First Steps in the Acquisition of German Consonants: Minimal Constraint Demotion*

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1 Introduction

This paper examines the acquisition of word-initial and word-final consonants by one German child, Naomi, between age 1;2.06 and 1;8.21 and compares the findings with data from another German child and from English, Dutch, and Portuguese children. Two standard assumptions in the literature on the early acquisition of phonology (e.g., Fikkert 1994a,b, Ingram 1978, Jakobson 1941) are: (i) the first words in child speech consist of a consonant followed by a vowel and (ii) the first consonants that appear in child speech are oral plosives. From these two assumptions the following predictions ensue: (i) vowel-initial words are absent in early child speech and (ii) consonants are initially realised as plosives. These predictions are not answered in the study of child speech that we present in this paper. We show that the first words in German child speech consist of at least one consonant and one vowel and the consonant may either precede or follow the vowel. Also, word-final fricatives may be realised as such from the onset of speech. Word-initial fricatives are deleted at the earliest word stage and, in contrast to the predictions formulated above, they are not necessarily replaced by any other consonant. Our findings are confirmed by another study on German child speech (Elsen 1991) and also support the findings of a study on Portuguese child speech where it is argued that children produce vowel-initial words at the earliest acquisition stage (Costa & Freitas 1998).

The aim of this paper is to provide an account of the initial stages in the acquisition of German onsets and codas, respectively. We demonstrate how an Optimality-theoretic approach can account for the fact that a word-final consonant is realised by Naomi and Annalena (see Elsen 1991) only in the absence of a word-initial consonant. We also account for the observation that an adult VVC or VCC rhyme is first realised with a long vowel without a following consonant, then with a short vowel plus a consonant, and finally as a tripositional rhyme. We argue that these observed stages arise through the gradual increase in complexity of syllable structure and minimal constraint demotion (see Tesar & Smolensky 1993, 1998). We furthermore show that the same set of constraints and the mechanism of constraint demotion can be used to explain different stages in the acquisition of Dutch consonants.

The paper is organised as follows. Section 2 presents the method used to collect and store the data. Section 3 introduces the German consonant inventory and briefly discusses German syllable structure. Section 4 illustrates Naomi's acquisition of word-initial consonants. Section 5 provides an OT-account for the earliest stages in the acquisition of German and Dutch word-initial consonants. Section 6 considers the development of rhyme structure and section 7 concludes.

2 Method

The data used in this paper were compiled in the following way. Sandra Joppen - Naomi's mother - took detailed notes about the child's speech from age 1;2.06. At this stage, Naomi had an active vocabulary of about 20 words. From age 1;4.26, audiotape recordings were made on a weekly basis at the child's home. Naomi grew up in Krefeld (near Düsseldorf). Both parents speak modern standard German and at this time, Naomi did not have brothers or sisters. The first recorded session took place on 19 September 1997 and the last one that we will consider in this paper took place on 14 January 1998. The first three taped sessions lasted approximately 15 minutes, later sessions lasted 30 minutes All recordings were transcribed by Sandra Joppen the same day as the recordings took place and the transcriptions were checked by at least one other person. All possible speech sounds that Naomi produced during the sessions were transcribed. However, for the analysis, only utterances that were intended to be real words and that were understood by the transcriber are counted as a speech sound. Immediate repetitions of identical forms are counted as a single utterance. The transcriptions were stored in a database system (Excel). It contains a list of the German words that Naomi attempted to say and a list of her actual speech in IPA font.

3 German consonants and syllable structure

The German consonant inventory consists of the segments in Figure 1 (based on Féry 1998, Hall 1992, Ramers & Vater 1995, Wiese 1996):

Figure 1: The German Consonant Inventory

	LABIAL	CORONAL			DORSAL		LAR.
	labial	alveolar	postalveolar	palatal	velar	uvular	glottal
[-son]	p,b,(p^f),f,v	t,d,t^s,s,z	$t^ʃ$, ʃ, ʒ	ç	k,g		h
[+son]	m	n,l		j	ŋ	ʀ	

Word-initially, the affricate /p^f/ is realised as [f] in most German dialects and this is also the case in the speech of Naomi’s parents. We also note that the strident fricative /s/ is rare in word-initial position. It occurs in certain loan words, e.g., *Sphäre* ['sfɛːʀə] ‘sphere’, and before /k/ in, e.g., *Skandal* [skan'da:l] ‘scandal’. In our corpus, initial /s/ is not attested at all.

In word-initial positions, consonant clusters consist of an obstruent followed by a non-homorganic sonorant consonant (Hall 1992, Vater 1992, Wiese 1996). Some examples are:

(1) a. Knie [kni:] ‘knee’
b. Plan [plan] ‘plan’
c. Prinz [pʀɪnt^s] ‘prince’
d. blau [blaʊ] ‘blue’
e. Fleisch [flaiʃ] ‘meat’

A strident fricative may precede a single oral plosive or a plosive-sonorant cluster as in, e.g., *springen* ['ʃpʀɪŋən] ‘to jump’. Moreover, the strident fricatives /ʃ/ and /s/ are the only fricatives that may precede /m/ word-initially, e.g. *Schmied* [ʃmiːt] ‘smith’ and *Smaragd* [sma'rakt] ‘emerald’. Word-internally, such clusters are syllabified as a coda-onset sequence. The words *Kiste* ‘case, box’ and *Kosmos*, for instance, are syllabified as [kɪs.tə] and [kɔs.mɔs], respectively, and not as, e.g., *[kɪ.stə] or *[kɔs.smɔs].[1] The exceptional distribution of word-initial strident fricatives suggests that they are not part of the onset. Following Vennemann (1988), we postulate an extra position at the left edge of words to accommodate /s/ and /ʃ/ before other consonants:

(2)
```
Appendix  Onset
   |       /  \
  s/ʃ     C1   C2
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In adult speech, the rhyme of a syllable may consist of a long vowel, as in the word *See* [ze:] ‘lake’, it may contain a diphthong, as in the word *Frau* [fʀaʊ] ‘woman’, or it may contain a sequence of a short vowel plus a consonant, as in *Ball* [bal] 'ball' and *mit* [mɪt] 'with'. There are no syllables that contain a full short vowel without a following segment. It may thus be concluded that the rhyme has minimally two positions in German. Apparent counter examples are syllables headed by Schwa (e.g., the final syllable in *Sprache* ['ʃpʀa:χə] 'language') and syllables headed by sonorant consonants (e.g., the final syllables in *sprechen* ['ʃpʀɛçn̩] 'to speak' and *Atem* [a:tm̩] 'breath'). Such syllables do not require an onset, they are never stressed, and they never form a word on their own. The minimal requirement for a German word is that it contains at least one syllable which has either a long vowel, a diphthong, or a short vowel plus a consonant, i.e., the minimal German word has two moras.

In word-final position, the rhyme of a syllable may be followed by another sonorant (see 3), or an obstruent (see 4):

(3)	a.	Bahn	[ba:n]	'railroad, tram'
	b.	sein	[zain]	'to be'; 'his'
	c.	Salm	[zalm]	'salmon'

(4)	a.	Bad	[ba:t]	'bathroom'
	b.	seit	[zait]	'since'
	c.	Salz	[zalt^{s}]	'salt'

The data presented above are compatible with the so-called "sonority sequencing principle" which requires post-vocalic consonants to fall in sonority (cf. e.g., Jespersen 1904). To ensure that the sonority sequencing principle is not violated, we propose that the two nucleus positions may be occupied by a long vowel, or a short vowel plus a sonorant (i.e., a glide, a liquid, or a nasal) and that obstruents never occupy a nucleus position. Segments in the nucleus may be followed by a less sonorant consonant in the coda position of a rhyme. Notice, however, that some post-vocalic consonant clusters have an equal level of sonority. In these clusters, the second member is always an alveolar obstruent:

(5)	a	Gips	[gɪps]	'plaster'
	b.	nicht	[nɪçt]	'not'
	c.	Keks	[ke:ks]	'biscuit'

If decreasing sonority in the rhyme is a valid condition for syllable-wellformedness in German, examples with word-final obstruent clusters pose a problem. Vennemann (1988) proposes that a so-called "coronal-appendix" outside the rhyme accommodates word-final alveolar obstruents in German. The appendix is not part of the rhyme and the sonority sequencing principle – which holds within the syllable - is therefore not violated by final coronal obstruents:[2]

(6) *German Syllable Structure:*

```
                                 σ
                                / \
                               /   \         coronal
               appendix  onset      rhyme    appendix
                   |       /\       /   \       /\
                   |      /  \  nucleus coda   /  \
                   |     /    \   /  \    |   /    \
                   C    C1    C2  V   X   C   C    C
   a. oft        [                ɔ       f   t      ]   ‘often’
   b. nichts     [      n         ɪ       ç   t    s ]   ‘nothing’
   c. Strands    [ ʃ    t     ʀ   a   n   t   s      ]   ‘beach’ (GEN)
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In summary, the syllable structure that we assume for German is characterised as follows. A German onset may be occupied by at most two consonants with increasing sonority and may be preceded by /s/ or /ʃ/. The nucleus may be filled by vocalic segments and sonorant consonants. The rhyme is minimally bipositional and maximally tripositional and may be followed by at most two coronal obstruents. The next section considers the realisation of onset consonants and post-vocalic consonants in early child speech.

4 First words: one consonant and one vowel

At the initial stage of speech production, three of the twelve Dutch children that Fikkert (1994a,b) examined exclusively produce syllables which contain one onset consonant followed by one vowel in the nucleus. Basing herself on this observation and on assumptions made in earlier literature (e.g. Jakobson 1941), Fikkert claims that children start speech production with consonant-initial syllables. On the other hand, Costa & Freitas (1998) show that at the initial stage, Portuguese children do not insert a consonant before a word-initial vowel and, moreover, these children tend to delete word-initial fricatives. Costa & Freitas argue that, in contrast to Dutch, the most favoured syllable at the initial stage is not necessarily a CV-syllable in Portuguese, but it can also be a V-initial syllable. We demonstrate below that from the onset of speech, German children also produce vowel-initial syllables.

Naomi correctly pronounces word-initial oral and nasal plosives at the earliest word-stage (approx. 1;2.06-1;5.01), but she does not realise affricates and fricatives correctly. In our corpus of this stage, word-initial plosives are realised as such 31 times and as an approximant once. Initial nasals are always realised as nasal plosives:

(7) *initial oral plosives are realised as oral plosives (97%)*

	Spelling	Adult form	Naomi's output		Gloss
a.	Ball	bal	ba	(1;2)	'ball'
b.	Buggy	'bagi[3]	ba:	(1;2-1;3)	'stroller'
c.	Buch	bu:x	bu:	(1;2-1;4.26)	'book'
d.	Brot	bʀo:t	bo:	(1;2-1;4.26)	'bread'

(8) *initial nasal plosives are realised as nasal plosives (100%)*

a.	Milch	mɪlç	mi:	(1;2)	'milk'
b.	Mülleimer	'mʏlʔaimɐ	ˈmʏmɐ	(1;5.01)	'wastebasket'
c.	nein	nain	nai	(1;5.01)	'no'

Initial affricates in adult speech are simplified in child speech and they are realised as an oral plosive:

(9) *initial affricates are simplified (100%)*

a.	zu	t^su:	tu	(1;2-1;3)	'closed'
b.	Ziege	't^si:gə	ti:ə	(1;5.01)	'goat'

At the earliest stage in the development of Naomi's speech, most word-initial fricatives are deleted and some word-initial fricatives are realised as a plosive:

(10) *initial fricatives are deleted (75%) or realised as a plosive (25%)*

a.	sauber	'zaubɐ	ˈabɐ	(1;2-1;5.01)	'clean'
b.	Wasser	'ʋasɐ	'dadɐ	(1;4.26)	'water'

Initial fricative deletion in early child speech has also been observed, for instance, by Elsen (1991) for German (see 11a), by Fikkert (1994a,b) for Dutch (see 11b), by Costa & Freitas (1998) for Portuguese (see 11c,d).

(11) *initial fricative deletion in German, Dutch, and Portuguese child speech*

a.	Ger: satt	zat	atʰ	(Annalena 1;2.19)	'satisfied'
b.	Du: fiets	fi:ts	i:s	(Jarmo 1;9.09)	'bicycle'
c.	Port: zebra	'zebrɐ	'ɛbɐ	(Luís 1;9.29)	'zebra'
d.	Port: vês	veʃ	eʃ/iʃ	(Marta 1;2.0)	'see'

Example (12a) from Velten (1943) and examples (12c-d) from Menn (1971) provide evidence for initial-fricative deletion in English.

(12) *initial fricative deletion in English child speech*

a.	Fuff	af	(Joan 1;2)	dog's name
b.	shoes	uz	(Daniel 1;10-2;1)	
c.	fish	ɪš	(Daniel 1;4-2;1)	
d.	watch	aš	(Daniel 1;4-2;1)	

The fact that word-initial fricatives are deleted rather than replaced by another consonant is unexpected under Fikkert's assumption that the first words in child speech have a CV-structure. We furthermore point out that deletion of initial fricatives and the realisation of a consonant somewhere else in the word (e.g. in final position) are related. Whenever a word-initial fricative is deleted, a coda consonant is realised. We find the same phenomenon in monosyllabic words which lack an initial consonant in adult speech. In such cases, a coda consonant is also obligatory realised in early child speech. It is a striking feature in Naomi's early speech that a word-final consonant is not realised in words with an initial plosive or nasal (see 13a,b), whereas it is always realised when the adult form does not have a word-initial consonant (14a-d).[4]

(13) *final consonant is not realised when the adult form has an initial plosive or nasal consonant*

	Spelling	Adult form	Naomi's output		Gloss
a.	Ball	bal	ba	(1;2-1;5.01)	'ball'
b.	Milch	mɪlç	mi:	(1;2)	'milk'

(14) *no consonant is inserted when the adult form lacks a word-initial consonant (100%) and another consonant in the word is realised.*

a.	ab	ap	apʰ	(1;4.26)	'off'
b.	an	an	an	(1;2-1;4.26)	'at'
c.	auf	auf	af	(1;3)	'on'
d.	Eimer	'ʔaimɐ	'a:mɐ	(1;5.01)	'bucket'

In German, vowel-initial words have an initial glottal stop in stressed syllables only (e.g., Wiese 1996). We did not find any word-initial glottal stops in Naomi's speech. Elsen (1991) reports that Annalena sometimes realises glottal stops. For *ab* [ʔap] 'off', Annalena's output is [ap^h] from 1;2.15 until approximately 1;5.30 and from then until 1;7.30 her output is [ʔap^h]. (Annalena loses word-final aspiration after 1;7.30, see Goad 1998 for discussion of this phenomenon). With respect to other words which lack an initial consonant, a glottal stop is hardly ever realised in Annalena's speech. For instance, the adult form *satt* [zat] 'satisfied' is realised by her as [at^h] at 1;2.19. Hence, this is a real case of fricative deletion and one that we also find in Naomi's speech (see 10a), the speech of Dutch children (see 11b), Portuguese children (see 11c,d), and English children (see 12a-d). Both Annalena and Naomi do not realise word-final consonants unless the adult word lacks a word-initial consonant or has an initial fricative. We believe this is an important generalisation that a theory of language acquisition has to explain.

To summarise this section, we saw that onsetless words are present from the beginning of language acquisition and that each word is characterised by at least one vowel and one consonant. With respect to the acquisition of onsets and coda consonants, two interesting problems arise for an OT-analysis. Optimality Theory (Prince & Smolensky 1993, McCarthy & Prince 1995) assumes that unmarked syllable structures emerge through the interactions of the constraints ONS - which requires that syllables have onsets - and NOCODA – which says that syllables should not have codas. These two constraints account for the fact that languages favour a CV-structure and the prevailing view is that these constraints are high-ranked in child speech. Under this assumption, it is surprising that we find vowel-initial syllables at the earliest acquisition stage in Naomi's speech, in Annalena's speech, and at the earliest stage in the speech of English and Portuguese children. We will address this problem in the following section.

5 The acquisition of consonants in German child speech: an OT-account

In contrast to Fikkert's (1994a,b) findings about the acquisition of Dutch, but in accordance with the observations of Costa & Freitas (1998) for Portuguese and Menn (1971) and Velten (1943) for English, we find that German children realise words without initial consonants at the earliest acquisition stage. Final consonants are only realised by Naomi and Annalena if there is no initial consonant and no word consists of a vowel only. Hence, at the initial stage, the speech of these two German children is characterised by the presence of one consonant and one vowel per word. This is in agreement with, for instance, Jakobson (1941) who proposes that the first phonological contrast that a child learns is the contrast between a vowel and a consonant, i.e., the largest contrast in constriction is acquired first. In other words, the first stage in child language is characterised by the following two (presumably universal) principles:

(15) a. CONSONANT: Every word contains at least one phase which is characterised by oral closure (i.e., every word has at least one consonant).

b. VOWEL: Every word contains at least one phase which is characterised by maximal oral release for vowels (i.e., every word has at least one vowel).

The account for consonant-vowel sequences in Naomi's and Annalena's speech that we present here is cast in an Optimality-theoretic framework. Henceforth, we refer to (15a) as a constraint which we call CONS and we refer to (15b) as a constraint which we call VOWEL. These constraints interact with other constraints. The familiar faithfulness constraints in (16a,b) below demand that any output form has as many segments as the input form.

(16) a. MAX - IO A segment in the input must have a correspondent in the output (no deletion)

b. DEP - IO A segment in the output must have a correspondent in the input (no epenthesis)

The fact that segments which are present in adult forms are missing in the child's output forms can be attributed to constraints which prohibit structure. In particular, we suggest that the constraints below (based on Prince & Smolensky 1993 and McCarthy & Prince 1995) play a significant role. These constraints prohibit consonantal and vocalic places of articulation:

(17) a. *LAB Have no Labial C-Place feature
b. *COR Have no Coronal C-Place feature
c. *DORS Have no Dorsal C-Place feature
d. *V-PL Have no V-Place feature

Onsetless words pronounced by Annalena and Naomi have at least one consonant (see 10a, 11a, 14a-d). Monosyllabic words which consist of a long vowel only or a diphthong without a preceding or a following consonant do not occur in Annalena's and Naomi's speech at this stage. Hence, the constraint CONS is never violated in their speech. Conversely, there are no words which consist of consonantal segments only and the constraint VOWEL is always satisfied. Since every word in German child speech has one consonant and one vowel (which may be in a vowel-consonant order), the constraints CONS and VOWEL are ranked higher than ONS and, possibly, NOCODA. In anticipation of the discussion in 5.1, this is illustrated in the tableau below for the word *ab* [ap] 'off'. Candidates (18a,c,d) each have more violations of highly ranked constraints than candidate (18b) which is selected as the optimal one even though it has a violation of ONS as well as NOCODA. The pointing finger ☞ marks the optimal candidate and *! marks the fatal constraint violation.

(18) Adult form [ap]; Naomi's output is [ap] at 1;4.26

	CONS	VOWEL	MAX-IO	DEP-IO	*LAB	*V-PL	ONS	NOCODA
a. a	*		*			*!	*	
b. ☞ ap					*	*	*	*
c. p		*	*		*!			
d. pa			*	*	*!	*		

Naomi's and Annalena's early word production supports Jakobson's proposal that the first contrast in child speech is one between consonantal closure and vocalic release, but the data do not support Fikkert's (1994a) claim that the first words in child speech have a CV-structure. In OT-terms, we need constraints which say that a consonant and a vowel are minimal requirements for words. When these constraints are higher-ranked than the constraint which says that every word should have an onset (ONS), vowel-initial words with a consonant in another position may emerge. The question is how the child arrives at such a ranking. This question is the topic of the next subsections.

5.1 *Constraint demotion in German child speech*

There are two competing OT-accounts to explain the first steps in the acquisition of phonology. To account for the fact that children produce forms which are less marked than adult forms, it is assumed under one approach that in the earliest stage of language acquisition, constraints against marked structure outrank faithfulness constraints. Gnanadesikan (1996) and others assume that the acquisition of the adult phonology involves the promotion of faithfulness constraints over constraints forbidding phonological markedness. A different view, advocated by Tesar & Smolensky (1993, 1998), is that the acquisition of the adult phonology involves the step-by-step demotion of one constraint below another constraint. We now have to ask the question which of the two accounts offers a better explanation for (i) the lack of codas in early child speech when an onset is present and (ii) the presence of codas when there is no onset.

We first test the hypothesis that at the earliest stage of speech production, markedness constraints outrank faithfulness constraints and that at later stages of speech production, faithfulness constraints are promoted. For this purpose, we assume a mini-grammar with the faithfulness constraints MAX-IO and DEP-IO and the markedness constraints ONS, NOCODA, CONS, VOWEL, *LAB, *COR, and *V-PLACE. The tableau below illustrates that the presumed initial ranking cannot account for a vowel-initial output such as *an* 'at' in child speech. Candidates (19a,d) each have three violations of markedness constraints, candidate (19c) has four, and candidate (19b) is wrongly selected as the winner, because it violates only two markedness constraints:

(19) Adult form [an]; Naomi's output is [an] at 1;2.06. Candidate (c) should win, but candidate (b) is wrongly selected as optimal.

	CONS	VOWEL	*COR	*LAB	*V-PL	ONS	NO CODA	DEP-IO	MAX-IO
a. a	*				*	*!			*
b. ☹ n		*	*						*
c. an			*		*	*!	*		
d. ʔan			*		*		*!	*	

One may argue that Naomi has arrived at a more advanced stage and that the initial ranking of markedness constraints over faithfulness constraints is replaced by one in which some faithfulness constraints outrank some markedness constraints. However, this will not get us the correct output form either. The promotion of all faithfulness constraints over all markedness constraints renders the correct output for *an* at this stage (see 20), but it has a serious drawback in that this ranking cannot account for the output [*ba*] for *Ball* at the same stage (see 21).

(20) Adult form [an]; Naomi's output is [an] at 1;2.06

	MAX-IO	DEP-IO	CONS	VOWEL	*COR	*LAB	*V-PL	ONS	NOCODA
a. a	*!		*				*	*	
b. n	*!			*	*				
c. ☞ an					*		*	*	*
d. ʔan		*!			*		*		*

(21) Adult form [bal]; Naomi's output is [ba] at 1;2.06. Candidate (c) should win, but candidate (e) is wrongly selected optimal.

	MAX-IO	DEP-IO	CONS	VOWEL	*COR	*LAB	*V-PL	ONS	NOCODA
a. a	*! *		*				*	*	
b. b	*! *			*		*			
c. ba	*!					*	*		
d. al	*!				*		*	*	*
e. ☹ bal					*	*	*		*

This excursion shows that promotion of faithfulness constraints over single markedness constraints or clusters of markedness constraints is not the correct way to explain Naomi's development of word-initial consonants, because it makes wrong predictions.[5] We now consider the other suggestion, viz. gradual constraint demotion.

Tesar & Smolensky (1993) observe that for their algorithm to learn to rank constraints, it is irrelevant how constraints are ranked at the earliest stage. Crucial to their proposal is that the learning process involves minimal demotion of constraints. For the sake of the argument, let us assume that there is no constraint ranking at the earliest stage. For adult CVC-words, the most optimal output form in child phonology will then be the "unmarked" CV-structure (see tableau 22). However, for VC-words, the grammar will generate an optimal output which consists of one consonant only and this does not accord with the facts that we observed in Naomi's speech (see 23).

(22) Adult form [bal] (or [ba:n]); Naomi's output is [ba] at 1;2.06

	CONS	VOWEL	*COR	*LAB	*V-PL	ONS	NOCODA	DEP-IO	MAX-IO
a. a	*				*	*			*! *
b. b		*		*					* *!
c. ☞ ba				*	*				*
d. al			*		*	*	*!		*
e. bal			*	*	*		*!		

(23) Adult form [an]; Naomi's output is [an] at 1;2.06. Candidate (c) should win, but candidates (b) and (d) are wrongly selected as optimal.

	CONS	VOWEL	*COR	*LAB	*V-PL	ONS	NOCODA	DEP-IO	MAX-IO
a. a	*				*	*			*!
b. ☹ n		*	*						*
c. an			*		*	*	*!		
d. ☹ ʔa					*			*	*
e. ʔan			*		*		*	*!	

Tesar & Smolensky propose that a constraint which is violated by the optimal candidate is demoted in child phonology to the next highest possible stratum in the hierarchy, i.e., immediately below the constraint which is responsible for the fact that a non-optimal output candidate loses. Naomi does not insert a segment to provide an onset, but realises a consonant somewhere else in the word instead. We conclude from this that ONS has been demoted to stratum immediately below constraints which are violated by losing candidates with an epenthetic onset, i.e. immediately below the constraints CONS and DEP-IO (see tableau 24).

Naomi and Annalena do not delete the final consonant in monosyllabic vowel-initial words, so that at least one consonant is present in all their output forms. From this, we conclude that NOCODA is ranked on a stratum immediately below CONS. In conclusion, assuming Tesar & Smolensky's theory of minimal constraint demotion, we propose that only ONS and NOCODA are minimally demoted in the constraint hierarchy. The other constraints are not yet ranked with respect to each other, and neither are ONS and NOCODA ranked with respect to each other. The following three tableaux illustrate that this set-up renders the correct output candidates for Naomi's speech at the earliest stage:

(24) Adult form [an]; Naomi's output is [an] at stage 1

	CONS	VOWEL	*COR	*LAB	*V-PL	MAX-IO	DEP-IO	ONS	NOCODA
a. a	*				*	*!		*	
b. n		*	*			*!			
c. ☞ an			*		*			*	*
d. ʔa					*	*	*!		
e. ʔan			*		*		*!		*

(25) Adult form [ap]; Naomi's output is [ap] at stage 1

	CONS	VOWEL	*COR	*LAB	*V-PL	MAX-IO	DEP-IO	ONS	NOCODA
a. a	*				*	*!		*	
b. ☞ ap				*	*			*	*
c. ʔap				*	*		*!		*

(26) Adult form [bal] (or [ba:n]); Naomi's output is [ba] at stage 1[6]

	CONS	VOWEL	*COR	*LAB	*V-PL	MAX-IO	DEP-IO	ONS	NOCODA
a. a	*				*	* *!		*	
b. b		*		*		* *!			
c. al			*		*	*		*!	*
d. ☞ ba				*	*	*			
e. bal			*	*	*				*!

We pointed out in section 4 that for vowel-initial words like *ab* 'off', Annalena's output is one without a glottal stop ([ap^h]) from 1;2.15 until approximately 1;5.30 and from that age onwards Annalena regularly realises glottal stops. We here propose that the constraint ranking in (24), (25), and (26) correctly predicts omission of onsets at the earliest word-stage for Annalena and Naomi.

Based on positive evidence (i.e., adult words with an epenthetic glottal stop), the constraint DEP-IO is demoted below ONS in Annalena's grammar at the next stage (i.e., under that ranking [ʔan] and [ʔap] are optimal outputs for /an/ and /ab/, respectively). For Naomi, demotion of DEP-IO has not taken place before 1;8.21.

In the next section, we propose an account of the acquisition of Dutch onsets which is based on the account that we gave for the German data in this section.

5.2 *Constraint demotion in Dutch child speech*

At the earliest acquisition stage, two of the twelve Dutch children that Fikkert (1994a) examined (Jarmo and Noortje), avoid the production of words which lack an onset in the adult form. At a later stage, when Jarmo starts to produce such words, there is free variation between forms with an epenthetic onset and forms without onsets (27b and 27a, resp.). This variation is also found in the production of onsets by two other Dutch children (Tom and Leonie) at an early age:

		Adult form (Dutch):		Jarmo's output:		Gloss
(27)	a.	aap	a:p	ɑp, a:p	(1;7.15)	'monkey'
	b.	apie	a:pi:	ta:pi:	(1;7.15)	'monkey'

		Adult form (Dutch):		Tom's output:		Gloss
(28)	a.	aap	a:p	a:β	(1;2.27)	'monkey'
	b.	aap	a:p	ba:p	(1,3.24)	'monkey'

		Adult form (Dutch):		Leonie's output:		Gloss
(29)	a.	aap	a:p	ɑp	(1;9.15)	'monkey'
	b.	aap	a:p	pa:p	(1;9.15)	'monkey'

The transition from one stage to the next is explained by Fikkert (1994a) as the setting of one or more parameters. She proposes that for Jarmo and Noortje, the parameter 'Are onsets obligatory?' is first in the default value (i.e., 'yes'). Subsequently, the parameter has to be reset and at this stage we find variation between forms with and without onsets for Jarmo, Tom, and Leonie. Finally, the parameter is set to the marked value (i.e., 'no') and nothing can change once the parameter is set, so that no variation will take place anymore. This account fails for German, because it misses an important generalisation: in Annalena's and Naomi's first words, an onset may be absent if and only if there is another consonant somewhere else in the word (see 13a,b versus 10a, 11a, and 14a-d). Based on the account we gave in 5.1 for the acquisition of onsets in German, an alternative analysis will be presented now for the acquisition of onsets in Dutch.

For Jarmo, Tom, and Leonie, one stage is characterised by an optional onset for words which lack an onset but have a coda in the adult grammar. At this stage, the constraint NOCODA is demoted in the hierarchy below MAX-IO, so that final consonants may be realised. Other constraints are not ranked with respect to each other and the following tableau illustrates that this ranking correctly predicts variation between forms with and without an additional onset:

(30) Adult form [a:p]; Jarmo's, Leonie's, and Tom's outputs vary at an early stage after minimal demotion of NOCODA[7]

	CONS	VOWEL	*COR	*LAB	*V-PL	MAX-IO	DEP-IO	ONS	NOCODA
a. a:	*				*	*		*!	
b. ☞ a:p				*	*			*	*
c. ☞ ba:p				*	*		*		*
d. ba:				*	*	*	*!		

At a later stage, a consonant is no longer inserted to provide onsets in the speech of these children and we conclude from this that ONS is minimally demoted to a position in the hierarchy where it is dominated by the constraint CONS, i.e. at the same stratum as NOCODA:

(31) Adult form [a:p]; Jarmo's Leonie's and Tom's output [a:p] at the next stage, due to minimal demotion of ONS

	CONS	VOWEL	*COR	*LAB	*V-PL	MAX-IO	DEP-IO	ONS	NOCODA
a. a:	*				*	*!		*	
b. ☞ a:p				*	*			*	*
c. ba:p				*	*		*!		*
d. ba:				*	*	*!	*		

The process of demoting constraints is to a certain extent subject to variation. Therefore, we predict that other children may demote another constraint, for instance DEP-IO instead of ONS, so that for them, the optimal output for [a:p] is [ba:] at a certain stage. We point out, however, that constraint demotion takes place on the basis of positive evidence only and Dutch children are never exposed to words with an epenthetic initial consonant. It is therefore unlikely that they will ever demote DEP-IO in their native language.[8]

The initial stages in the acquisition of Dutch onsets can be characterised as follows:

(32) *Development of onsets for some Dutch children:*

Initial stage: Obligatory onsets and vowel-initial words are not realised

no ranking: CONS, VOWEL, *COR, *LAB, *V-PLACE, ONS, NOCODA, MAX-IO, DEP-IO

Intermediate stage: Optional onsets

ranking: CONS, VOWEL, *COR, *LAB, *V-PLACE, ONS, MAX-IO, DEP-IO >> NOCODA

Final stage: Faithful onsets

ranking: CONS, VOWEL, *COR, *LAB, *V-PLACE, MAX-IO, DEP-IO >> NOCODA, ONS

Fikkert (1994a,b) claims that a child who acquires a language initially tries to produce the "unmarked" CV-syllable. With Costa & Freitas (1998), we assume instead that V-initial syllables are as unmarked as CV-syllables in child grammar. We do not take issue with the claim that because every language allows consonant-initial syllables and some languages permit no others, this must reflect some universal principle or constraint. We suggest, though, that this principle or constraint does not always play the most important role at the initial stage of acquisition of every language. In Dutch, German, and Portuguese, at least, the effect of a principle referring to the onset diminishes at an early stage in the acquisition of phonology. In OT-terms, this implies that children determine relatively early that other constraints are ranked higher than ONS.

The ranking of constraints that three of twelve Dutch children (i.e., Jarmo, Tom, and Leonie) arrive at at a relatively late stage, is the same as the ranking of constraints that other Dutch children have from the onset of speech. We conclude from this, that the process of ranking constraints does not always proceed in exactly the same way for every child. The way they get to the ultimate constraint-ranking for a particular language may vary to some extent from child to child, but it is always triggered by positive evidence.

Costa & Freitas (1998) found that Portuguese children may pronounce words with one vowel only (e.g. the adult form *é* /ɛ/ 'is' is realised as [ɛ] by João 1;0.12 and Inês 1;0.25). To us this suggests that at this stage, the constraints ONS and NOCODA are ranked lower than DEP-IO in the grammar of these children. Moreover, fricative-initial words may be realised without a consonant (e.g. the adult form *vou* /vo/ 'go' is realised as /o/ by Luís 1;9.29) and this may be due to the fact that the constraint CONS is ranked relatively low in Portuguese child speech.

With respect to German child speech, we argued that the demotion of ONS and NOCODA below CONS and MAX-IO accounts for the fact that Naomi realises the final consonant in monosyllabic words like *an* and *ab* (see 24 and 25). At this stage, final consonants are not realised in words like *Ball* and *Bahn* and this is accounted for by high-ranked constraints against consonantal places of articulation (see 26). The next development is that final consonants begin to emerge in consonant-initial words. We will illustrate and account for this development now.

6 The acquisition of rhyme structure in German child speech: gradual demotion of constraints

At 1;2 and 1;3, Naomi produces words with an initial consonant followed by a short or a long vowel, as well as words without an initial consonant, but with a final consonant. From 1;4.26 words with an initial consonant and a single short vowel have become very rare and most monosyllabic words have a long vowel (see 33a-b), a short vowel plus a sonorant (34a), or an obstruent (34b).

(33)	a. Bahn	[ba:n]	ba:	(1;4.26-1;5.01)	'tram'
	b. Buch	[bu:x]	bu:	(1;4.26-1;5.08)	'book'
(34)	a. an	[an]	an	(1;2-1;4.26)	'at'
	b. auf	[auf]	af	(1;3-1;5.01)	'on'

From 1;5.01, Naomi no longer produces syllables with a single short vowel, i.e., from that age onwards, each rhyme is filled by minimally two positions.[9] We attribute this to a so-called "minimality requirement" which says that a word must have at least and at most two moras (cf. Prince & Smolensky 1993 who propose that each word contains at least one foot and each foot contains at least two moras).

(35) Word Binarity (WORDBIN): a word is minimally and maximally bimoraic.

The question is whether this constraint has been present from the beginning of speech production. Rice & Avery (1995) propose that initial phonological representations are relatively impoverished, with little or no structure. Structure is elaborated under pressure from the phonology, i.e. positive evidence forces the addition of structure to representations. If we were to adapt this proposal to explain the growing complexity in word-structure, we might argue that the initial representation of words is very simple, viz. each word has a vowel and a consonant. Structure is elaborated minimally in the sense that the child discovers that segments combine into syllables and that a syllable has a branching rhyme, i.e. the next step (stage II) is one in which each word is bimoraic (cf. 35). Under this assumption, WORDBIN is a constraint which is vacuous at the earliest stage of speech production and has to mature. We propose that this markedness constraint interacts with the faithfulness constraint which says that each mora in the input should have a correspondent in the output (MAX-μ). At stage II in Naomi's acquisition of rhyme structure, it is more important to have a bimoraic word than to be faithful to the adult trimoraic rhyme, i.e. WORDBIN is ranked higher than MAX-μ.

We consider next which aspects determine whether the two positions available for a mora in a rhyme are filled by a long vowel, or by a sequence of a short vowel and a consonant. Notice in this respect that the constraint which prohibits the occurrence of V-Place (i.e., *V-PLACE) is violated once for long vowels, because only one vocalic segment is involved. A sequence of a short vowel plus a consonant constitutes one violation of the constraint *V-PLACE and one violation of *LAB, *COR, or *DORS. To account for the fact that CV:C words are realised mostly as CV: words and not as CVC words until approximately 1;5.08, we propose that constraints which prohibit consonantal places of articulation are not yet demoted to a position lower than WORDBIN. This ranking will give [ba:] as the child's optimal output for the adult target [ba:n]:[10]

(36) Adult form [ba:n]; Naomi's output is [ba:] at 1;5.01 (stage II)

		MAX-IO	*LAB	*COR	*V-PLACE	WORD-BIN	MAX-μ	ONS	NO CODA
a.	an	*		*	*		*	*!	*
b. ☞	ba:	*	*		*		*		
c.	ban		*	*	*		*		*!
d.	ba	*	*		*	*!	*		
e.	ba:n		*	*	*	*!			*

Until 1;4.26, there is a strong tendency for one consonantal place of articulation per word, but from 1;5.01 more and more exceptions to this generalisation begin to emerge. The examples below each have a labial as well as a coronal consonant:

(37) a. Mann [man] man (1;5.01) ‘man’
b. Butter ['bʊtɐ] 'bu:tɐ (1;5.29) ‘butter’
c. kaputt [ka'pʊt] but^{ʕ} (1;6.05)[11] ‘broken’
d. Tomate [to'ma:tə] 'matə: (1;6.27) ‘tomato’

It is interesting to note that at the same time, monosyllabic words with a long vowel plus a consonant are no longer realised with a long vowel (as in 33a,b), but with a short vowel plus a consonant:

(38) a. warm [ʋa:m] bam (1;6.05) ‘warm’
b. Bahn [ba:n] ban (1;6.12) ‘tram’
c. Buch [bu:x] buχ (1;6.19-1;7.09) ‘book’

The examples above show that it becomes more important at this stage to be faithful to the target places of articulation, and we account for this by means of gradual constraint demotion. That is to say, we propose that *LAB, *COR (and *DORS) are demoted in the constraint hierarchy to a position lower than Max-IO.[12] We illustrate this for consonantal places of articulation in the tableau below for the word *Bahn* [ba:n] ‘railroad, tram’:

(39) Adult form [ba:n]; Naomi’s output is [ban] at stage III

		MAX-IO	*V-PLACE	WORD-BIN	MAX-μ	ONS	NO CODA	*LAB	*COR
a.	an	*!	*		*	*	*		*
b.	ba:	*!	*		*			*	
c. ☞	ban		*		*		*	*	*
d.	ba	*!	*	*	* *			*	
e.	ba:n		*	*!			*	*	*

We attribute the fact that adult words which have three positions in the rhyme are realised by Naomi and Annalena with a short vowel and one consonant at this stage to the high-ranked constraint WORDBIN. This constraint requires exactly two positions in the rhyme and forbids words with more than two moras and for this reason, adult words with a final consonant cluster are realised with at most one consonant at this stage:

(40) a. klappt [klapt] dat (1;5.15) ‘(it) works’
b. Hund [hʊnt] hut^{j} (1;5.01-1;5.21) ‘dog’
c. Milch [mɪlç] miç (1;5.29) ‘milk’

From 1;6.12, we find that most adult words which have three positions in the rhyme are realised by Naomi with three positions in the rhyme:

(41)	a.	stimmt	[ʃtɪmt]	tɪnt	(1;7.27)	'that's right'
	b.	Hund	[hʊnt]	huːtˤ	(1;6.12)	'dog'
	c.	Geld	[gɛlt]	dɛlt	(1;6.19)	'money'
	d.	Milch	[mɪlç]	miːç	(1;7.02)	'milk'

The following Figure shows that until 1;6.05, a bipositional rhyme is preferred, whereas from 1;6.12, -VVC and -VCC rhymes are mostly realised with three positions:

Figure 2: Structure of Naomi's rhymes for adult -VVC and -VCC rhymes

Input Rhyme CVXC	Rhyme one position (-V)	Rhyme two positions (-VV, -VC)	Rhyme three positions (-VVC, -VCC)
1;2.06-1;4.26	0	7 (100%)	0
1;5.01-1;6.05	3 (6%)	35 (71%)	11 (23%)
1;6.12-1;7.27	0	19 (24%)	60 (76%)

Naomi thus begins to realise rhyme structure more faithfully. We suggested above that at the beginning of speech acquisition, a child assumes as little structure as possible until she is 'forced' to change this assumption. We find that from 1;2 to 1;3 each word has a vowel, but it does not matter whether the rhyme branches or not. From 1;5.01, Naomi produces words with two positions in the rhyme (i.e. a rhyme may branch). From 1;6.12, the rhyme structure is more complex (i.e. a rhyme may branch and so may the nucleus). In the framework that we assume here, this may be attributed to minimal demotion of WORDBIN to a stratum below the constraint which says that the output should be faithful to the number of moras in the input, i.e. MAX-μ:

(42) Adult form [ba:n]; Naomi's output is [ba:n] at stage IV

		MAX-IO	ONS	NO CODA	*LAB	*COR	MAX-μ	WORD-BIN
a.	an	*!	*	*		*	*	
b.	ba:	*!			*		*	
c.	ban			*	*	*	*!	
d.	ba	*!			*		* *	*
e. ☞	ba:n			*	*	*		*

Naomi's steps in the development of rhymes can be characterised as follows:

(43) *Naomi's first steps in the acquisition of rhyme structure:*

Stage I (1;2.06 – 1;4.26):	Vowel length is not distinctive One consonant per word
Stage II (1;4.26 – 1;5.08):	Rhyme exactly two positions One consonant per word
Stage III (1;5.08 – 1;6.05)	Rhyme exactly two positions More than one consonant per word
Stage IV (1;6.12-1;8.21)	Rhyme may have three positions

Adult CV(C)C- and CV:C-words which had a CV:-structure in stage II are more often realised with a CVC-structure in stage III. This effect can be attributed to the fact that Naomi realises more consonantal places of articulation per word in stage III. In OT-terms, this means that the child reranks markedness constraints and faithfulness constraints. In particular, we see that the constraints penalising consonantal places of articulation are demoted to a position lower than MAX-IO. We have argued that the step from stage III to stage IV involves the demotion of the markedness constraint WORDBIN to a position lower than MAX-μ:

(44) *The acquisition of Rhyme structure and gradual constraint demotion*

Stage I:	MAX IO, *LAB, *COR, WORDBIN, MAX-μ, ONS, NOCODA
Stage II:	MAX IO, *LAB, *COR, WORDBIN >> MAX-μ, ONS, NOCODA
Stage III:	MAX IO, WORDBIN >> MAX-μ, ONS, NOCODA, *LAB, *COR
Stage IV:	MAX IO >> MAX-μ, ONS, NOCODA, *LAB, *COR >> WORDBIN

7 Conclusion

Naomi's and Annalena's early speech are characterised by exactly one consonant and exactly one vowel. They may occur in a consonant-vowel sequence, but also in a vowel-consonant sequence. In contrast to Fikkert's (1994a,b) assumptions for Dutch, but in accordance with the findings of Menn (1971) for English and Costa & Freitas (1998) for Portuguese, we found that words without initial consonants are pronounced at the earliest word-stage in German. We pointed out that word-final consonants are only realised in early German child speech if there is no word-initial consonant. There is no stage which might be characterised as "avoid onsetless words" in the development of German onsets and in this paper we question the standard assumption that a CV-sequence is the unmarked syllable in child speech. We propose that CV-structures do not emerge because an onset is favoured in early child language, but rather because ideally each word shows the maximal contrast between a consonant and a vowel. In the framework of OT, this implies that the constraints ONS and NOCODA are demoted early on to a stratum below the constraints CONS, VOWEL, MAX-IO, and DEP-IO.

At the initial stage in the acquisition of German words, vowel length is not distinctive. From 1;5.01, Naomi realises each monosyllabic word with either a long vowel, or a short vowel followed by one consonant. We concluded from this, that Naomi initially assumes as little structure as possible, but at age 1;5.01 she has learnt that the rhyme matters and from that age onwards until approximately 1;6.12, she presupposes that rhymes have minimally and maximally two positions. Under the theory assumed in this paper, this means that the constraint WORDBIN outranks MAX-μ at this stage.

Gradually, Naomi begins to realise more than one consonant per word. We attributed this development to the fact that the initial stage in which the child produces as little structure as possible changes to a stage in which she is forced to realise consonantal places of articulation more faithfully, so that, for instance, *Bahn* 'railroad, tram' and *warm* 'warm' are no longer realised by the same form (viz. as [ba:]), but distinctively (i.e., as [ban] and [bam], respectively). We attributed this development to the minimal demotion of constraints against places of consonantal articulation (*LAB and *COR).

The next step in the acquisition of German phonology is a distinction between rhymes with two positions and rhymes with three positions. We accounted for this development by assuming that at this stage, the child demotes the constraint WORDBIN below MAX-μ.

In this paper, we demonstrated that the first steps in the acquisition of German consonants are best accounted for by minimal constraint demotion. Moreover, we have indicated that the same set of constraints and the mechanism of constraint demotion also explains different stages in the acquisition of the phonology of other languages.

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[1] Syllable boundaries are indicated by a dot.

[2] In (6) and below, 'V'= vowel, 'X' = vowel, glide, liquid, or nasal, and 'C' = consonant. The symbol 'σ' denotes a syllable.

[3] Primary stress is indicated by ' before the stressed syllable.

[4] The glottal stop [ʔ] is not a phoneme in German. It is not present in underlying representations, but added by the grammar (in OT-terms: the constraint ranking) to provide an onset to stressed syllables. We argue below that in adult German grammar, the constraint which says that a foot should have a consonantal onset (ONSET-FOOT) outranks a constraint against epenthesis (DEP-IO) and this particular ranking is acquired relatively late by German children.

[5] For reasons of space, we do not present all possible promotions of single faithfulness constraints over single markedness constraints and we trust that the reader will be able to check that none of these possibilities provides an account of all the forms that are attested in stage 1.

[6] At a later stage, the child assumes a 'minimally and maximally binary rhyme', i.e. /ba:n/ → [ba:] (1;5.01), then *Cor is demoted, so that /ba:n/ → [ban] (1,6.12), and finally the markedness constraint on rhymes is demoted and the most faithful parse [ba:n] wins (see section 6).

[7] We tentatively assume that the feature Labial is shared between the final consonant and the epenthetic initial consonant in Tom's and Leonie's outputs to avoid a DEP-C-PLACE violation. Jarmo makes use of another option, viz. to insert /t/. We assume that in his grammar, *Cor is demoted and ranked lower than a constraint which prohibits shared association lines.

[8] If second language acquisition is based on first language grammar, we expect to find effects of this constraint in a second language, because it is never demoted in the first language (see Grijzenhout 2000). This prediction seems to be borne out, because learners of German whose first language is Dutch are notorious for not producing glottal stops when they first learn German. This may be attributed to

the fact that for them, the constraint DEP-IO is ranked higher than ONS and they must learn to demote this constraint when they acquire the grammar for German.

9 At 1;4.26 and 1;5.01 there is still some variation and some words are realised with short vowels. For instance, at 1;5.01 *Hund* [hʊnt] 'dog' is realised once as [hu], once as [hu:] and once as [hut^j] and *zu* [tsu:] is realised twice with a short vowel and once with a long one.

10 Previous sections showed that the constraints ONS and NOCODA are low-ranked at this stage.

11 Naomi regularly produces a fricated release after word-final /t/.

12 Presumably, MAX C-PLACE is not ranked with respect to *LAB, because we find alternations between forms which satisfy MAX C-PLACE and violate *LAB and forms which violate MAX C-PLACE and satisfy *LAB (e.g. timt → tint).