosodic distinction between V and C elements of the timing tier” (ibid.: 292).

Specifically, segments which are dominated by a V-node are vowels or syllabic consonants with the feature [+syllabic], segments dominated by a C-node are glides or syllabic consonants with the feature [-syllabic].

Clements claims that the feature [syllabic] “is the only major class feature that cross-classifies all others (ibid.: 295)”. That is because this feature defines the probability of a class to represent a syllable peak in terms of the major classes. A greater sonority increases the probability of associating a segment with a V-root and assigning to it the feature [+syllabic].

The realisation of a linear sequence of segments constitutes a sonority cycle according to the described hierarchy (1=lowest sonority to 4= highest sonority).

A relevant attribute of the sonority cycle is, that “sequences of syllables display a quasiperiodic rise and fall in sonority“ (ibid.: 299).



According to Clements “the preferred syllable type shows a sonority profile that *rises maximally toward the peak and falls minimally towards the end*, proceeding from left to right.” (ibid.: 301)

The distance from a given structure to the preferred syllable can be calculated and contributes to phonological complexity.

This distance to the optimal syllable is termed *D* and is calculated on the basis of demisyllables. The syllable splits into two overlapping parts, the demisyllables, each containing the syllable peak.

A demisyllable is defined in the following way (ibid.: 303):

“A demisyllable is a maximal sequence of tautosyllabic segments of the form  $C_m \dots C_n V$  or  $V C_m \dots C_n$ , where  $n \geq m \geq 0$ .”

According to Clements [kran] would consist of the demisyllables [kra,an], [pa] of [pa,a] and [ap] of [a,ap]. The sonority profile of the first demisyllable is independent of the sonority profile of the second demisyllable, therefore phonological complexity of the demisyllables can also differ from each other.

Distance is calculated as follows:

$$D = \sum_{i=1}^m 1/d_i^2$$

“Here, *d* is the distance in sonority rank between each *i*-th pair of segments in the demisyllable (including all nonadjacent pairs), and *m* is the number of pairs in the demisyllable, equal to  $n(n-1)/2$ , where *n* is the number of segments. It states that *D*, the dispersion in sonority within a demisyllable, varies according to the sum of the inverse of the squared values of the sonority distances between the members of each pair of segments within it.” (ibid.: 304)

Given the calculated value for possible initial and final demisyllables the important dispersion principle can be defined:

*Dispersion Principle*

- a. *The preferred initial demisyllables minimizes D*
- b. *The preferred final demisyllables maximizes D.*

**Table 1**

	D	C (degree of complexity)
a. Two-member demisyllables		
i. initial:		
OV	0.06	1
NV	0.11	2
LV	0.25	3
GV	1.00	4
ii. final		
VO	0.06	4
VN	0.11	3
VL	0.25	2
VG	1.00	1
b. Three-member demisyllables		
i. initial:		
OLV	0.56	1
ONV, OGV	1.17	2
NLV, NGV	1.36	3
LGV	2.25	4
ii. final		
VLO	0.56	4
VGO, VNO	1.17	3
VLN, VGN	1.36	2
VGL	2.25	1

There are implicational relations in such a way “that core syllabification rules do not create complex types unless they create the more simple syllable types”

(cf. Complexity/Length Hierarchy: 308).

### **3                    *Developmental issues concerning syllable structure and schwa acquisition***

#### **3.1                  Acquisition of syllable structure**

Children’s first words focus on stressed syllables of their mother tongue. According to Penner (2002: 24) children have to set three speech-rhythm-parameters in acquisition of word-prosody while they are in the stage of canonical babbling (7 - 10 months of age according to Oller 1980):

The child has to identify the basic stress rule of the minimal word (in German stressed-non-stressed / trochaic ) (a), assign more weight (temporal duration in moras) to the stressed syllable (b) and realize the critical status of schwa for word-boundary marking of the trochaic feet (c).



After these parameters have been set the word-production starts with realization of the prominent prosodic elements, i.e. the stressed syllables of target-words.

One of the most important and influential models of syllable acquisition is proposed in Fikkert (1994a). This model is grounded on longitudinal data of 12 children acquiring Dutch as their first language. In the present article only representative data of one child, Jarmo, are considered (cf. Fikkert 1994b).

Fikkert identifies four stages in syllable acquisition initiated by setting of three parameters. Her model is therefore a parameter-based approach in line with the theory of universal grammar (cf. Chomsky 1986, Meisel 1995).

**Stage 1** (until 1;6.13) is characterized by core CV-syllables. Coda consonants are deleted throughout. This is not due to vowel length representation. The examples beneath show that vowel length is realized randomly and so Fikkert assumes an association of vowels with only one V slot.

	<i>Final consonant deletion</i>			
a.	klaar 'ready' /kla:r/	→	[kɑ], [ka:]	(1;4.18)
b.	daar 'there' /da:r/	→	[da:], [dɑ]	(1;5.2)
c.	poes 'puss' /pu:s/	→	[pu:]	(1;5.2)
d.	dit 'this' /dɪt/	→	[tɪ], [ti:]	(1;5.2)
e.	tok 'cluck' /tɔk/	→	[kɔ], [ka:]	(1;5.27)

(Fikkert 1994b: 2)

At **stage 2** syllable-final fricatives (1;6.13) and plosives (1;7.15) appear. Fricatives are produced both as target (a.) and substitute (b.) forms.

a.	<i>Final fricatives</i>			
	deze 'these' /de:zə/	→	[tei]	(1;6.13)
	deze 'these' /de:zə/	→	[de:s]	(1;6.27)
	poes 'puss' /pu:s/	→	[pu:s]	(1;7.29)
b.	<i>Substitutions by fricatives</i>			
	paard 'horse' /pa:rt/	→	[pa:s]	(1;7.15)
	bal 'ball' /bal/	→	[bɑf]	(1;8.12)
	boot 'boat' /bo:t/	→	[pauf]	(1;8.26)
	<i>Final plosives</i>			
	aap 'monkey' /a:p/	→	[ɑp], [a:p]	(1;7.15)
	eend 'duck' /e:nt/	→	[ɑt]	(1;7.15)
	schaap 'sheep' /sʰa:p/	→	[hɑ:p], [hɑp]	(1;7.15)
	eend 'duck' /e:nt/	→	[ɑt]	(1;7.29)

(ibid.: 2-3)

Sonorants are not yet produced. They are usually deleted and far less frequently replaced by fricatives.

Vowel length errors provide enough evidence for assuming that vowel length is randomly produced.

*Percentages of vowel length errors at stage 2 in the production of target closed syllables*

<b>Vowel length errors</b>
39% (67/174)

(ibid.: 3)

Crucial to **stage 3** is the appearance of syllable-final nasals (a.) (1;7.29), which are still frequently deleted (b.), and sometimes liquids (c.) (1;11.20), nevertheless frequently substituted (d.).

a.	<i>Final nasals</i>			
	boom 'tree' /bom/	→	[bom]	(1;7.29)
	haan 'cock' /ha:n/	→	[ham]	(1;7.29)
	bom 'boom' /bom/	→	[pom]	(1;7.29)
	haan 'cock' /ha:n/	→	[an]	(1;8.12)
b.	<i>Deletion of final nasals</i>			
	boom 'tree' /bom/	→	[bau]	(1;7.29)
	haan 'cock' /ha:n/	→	[au]	(1;8.12)
	trein 'train' /trein/	→	[tei]	(1;8.26)
c.	<i>Final Liquids</i>			
	bal 'ball' /bal/	→	[bal]	(1;11.20)
	bril 'glasses' /bril/	→	[pui]	(2;3.9)
d.	<i>Substitution of final liquids</i>			
	bal 'ball' /bal/	→	[baφ]	(1;8.12)
	uil 'owl' /ʌyl/	→	[en]	(1;7.29)

(ibid.: 4)

There is a tendency in the deletion of consonants. When closed syllables with final sonorants are produced the vowel length is either solely preserved, shortened after a sonorant or lengthened without a sonorant. There seems to be a connection between sonorant production and vowel length. No such connection is found with syllable-final obstruents. Because here vowel length is here still random, obstruents do not trigger vowel length distinction at this stage. As Fikkert states

“we may therefore conclude that vowel length is non-distinctive before obstruents: all vowels are monopositional in this position. If this is correct, than the child has a (minimal and maximal) bipositional rhyme template at this stage.” (ibid.: 6)

	<i>Adult target</i>	→	<i>Jarmo's production form</i>
a.	VVC <sub>son</sub>	→	VC <sub>son</sub> or VV
	VC <sub>son</sub>	→	VC <sub>son</sub> or VV
b.	VVC <sub>obst</sub>	→	VC <sub>obst</sub> or VVC <sub>obst</sub>
	VC <sub>obst</sub>	→	VC <sub>obst</sub> or VVC <sub>obst</sub>

(ibid.: 4)

This pattern of final-syllable obstruent production changes at **stage 4** (2;2.6). It is now similar to the pattern of sonorant production at stage 3:

- Jarmo's production of target words ending in a final obstruent*
- a.  $VVC_{\text{obst}} \rightarrow VC_{\text{obst}}$  or  $VV$
  - b.  $VC_{\text{obst}} \rightarrow VC_{\text{obst}}$

(ibid.: 7)

According to Fikkert, “the child seems to recognize the relationship between vowel length and the possibility of having a final obstruent.” (ibid.: 7) Vowel length errors are infrequent in both environments so that vowel length distinction seems to be established in a systematic way. Furthermore a form  $VVC_{\text{son}}$  is allowed which point to the acquisition of an extrarhymal position:

$VVC_{\text{son}} \rightarrow VVC_{\text{son}}$			
haan ‘cock’ /ha:n/	→	[ha:m]	(2;2.6)
kalkoen ‘turkey’ /kalku:n/	→	[ku:ŋ]	(2;2.6)
schuur ‘shed’ /sɣy:r/	→	[ɣu:r]	(2;2.6)
tuin ‘garden’ /tʌyn/	→	[tʌyn]	(2;2.27)
daar ‘there’ /da:r/	→	[ta:r]	(2;3.9)
banaan ‘banana’ /bana:n/	→	[na:n]	(2;3.9)

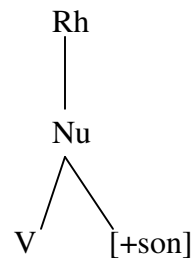
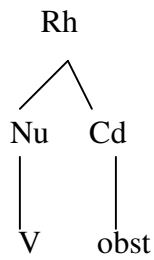
(ibid.: 7)

Embedding the observations into a parameter-based model the acquisition of syllable structure Fikkert identifies the following stages (ibid.: 8-11):

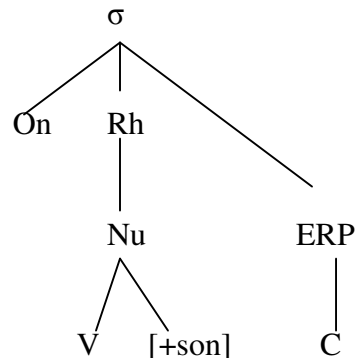
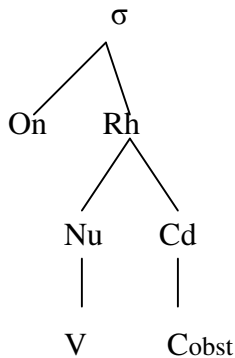
1. CV-Core-syllable (stage 1)
2. Branching rhyme parameter (stage 2):
  - Rhymes can branch into a nucleus and a coda [No/Yes]
3. Branching nucleus parameter (stage 3):
  - The nucleus can be branching [No/Yes]
4. Extrarhymal parameter (stage 4):
  - A (final) bipositional rhyme can be followed by an extra consonant. [No/Yes]

Additionally she gives a completion concerning onset-rhyme and feature description:

stage 2: branching rhyme template    stage 3: branching rhyme and maximal rhyme constraint



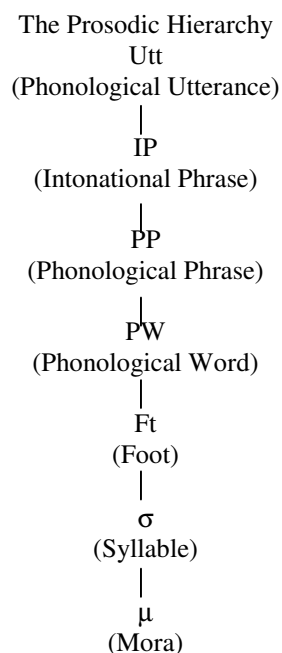
stage 4: extrarhymal consonants



(ibid.: 8-11)

### 3.2 Development of disyllables containing final schwa

In the previous chapters we have dealt with syllable acquisition concerning markedness and sonority in a monosyllabic context. A further issue in language acquisition is how children acquire the syllable structure of polysyllabic monomorphemic words. In this respect recent research considers the prosodic structure of words in non-impaired child language (Fikkert 1994a; Demuth et al. 2006). The frame for the analysis of prosodic structure is usually the Prosodic Hierarchy which divides linguistic units into different levels (see below)



The levels of the mora, the syllable and the foot are crucial for the analysis of the development of monomorphemic words. These entities also are the basis of stress assignment and syllable weight (cf. chapter 1).

The question at stake is in which way do children acquire polysyllabic words and what characterises the developmental course of these words. In German, different types of monomorphemic polysyllabic words have to be learned by the child (for an overview cf. Penner 2000, and Penner et al. 2006). A typical pattern in German are disyllabic words with a trochaic stress pattern containing final schwa. To our knowledge the only study discussing the development of these words in German is Kehoe and Lleó (2003).

In their study, Kehoe and Lleó revealed different stages of schwa acquisition. The authors analysed the spontaneous word productions of four monolingual German-speaking children between 1;7 to 3;1 years. They mainly focused on word-final schwa which comprises words ending with schwa [ə] (*Katze* ‘cat’, *Biene* ‘bee’) and words ending with a syllabic consonant ([<sup>l</sup>?apfl] *Apfel* ‘apple’, [<sup>l</sup>fo:g] *Vogel* ‘bird’). Both types were subsumed under the term SCHWA. One assumption was that syllabic consonants will be acquired earlier than schwa due to different representations for both kinds of SCHWA. The theoretical frame which the authors adopt is the Projection Theory (Van Ostendorp 2000). In this theory, syllabic consonants and final schwa differ in that only the former are specified for place of articulation. In this account, schwa violates the following projection constraint: only articulatory specified segments project to prosodic positions. Syllables containing schwa are defectively monomoraic and thus constitute a difficult learning task in language acquisition, because children have to learn that segments which are not specified for place can project to prosodic positions.

In the following, we only discuss the results for final schwa (cf. table 2). Kehoe and Lleó identify three phases and five categories in the acquisition of schwa. In the early phase (category 1) children delete schwa by either producing target words containing schwa as closed syllables or as disyllables where the vowel of the stressed syllable is reduplicated. The middle phase includes categories 2 and 3. The former is observed in one child and is characterised by moraic and segmental augmentation. He substitutes a long vowel or a short vowel plus sonorant [n] for schwa and thus produces a heavy final syllable. Category 3 of the middle phase is found in the other children and is marked by segmental augmentation. Here schwa is substituted with a short full vowel thus leaving the moraic content of the unstressed syllable unchanged but augmenting the segmental content. In the final phase we find at first category 4 where the children produces the centralized vowel [ë] instead of schwa. This is interpreted as

an additional specification because the feature [+low] differentiates [ɛ̃] from [ɛ]. Category 5 represents the stage where target schwa syllables are realized as schwa.

Kehoe and Lleó assume acquisition of schwa implies two reduction processes. One process is *quantitative reduction*, i.e. a loss of one mora which turns a heavy syllable into a monomoraic. The other process is *qualitative reduction* where the place features of the vowel have to be detached from the root node and thus forming a placeless vowel. Kehoe and Lleó conclude that schwa, “in spite of its lack of phonetic specification, is a difficult sound for some children, not being learned until about 2;3-2;6.” (2003: 323). To them acquiring schwa implies two goals: first in augmenting schwa prosodically (and segmentally) to a full vowel and second augmenting schwa segmentally to a short full vowel. This is due to the constraint that “the child will initially associate articulatorily specified segments to prosodic structures” (2003: 290).

**Table 2 Acquisition phases of final schwa for the word *Puppe* [ˈpʊpə] ‘doll’ (adapted from Kehoe & Lleó, 2003)**

	Early Phase (Category 1)	Middle Phase (Category 2)	Middle Phase (Category 3)	Final Phase (Category 4)	Final Phase (Category 5)
Child form	[ˈpʊpʊ] [ˈpʊp]	[ˈpʊpɛ:]	[ˈpʊpɛ]	[ˈpʊpɛ̃]	[ˈpʊpə]
Process	reduplication / truncation	moraic and segmental augmentation	segmental augmentation and quantita- tive reduction (loss of one mora)	segmental augmentation and additional vowel specifi- cation [+low]	qualitative reduction (de- tachment of place features from the root node)

In the next chapters we will present a single case study of a language impaired child. The developmental course will be discussed with regard to the outlined theories.

## **4 Methodology**

The data consist of spontaneous as well as elicited word productions of a German-speaking boy. The data was recorded during eight language therapy sessions in a time period of two months. Each session lasted approximately 45 minutes. The video and audio recordings were subsequently digitalized and phonetically transcribed by two native speakers. The analysis

was restricted to those forms which are relevant for this study (closed syllables and disyllables containing final schwa). Only those forms were taken into consideration where both listeners agreed with respect to the transcription.

#### **4.1 The participant**

At the beginning of data recording P. was aged 5;3. Since the age of 3;0 he received ambulatory speech therapy weekly. When the child was at the age of 4;7 he was first introduced to the authors during a stationary intensive language therapy for five weeks in a hospital. This treatment has been repeated at the age of 5;2 years for four weeks. The following treatment was conducted by one of the authors once a week.

During the stationary periods his cognitive development and his receptive language capacities were tested. Standardised tests concerning his expressive speech and language were not possible until 5;7 due to his massive expressive language impairment. Intelligence was normal excluding his verbal abilities. In his non-verbal sensory-motor capacities there had been no noticeable problems. No orofacial myofunctional disorder was attested. Receptive language was unimpaired, above-average. This has been tested twice with the Verbal Comprehension Scale of the Reynell Language Developmental Scales (Germ. version Reynell Sprachentwicklungsskalen 1985). At the age of 4;7 he reached in this subtest a developmental age of 4;10 years and with 5;2 a developmental age of 5;5. Therefore P. could be identified as child with SLI-E.

#### **4.2 Case description**

Here we describe P.'s expressive language between the ages of 4;7 and 5;3. His productive vocabulary consisted mainly of so-called protowords which are defined according to Vihman (1996:130) as "...relatively stable child forms with relatively consistent use which lack any clear connection with the form + meaning unit of a conventional adult model." His lexicon comprised content as well as a few function words, the latter being pronounced more target-like. P. was able to merge his words into compound words, DPs and VPs.

The speech rate was fluent and despite his severe language impairment he willingly used his forms at his disposal for purpose of communication disregarding the difficulties of the environment to understand him.

## 5 Results

### 5.1 P.'s realization of coda plosives in monosyllabic words

Before the enlargement of P.'s output forms, he did not produce any monosyllabic words containing a plosive in the coda. The only consonants he used in this position were fricatives and nasals (cf. table 3)

**Table 3 P.s monosyllables before the transition phase**

<b>Fricatives</b>	<b>Meaning</b>	<b>Nasals</b>	<b>Meaning</b>
[ʔauf]	auf (open)	[ʔam]	anfangen (to begin)
[pɔf]	schießen (to shoot)	[ham]	essen (to eat)
[ʔeç]	ich (I, me)	[nain]	Nein (no)
[ʔaiç]	Eis, weiß (ice, white)	[ʔainç]	Eins (one)
		[ʔo:x]	hoch (high)

His difficulties in producing coda plosives were obvious in his production of the proper name *Bob* (his favourite TV-character) which he pronounced as [bo:] instead of [bɔp<sup>h</sup>]. These difficulties were also observed one time in a nonsense word task where he realized [pap<sup>h</sup>] as [pau] and [ʔap<sup>h</sup>] as [ʔam] while he refused to repeat other words containing coda plosives. As can be seen in table 3 the plosives in coda position were always replaced by a segment with the feature [+sonorant] which was either a vowel or a nasal.

During the transition phase these substitutions could be observed more frequently in his realizations of target words (cf. table 4).

**Table 4 Substitution of nasal sonorants for coda plosives**

<b>target form</b>	<b>P.s realization</b>
[bo:t <sup>h</sup> ] (boat)	[bɔ'n']
[ha:p <sup>h</sup> ] (to have, 1. Ps. Sg.)	[ha'n']
[ba:t <sup>h</sup> ] (bath)	[ba'n']
[to:t <sup>h</sup> ] (dead)	[dɔ'n']
[baut <sup>h</sup> ] (to build, 3. Ps. Sg.)	[baun]



This substitution pattern lasted only for a short period of time (during one week) and he soon began to realize coda plosives in a target like manner (cf. table 5)

**Table 5 P.s realization of coda plosives**

<b>target form</b>	<b>P.s realization</b>
[bo:t <sup>h</sup> ] (boat)	[bo:t <sup>h</sup> ]
[ba:t <sup>h</sup> ] (bath)	[ba:t <sup>h</sup> ]
[hu:t <sup>h</sup> ] (hat)	[hu:t <sup>h</sup> ]
[bet <sup>h</sup> ] (bed)	[bet <sup>h</sup> ]
[ʔap <sup>h</sup> ] (particle, preposition)	[ʔap <sup>h</sup> ]

Vowel length is phonetically at random before coda plosives. Therefore at this stage the vowel length distinction is not triggered by the feature set of plosives (see discussion).

## **5.2 P.'s realization of schwa and the missing vowel length contrast**

When he was 4;5 years old P. used a lot of reduplicated or quasi reduplicated CV(C)-forms which contained a full vowel or a diphthong as nucleus. In one case a full vowel plus a sonorant consonant (*bibi, popo, hamham, mama, papa, a-a, buabua, pijau, wauwau, wauwi, wawa, dudu, jaujau, aja, jaji, heija*). The only disyllabic forms which were not simply reduplicated and corresponded to the adult words were *auto* (car) and *bitte* (please). The former was pronounced correctly, the latter with [ɛ̃][<sup>h</sup>bitẽ] instead of final schwa. In the period between 5;00 and 5;05 years he came up with some new words consisting of disyllabic and often target-like forms, f.e. *heppo* (character from a comic serial for children), *andi* and *udo* (proper names) and *uba* (target: U-Bahn, engl. metro). It is of interest that most of these new forms contained a full vowel in the second syllable but none of the new words contained final schwa.

Therefore we were interested in P.'s realization of final schwa when he began to increase his productive vocabulary. Among his new words there were several disyllabic forms which have a final schwa. These are listed in table 6.

Table 6 P.s realization of final schwa

target form	P.s realization
[ <sup>1</sup> bi:nə] (bee)	[ <sup>1</sup> bi'nɛ]
[ <sup>1</sup> hɛ:nə] (pl. rooster)	[ <sup>1</sup> hɛ'nɛ]
[ <sup>1</sup> bainə] (pl. leg)	[ <sup>1</sup> bainə]
[ <sup>1</sup> mainə] (my)	[ <sup>1</sup> mainə]
[ <sup>1</sup> ?ainə] (a, an)	[ <sup>1</sup> ?ainə]

As can be seen in table 6 there is a striking difference between words with a long tense vowel and words with the diphthong [ai] as nucleus of the stressed syllable in the target form. Both target forms have branching nuclei. With respect to tense long vowels P. did not realize the full length (transcribed with a half length mark). In such cases, final schwa is produced as the short full vowel [ɛ]. But if the stressed syllable has a diphthong as nucleus final schwa can be realized correctly. Thus there seems to be a close relationship between branching nuclei and final schwa realization, i. e. if there is a branching nucleus and if both positions can be filled, it is easier to produce schwa. A diphthong like [ai] satisfies this condition as it already contains two different positions. But if it is not possible to fill in both nucleus positions sufficiently due to a missing vowel length contrast, schwa is not realized correctly.

The missing vowel length contrast in P.'s output is also found in monosyllabic words. He produced several monosyllabic words with a half long vowel instead of a full one. If the vowel is followed by a nasal in the coda position, this consonant is spoken with a longer duration than in the adult word (denoted here with a half length mark). The words are listed up in table 7.

Table 7 P.s realization of vowel length contrast

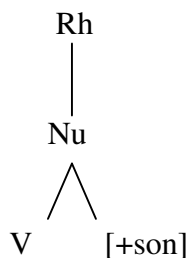
target form	P.s realization
[hɑ:n] (rooster)	[hɑ'n̄]
[bɑ:n] (rail)	[bɑ'n̄]
[ne:m] (I'm taking)	[mɛ'n̄]
[be:t <sup>h</sup> ] (flowerbed)	[bet <sup>h</sup> ]

## 6 Discussion

### 6.1 Missing coda plosives

In the following, we discuss the question if the presented data can be accounted for the acquisition stages of prosodic development according to Fikkert (1994a). As can be seen in table 3, 5 and 6 P. did not yet master the vowel length contrast. The second position of the nucleus was filled with a sonorant (nasal). Both, the missing vowel length contrast and the replacement of the second nucleus position by a sonorant are crucial marks for phase 3 in Fikkert's model.

Stage 3: branching rhyme and maximal rhyme constraint



There remains the problem that P. was not able to produce coda plosives (cf. table 3). According to Fikkert obstruents (fricatives as well as plosives) in coda position are already established at stage 2. The question is whether his difficulties with coda plosives might point to an even earlier phase in which coda consonants are missing (phase 1) and only open syllables are produced. His frequent use of reduplicated syllables which have only a CV-structure supports this assumption. Analysing the data in the context of Fikkert's model P.'s acquisition of syllable structure is not in agreement with the proposed developmental stages.

Instead, the data can be interpreted in line with the markedness theory concerning syllable structure according to Clements (1990).

In P.'s speech-production-system there seemed to be problems in the computation of the marked feature-set [+syllabic; -vocoid; -approximant; -sonorant; -cont].

According to Clements, there is only the major class of obstruents and no subdivision into fricatives and plosives. Clements theory is typologically motivated, trying to minimize the postulated set of feature classes to make a universal account. But according to Wiese (1988), especially for German there is a motivation to divide plosives and fricatives in sonority hierarchy with plosives as the least sonorous feature class. It is therefore legitimate to take plo-

sives (in line with Clements) as the phonological most complex structure in German codas or final demisyllables with one position.

The substitutions in *bon* for 'Boot' (boat) or *han* for 'hab' (have) can be explained with the Dispersion Principle. The least sonorant plosives were replaced by the more sonorant nasals to reduce phonological complexity. There appeared to be a developmental peak in terms of phonological complexity that the processor of P. was unable to master.

In context with the topic discussed at stake Sites, Demuth & Kirk (2004) present data of children who either acquire coda consonants due to markedness hierarchy or frequency.

Therefore, it can be concluded that P.'s lack of coda plosives is a phenomenon that can be explained in terms of a markedness theory and phonological complexity. Problems concerning this explanation is the fact that the liquids [l] and [ʀ] and the velars [k], [g] and [ŋ] are still missing in all phonotactic contexts. Finally, it is not possible to state whether coda sonorants were acquired before coda fricatives before data recording began.

## **6.2 Schwa realization**

In the following, we present an explanation for the absence of final schwa syllables in P.'s output. Therefore we apply to a recent account for language impaired children which takes schwa into consideration.

In the account of Penner et al. prosodic deficits point to an impaired language development (Penner et al. 2006: 131). In this bootstrapping account language impaired children fail to set the necessary parameter for triggering the unmarked word (Minimal Word) form: the disyllabic trimoraic foot with a trochaic stress pattern containing schwa (ibid.: 103). Schwa is the cornerstone of this account. The final schwa with one mora plus the dimoraic stressed first syllable forms a trimoraic foot, the trimoraic principle. If the child does not master this principle it is not able to extend his productive vocabulary (ibid.: 66). In this regard normally developing children produce a greater proportion of final schwa instead of a full vowel. Children who are conspicuous of being language delayed or impaired show the reverse pattern. They produce more full vowels instead of schwa. According to Penner et al. (ibid.: 125) an infrequent schwa production and the realisation of schwa as a full vowel is an indicator for a delayed or impaired development. If children produce a full vowel instead of final schwa they do not possess the unmarked form of a trimoraic disyllabic foot. They rather possess and produce a marked word form with a bimoraic second syllable.

In accordance with this account P.'s stagnation in language acquisition is explainable by a prosodic deficit as he had only few trimoraic disyllabic feet in his earlier output forms and

produced final schwa in the transition phase as a full vowel. But to propose that the realization of final schwa as a full vowel is an indication for a prosodic deficit is in contrast with the results of Kehoe and Lleó (2003; cf. chapter 3.2). As it was shown above all children in their study displayed a pattern of schwa acquisition where final schwa is realized as a full vowel. Additionally, Kehoe and Lleó observed that schwa is a difficult sound to acquire and is not mastered until 2;3-2;6 whereas Penner et al. state that unimpaired children have already acquired schwa at the age of 2;00 (ibid.: 67).

Another critical issue in the account of Penner et al. is that he analyses the minimal word in German as trimoraic whereas in other languages the minimal word is bimoraic (Demuth et al. 2006). Féry (2003) for example claims that a trimoraic word is not necessary in German so that German words are only bimoraic. Therefore there is no sufficient evidence in Penner's account to assign such a central role to the realisation of final schwa.

In sum, the substitution of a full vowel for final schwa does not necessarily point to the cause of the impairment but might simply indicate a stagnation or in P.'s case marks the beginning of a developmental course similar to unimpaired children.

## **7 Conclusion**

It could not exactly be attested what the source of system-internal change was. One can say P. never really reached Fikkert's Stage 2, resulting in a stagnation of the entire system; but it is also possible that P. had no access to his mental lexicon for output representation. At least there is a deep connection between coda consonant representation and word-form accessibility.

Stoel-Gammon and Cooper (1984) studied the acquisition paths of three English speaking children and found that one child, Will, used many so-called quasi-words in the form of reduplicated CVCV-structures. Interestingly this child had the slowest rate of lexical acquisition whereas another child which produced closed syllables first showed the fastest rate of lexical acquisition.

To conclude, there is yet no sufficient (psycho-)linguistic explanation for the cause of P.'s language impairment. The more frequent use of target related word forms in the transition phase could be initiated as already stated by a new access to his mental word form lexicon and as an effect his syllable acquisition progressed and vice versa. Which cognitive module triggered the emergence of the other is inconclusive due to the covert nature of language system-internal processing.

Nevertheless, a detailed expertise and the linguistic description of syllable structures and their development in language acquisition bears high importance for an adequate diagnosis and

treatment of language impaired children. As a preliminary implication in the treatment of phonologically delayed and disordered children which only possess simple syllable structures would be that therapists should take the sound classes into account that are produced in the syllable's onset and coda. The phonetic inventory itself does not necessarily reveal the level of phonological development. For example, a child who produces [p] in the onset of the syllable might not realize this sound in the coda. Furthermore, complex syllable structures cannot simply be understood as a concatenation of consonants and vowels and that complex syllables are those with a greater number of sounds. Rather syllable structure implies even at a 'simple' CV- or VC- level a complex structure depending on the sound class of the consonant in the onset or coda-position of the syllable. All in all, these issues question the typical treatment procedure of speech and language therapists exercising sounds which are missing in the child's phonetic inventory.

Finally, there is the need for clinical studies which focus on developmental problems concerning syllable structures.

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