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Paula Fikkert

On the Acquisition of Prosodic Structure

HIL

HOLLAND INSTITUTE OF GENERATIVE LINGUISTICS

On the Acquisition of Prosodic Structure

UBN

voor Rune

On the Acquisition of Prosodic Structure

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De Wet der Nature
Die alle de Klanken regeleert
D'Orakelmond van Vrouw Natuur
Leert ons de waarheid op den duur
Zo pal, dat haar nooit mond of pen
Betwist, als die haar niet en kent.

Quirinus van Blankenburg, ***Elementa musica,*** *1739*

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Contents

1. Preliminaries **1**
1.1. The principles and parameters model 3
1.1.1. The logical problem of acquisition 3
1.1.1.1. Universal Grammar 4
1.1.1.2. Data 7
1.1.1.3. Grammar 8
1.1.1.4. Learning theory 10
1.1.2. Residual issues 14
1.1.3. Implications for the theory of language acquisition 15
1.2. Aspects of prosodic theory 16
1.2.1. The prosodic hierarchy 17
1.2.2. Other prosodic principles 18
1.3. Preview 21

2. Methods and Materials **23**
2.1. The design of the research 23
2.1.1. Naturalistic longitudinal observation 24
2.1.2. Subject selection 24
2.1.3. Data collection 26
2.1.4. Transcription 28
2.1.5. The organisation and analysis of data 28
2.1.6. Reliability 31
2.2. Stages 32

3. Syllable Templates and the Syllable in Dutch **34**
3.1. The 'onset-rhyme' versus the 'moraic' syllable 34
3.2. The roles of the syllable in phonological theory 41
3.3. Syllable structure in Dutch 43
3.4. Length and weight in Dutch 51
3.5. The core syllable in Dutch 53

4. The Acquisition of Syllable Structure: the Onset 56
4.1. Simple onsets, empty onsets and the core syllable 56
4.2. Summary and discussion 65
4.3. Complex onsets 71
4.3.1. Plosive-liquid clusters 71
4.3.2. Plosive-glide clusters 80
4.3.3. Plosive-nasal clusters 82
4.3.4. Fricative-liquid clusters 85
4.3.5. Fricative-nasal clusters 92
4.3.6. Fricative-glide clusters 96
4.3.7. /s/-plosive clusters 98
4.3.8. /s/-fricative clusters 99
4.3.9. Clusters consisting of three consonants 101
4.4. Summary 103
4.5. Discussion 107
4.5.1. The 'maximal onset' parameter 107
4.5.2. Branching onsets or extrasyllabic consonants? 109
4.5.3. Language-specific onset constraints 119
4.5.4. Summary of the parameters 124

5. The Acquisition of Syllable Structure: the Rhyme 126
5.1. Developmental stages in the acquisition of rhymes 128
5.1.1. Stage I: the core syllable 129
5.1.2. Stage II: the appearance of final obstruents 131
5.1.3. Stage III: the appearance of final sonorants and vowel length 136
5.1.4. Stage IV: mastering vowel length and extrarhymal consonants 141
5.2. Summary 145
5.3. Discussion and formal account 147
5.3.1. Stage I: no codas 147
5.3.2. Stage II: branching rhymes 149
5.3.3. Stage III: branching nuclei and the maximal rhyme constraint 152
5.3.4. Stage IV: extrarhymal consonants 156
5.4. Consonant clusters 159
5.4.1. Final consonant clusters 159
5.4.2. Medial consonant clusters 170
5.4.3. Summary and discussion 174
5.5. Diphthongs, long vowels and weight 175
5.6. Onsets versus final consonants 177
5.7. Summary and conclusions 180

6. The Acquisition of Dutch Stress **184**
6.1. Previous research on acquisition of stress 185
6.1.1. Lexical learning of stress versus the learning of stress by rule 186
6.1.2. Bias towards trochaic foot versus neutral approach . . . 188
6.1.3. Perceptual biases 192
6.1.4. Other approaches 194
6.1.5. Summary and conclusions 196
6.2. Description of Dutch stress 197
6.3. Truncation and stress patterns in Dutch child language 199
6.3.1. The special status of disyllabic words with final stress . 200
6.3.2. Developmental stages: description 202
6.4. Formal account 207
6.4.1. Stage 1 207
6.4.2. Stage 2 210
6.4.3. Stage 3 214
6.4.4. Stage 4 215
6.4.5. Summary and discussion 215
6.5. Predictions for longer words 218
6.5.1. Trisyllabic words with final main stress 218
6.5.2. Trisyllabic words with initial main stress 224
6.5.3. Trisyllabic words with medial main stress 229
6.5.4. Target words with more than three syllables 232
6.5.5. Conclusions 234
6.6. Segmental changes 237

7. A Parametric Learning Model for Syllable Structure and Stress **245**
7.1. Metrical theory as part of UG 246
7.2. A metrical analysis of Dutch stress 249
7.3. The input to the learner 254
7.3.1. The form of the input 254
7.3.2. Incremental versus batch mode learning 256
7.4. A cue-based learning theory 258
7.4.1. Deterministic versus non-deterministic learners 258
7.4.2. The cues 260
7.5. The structure of Dresher & Kaye's machine learner 267
7.6. The Dutch acquisition data again 270
7.6.1. The transition from stage 0 to stage 1 270
7.6.2. The transition from stage 1 to stage 2 281
7.6.3. The transition from stage 2 to stage 3 283
7.6.4. The transition from stage 3 to stage 4 291
7.7. Summary and conclusions 298

8. Summary and Conclusions 304

Appendix A. The International Phonetic Alphabet 311

Appendix B. Glossary 313

Appendix C. The Dutch segment inventory 317

Appendix D. Initial simple and complex onsets 318

Appendix E. Onset clusters in Dutch 330

Appendix F. Final consonants 332

Appendix G. Acquisition of rhymes 333

References 343

Samenvatting in het Nederlands 351

Curriculum vitae 359

1 Preliminaries

IN THIS DISSERTATION I identify the stages that occur during the acquisition of syllable structure and stress by children learning Dutch as their first language, describe them in terms of current prosodic theory (e.g., McCarthy & Prince 1986, 1990, Hayes 1981, 1991), and explain the transitions from one stage to the next as the setting of one or more prosodic parameters. The aim is to develop a theory of the acquisition of prosodic structure. During acquisition several changes in the prosodic system take place, as can be inferred from the actual acquisition data. I will focus both on learnability aspects and on developmental aspects of acquisition in the area of prosodic phonology. The LOGICAL PROBLEM OF ACQUISITION is distinct from the DEVELOPMENTAL PROBLEM OF ACQUISITION (Hornstein & Lightfoot 1981). Ingram (1989a) distinguishes research into LANGUAGE ACQUISITION, which is concerned with evidence from what speakers know, from research into CHILD LANGUAGE, which is concerned with evidence from what children say. The first studies the logical problem of acquisition, the second studies the developmental problem of acquisition. A theory of grammar for which there is no tractable learning algorithm is unlikely to play an important role in a theory of language acquisition. Only a grammatical theory with learnability properties is a plausible candidate for a theory of acquisition (Dresher & Kaye 1990, Dresher 1991, 1992, Clark 1992, Clark & Roberts 1993, Dresher & van der Hulst to appear). Ideally the two lines of research should be combined (Bennett-Kastor 1988, Ingram 1989a). This is the aim of the research undertaken here.

The topic needs little motivation. There is hardly any work on the acquisition of prosodic structure, research on the acquisition of phonology having focused mainly on segmental structure. Research into the acquisition of segmental structure is different in that it investigates the acquisition of the properties of lexical items. A child has to learn a huge number of vocabulary items. Many properties of those items are entirely non-predictable. The child has to learn the segmental composition of each item, how it is exactly pronounced, its meaning, etc. Although, in principle, syllable structure and stress could be learned lexically, I will show that this is not

the case. Rather, children learn syllable structure and stress on a parametric basis. That is, they have to learn what the parameter values are of the language they are learning. Since adult speakers have more or less clear intuitions about what constitutes a possible syllable or word in Dutch, and, furthermore, have intuitions about where to place stress in nonsense words, this view of acquisition is also preferable, because it explains why adults have these intuitions, which they would not have displayed if syllable structure and stress were lexical properties. The acquisition of prosodic structure also differs in another respect from the acquisition of segmental composition, since it involves the learning of parameter values which also play an important role in the adult grammar. In this way it resembles the acquisition of syntax more closely than the acquisition of segmental phonology,[1] the study of which mainly focuses on phenomena specific to child language, for instance, consonant harmony, especially if the child is learning a language which does not have this process in adult speech. Rules for syllable and stress structure are different in this respect, because they also form part of the adult's grammar. Another motivation for the subject of this dissertation is that there are well-defined parametric theories for both syllable structure and stress, although the latter is better articulated than the former. As I will discuss below, it is generally assumed that parameters are innate. This means that we have some ideas about the innate properties with which the child is born, namely, the principles and parameters of UNIVERSAL GRAMMAR (UG), which is of considerable help for the understanding of the developmental stages, as will be shown in this dissertation. Moreover, it is possible to write algorithms which, when applied to machine learners, are able to choose the correct parametric values for stress and syllable structure in a given language (Dresher & Kaye 1990, Dresher 1991, 1992). This means that the theory has the property that it is, in principle, learnable, although this does not necessarily mean that it is also an adequate theory of acquisition, as we will see shortly.

A theory of language acquisition must first give a characterisation of the developmental stages of language acquisition. It also must provide a characterisation of the errors children make when acquiring their first language. However, a theory of language acquisition must further explain why certain types of logically possible errors do not occur (Brown 1973). This thesis will both describe the developmental patterns and stages found in the data, and offer an explanation for these patterns and stages. Chapters 4 and 5 deal with acquisition of syllable structure; in chapter 4 I discuss the

[1] It might be the case that the learning of segment inventories is also parametric; however, the segmental composition of words has to be learned lexically, since this information is not predictable.

developmental patterns involving onsets, and in chapter 5 those involving rhymes. Chapter 6 describes the patterns found during the acquisition of Dutch stress. It will be shown that many of the logically possible errors indeed do not occur. Errors are generally of a systematic kind. An adequate theory of language acquisition must be able to explain this.

A theory of language acquisition must not only make explicit exactly how development takes place, but also specify what the triggers are for the transition from one stage to the next. In other words, what is further needed is a LEARNING THEORY which explains the patterns of development described in chapters 4, 5, and 6. This will be the central topic of chapter 7. There, the question of the learnability of grammars is addressed. However, a learning theory is not necessarily the same as a theory of acquisition, but the former should be part of the latter. This difference becomes clear when we compare machine learners with children. Machine learners are typically instantaneous learners. That is, they do not show developmental stages, but instead proceed instantaneously from the initial state S_0 to the final or steady state S_s. Thus, it is the logical problem of language acquisition which is primarily addressed, not the developmental problem.

The aim of this chapter is to make the theoretical framework adopted in this thesis explicit. It is divided into two parts. The first part contains a brief outline of the PRINCIPLES AND PARAMETERS approach to generative grammar (Chomsky 1981b, 1986, Atkinson 1992), and discusses the implication for the study of child language acquisition (1.1). The second part introduces some of the basic concepts and modules of prosodic theory (1.2).

1.1. The principles and parameters model

1.1.1. The logical problem of acquisition

The general questions which generative linguists try to answer are what constitutes knowledge of language and how such knowledge is acquired (Chomsky 1986). Because children acquire language relatively easily and quickly, it is assumed by most linguists and many psycholinguists that children have some innate knowledge of language. This is referred to as Universal Grammar (UG), and underlies all natural languages. UG consists of a set of principles that apply to all languages and a set of parameters whose values vary within clearly defined limits from one language to another.[2] The variation in the grammars of the world's languages is largely

[2] In current work in the area of phonology, particularly work that falls within 'Optimality Theory' (Prince & Smolensky 1993, McCarthy & Prince 1993, and various of the papers in

due to different parameter settings.[3] Acquiring a particular language is a matter of setting the appropriate parameter values required by that particular language on the basis of data the child is confronted with, i.e., the input. This is called the logical problem of language acquisition (Hornstein & Lightfoot 1981, Dresher & Kaye 1990) and is schematised in (1):

(1) *The logical problem of language acquisition*

The problem is how, given UG, the grammar of a language can be learned from its data. It is generally assumed that the grammar is acquired through UG. However, the exact relation between UG and the data has to be made specific. How does the child make hypotheses about the parameter settings on the basis of data? In addition to UG there must be a learning theory that relates the data to UG. Even if UG contains a set of parameters the learner must still determine, on the basis of the data, what value must be chosen for each parameter (Dresher & Kaye 1990). Let us briefly discuss the different components of (1).

1.1.1.1. Universal Grammar

The goal of much research in linguistics is to establish the properties of Universal Grammar and hence the innate linguistic properties of the mind. There are at least two different strategies for doing this (Atkinson 1990). The first, used by most linguists, is to discover the variant and invariant properties of grammars of different languages. On the assumption that UG underlies all languages, the invariant properties are due to universal principles, while variation in languages is due to differences in parameter settings. This line of research has resulted in particular parameter models in different areas of linguistics which capture differences between languages in

---

Goldsmith 1993, among others) UG is viewed as a set of universal principles and constraints, rather than parameters, which are at work in every language. In optimality theory it is important that constraints are not absolute, but are violable. Whether or not constraints are satisfied depends on the way they are ranked and interact. In such a theory languages differ in the ordering of constraints. I have decided not to adopt the idea of UG consisting of constraints, but rather that it contains a set of (binary) parameters. However, it is not difficult to see that each parameter could be stated as a constraint based on the unmarked value of the parameter.

[3] Languages may also have language-specific properties which lie outside the scope of the core grammar. Thus, beside the core grammar, the child also has to master these language-specific properties.

terms of parametric variation, e.g., syllable structure (cf. Kaye & Lowenstamm 1981, Selkirk 1982, Cairns & Feinstein 1982, Clements & Keyser 1983, Itô 1986, Cairns 1988, Kaye, Lowenstamm & Vergnaud 1990) and stress (cf. Hayes 1981, 1991, Hammond 1984, Halle & Vergnaud 1987a,b, Kager 1989, to appear). In this way the set of possible grammars is limited. It also restricts the 'hypothesis space' for the language learner. The central question for the study of language acquisition in this line of research is how the child moves from an initial zero state, S_0, in which s/he does not have any language, but is equipped with UG, to a final or steady state, S_s, in which s/he has mastered the grammar of the language of the environment. The relationship between S_0 and S_s is crucial. In other words, the idealisation of the instantaneous learner is assumed, i.e., it is assumed that a child has simultaneous access to the full range of primary linguistic data. The correct grammar for the language emerges from the interaction of UG with this full set of data. The observed gradualness of the acquisition process and how the transition between S_0 and S_s is effected is not considered. Research along these lines addresses the logical problem of acquisition. This problem can in principle be solved without reference to actual data from language acquisition. Of primary concern is the learnability of grammar.

The other strategy for establishing innate properties is to carefully investigate the primary linguistic data produced by children. Central to this line of research is the developmental problem of acquisition. The goal is to construct a model of the child's development in real time. The two strategies have in common that they both assume an initial state S_0 and a steady state S_s, but in the latter strategy seeks to identify the intermediate stages, and investigates what governs the transition from one stage to the next. Assuming that the full set of principles and parameters is present from S_0 the child's task is to select and test hypotheses on the basis of exposure to data. The task of the researcher is to provide an account of how exactly this task is accomplished (Cook 1990).[4] This line of research examines child language, i.e., the developmental problem (Ingram 1989a). In an ideal world, both lines of research are combined.

If UG contains a set of parameters, there are in principle two logical possibilities for the setting of those parameters in the initial state S_0. Parameters are either unset, i.e., they are in neutral position with no bias towards any particular setting, or preset, i.e., they begin at a default setting

[4] It might be the case that some principles and parameters only become available as the child develops. If this is the case, we have to figure out what is responsible for the emergence of those principles and parameters which are not available in the initial stage. However, as an initial hypothesis I assume that all properties of UG are available from the beginning. I will show in chapter 7 that not all parameters are relevant from the start.

in S_0, and can be set to the marked value on the basis of the input the child receives, if the data require this marked setting. It is usually assumed that certain parameter settings are more marked than others. The MARKEDNESS issue is a complex one, however. One interpretation of markedness is that the marked settings of parameters are those for which evidence in the input is most available; unmarked settings are defaults and can be assigned in the case of absence of evidence. In this interpretation children need evidence to move from unmarked to marked settings. This notion of markedness underlies the SUBSET PRINCIPLE, originally proposed by Berwick (1982), which is defined as in (2):

(2) *Subset Principle*
If a parameter has two values + and −, and the value − generates a proper subset of the grammatical sentences generated with the choice of value +, then − is the 'unmarked value' selected in the absence of evidence (Chomsky 1986:146).

As is clear from this definition, the subset principle has mainly served in syntactic literature. There is no reason, however, not to extend the definition to phonology. In fact, the notion is used in phonology, although not in exactly the same manner. Phonologists frequently make use of 'implicational universals', which contain the notions of subset and superset. One such implicational universal mentioned by Jakobson (1941/68) is that if a language has fricatives it also has plosives. There are no languages that have fricatives but lack plosives. In other words, languages that have plosives but lack fricatives are a subset of the languages that have both plosives and fricatives. The claim made by the subset principle is that the child should start with plosives, and only produce fricatives if the data call for fricatives. Another implicational universal is the following: languages that allow onsetless syllables also have syllables with onsets. In this case the child should start by assuming that all syllables have onsets, and only change this assumption to include onsetless syllables if this is forced by the data. However, the relationship between the parameters in phonology and actual phonological development has not often been addressed (contrary to the situation in syntax). This is probably due to the fact that phonologists studying child language have mainly concentrated on the acquisition of segmental properties of lexical items. Lexical information is seldom predictable. However, although the exact pronunciation of words is almost entirely unpredictable,[5] the structures words may take, e.g., syllable and

[5] However, see Levelt (to appear), who claims that the segmental make-up of children's earliest words is largely predictable.

stress structures, are parametrically determined. These do not have to be learned lexically.

The assumption that parameters are preset to the default value for all parameters places less of a burden on the language learner. If parameters are unset in the initial state, the child has to set parameters from the start. S/he still may start with the unmarked value, but this assumes that markedness theory is part of UG. The question then is how markedness is implemented in UG. If markedness theory has no place in UG, the hypothesis space is much less restricted than if parameters are preset to the unmarked value. In the latter case, markedness theory is implemented in UG by means of default, unmarked values. If parameters come preset a more constrained view of learning is possible. If the child is a conservative learner, s/he will not switch the parameter setting to the marked setting unless the data forces this more marked setting. The claim that can be made, then, is that once a parameter is set, it is set, and it is not possible to reset the parameter. If resetting is a possibility, the learning process is far more complicated, especially if resetting of one parameter has consequences for other parameters. In principle, then, the child can never be sure that he has set any parameter appropriately.

I assume, therefore, that the child is a conservative leaner and that the parameters in UG come preset, i.e., I assume that all parameters have default values in S_0. In this way, markedness is reflected in UG by initially having all parameters in the unmarked (default) mode. This can be seen as a sort of switch. The off setting is unmarked, while if the parameter is actively switched on, it is in the marked setting. In this way the hypothesis space available to the child is severely restricted.

The parameters must have the property that they can be fixed by quite simple evidence, because this is what is available to the child (Chomsky 1986). This is also called the principle of 'epistemological priority' (Atkinson 1992). That is, the acquisition process must take place in the context of data which it is plausible to assume the child has access to. Let us now turn to the second component of figure (1), the data.

1.1.1.2. Data

Children have to acquire their language from the evidence they receive from the environment. They have to set parameters, the setting of parameters is triggered by evidence. What constitutes this evidence? There are different types of evidence. One obvious sort of data which the child has access to is constituted by the input s/he receives from the environment. This is called POSITIVE EVIDENCE. However, children do make errors. How do they

get rid of them without DIRECT NEGATIVE EVIDENCE? That is, if children are not corrected, how do they know that their output does not conform to the adult input? The answer may lie in the fact that children do not work on all parameters simultaneously. Errors can occur if certain parameters are not yet set. That is, errors can occur if (some of) the parameters are still in the default setting, even though the language requires the marked setting. Once the relevant parameters are set, these errors cease to occur. This poses the question whether parameters are ordered in UG. Some of the best-known accounts of parameter setting assume that parameters are ordered, so that it makes sense to talk of them as forming a markedness hierarchy. This is true both of Hyams' (1986, 1987) theory of null subjects and of Wexler & Manzini's (1987) proposals for the Binding Theory parameters. I will assume that parameters are ordered and I shall discuss this issue at various points in the dissertation. For example, I will show in chapter 4 that Dutch requires the marked value for both the 'minimal onset parameter' (onsets are optional) and the 'maximal onset parameter' (onsets can branch). Children invariably fix the minimal onset parameter before the maximal onset parameter, indicating that the latter is ordered after the former.

It is generally agreed that *direct* negative evidence is of no help to the child. However, some researchers assume that the cumulative lack of positive evidence may be relevant evidence (Atkinson 1990). This is called INDIRECT NEGATIVE EVIDENCE. This seems to imply that the child remembers that in all previous utterances s/he has heard a particular type of evidence was not present. If the child has a certain hypothesis about the structure of the language s/he is learning, s/he might expect certain structures to appear in the data. If these data do not occur, i.e., if positive evidence is lacking, this constitutes indirect negative evidence that can guide the child in the testing of the hypothesis.

A less obvious, but, as we will see, important kind of data is formed by the child's own output. The child's output may also serve as its input. Jakobson (1941/68) observed that "for normal development the acoustic impression of one's own sound productions is all-important." The child's own speech is not only produced, but also perceived. I will come back to this in 1.1.1.4, where I discuss the OUTPUT-AS-INPUT model.

1.1.1.3. Grammar

The grammar of a particular language consists of the specific values for the parameters, which form the CORE GRAMMAR. In addition to the core grammar the language may have LANGUAGE-SPECIFIC CONSTRAINTS that lie outside the core grammar. Now that we have some idea of how the core

grammar is acquired, i.e., by parameter setting, what can we say about the idiosyncratic properties of the language that is being learned? These idiosyncratic properties lie outside the scope of the core grammar and are more specific than properties of the core grammar. They may or may not be parametrised. This might have consequences for the learning of these properties.

I hypothesise that these properties are learned later than the core grammar, precisely because they are specific. If these language-specific properties are not parametrised, then they have to be learned in a different way from the core grammar. Therefore, I further hypothesise that the core grammar is learned on the basis of positive evidence only, but that indirect negative evidence may help the child in the acquisition of language-specific constraints. On the basis of these hypotheses I expect that children make many errors with regard to these language-specific properties, and that these errors survive for quite a long time. Since these properties are not part of UG, the child will not make hypotheses about these properties until the core grammar is fixed. That this indeed occurs will be shown in chapter 7; at a certain point in development the child will discover that Dutch is a quantity-sensitive language, and that closed syllables are heavy, and must therefore be stressed. This has as a consequence that words like *Robin* /ˈrɔbɪn/ and *ballon* 'balloon' /bɑˈlɔn/, which were previously produced as [ˈhɔpɪn] and [ˈbaːlɔn] (see chapter 6), now receive (an extra) stress on the final closed syllable, i.e., they are produced as [ˈhoːˈpɪn] and [ˈbaːˈlɔn]. Final stress is correct in the latter case, but not in the former. Moreover, in the child's earlier productions of the word *Robin* stress was correctly placed. The child's task is now to discover what language-specific property underlies one of the words.[6] I will show in chapter 7 that in this case the language-specific property is parametrised, but lies outside the scope of the core grammar.

If these properties are not parametrised, errors cannot disappear by a parameter switching. Examples of such properties will be give in chapter 4. It seems that the only way to discover the source of the errors, which are usually caused by a grammar which is too general, is to use indirect negative evidence. For example, onsets in Dutch can be branching. The members of the onset cluster have to obey certain sonority requirements. Words like *praten* 'to talk' /ˈpraːtə[n]/, *draaien* 'to turn' /ˈdraːjə[n]/, and *kleur* 'colour' /kløːr/ contain well-formed onset clusters. However, although /tl/ and /dl/

[6] Since the final stress is the result of switching a parameter setting to the marked value, the incorrectly assigned final stress to the word *Robin* has to be 'undone'. However, this does not mean that the switching of the parameter setting has to be undone, since for many words it is the correct setting. I come back to this issue in chapter 7, where I deal with the acquisition of exceptions to the stress system.

clusters obey the sonority requirements, they are not well-formed in Dutch. Nevertheless, children often realise words like *drinken* 'to drink' /ˈdrɪŋkə[n]/ as [ˈtlɪŋkə]. They have not received positive evidence for clusters like these. How do children get rid of these forms if they are not corrected? It seems that the only explanation is that they use indirect negative evidence.

1.1.1.4. Learning theory

Learning theory is the last component of the model in (1). It is also the most difficult and least discussed by linguists. In chapter 7 I will develop a parametric learning model for the acquisition of stress and syllable structure, based on the model described by Dresher & Kaye (1990). Here, I want to make explicit the assumptions I adopt concerning a learning theory.

Until now I have assumed that learning a language involves learning the correct values for all parameters and learning the language-specific properties. I have said that the child formulates and tests hypotheses on the basis of the input data. I mentioned that the hypothesis space is severely restricted, on the assumption that UG contains preset parameters. What, however, constitutes learning?

Although I have distinguished language acquisition from language development, I have used the term 'learning' rather inconsistently. However, the claim that development reflects a learning process is controversial (Atkinson 1992). According to Chomsky (1987) knowledge of language grows in the mind of a child. It therefore involves no learning. An alternative to learning is TRIGGERING. The recognition of some cue in the data, the child's 'trigger experience' (Lightfoot 1989), is said to trigger parameter setting. Triggering is a relationship between the data and their consequences for parameter setting. This involves no conscious learning. Rather, on this view UG must also contain the cues for which the language learner looks in the data, and which may trigger parameter setting. In this sense, hypothesis testing is looking for cues in the data which may trigger parameter setting. Should hypothesis formulation and testing be identified with learning, triggering or neither? We could relate the difference between triggering and learning to the difference between the learning of the core grammar and that of language-specific idiosyncratic properties. That is, triggering refers to the setting of parameters that are part of the core grammar on the basis of cues, and learning refers either to the setting of parameters that lie *outside* the core grammar, or the learning of idiosyncratic properties. However, I will use the term learning for both cases.

What procedures does a child use in selecting hypotheses on the basis of

exposure to the data? I also assume that UG contains, beside universal principles and parameters, CUES that are associated with the parameters (Lightfoot 1989, Dresher & Kaye 1990). Since the parameters are assumed to be ordered (Dresher & Kaye 1990, and references given above), the formulation of hypotheses is inherent in UG. That is, if parameter P_1 is the first parameter to be set, then the child looks for the cue associated with this parameter in the data. If s/he does find the cue in the data, the parameter is set to the marked value. If the cue is not found, nothing is done by the learner, since there is no evidence to change the parameter setting. Then the learner goes on to look for the cue to fix the second parameter, P_2, etc. Alternatively, the child could look for the cues for all parameters simultaneously, and as soon as one cue is found, the corresponding parameter is set; no specific order for searching of cues is imposed. If all parameters were independent of each other, this strategy could in principle work. However, parameters are often dependent on each other. If the order in which parameters are fixed is free, this could lead to the early fixing of a parameter which is dependent on some other parameter. When, at some later point, the latter parameter is set, the value of the dependent parameter may also change. However, this requires that a parameter, once it is set, can be reset. Ultimately, this means that at any point any parameter value can change from the marked value to the unmarked value and vice versa. From a learnability perspective this is undesirable, since it increases the hypothesis space tremendously. Rather, I assume a deterministic model of language learning (see also chapter 7), in which parameters cannot be reset, once they are set to the marked value.[7]

It has been suggested that children are conservative learners, as I briefly mentioned in 1.1.1.1. They do not set parameters until they have encountered a certain amount of evidence in the data. Moreover, once a parameter is set, it cannot be reset. In other words, there is no structure destroying and there is no backtracking. Therefore, unless they are sure about the marked value of a parameter, children keep the parameter in the default value. This is not to say that the child is a BATCH MODE LEARNER (Dresher & Kaye 1990). A batch mode learner collects all data, and then sets all parameters. This has the consequence that the child is assumed to be an INSTANTANEOUS LEARNER. Given the developmental patterns encountered in the data, this is a clear idealisation. However, I do not claim that the child

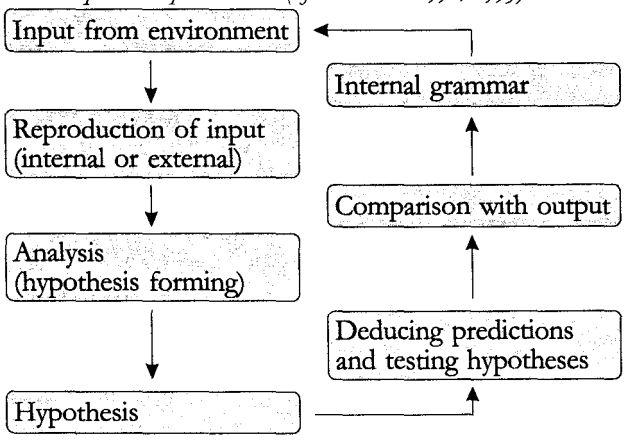
[7] It is possible to limit backtrackings, so that whenever a parameter P_k changes its setting, all parameters dependent on it revert to default. This is in fact necessary to make an incremental version of the Dresher & Kaye learner work without falling into fatal errors. However, I will show in chapter 7 that this modification is not needed, since children do not try setting parameters until they are 'ready' for them, unlike a machine learner.

is the extreme opposite of a batch mode learner, i.e., a strict INCREMENTAL LEARNER. A strict incremental learner adjusts parameter settings as *each* piece of data comes in. In that case, there would be no way to ensure that exceptions do not trigger the wrong parameter settings. Moreover, as motivated above, children are conservative in that they stick to the unmarked (default) value of a parameter unless they have enough evidence for the marked setting. Clearly, on a scale with a batch mode learner on the one end and a strict incremental learner on the other, the child is somewhere in between the two kinds of learners. On the one hand, the incremental learning model lends itself better to a developmental interpretation. On the other hand, the learner is conservative, and more a batch mode learner, in that s/he first collects a certain amount of data, on which generalisations are made, and hypotheses are tested. This means that learning is not strictly incremental: to a certain extent, the child does have access to previous data. This is inherent in the 'output-as-input' model (Elbers 1991, 1993), to which I now turn.

As I mentioned in 1.1.1.2, the child's own speech is not only produced, but also perceived. The child's own speech is multiply accessible for perception. Clark (1977, 1982) has shown that the comprehension of the input provided by the adults is a complex matter for the child. The child has to adjust the speaker's tempo and perspective. There are arguments that the analysis of the language's structure takes place on the basis of the child's own production (see Elbers 1991, 1993). Adult utterances need not be fully analysed at the initial stages of acquisition. This is especially clear from the production of longer words, which are usually only partly realised by the child. The data in chapter 6 clearly show that the child's own shorter form serves as input for the subsequent stages in which the shorter form is expanded until it resembles the longer adult form. Furthermore, production tasks are more effortful than perception tasks, and result in better retention. These considerations have led Elbers (1991, 1993) to propose the 'output-as-input' model. This model can be schematised as in (3).

The analysis of the input need not be immediately complete at the early stages. The child can make a selection of what kind of input s/he first takes into consideration for analysis. This is called the SELECTION STRATEGY (Ferguson & Farwell 1975, Menn 1976, Schwartz & Leonard 1982, Schwartz *et al.* 1987, Schwartz 1988, Stoel-Gammon & Cooper 1984). For example, if the child's own system does not contain velar plosives, but adult input forms do, there are in principle two ways in which the child can deal with these input forms. One is to simply avoid such forms in his or her own production forms. In other words, the child only selects forms that fit into his or her grammatical system at a particular stage. The second strategy is one of repair. In this case, the child selects adult input forms with velar

(3) *The 'output-as-input' model (after Elbers 1991, 1993)*



plosives, but the velar plosives are either 'deleted' or 'replaced' by some other place of articulation. I will refer to this strategy as the REPAIR STRATEGY, although the terminology is somewhat misleading, since it will be shown that there are no rules involved; rather, mismatches between the adult input form and the child's production form will be argued to be the result of mapping the adult target word onto the child's template. The child's template at each stage of the development determines the relation between the input and the output. These strategies may be part of the 'reproduction of the input' in (3).

The child then makes and tests hypotheses on the basis of his or her own reproduction of the input, the output forms. When the child compares his or her own output with the input from the environment and discovers a 'mismatch', the result may be that the next output form is closer to the input form. There is a cumulative effect of the analysis process. The model becomes redundant when the child has gained enough knowledge of the language to be able to make on-line analyses of the input. In this sense, the child's language is constrained on the basis of the child's own output, which is restricted, rather than the input, which is largely varied from the beginning. The often found U-shape behaviour (Strauss 1982, Bowerman 1982) can be explained as follows. First, the child imitates a form correctly. The form is not yet analysed, but when s/he tries to analyse this form errors may occur, based on the system the child has discovered. Errors illustrate the child's analysis. Evidence for this lies in speech production forms that do *not* occur in the input of the environment, such as stress errors. This model resembles the learning model of Dresher & Kaye (1990), to which I will return in chapter 7.

1.1.2. Residual issues

We have to keep in mind that the child's production data reflect both COMPETENCE and PERFORMANCE factors. Since we are interested in the child's competence, the knowledge of language, we have no choice but to study it through performance, the production data, since we have no direct access to the child's mind.[8] Only on the assumption that performance reflects competence is the study of child language development of interest to linguists. I therefore assume that performance reflects competence, unless performance factors can be identified, as is, for example, the case with immediate imitations. They do not necessarily reflect the child's competence, but are likely to be due to performance factors, like short-term memory.

Another problem is that we do not exactly know how accurate the child's PERCEPTION of adult speech is. I have been assuming that children generally perceive adult speech accurately (cf. Spencer 1986, 1988, 1989, Ingram 1989a, Gerken 1992a,b, Kuijpers 1993). Does this mean that the child has an adult-like underlying representation? Is this the same representation underlying the child's PRODUCTION? In perception one can distinguish between discrimination and identification. This claim is made explicit for adults in Lahiri & Marslen-Wilson (1991). Identification seems to relate to representation. That is, the child's representation is based on what is identified in perception, not on what is discriminated. I therefore assume that the child has a single representation underlying both perception and production. However, the child's stored representations are probably not the same as those of the adults, but are simplified in comparison with the adult representation. This does not mean that the child has an incomplete perception of the adult speech, but merely that the child has not analysed or categorised the complete perceptual representation (see also Waterson 1971, 1987 for a similar view).

The child's initially simple grammar mediates between the input and the output forms. That the child's stored forms are different from the input forms s/he receives from the environment is largely due to the child's restricted grammar. That is, the input forms violate the child's phonological system which s/he is building up. Therefore, repair strategies appear. They alter the input representation in such a way that they no longer violate the child's grammar. For example, if a child's grammatical system only allows CV(C) syllables, the child has to 'repair' a word like *trap* 'stairs' /trɑp/; the child's production form [tɑp] for *trap* is not due to an incomplete represen-

[8] It is claimed by psycholinguists that it is possible to look into the 'mental' lexicon experimentally (Levelt 1989).

tation, but due to an incomplete grammatical system. If the grammatical system grows in such a way that it allows for initial clusters, this repair strategy is no longer needed and ceases to occur. The repair strategy is therefore not an active rule, which has to be unlearned, but the necessary consequence of a grammatical system which is limited. This is implicit in the output-as-input model of Elbers (1991, 1993). In this respect it is comparable to processes in adult language. In adult phonology representations sometimes arise that are not allowed by the grammar of the language. Although, for example, the syllable structure parameters can be such that the maximal syllable is CVC, representations such as CCVC or CVCC can arise during derivations. These strings can, however, not be exhaustively parsed into syllables. Many languages use epenthesis as a repair strategy (see Itô 1989). However, languages can differ in their strategies. Deletion of one of the consonants is also possible. The choice between the different solutions is not governed by UG. Different children may adopt different strategies. Even for a single child different strategies are possible (cf. Menn 1977, Ingram 1989a). However, unlike the adult's grammar, which has reached a steady state, the child's grammar is in constant development.

The idea that children apply rules to a (basically adult-like) representation to create their own representation, which develops towards the adult-like representation by ceasing to use the rules, as for example assumed in Smith (1973), is not very attractive in the light of learnability factors. Rather, I assume that the child's (production) representations are initially very limited, and gradually expand along parametric dimensions. In other words, I assume continuity in the course of development guided by UG. Production is constrained by performance limitations, and by incomplete representations. The former reflects performance, the latter competence. I am mainly concerned with the latter, although the former cannot completely be ignored.

A related question is the following: if the child's representation is incomplete in comparison with the adult target, what determines what the child extracts from the adult input form? Perceptual biases, i.e., performance factors, are often mentioned (Slobin 1973, Peters 1977, 1983, Echols 1987, 1988). However, the child's perception may also be guided by UG. I shall come back to this issue in detail in chapters 4, 5 and 6.

1.1.3. Implications for the theory of language acquisition

To summarise, the major challenge for a theory of language acquisition comes from the necessity of explaining both language and development. A theory of language acquisition must be able to give an account of developmental patterns found in the children's data. It must account for the

transitions from one stage to the next, as well as for the types of errors found and not found. It must be empirically adequate, in such a way that it both accounts for the acquisition data and is empirically adequate within the theory of phonology. It must account for the developmental stages in such a way that the subsequent stage is more complex than the previous one. It must have predictive value, so that it is testable; and it must meet the criterion of learnability. That is, only a theory which is learnable in principle can serve as a theory of language acquisition.

I have assumed that children are endowed with innate cognitive abilities, one of these being linguistic abilities. Principles and parameters are in the default setting, with the range of possible (marked) settings given along with cues for which the learner has to look in the data. I have assumed that parameters are ordered if they are dependent on each other. All these assumptions severely restrict the hypothesis space of the learner.

In the developmental account I have to detect the point at which what parameters are set. I have to account for the different stages found in the data. Not all parameters are set at the same time. Therefore, I expect errors to occur which are the result of parameters not yet being fixed. Certain errors are not expected, given the principles and parameters approach. On the other hand, I also expect errors not related to parameters, but related to language-particular constraints that lie outside the scope of the core grammar, as mentioned above.

When discussing theories of syllable and stress structure, I will, besides focusing on developmental aspects, discuss the learnability of the theories. Some theoretical analyses seem to work well for linguistic descriptions: however, when they are considered from a learnability perspective, they turn out to be flawed (see also Dresher & van der Hulst to appear).

1.2. Aspects of prosodic theory

In this section, I will present some of the basic concepts of prosodic theory, as far as they are relevant for the subsequent discussions. Since I will not discuss prosodic structure above the word level,[9] I will remain silent on these aspects of prosodic theory. In 1.2.1 I discuss the prosodic units of the prosodic hierarchy, as proposed by Selkirk (1980, 1984a), McCarthy & Prince (1986, 1990), and others. In 1.2.2 I discuss some of the other principles of prosodic theory, insofar they are important for acquisition of prosodic structure.

[9] Prosodic structure above the word level is discussed in Selkirk (1984b), Nespor & Vogel (1986), among others.

1.2.1. The prosodic hierarchy

Up to the word level prosodic theory distinguishes the following constituents, which are hierarchically arranged in a PROSODIC HIERARCHY (McCarthy & Prince 1986):

(4) *Prosodic Hierarchy*

Prosodic Word	Wd
Foot	F
Syllable	σ
Mora	μ

Each higher level is comprised of units from the level directly below, such that the phonological word is constituted by feet, feet by syllables, and syllables by moras.

In the theory of McCarthy & Prince (among others) the MORA has a dual status: it is a weight unit, i.e., it determines the weight of a syllable, and also functions as a subsyllabic constituent. A SYLLABLE can contain one or two moras. The prosodic dichotomy between one and two moras reflects the weight distinction between light and heavy syllables. A light syllable contains one mora; a heavy syllable contains two moras. However, not all researchers adopt the mora as a subsyllabic constituent, nor do they express syllable weight in terms of moras. Rather, they adopt the more traditional view of a syllable, in which the onset, the rhyme, the nucleus and the coda are subsyllabic constituents. In such a view syllable weight can be expressed in terms of branching rhymes or nuclei. In chapter 3 I discuss the differences between a moraic and an onset-rhyme view of the syllable. I will adopt the latter view, and will give which from acquisition data in chapters 4 and 5.

The syllables of a word are parsed into FEET, which contain *strong* and *weak* positions. Ideally, there is a pattern of alternating stressed and unstressed positions, reflecting a basic rhythmical principle of alternation. The study of syllable structure and stress assignment has resulted in a parametric theory of metrical structure (cf. Hayes 1981, 1991, van der Hulst 1984, Halle & Vergnaud 1987a,b, Kager 1989), the goal of which is to express the enormous diversity of stress patterns in the world's languages by a limited number of parameters. In chapter 7 I present a detailed description of one particular version of a parametric theory of stress.

Feet are organised into PROSODIC WORDS. The smallest prosodic word often has a special role in the phonology of languages, and is referred to as the MINIMAL WORD. The minimal word of a language represents the minimal size that a major-category (or content) word may have. Since content words

must be stressable, the minimal word is equal to the minimal foot (the unmarked foot of the language). This follows from the prosodic hierarchy. In quantity-sensitive systems the minimal stressed foot contains one heavy syllable or two light syllables; in quantity-insensitive systems the minimal stressed foot contains two syllables. Some languages have minimal word constraints. Words which are too small are augmented in such a way that they conform to the minimal word template. Further evidence for the operation of the minimal word requirement occurs in truncation processes. I will consider the notion of word minimality in child language in chapters 6 and 7.

1.2.2. Other prosodic principles

There are three other principles that play an important role in prosodic theory. They are given in (5):

(5) *Principles of Prosodic Morphology* (McCarthy & Prince 1993)

a. *Prosodic Morphology Hypothesis*
Templates are defined in terms of the authentic units of prosody: mora (μ), syllable (σ), foot (F), prosodic word (Wd).

b. *Template Satisfaction Condition*
Satisfaction of templatic constraints is obligatory and is determined by the principles of prosody, both universal and language-specific.

c. *Prosodic Circumscription*
The domain to which morphological operations apply may be circumscribed by prosodic criteria as well as by the more familiar morphological ones.

The questions I will restrict myself to are the following. What is the role of these principles in the acquisition of prosodic structure? What is the relation between these principles and the parameters of UG? I suggest the following hypothesis concerning the relation between prosodic theory and acquisition: the child's template is determined by the prosodic parameters, all of which are in the default setting at the early stages of acquisition. On the basis of evidence in the data the child sets parameters to the marked values. The child's template is thus defined in terms of the authentic prosodic units. It determines the relation between the input (target or base) and the output (the child's production form). The child maps the input forms, i.e., (part of) the adult target forms, onto his or her template, in such a way that the template is maximally satisfied. Modifications of the target (or the base) are due to

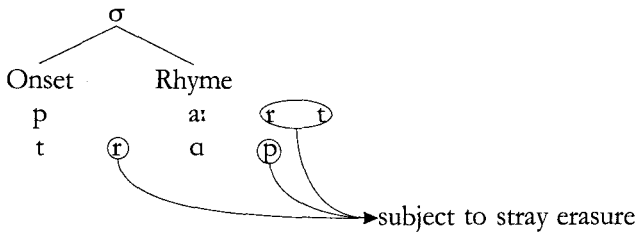
the fact that the child's template is more constrained than that of the adult.

For example, if all syllable parameters are in the default value, the template defined by these values is the core syllable CV. Since adult target words often have a more elaborate structure than just CV, the child may only select for his or her production adult target words that conform to the core syllable template (selection strategy); or s/he may select words that do not conform to his or her template, e.g., *paard* 'horse' /paːrt/ or *trap* 'stairs' /trɑp/. However, when these target forms are mapped onto the child's template not all material can be accommodated into the template. Codas will be eliminated, since the template does not allow codas, and complex onsets will be reduced, since complex onsets are not allowed. In other words, the material that cannot be licensed by the template is deleted, in accordance with Itô's prosodic licensing, which is defined as follows:

(6) *Prosodic Licensing* (Itô 1986:2)
All phonological units must be prosodically licensed, i.e., belong to higher prosodic structure (modulo extraprosodicity).

Phonological units that are not prosodically licensed are subject to stray erasure. The possible effects of mapping the target forms /paːrt/ and /trɑp/ onto the child's core syllable template are illustrated in (7):[10]

(7) *Mapping of target onto child's template*



However, template mapping not only results in deletion of segments (and/or syllables) or in simplifications. Template satisfaction may also dictate the expansion of a target form. For example, given the child's core

[10] Besides deletion (i.e., erasure) of segments that do not fit into the template, other outcomes are possible. For example, as long as the child only allows plosives in onset position, target segments with other manners of articulation are replaced by stops (see chapter 4); as long as the child only allows fricatives in coda position, other target segments are replaced by fricatives, or else deleted (see chapter 5). The child may also select features from different target segments and combine them, as in a child's production of the word *banaan* 'banana' /baˈnaːn/ as [ˈmaːn], where the nasal of the stressed foot is realised, but place of articulation comes from the target initial consonant (see chapter 6 for details).

syllable template in (7) an onsetless target word can be supplied with an onset in the child's production form. Since at the early stages onsets are obligatory in the child's template, rather than optional, a word like *auto* 'car' /ˈoːtoː/ is produced as [ˈtoːtoː] by the child to satisfy his or her template.

If the target word consists of more than one foot and the child's template contains a single foot, only one foot of the target word is selected for production. This resembles the mechanism of prosodic circumscription. I will show that in these cases the child circumscribes the rightmost foot of the adult target form, rather than the whole adult target form, and maps the segmental material of this foot onto his or her template. For example, the target word *olifant* 'elephant' /ˈoːliˌfɑnt/ contains two feet. However, at the early stages the child's template is a single foot; therefore, a single foot is selected from the right edge of the target, resulting in forms like [hɑm] and [fɑn]. In chapter 6 I will discuss syllable truncation in detail and show how the child's templates expand in the course of development.

The mapping procedures mentioned here resemble the matching procedures described by Steriade (1988) for explaining different types of reduplication in adult languages. There is an important difference, however. Steriade argues that both segments and their associated prosodic structure are copied, whereas I will provide evidence against the copying of prosodic structure along with segmental content. I will show in chapter 6 that the prosodic structure of the child's form may differ from that of the adult target form.

This completes the brief outline of prosodic theory. Relevant issues will be discussed further in relation to the particular problems analysed. An adequate theory is expected to be suitable to deal with acquisition data, and the hypothesis adopted is that the linguistic principles and parameters will be confirmed by the acquisition data. The theory as it is, however, does not predict how a child will acquire the prosodic aspects of phonology. What is needed is a markedness theory and a learning theory. Research into child language development may test and support our theory of UG and of linguistic theory in general, while on the other hand, linguistic theory can benefit from such research in that answers to markedness issues may be provided. However, we need to be careful if we assign markedness on the basis of development, since there is the danger of circularity if there is no reason for a setting to be unmarked other than its earlier occurrence. Without a theoretical rationale this kind of markedness amounts to saying 'whatever is learned first is learned first' (Spencer 1989). However, when such research is undertaken within the framework of recent linguistic theories, it may provide a genuinely explanatory account of the child's achievement in mastering his or her first language.

1.3. Preview

The outline of the dissertation is as follows: I give a description of the methods and materials in chapter 2. Chapter 3 provides the background for chapters 4 and 5. It discusses various topics in syllable structure in general and Dutch in particular. Chapters 4 and 5 describe the developmental stages in the acquisition of syllable structure. In chapter 4, I discuss the acquisition of onsets. It will be shown that development takes place along parametric dimensions. At the early stages the child's syllable template is a core syllable in which onsets are obligatory. At the next stage onsets are no longer obligatory. Then complex onsets appear. I will show that children differ in the way in which they extend their system: most children first allow complex onsets consisting of an obstruent plus a sonorant, but some children have clusters consisting of /s/ plus an obstruent before they have obstruent-sonorant onset clusters. I will show that the two groups of children focus on different parameters first.

In chapter 5 the acquisition of rhyme structures is discussed. At the initial stages of acquisition all syllables are open, giving support to the core syllable hypothesis. At the next stage closed syllables are allowed. However, syllables are invariably closed by an obstruent at the early stages. Sonorants are still deleted. At a later stage sonorants also appear in syllable-final position. However, there appears to be a close relation with the length of the preceding vowel. If the target word contains a long vowel followed by a sonorant, we find either that (i) vowel length is preserved, but the sonorant is deleted; or (ii) the sonorant is realised, but the preceding vowel is shortened. Obstruents do not have such a relationship with the preceding vowel. I therefore argue that obstruents are in the coda, but sonorants are part of the nucleus. Compensatory lengthening takes place within the nucleus.

In chapter 6 the developmental patterns that occur during the acquisition of the Dutch stress system will be described. There are several stages to be distinguished in the acquisition of disyllabic target words with final stress. These stages can be characterised by making use of the tools of prosodic theory. At the first stage a foot at the right edge is selected for production and the segmental content of this foot is mapped onto the child's quantity-insensitive (QI) trochaic template. At the next stage an additional syllable from the adult target is selected in those cases in which the previous form contained one single syllable. The segmental material of this foot is concatenated to the child's earlier form, and this complex is mapped onto the child's (QI) trochaic template. At the third stage two feet are produced by the child; however, both feet receive an equal amount of stress, since the word-tree dominance parameter (or main stress rule) has not yet been learned. This parameter is set at the final stage, resulting in the correct stress

pattern and number of syllables. The theoretical account given for the different stages also makes the right predictions for longer words. It will furthermore be shown in this chapter that the child's previous forms are important for the way the system develops.

In chapter 7 the parametrical learning model for stress proposed by Dresher & Kaye (1990) is discussed and tested against the acquisition data. The developmental stages found in chapter 6 are discussed in relation to parameter setting. Although there are a number of important differences between machine learners and children the model can, with some adaptations, serve as a basis for a model for acquisition of stress by children.

Finally, chapter 8 provides a summary of the main findings of this study.

2 Methods and Materials

AS MENTIONED IN the previous chapter the goal of this study is to develop a theory for the acquisition of prosodic phonology. A theory of language acquisition in general has to solve two problems: the logical problem of acquisition, and the developmental problem of acquisition. The former seeks to develop a theory of language acquisition which is learnable. The latter aims to give an empirically adequate account of the developmental patterns found in the course of acquisition, and an explanation for the transitions from one stage to the next on the basis of the available data.

To solve the logical problem of acquisition no reference needs to be made to acquisition data at all, since instantaneous acquisition is usually assumed to be sufficient to decide on the learnability of a theory. However, to solve the developmental problem of acquisition we need to have access to actual acquisition data. The research as reported in this dissertation was part of a joint project with Clara Levelt (see Levelt to appear) The data were partly collected in Groningen (Fikkert) and partly in Leiden (Levelt). We shared the work of collecting, transcribing and coding the data, and we make use of the same database. The scope of the project was wider than the subject matter of the present dissertation. We therefore set out to collect data that could support research on a variety of phonological topics. This method has both advantages and disadvantages. The recordings and the transcriptions have not been biased by any preconceptions. On the other hand, it turned out that sometimes crucial information was scarcely present, or not present at all.

2.1. The design of the research

The general goals affect the design of research. That is, the domain of inquiry affects what kind of data is needed, which affects decisions about collection of data, such as the appropriate means of recording, the number and nature of subjects, etc. A number of issues have to be taken into consideration: the method of observation, subject selection, the actual data

collection, the transcription method, the organisation and analysis of data, and reliability. These will be discussed in subsequent sections.

2.1.1. Naturalistic longitudinal observation

Typically, when the elicitor is the parent, the data are assumed to be naturalistic, but where the elicitor is an investigator, the data are considered to be experimental, since in the latter case observation is more controlled. Nevertheless, the setting of our data collection is primarily natural, in that the child did not recognise that s/he was being observed or involved in an experiment. Utterances were recorded in the child's home during natural, spontaneous, interactive sessions with one or both of the experimenters and occasionally with one of the parents in addition. During the recording sessions one of the researchers took care of the microphone and the audio equipment, and made notes about the contexts of utterances, etc. The other researcher and/or parent interacted with the child by reading books, playing with toys, etc. Occasionally, we elicited data by asking the child what it was s/he saw in the books or what s/he was doing, or by pointing to pictures. In this way we structured the natural observations to a certain extent. The recording sessions lasted on average 30 to 45 minutes. The duration of the recording session was not determined by a certain number of recorded utterances, since the children, especially the relatively young ones, did not always have many utterances.

We first visited the parents and the children once or twice to inform the parents about the research. During these visits the child got to know the researchers, and we got to know the child. Only after these first visits did we use a DAT-recorder, which was present all the time. The DAT-recorder and the microphone did not appear to distract the child's attention.

Experimental studies are not very suitable for very young children, for a variety of reasons. A young child can be easily distracted, can quickly lose interest in the tasks, and has a tendency to tire easily. On the other hand, the disadvantages of naturalistic observation are also apparent. The research is not easy to replicate. In 'raw' data the variables are uncontrolled and unidentified. It is time consuming and the production of certain data, and of certain types of errors, is left to chance and circumstances.

2.1.2. Subject selection

The subjects were twelve children, six boys and six girls, between the ages of 1;0 and 1;11 at the beginning of the approximately one-year period of

data collection. The subjects were selected by placing advertisements in the university papers of Groningen and Leiden and at several crèches. In total, twelve parents replied who were willing to let their children participate in this study (6 in Groningen and 6 in Leiden).

If the purpose of this research has been to make quantifiable comparisons among studies and to set standards for normal acquisition, then we would have gathered as large an amount of data as possible from as many children as possible, either representing a wide range of backgrounds, or forming a homogeneous group. However, the purpose of this study was to understand the extent to which specific aspects of language development are shaped by characteristics of individual children. Therefore, we examined methodologically specific details of all the potentially relevant characteristics of individual children. The study is not designed in such a way that it is amenable to statistical analysis, not only because the number of subjects is too small, but because the goal is not to come up with 'norms' for acquisition. In child language research, studies with small numbers of subjects tend to be exploratory analyses which serve the essential functions of (1) providing descriptive groundwork, and (2) suggesting possible correlations and hypotheses which can be systematically examined in subsequent research, usually with a larger sample population and with greater attempts to control other sources of variability.

In linguistics, language acquisition is usually studied using longitudinal acquisition data from one or two children (cf. Leopold 1939/49, Smith 1973). Small numbers of subjects are often necessitated by frequent sampling and the time required to transcribe and analyse data. Nevertheless, we wanted to follow as many children as possible, given the time limit of this project, not only to capture the idiosyncratic development of one or two children, but also to gain an idea of the variation and similarities between individual children. Ideally, we wanted to follow children from the time that they produced their first meaningful speech, usually around their first birthday, until the point that their basic phonological system was more or less adult-like, approximately around the age of three, because the goal is to describe and explain the range of structures of certain features of a child's language.

The focus is on the actual development of these structures. It is, therefore, necessary either to follow individual children for a long period of time or to use a cross-sectional design. Since time restrictions forced us to observe the children for a shorter period, we decided to use a cross-sectional design. It is often assumed that cross-sectional data provide similar information to, and are therefore comparable with, longitudinal data. Therefore, we tried to combine the longitudinal approach with a cross-sectional study, by selecting children aged between one and two years old

at the start of the collection period, to capture the whole period. The aim was to select subjects of a sufficient range in age that these changes would be clearly exhibited. The table in (1) on page 27 gives the ages at which we started and stopped collecting the data for each child.

(1) also gives other subject variables, such as sex and sibling position, although we did not select subjects according to these variables, since it has never been demonstrated that the differences are significant for the actual developmental patterns found. There is research suggesting that girls learn language faster than boys, and also that sibling position and rate of development are dependent. The evidence, however, is often contradictory, and for our concern, the actual developmental patterns, the variables are assumed not to be significant.

Another variable, often reported, although its significance has never been shown for the acquisition of phonology nor is it very likely to be so, is socio-economic status. In this respect, the children form a homogeneous group, since all children are from families in which at least one of the parents had an academic degree. There are no significant cultural differences between the families. All families had the same linguistic background: the families were monolingual speakers of standard Dutch. That half of the children came from Groningen and half from Leiden had a practical reason.[1] We did not find differences between the two groups of children. Nevertheless, (1) also reports this variable for each child. As a final note, I should mention that all children are apparently developing normally.

2.1.3. Data collection

We collected naturalistic, longitudinal speech samples, enhanced by a cross-sectional design. The recordings lasted on average between 30 and 45 minutes. The frequency of recording was every other week. We were aware of the importance of the fact that recordings should be made at the shortest possible intervals. While an increase in frequency may allow one to decrease duration we took the risk of decreasing frequency with a larger group of children on the assumption that each subject would be at a different level, so the inherent variability and instability of systems and forms in transition would be exhibited in at least some subjects. A two-week interval was

[1] There are minor differences between the language spoken in Groningen and Leiden. Notable are the differences in some consonants closing an unstressed syllable. After /ə/ final /n/ is normally deleted in the Leiden dialect, whereas it is regularly pronounced in the Groningen dialect. An /r/ following schwa tends to be vocalised in the Leiden dialect, whereas this is seldom the case in the Groningen dialect. However, these are not subjects of my investigation.

(1) *The subjects*

NAME	SEX	PLACE	SIBLING POSITION	FIRST SESSION AT	LAST SESSION AT
Tom	M	Groningen	second	1;0.10	2;2.2
Eva	F	Leiden	second	1;4.12	1;11.8[2]
Jarmo	M	Groningen	second	1;4.18	2;4.1
Robin	M	Leiden	first	1;5.11	2;4.28
Elke	F	Groningen	first	1;6.4	2;4.29
Noortje	F	Groningen	second	1;7.14	2;11.0
Tirza	F	Leiden	third	1;7.25	2;6.12
Leonie[3]	F	Leiden	second	1;9.15	1;11.18
Leon	M	Groningen	second	1;10.1	2;9.2
Catootje	F	Leiden	first	1;10.12	2;7.4
David	M	Groningen	first	1;10.25	2;8.19
Enzo	M	Leiden	first	1;11.8	2;6.11

chosen because it allows the child to show some, but not too much change. If the interval were too long, crucial changes could be missed. These changes were even apparent with a two-week interval. Ideally, the child should have been recorded on a daily basis. However, to do so we would have been forced to limit the number of subjects to only one or two, because of time limitations. We sometimes had a more flexible schedule and occasionally visits were more frequent. We collected the data for approximately one year. In this way, we gained a large data set, which consisted of both qualitatively and quantitatively rich material. In general, the validity of the data gathered is increased if the number of subjects is large enough, which often means more than three in the field of linguistics (Bennett-Kastor 1988, Ingram 1989a), and if the intervals for observation are frequent and regular.

Sessions were recorded for later transcription. Recordings of the children from Groningen were made on cassette audio-tapes during the first two months using a Sony cassette tape deck with a Sony microphone. All other sessions were recorded with either a Sony or a Casio DAT-recorder. We used a Sennheiser MD 421N microphone which was placed in front of the child. Since the adult was usually sitting next to the child the adult speech was recorded as well.

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[2] For various reasons some children were not recorded for a full year.

[3] Leonie's data were collected and transcribed by Levelt for an earlier study. She was recorded every week, for a period of two months.

2.1.4. Transcription

The taped utterances were phonetically transcribed, usually immediately after the recording session, using the International Phonetic Alphabet (IPA) as employed for Dutch by Vieregge (1985), revised as described in the report on the 1989 Kiel Convention. The phonetic symbols used are listed in appendix A. Utterances were transcribed using a narrow transcription, independently by two persons. We only transcribed the child's utterances. Adult utterances were not transcribed, since our interest was in the formal linguistic structures underlying the child's competence. Unintelligible utterances were left out, i.e. those utterances for which no single transcription could be obtained, or no single interpretation could be given. False starts, errors, breakdowns, etc., were transcribed, however, since they may provide valuable information about the child's competence. If the child's utterances consisted of more than one word, boundaries were placed between the words. No boundaries were placed if we were not sure that the child knew the different words of which the utterance consisted. For example, it was unclear whether the child recognised the different words in an utterance such as *wat is dat?* 'what is that?', since this was often pronounced as ['tɪtɑ], ['sɪtɑt], etc.[4] In these cases we did not place a word boundary. In the text I use square brackets to indicate the narrow transcription of the child's speech. To distinguish the child's utterance from the adult (broad) phonetic transcription, the latter is given between slashes. This refers to a broad transcription of adult targets, not to the underlying representation. For example, /kɪnt/ is the broad phonetic transcription of the adult target *kind*, whereas the child's pronunciation is given as [kɪn̪t].[5]

As a convention, I use the length mark : to indicate a phonologically long vowel throughout this dissertation; it does not necessarily mean phonetically long (Moulton 1962). However, in the database length is only marked when a vowel is produced with more length then usual; this can apply to both phonologically long and short vowels.

2.1.5. The organisation and analysis of data

The transcribed utterances are entered into a Macintosh database system, CHILDPHON, developed at the Max Planck Institute for Psycholinguistics,

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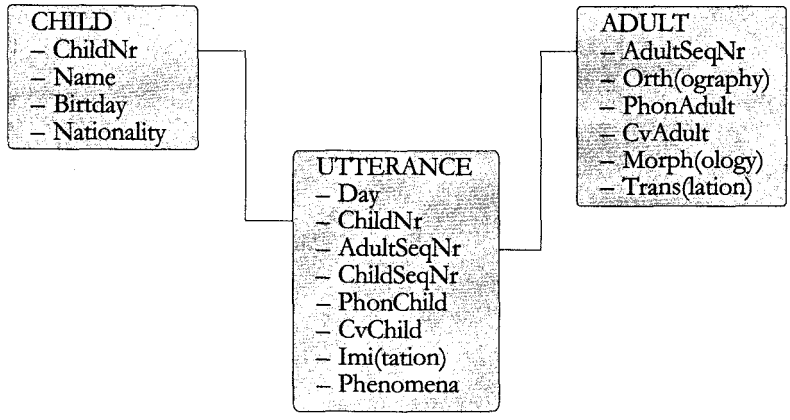
[4] As a result the final /s/ of *is* in the adult target is not considered to be word-final, but part of an intervocalic cluster.

[5] A complete list of adult target words used in this dissertation their glosses is given in appendix B.

Nijmegen, which contains currently over 20,000 utterances. CHILDPHON is an application generated with the relational database package *4th Dimension*, version 2.0. The structure of CHILDPHON is such that it contains three files: (a) File Child, (b) File Adult and (c) File Utterance. The structure and relationships between the files are depicted in (2):

(2) *Structure for ChildPhon*



The first file, *Child*, contains general information about the children, such as name, birthday and nationality. Each child receives a unique number, which relates this file to the Utterance file. The file *Utterance* contains information about the utterances of the children. It contains columns for the date of the recording session (Day), the number of the child (ChildNr), the adult sequence number (AdultSeqNr), which relates the utterances to the Adult file, the number of the child utterance for numbering the child utterances per adult target (ChildSeqNr), the phonetic transcription of the utterance (PhonChild), the consonant-vowel structure of the utterance of the child (CvChild), information about whether the utterance was spontaneous or imitated (Imi), and phenomena codes (Phenomena), which will be discussed shortly. The file *Adult* contains information about the adult forms corresponding to the children's utterances. The adult forms are direct and word by word 'translations' of the child utterances. As far as possible we avoided giving interpretations. The file Adult consists of the following columns: the adult sequence number (AdultSeqNr), which is the unique number for each adult target, the orthography (Orth), the broad phonetic description of the adult target (PhonAdult), the consonant vowel structure of the adult target (CvAdult), information about the morphological structure of the adult target (Morph) and the English gloss of the adult target (Trans).

The utterances were coded for phenomena to capture their relationship to the adult target on several levels. By coding the data for certain

phenomena we simplified the searching process through the more than 20,000 utterances of which the database consists. We coded the data for the following phenomena (partly based on phenomena reported in the literature, as for example in Ingram (1974, 1976, 1989a) and Menn (1971, 1977, 1978), among others). Segmental phenomena are coded by numbers, prosodic phenomena by (capital) letters. In combination with these numbers and letters some additional markings are used.

(3) *List of phenomena codes*

	SEGMENTAL PHENOMENA	EXAMPLES			
1.	Substitution of a consonant	vis	/vɪs/	→	[pɪs]
2.	Substitution of a vowel	baby	/ˈbeːbiː/	→	[ˈbiːbiː]
3.	Consonant harmony	poes	/puːs/	→	[puːf]
4.	Vowel harmony	baby	/ˈbeːbiː/	→	[ˈbiːbiː]
5.	Phenomena affecting	trein	/trɛin/	→	[tɛin]
	consonant clusters	paard	/paːrt/	→	[paː]
6.	Metathesis	kip	/kɪp/	→	[pɪk]
7.	Deletion of a consonant	trein	/trɛin/	→	[tɛi]
8.	Reduplication	baby	/ˈbeːbiː/	→	[ˈbiːbiː]
		klaar	/klaːr/	→	[ˈkaːkaː]
9.	Addition of a consonant	koe	/kuː/	→	[kuːχ]
		aap	/aːp/	→	[paːp]
10.	Deletion of a vowel	koffie	/ˈkɔfiː/	→	[pɔf]
11.	Addition of a vowel	trein	/trɛin/	→	[ˈtɛinɑ]
	PROSODIC PHENOMENA	EXAMPLES			
A.	Deletion of a syllable	ballon	/bɑˈlɔn/	→	[lɔn]
		koffie	/ˈkɔfiː/	→	[pɔf]
B.	Production of an extra syllable	trein	/trɛin/	→	[ˈtɛinɑ]
		schaap	/sχaːp/	→	[əsˈhaːp]
C.	Stress error	gitaar	/χiːˈtaːr/	→	[ˈsiːtaː]
		ballon	/bɑˈlɔn/	→	[ˈbɑnˈdɔn]
D.	Reduction of a vowel	konijn	/koːˈnɛin/	→	[kəˈnɛin]
E.	Resyllabification	panda	/ˈpɑndaː/	→	[ˈpɑmaː]
F.	Fortification of a syllable	emmer	/ˈɛmər/	→	[ˈɛmaː]
G.	Gemination	pakken	/ˈpɑkə[n]/	→	[ˈpɑk.kaː]

	ADDITIONAL MARKINGS		
i	word-initial position	r	reduction
f	word-final position	d	deletion
m	word-medial position	L	from left to right
s	stressed vowel	R	from right to left
us	unstressed vowel	e	epenthesis

As is clear from the examples, utterances can be coded for several phenomena simultaneously. The production of *koffie* /ˈkɔfiː/ as [pɔf] can be marked as [1i, 3R, 1of, Af]. These codings are not to be interpreted as a complete analysis of the data, but rather they are of help in discovering regularities in the data, which are then subjected to a closer analysis.

2.1.6. Reliability

To reach a high degree of reliability several aspects were taken into consideration. Firstly, the research was designed in such a way that the setting, frequency, duration of the interview, longevity, and other aspects of observation made unrepresentative behaviour unlikely to occur. Secondly, less effective, but also important, is the use of inter-observer reliability measures at various stages. All recordings were individually transcribed and coded by two researchers trained in phonetic transcriptions. Only those transcriptions and coding on which both researchers agreed are entered into the database and taken into consideration for further analysis. In addition, the reliability of the transcriptions and coding of the Leiden team and the Groningen team was checked by discussing and judging a subset of each other's transcriptions and coding. This was done to ensure that both groups produced comparable transcriptions.

According to Fassnacht (1982), cited in Bennett-Kastor (1988:100), the most reliable data are to be obtained by having:

1. as many data as possible which have been subject to control of setting and other aspects of collection;
2. as many subjects as feasible, or alternatively as many instances of the features in question as possible;
3. a combination of recording techniques which complement each other such that where one is defective the other is superior (e.g. audio-tape is non-selective; human note-taking observers are highly selective);
4. multiple observers and/or analysers to maximise attempts at objectivity;
5. clearly and formally articulated procedures for recording;
6. consistent, well-defined coding categories;
7. reliability measures;
8. an open mind.

We have tried to respect as many of these criteria as possible, and are confident in the reliability of our data.

2.2. Stages

In chapter 1 the notion of 'stage' is already mentioned. Here, I want to make more explicit what is meant by it, since I want to make use of stages of acquisition as evidence for a theory of language acquisition. Ingram (1989a) gives an elaborate overview of the different ways in which the notion 'stage' is used.

In many cases the transition between two stages is characterised by a change in linguistic behaviour. For example, for a certain period of time the child's grammatical system only allows open syllables (stage A). The appearance of closed syllables at some later point in the development marks the beginning of stage B. This kind of stage is called a TRANSITION STAGE (Ingram 1989a): it refers to a certain period in time in which a certain behaviour has plateaued but is expected to change again at some later time, as long as the behaviour is not yet adult-like. Stage in this sense refers to a period when no change occurs.

Another way to use the notion 'stage' is in the sense of a point on a continuum. In Ingram's definition a CONTINUOUS STAGE is one where a single dimension of behaviour is being observed, and the difference between stages is only between the points along the continuum that are being selected for observation. The continuity stage can also be proposed for the measurement of some behaviour that is either on the increase or decrease. In chapter 5, I make use of this type of stage, since it was not always possible to find a clear point in the development where transition took place. However, by comparing a some aspects of linguistic behaviour at different points on a continuum it became clear that development had taken place.

I assumed that the principles and parameters of UG are present in the child's mind from the start, and that the learning process consists of fixing parameters, which all have the default value at the initial stage, and are set to the marked value if the data require the marked setting. I further assumed that once a parameter is set this setting cannot be undone. This implies that development is continuous in that the system is gradually becoming more complex, that is, more adult-like. Therefore, the stages used fulfil the continuous requirement. For a certain period of time to be called a stage, I assume that a certain linguistic behaviour has plateaued for a certain time. This does not mean that behaviours typical of the previous stage do not occur at all, nor does it mean that behaviours typical of the following stage do not occur. There are always 'fossil' forms and forms that are 'ahead of their time', as frequently mentioned in the literature on language acquisition (Priestly 1977, Ingram 1989a). We will furthermore see that changes are always gradual, and hardly ever occur across the board.

Important for the theory of acquisition is the explanation of the different

stages thus defined. The transitions between the stages must be accounted for in a principled way. Thus, I restrict the use of 'stage' to those cases where I am referring to behaviour that is being explained in some way. To explain a behaviour is to offer a cause for its occurrence. Only when this is done do the stages reflect real development.

This use of the notion 'stage' refers to a single behaviour. They do not provide general stages of development. In this dissertation I will not be concerned with general stages of development, but concentrate on the stages of acquiring different prosodic structures. I believe that the relation between the different behaviours at the different stages can only be studied successfully when more is known about the acquisition of single behaviours.

An additional issue concerns the age–stage relationship. This description of stages is done for individual children, and given stages correspond to different ages for different children. Therefore, the age–stage relationship is not straightforward. Furthermore, there is not only variability between children, but also within individual children. When it comes to genuine developmental studies, researchers have a challenging situation in choosing subjects of the appropriate age, since so much variability within an age group exists. Because of this variability subjects cannot simply be matched for chronological age. To be able to compare linguistic behaviours of different children, the use of the notion stage is therefore crucial.

3 Syllable Templates and the Syllable in Dutch

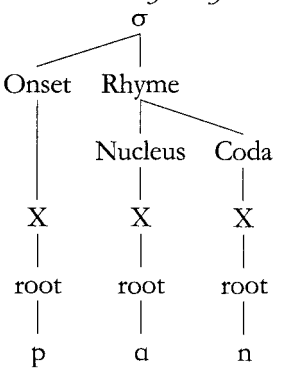
THE PURPOSE OF this chapter is to provide the background for the next two chapters, which deal with the acquisition of syllable structure in Dutch. In section 3.1 I sketch the two most commonly held views on the structure of the syllable: the classical 'onset-rhyme' syllable and the 'moraic' syllable. I review some of the arguments for each syllable template, with special reference to 'onsets' and 'rhymes'. After a brief summary of the roles of the syllable in phonological theory in section 3.2, a description of what constitutes a possible syllable in (adult) Dutch is given (section 3.3). In section 3.4 I discuss the distinction between length and weight in Dutch. Finally, in section 3.5 I address the issue of whether or not Dutch has the universal core syllable CV, and I will show that although Dutch disallows short vowels in open syllables, it does have light open syllables (universal core syllables).

Compelling arguments for recognising the syllable as a hierarchical unit in phonological representation are not hard to find (Fudge 1969, Kahn 1976, Kiparsky 1979, McCarthy 1979, Selkirk 1982, Clements & Keyser 1983, Trommelen 1983, van der Hulst 1984, Davis 1985, Itô 1986, 1989, McCarthy & Prince 1986, among others). However, less agreement exists as to the exact nature of the hierarchical structure, the number of levels mediating between the syllable node and the root nodes, the syllabic constituents, and the parameters which define the differences in syllable structure between languages. Since it is not my purpose to describe all possible views of the syllable, I will only sketch the two most commonly held theories on the structure of the syllable.

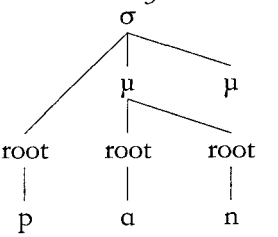
3.1. The 'onset-rhyme' versus the 'moraic' syllable

The two most commonly held views on the structure of the syllable are represented in (1a, b):

(1) a. *'Onset-rhyme' syllable*



b. *'Moraic' syllable*



In the 'onset-rhyme' view[1] (1a) a syllable consists of a head, the RHYME, and a non-head, the ONSET; the rhyme itself also contains a head, the NUCLEUS, and a non-head, the CODA (Fudge 1969, Selkirk 1982, Cairns & Feinstein 1982, Trommelen 1983, Cairns 1988, among others). In this view there are subsyllabic constituents, which can themselves contain subconstituents. It is generally assumed that weight is a property of syllables. In the 'onset-rhyme' view weight is computed by an interpretative procedure: it is usually assumed that branching rhymes contribute to the weight of the syllable (Hayes 1981, Kager, Trommelen & Visch 1985, Kager, Visch & Zonneveld 1987, Trommelen & Zonneveld 1989).

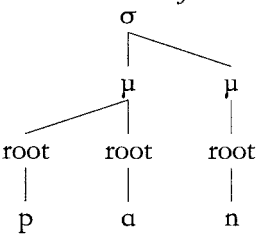
In the 'moraic' view of (1b), the syllable consists of at least one and at most two moras.[2] In general it is assumed that vowels are moraic. Short vowels have one mora, and long vowels have two moras (Hayes 1989). Zec (1988) makes a distinction between the first and the second mora of a syllable. She calls the first mora 'syllabic', the second one 'moraic'. Conso-

[1] Many researchers adopt structures deviating from the two broad types to a greater or lesser extent. For example, Cairns & Feinstein (1982) and Cairns (1988) allow several subconstituents in both the onset (see 4.5.2) and the rhyme. Others have onsets, nuclei and codas, but no rhymes and no hierarchical structure below the syllable node, i.e.,, they adopt a 'flat' structure (for example, Davis 1985, Noske 1992). There are also differences among the linguists advocating the moraic syllable. Hyman (1985), for example, assumes that each segment has a weight unit (μ) of its own in the underlying representation. However, the Onset Creation Rule adjoins the consonantal segments preceding the syllable peak or nucleus to the first mora (*not* to the syllable node) and deletes their weight units. I will not discuss the different proposals here.

[2] This follows from the universal principle of locality (McCarthy & Prince 1986, Kaye, Lowenstamm & Vergnaud 1990, Prince & Smolensky 1993), since "a rule may fix on one specified element and examine a structurally adjacent element and no other" (McCarthy & Prince 1986:1). More generally, it is often assumed that linguistic structures are at most binary, both in syntax and phonology. In the 'classical' view each constituent maximally contains two elements as well.

nants may or may not be moraic. Consonants preceding the first mora of a syllable and belonging to the same syllable are never moraic and are directly linked to the syllable node (Itô 1986, 1989, McCarthy & Prince 1986, *et seq.*, Hayes 1989, Archangeli 1991, and others). Alternatively, they are linked to the first mora (the 'syllabic' mora), as in (2) (Hyman 1985, Zec 1988, Itô 1989). In neither case do they form a mora on their own.

(2) *Pre-moraic consonant adjoined to first mora*



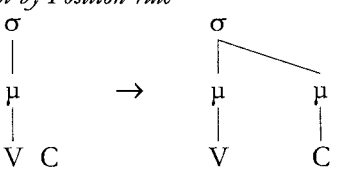
The difference between (1b) and (2) is that in (1b) the mora cannot be an ultimate prosodic unit (Zec 1988), because it violates the strict layer hypothesis, given as (3):

(3) *Strict layer hypothesis*
A category of level *i* in the hierarchy immediately dominates (a sequence of) categories at level *i*-1. (Selkirk 1984b)

This seems to be an argument in favour of (2). However, in (2) a mora can dominate more than two elements, for instance if there is a complex 'onset', which violates the locality or binarity principle. However, both (1b) and (2) express the fact that the mora is a subsyllabic constituent (see Zec 1988). Since I am only concerned with the status of the mora as a subsyllabic constituent here, I will use the representation in (1b) throughout this dissertation.

Consonants following the first mora of a syllable may or may not be moraic. If in a quantity-sensitive language CVC is heavy, the language has a Weight-by-Position (WbP) rule which assigns a mora to the consonant following the vowel (Hayes 1989: 258). This rule is given in (4):

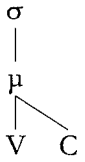
(4) *Weight-by-Position rule*



If the language is not quantity-sensitive, or if CVC does not count as heavy (but CVV does) then the language does not employ the WbP rule; rather, post-vocalic consonants that belong to the same syllable as the preceding

vowel are directly adjoined to the mora of that vowel.[3] This is schematised in (5):

(5) *Weightless post-vocalic consonants*



In the 'moraic' representation of the syllable, weight is computed in a straightforward fashion. Monomoraic syllables are light, bimoraic syllables are heavy.

To summarise, in the 'moraic' view as represented in (1b) there is (i) a difference between moraic and non-moraic (weightless) segments, and (ii) a difference between pre-vocalic consonants, which are adjoined to the syllable node, and the post-vocalic consonants, which either have a mora of their own, or are adjoined to the preceding mora. The pre-vocalic non-moraic consonants in (1b) correspond to the onset in (1a), although crucially in the 'moraic' view onsets have no theoretical status as a constituent. The post-vocalic consonants correspond to those in coda position in the 'onset-rhyme' view, although, again, the coda has no theoretical status in the 'moraic' view. The moraic segments in (1b) correspond roughly with the rhyme in (1a).

The 'onset-rhyme' view is motivated on the following grounds. First, only rhymes add to the weight[4] of the syllable, onset consonants are weightless. Therefore, it is stipulated that only rhymes count for weight. In the 'moraic' view this is directly expressed, since 'onset' consonants are never moraic.

Second, most phonotactic restrictions hold within onsets and within rhymes.[5] For example, we will see in chapter 4 that when children learn complex onsets, the two members of the onset differ maximally in sonority, the optimal complex onset consisting of a plosive followed by a glide. This phonotactic constraint is easy to express in the 'onset-rhyme' view, since

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[3] Alternatively, the non-moraic post-vocalic consonant is adjoined directly to the syllable node. I will not discuss this possibility. The reader is referred to McCarthy & Prince (1986), who discuss the full range of possibilities.

[4] The question of weight with respect to stress assignment will be extensively dealt with in chapters 6 and 7. The relation between length and weight will be discussed in this chapter.

[5] There are also restrictions based on the syllable. For example, as in many languages, Dutch does not allow /j/ before /i/. Also /h/ before schwa is prohibited in Dutch. Another pansyllabic constraint in Dutch concerns the occurrence of two identical liquids in a syllable: Dutch does not have words of the types /lVVl/ and /rVr/. Booij (to appear) refers to this as the Double Approximant Constraint (see also Cairns (1988) for similar observations in English).

onsets form separate constituents from rhymes. To express the constraint without referring to the onset, one has to state that the non-moraic consonants to the left of the first moraic vowel and within the same syllable as the vowel have to differ maximally in sonority value. This seems rather arbitrary and it is not easy to see why this should be so. Jakobson (1941/68) noticed that at the initial stages of acquisition children produce CV syllables consisting of a plosive followed by an (open) vowel, since these provide a maximal contrast between the two members of the syllable. Similarly, when learning onset clusters the child prefers maximal contrast between the two members of the onset. The child does not strive for a maximal contrast between the (complex) onset on the one hand and the rhyme on the other, nor does s/he strive for an equal sonority distance between all segments of the syllable. This can only be stated in a theory which regards the onset as a constituent. In the 'moraic' view this generalisation is difficult to express in a non-trivial way. Chapter 5 will show that also with respect to the acquisition of complex rhymes and complex nuclei children strive for maximal contrast in sonority between the two members of constituents.

Third, onsets and rhymes seem to be independent of each other with respect to phonotactic restrictions. It is claimed that syllable structure conditions never involve distributional constraints holding between the nucleus and the preceding elements, while they are frequently found to express cooccurrence restrictions between the nucleus and the following elements.[6] Simplification of the onset never triggers vowel lengthening in either child language or adult languages. However, as will be shown in chapter 5, deletion of sonorants, which will be argued to be part of the nucleus in child language, triggers compensatory lengthening, but deletion of obstruents, which I will argue to be part of the coda, does not. In other words, it seems that compensatory lengthening takes place within the nucleus in this process, not within the rhyme. It will also be shown that this compensatory lengthening process involves preservation of *length*, not of weight. Crucially, length distinctions are learned before weight distinctions. Chapter 5 and chapter 7 will illustrate this in detail. Although compensatory lengthening has been used as an argument in favour of the 'moraic' view (Hayes 1989), this argument is only valid in languages in which length and weight are expressible by the same means. This is not the case for Dutch, as we will see in section 3.4. In a theory which recognises the nucleus as a

[6] According to Clements & Keyser (1983), "co-occurrence restrictions holding between the nucleus and preceding elements of the syllable appear to be just as common as co-occurrence restrictions holding between the nucleus and following elements." However, counterarguments are given by Fudge (1987), who claims that nucleus–coda restrictions are considerably more frequent than those between onset and nucleus.

subsyllabic constituent, the compensatory lengthening process found in child language is easy to capture.

Fourth, onsets appear to function as constituents in speech errors, language games and alliteration patterns in poetry. Speech errors typically involve switching of syllable-initial consonants (the onset), not the rhyme, nucleus or coda (MacKay 1970, Treiman 1983, 1985, 1986, Fudge 1987, 1989). In word games, too, the onset is often replaced, not the rhyme, such as in the Pig Latin word game in which the word-initial onset is moved to the end of the word where a rhyme *ey* is added; thus, *street* becomes *eetstrey* and *criminal* becomes *iminalcrey* (Treiman 1986, Fudge 1987, 1989). In child language there is a similar phenomenon: disyllabic adult target words with final stress are often truncated, in which case the first syllable is deleted (see chapter 6 for a detailed analysis). However, the onset of the first syllable is often realised instead of the onset of the second syllable. Examples are given in (6):

(6)

konijn	/koːˈnɛin/	→	[kɛin]	*Elke*	(2;3.27)
ballon	/bɑˈlɔn/	→	[ˈbɔmə]	*Robin*	(1;7.13)
kadootje	/kaːˈdoːt͡ʃə/	→	[ˈkoːs͡jə]	*Jarmo*	(2;1.8)
banaan	/baːˈnaːn/	→	[paːn]	*Robin*	(2;0.18)

Without making reference to onsets this process has to be stated along the following lines: replace the non-moraic consonant(s) to the left of the mora that is the head of the stressed syllable by the non-moraic consonant(s) to the left of the mora that is the head of the stressless syllable.

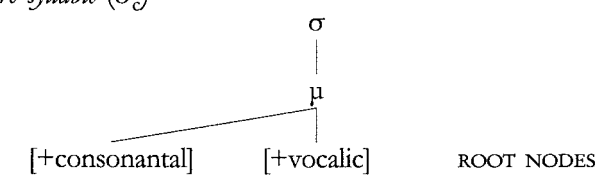
Besides compensatory lengthening (Hayes 1989), other arguments for the 'moraic' representation of the syllable come from tonal phenomena (Hyman 1985), and the properties of various prosodic templates (McCarthy & Prince 1986, et seq.). I will not discuss the arguments from tonal phenomena. Arguments from prosodic templates largely come from reduplication and foot typology and will be briefly discussed in chapters 6 and 7.

A final remark should be made concerning the status of the skeleton. The 'onset-rhyme' syllable in (1) has a skeletal level mediating between the subsyllabic constituents and the root nodes, while no such level is postulated for the moraic syllable. The skeletal level is needed to represent, for example, long vowels, which have two skeletal positions, but only one root node. In a moraic theory long vowels are represented by two moras which are linked to one root node. In other words, the moras are the skeletal units. The 'onset-rhyme' theory has often been criticised as containing too much redundant information. However, since in Dutch long vowels are light, there is no direct relation between vowel length and weight. Length and weight cannot be expressed by the same means, which poses problems

for a moraic analysis of Dutch syllable structure. I therefore adopt the 'onset-rhyme' syllable in (1a).

Although the theoretical status of subsyllabic constituents like 'onsets' and 'rhymes' is still a topic of debate, all phonologists make use of the notions 'onsets', 'rhymes', 'codas', etc., in a pre-theoretical sense. Furthermore, all theories seem to make reference to core syllables, onsetless syllables (or syllables with empty onsets),[7] and they must also be able to refer to branching onsets. In the classical 'onset-rhyme' view this can be done by two onset parameters: (i) Are onsets obligatory? Yes/No, and (ii) Can onsets branch? Yes/No. The default values for these parameters will be argued to be the underlined values, which together result in a simple onset, required for the core syllable. The question is how to make reference to core syllables (which by definition start with a consonant),[8] onsetless syllables and syllables starting with two consonants in the 'moraic' view, that is, without referring to onsets. Since there is no CV or X tier between the moras and the root nodes, reference has to be made to the root nodes containing the major class features [+consonantal] and [+vocalic] or [−consonantal].[9] In other words, the core syllable in moraic theory is:

(7) *Core syllable* (σ_c)



Reference to onsetless syllables and to branching onsets can be made by means of two parameters: (i) Can syllables start with vowels? Yes/No, and (ii) Can syllables start with more than one consonant? Yes/No. Again, the default values are the underlined ones, so that the default (core) syllable starts with a single consonant. Although it is not impossible to state the generalisations without referring to onsets, it is more complicated.

Since the labels in (1a) are apparently more convenient for describing the developmental patterns that occur during the acquisition of syllable structure

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[7] Kaye, Lowenstamm & Vergnaud (1990) assume that words are made up of onset rhymes/nucleus pairs, which can be empty. Whether the empty onset or rhyme is phonetically realised depends on licensing relations involved. It is also crucial for Giegerich (1992) to have an onset, which may remain empty, rather than no onset, to explain, for example, glottal stop insertion in German. For a similar position see also Noske (1992).

[8] McCarthy & Prince (1986:8) "interpret σ_c to include σ=V in languages which allow optionality of onsets." They assume that the core syllable is the minimal syllable.

[9] Reference to [−consonantal] or [+vocalic] is necessary because geminates also have a mora underlyingly, but cannot be the first mora of the syllable.

than those in (1b), I will use the 'onset-rhyme' theory. Furthermore, as we shall see in detail in chapters 4 and 5, it seems that an adequate account of the acquisition data demands that reference can be made to the constituents of the 'onset-rhyme' syllable model.

3.2. The roles of the syllable in phonological theory

The syllable has three roles in phonological theory. First, it functions as a the bearer of prosodic properties, such as stress.[10] This will be dealt with in chapter 6. Second, it is an important domain for stating phonotactic restrictions, although, as we saw above, phonotactic restrictions are largely defined within onsets and within rhymes, and not so much within the syllable per se. Third, it functions as a domain of phonological rules. In this chapter, I will be concerned with the role of the syllable as the domain for stating phonotactic restrictions.

The phonotactic restrictions on the syllable are of two kinds: (i) those that restrict the number of skeletal positions in each syllable constituent; and, (ii) those that place restrictions on the nature of consonantal sequences (the non-heads) within the syllable.[11] Phonotactic restrictions of the first type are often expressed by parameters. Two onset parameters can be distinguished that play a role in the acquisition of onset structure in Dutch. They are given in (8):

(8) *Onset parameters*

a. MINIMAL ONSET PARAMETER: are onsets obligatory? (Yes/No)

b. MAXIMAL ONSET PARAMETER: can onsets be branching? (Yes/No)

There are at least two parameters defining possible rhyme templates, given in (9):

(9) *Rhyme parameters*

a. CODA PARAMETER: are closed syllables allowed? (Yes/No)

b. NUCLEUS PARAMETER: can the nucleus be branching? (Yes/No)

---

[10] One could argue that the bearer of stress is the head of the syllable, not the whole syllable. However, it will be shown in chapter 6 that stress is not a segmental property, but rather that the syllable is the stress-bearing unit. We have to keep in mind that not all syllables are stress-bearing but only those which are in the strong position of the foot (see chapter 6).

[11] There are very few restrictions on consonant-vowel sequences in adult languages, and virtually none in Dutch, although, as Levelt (1993, to appear) has pointed out, restrictions on consonant-vowel sequences are found in the early stages of child language.

The underlined values will be argued to be the default or unmarked values in chapters 4 and 5. We will see in section 3.3 that Dutch allows the marked setting of all the parameters in (8) and (9).

Sonority is said to play a crucial role in defining the second type of phonotactic restriction (Hankamer & Aissen 1974, Selkirk 1984a, Clements 1990). That is, sequences of consonants in the same syllable have to obey the SONORITY SEQUENCING PRINCIPLE (Selkirk 1984a):

(10) *Sonority Sequencing Principle (SSP)*
In any syllable, there is a segment constituting a sonority peak which is preceded and/or followed by a sequence of segments with progressively decreasing sonority values.

The sonority scale is given in (11):

(11) *Sonority scale*
Vowels – Glides – Liquids – Nasals – Fricatives – Plosives
where the sonority value decreases from left to right

The next section gives a description of the phonotactic restrictions for adult Dutch and of the notion 'possible syllable of Dutch'. I will argue in chapters 4 and 5 that the Sonority Sequencing Principle is indeed a principle of UG, and plays a role in child language from the start. I will argue that segments which do not obey the SSP lie outside the scope of the syllable, and must be licensed by extraprosodicity.

Zec (1988) makes another point with respect to sonority and syllable structure. Her claim is that languages may differ in the set of segments that are syllabic (first mora of a syllable) and in the set of segments that are moraic (second mora of a syllable). That is, if the language is quantity-sensitive in the sense that segments following the 'syllabic' segment (the first mora) contribute to weight, the Weight-by-Position rule (4) does not necessarily apply to all segments, but may apply to a subset of the segmental inventory. She argues that the syllabic segments are a subset of the moraic segments, which are a subset of the segmental inventory of the language. I will come back to this point in section 3.4, since Dutch seems to be an exception to this generalisation. In Dutch, vowels seem to be syllabic, but not moraic.[12] Therefore, the set of syllabic segments is not a subset of the moraic segments.

[12] Long vowels are not bimoraic, but monomoraic. Since diphthongs are bimoraic, one could argue that diphthongs are short vowels followed by a glide. I examine this possibility in chapter 5.

3.3. Syllable structure in Dutch

For each language one has to specify what a possible syllable of the language is (Itô 1986, 1989).[13] This can be done by means of a syllable template, i.e., a well-formedness condition defining the possible skeletal sequences of a language. Syllable structure in Dutch has received much attention in the literature in the last decade (e.g., Booij 1981, 1984, to appear, Trommelen 1983, van der Hulst 1984, 1985, Kager & Zonneveld 1986, Kager, Visch & Zonneveld 1987, van der Hulst & van Lit 1987, Kager 1989). Although there is no general agreement on what constitutes the syllable template in Dutch, the following description is adopted by most linguists.

Each syllable consists of an obligatory nucleus (a vowel) preceded by zero or more consonants (the onset), and followed by zero or more consonants (the coda). Nucleus and coda form the rhyme, the part of the syllable that is important for stress assignment.

The notion 'possible syllable of Dutch' is defined by the following set of constraints (Booij to appear). First, Dutch syllables normally obey the Sonority Sequencing Principle, except for some clusters, like initial /str/ clusters, which seem to disobey it. It is often claimed that /s/ in such clusters is outside the core syllable, i.e., there is an initial extrasyllabic position which the /s/ occupies. We will see that the child language data strongly argue for the SSP as a linguistic principle. Moreover, it will be argued that elements that do not obey the SSP are not part of the syllable, but lie outside it.

Although there are some language-specific restrictions, onsets and codas are said to show pretty much a mirror-image behaviour, an observation made by Sievers (1881) and Jespersen (1922) (see Clements 1990 for an overview). That is, obstruents and sonorants can occur in both onsets and codas. This is largely true for adult Dutch, but we will see that, when we compare the order in which consonants are acquired in onsets and codas, several differences can be found (see chapter 4 and 5). They do not exactly show a mirror-image behaviour.[14] Moreover, with respect to initial and final clusters, we will see that the latter allow more variation than the former.

Second, the parameter of syllabicity (Clements 1990) also restricts the possible syllables in Dutch. Universally, vowels can function as heads of nuclei (syllabic segments), but languages can differ with respect to the syllabicity of consonants. The unmarked setting for the parameter is that

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[13] The Dutch segment inventory is given in appendix C.

[14] This is another argument for distinguishing onsets and rhymes, and against a flat structure of the syllable.

only vowels function as nuclei. This is also the setting for standard Dutch,[15] but, in other languages sonorants can function as nuclei, too (see, for example, Zec 1988 and Bagemihl 1991). In Dutch child language only vowels function as nuclei;[16] in other words, the children seem to use the default option. They will not receive positive evidence for the marked option, and therefore they do not change the setting of the parameter to the marked option. For this reason I will not discuss this parameter further. Besides the parameter of syllabicity (which refers to the first mora, or the 'syllabic' mora), languages also differ along the parameter of 'moraicity': each quantity-sensitive language has to decide what can make syllables heavy, or in moraic terms, which segments are subject to the Weight-by-Position rule. In Dutch, moraic segments are not restricted to a subset of the set of consonants, that is, all consonants can contribute to weight. However, long (non-diphthongal) vowels, although they are argued to be bipositional, do not contribute to weight. The generalisation is that closed syllables are heavy. We will see in chapter 5 that in child language sonorants are part of a branching nucleus, whereas obstruents are in the coda. However, this does not seem to correspond to differences in weight, as will be shown in chapter 7.

Third, there are language-specific restrictions on the number of skeletal positions in the different syllable constituents. The onset is optional in Dutch: syllables can start with a vowel. Dutch also allows branching onsets. Most researchers agree on the following: Dutch only allows binary branching onsets consisting of an obstruent followed by a sonorant. That is, in onset clusters, such as /str/, the /s/ is said to be extrasyllabic (Trommelen 1983).[17] Trommelen further assumes that the /s/ in clusters is always extrasyllabic, as well as the obstruent in obstruent plus nasal clusters; i.e., the /k/ in initial /kn/ clusters is also extrasyllabic. I will discuss this view in detail in chapter 4 when discussing the acquisition of onsets. Appendix E gives the possible onset clusters in Dutch.

Most researchers agree on the following minimality constraint for rhymes in Dutch:

(12) *Minimal rhyme constraint*
Rhymes are minimally bipositional.

---

[15] In some dialects of Dutch, nasals can function as nuclei too, but, remarkably, not liquids or glides. However, since all children in the research are learning standard Dutch, which does not allow nasals in the nucleus, I will not address this point further.

[16] We will see that sonorants can be part of the nucleus in child language; however, they are preceded by a vowel in the nucleus (see chapter 5).

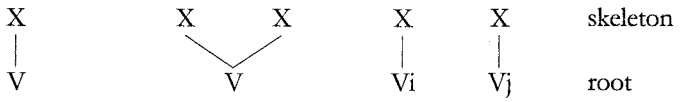
[17] Some researchers adopt tripositional onsets, in which the third (the leftmost member) can only be filled by /s/ (Booij to appear). I will come back to this in section 4.5.2.

The argument for this minimality constraint is the absence of short vowels in open syllables. Furthermore, distributionally, long vowels and diphthongs pattern like combinations of a short vowel plus a consonant. Long vowels and diphthongs can occur in open syllables (13a, b), but short vowels cannot (13d); they have to be followed by a consonant (13c).

(13)	a.	thee	'tea'	/teː/
	b.	tij	'tide'	/tɛi/
	c.	tel	'second'	/tɛl/
	d.	*te		/tɛ/

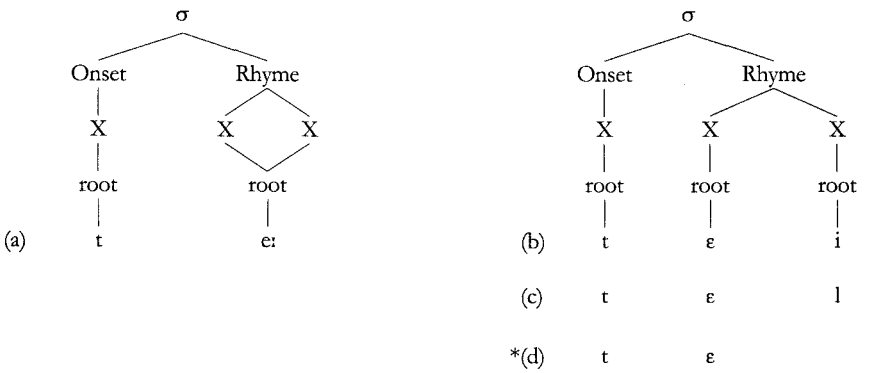
The difference between long and short vowels has been argued by some to be that the former occupy two skeletal slots, whereas the latter only occupy one slot on the skeletal tier. Long vowels and short vowels both have one root node, in contrast to diphthongs, which have two root nodes (14):

(14) a. *Short Vowel* b. *Long Vowel* c. *Diphtong*



Thus, the forms in (13) can be represented as in (15):

(15) *Minimal bipositional rhyme*



Kager & Zonneveld (1986) assume that rhymes are not only minimally bipositional but also maximally bipositional. Kaye & Lowenstamm (1981) claim that the maximal rhyme constraint is universal:

(16) *Maximal rhyme constraint*
Rhymes are maximally bipositionally.

The argument rests on the near absence of non-final syllables in underived words containing more than two rhyme positions. This maximality require-

ment and the bipositional representation of long vowels explain the data in (17):[18]

(17) *Maximal bipositional rhyme*

				(On	$Rh)_\sigma$	(On	$Rh)_\sigma$
a.	tempo	'tempo'	/ˈtɛmpoː/	t	em	p	o
b.	*teempo		/ˈteːmpoː/	t	ee (m)	p	o
c.	*teimpo		/ˈtɛimpoː/	t	ei (m)	p	o
d.	*telmpo		/ˈtɛlmpoː/	t	el (m)	p	o

Where On = Onset, Rh = Rhyme. The /m/ in parenthesis indicates that this consonant cannot be mapped onto the bipositional rhyme since this is already filled.

A short vowel can be followed by a cluster (ending in a non-coronal consonant), for example /mp/, as in (17a), but long vowels, diphthongs and checked short vowels cannot, as shown in (17b–d). In chapter 5 I will present evidence for the claim that the maximal rhyme constraint is universal.

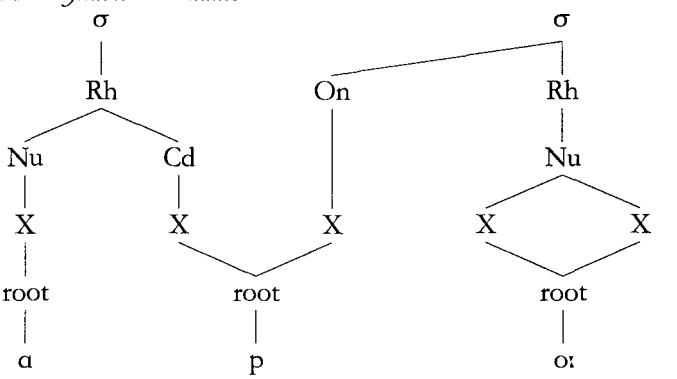
A consequence of the minimality requirement is that a single intervocalic consonant which follows a short vowel must be the coda of the syllable containing that short vowel (Trommelen 1983, van der Hulst 1985, Kager 1989). However, it is claimed by many researchers that a syllable must have an onset if there is a legitimate candidate for it.[19] Some have proposed syllabification rules which ensure that, after the vowel (nucleus) is linked to the syllable node, as many consonants as can form a permissible onset are first adjoined to the syllable node (onset). This is often referred to as the MAXIMAL ONSET PRINCIPLE (Kahn 1976). Others first create core syllables (CV) (Itô 1986), if possible, and therefore, if there is a candidate for the onset, it fills the onset position. Clements (1990) assumes the SONORITY CYCLE, by which the sonority profile of the preferred syllable type rises sharply at the beginning of a syllable, i.e., syllables like to have onsets, preferably filled by the least sonorous consonants. This has the consequence

[18] The restrictions on non-final tripositional rhymes have been much debated. Some researchers do not exclude non-final tripositional rhymes (van der Hulst 1984, Booij to appear); others impose restrictions in that they assume that rhymes can be maximally bipositional (Kager & Zonneveld 1986, Kager 1989). However, tripositional non-final rhymes cannot be completely excluded, given the existence of words like *priester* 'priest', *aarde* 'earth', *aardappel* 'potato', *aalmoes* 'alms'. Trommelen (1983) incorporates words like *priester*, but argues that words like *aarde* are exceptions. Note that the same is true for non-initial tripositional onsets, witness the existence of words like *Australië* 'Australia', *extra* 'extra', etc. A recent discussion of these problematic cases can be found in Zonneveld (1992).

[19] Myers (1987) argues that since the intervocalic consonant has to be the coda of the previous syllable, the next syllable is onsetless. Van der Hulst (1985), on the other hand, argues for two consonantal roots, since both constraints can then be obeyed.

that in Dutch a single intervocalic consonant following a short vowel is both the coda of the first syllable and the onset of the second. In other words, it is AMBISYLLABIC. Thus, the /p/ in words like *appel* 'apple' /ˈɑpəl/ and *Appo* (name) /ˈɑpoː/ is both the coda of the first syllable and the onset of the second. The representation of the word *Appo* is given in (18):[20]

(18) *Ambisyllabic consonants*



Where On = Onset, Rh = Rhyme, Nu = Nucleus, Cd = Coda

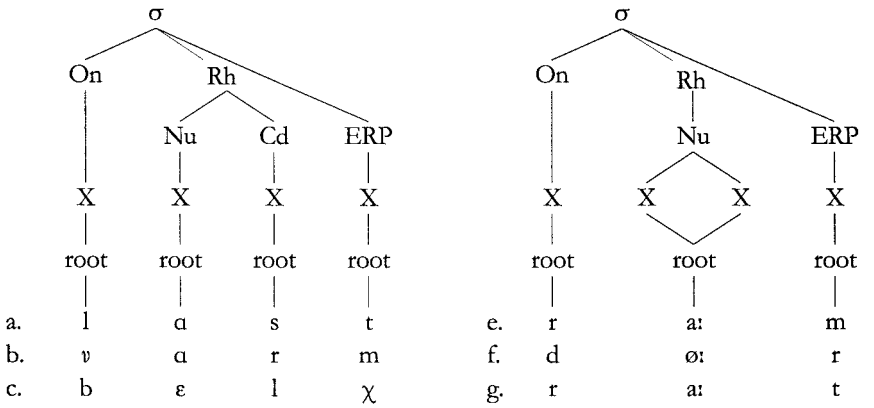
In word-final syllables 'tripositional' rhymes are quite common, as can be seen in the data in (19). (20) gives the representation of these words. These rhymes are usually analysed as bipositional rhymes followed by an extrasyllabic consonant, which is licensed by the word (boundary). In this way these tripositional rhymes resemble tripositional onsets: in both cases there is an extrasyllabic consonant. However, there is a difference between initial extrasyllabic consonants and final extrasyllabic consonants in that the latter have to obey the sonority hierarchy, whereas I will claim that the former do not obey the sonority hierarchy. To express this difference, I assume that initial extrasyllabic consonants are licensed by the word (Wd), while final extrasyllabic consonants are licensed by the syllable node, since all elements within the syllable are subject to the SSP. I therefore, use the term extrarhymal, instead of extrasyllabic.

(19) *Tripositional rhymes in word-final syllables*

a.	last	'load'	/lɑst/	las-t
b.	warm	'warm'	/vɑrm/	war-m
c.	Belg	'Belgian'	/bɛlχ/	bel-g
d.	raam	'window'	/raːm/	raa-m
e.	deur	'door'	/døːr/	deu-r
f.	raad	'advice'	/raːt/	raa-t

[20] Ambisyllabic consonants are often indicated as double consonants in the orthography.

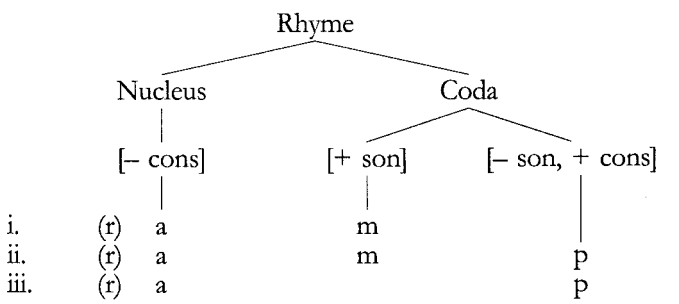
(20) *Final extrarhymal consonants*



where ERP = Extrarhymal position

Trommelen (1983) has a somewhat different analysis. She assumes that rhymes consist of an obligatory peak (nucleus) consisting of a [−cons] segment. This peak (nucleus) is followed by a [+son] segment. If this [+son] segment is a consonant it is part of the coda (21a). If this [+son] segment is a vowel this results in a branching peak (nucleus) (21b). A [+son] segment can be followed by a [−son, +cons] segment, which forms (part of) the coda. This leads to the templates in (21). In other words, short vowels followed by an obstruent have an (obligatorily) empty [+son] segment, while sonorant consonants following a long vowel are not incorporated in the rhyme, but are extrasyllabic.[21]

(21) a.

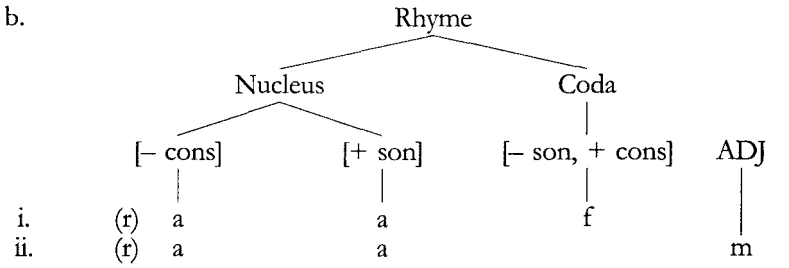


[21] Trommelen (1987) points out that most cases of 'excessive weight', that is, those with tripositional rhymes in non-final position, involve high long vowels, which do not have short counterparts. She suggests that they have to be analysed as short high vowels, although they are not distinguishable from the long ones by segmental feature specification. (i) gives some examples:

(i) toen.dra pries.ter mues.li

See Kager (1989) for a discussion of the advantages and disadvantages of this position.

b.



The extrarhymal consonant in (20) is to be distinguished from the appendix. A final rhyme can be followed by any consonant, the extrarhymal consonant, as in (19, 20), as long as it obeys the Sonority Sequencing Principle. In addition, it can be followed by an appendix, which can consist of maximally three coronal obstruents, as in the word *prom-p-tst*, in which the bipositional rhyme is followed by a extrarhymal consonant, /p/, and an appendix /tst/. The Sonority Sequencing Principle does not apply to the appendix, as can be seen in (22),[22] nor to the initial extrasyllabic consonant, since an extrasyllabic /s/ can be followed by a voiceless obstruent, as in (23). However, it does apply to the final extrarhymal consonant. I will argue that elements that do not obey the sonority hierarchy have to be in initial extrasyllabic position or in the appendix and have to be licensed by the word, while segments which obey the sonority hierarchy are licensed by the syllable. The representations of (22) and (23) are given in (24) and (25) respectively:

(22) *Appendix*

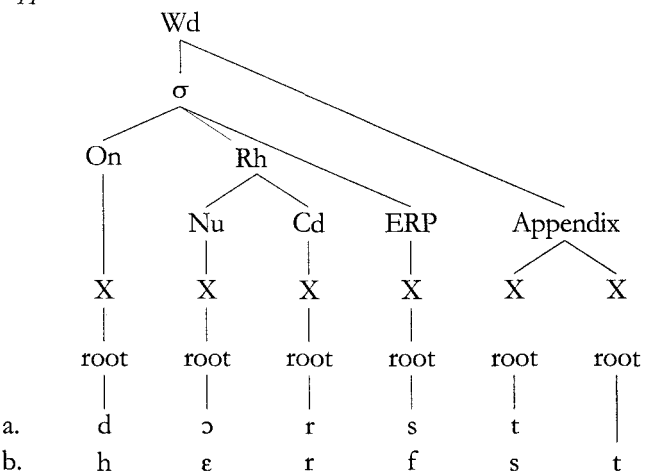
a.	dorst	'thirst'	/dɔrst/	dor-s-t
b.	herfst	'autumn'	/hɛrfst/	her-f-st

(23) *'Tripositional' onsets*

a.	spreken	'to speak'	/ˈspreːkə[n]/	s-pr-eken
b.	straat	'street'	/straːt/	s-tr-aat

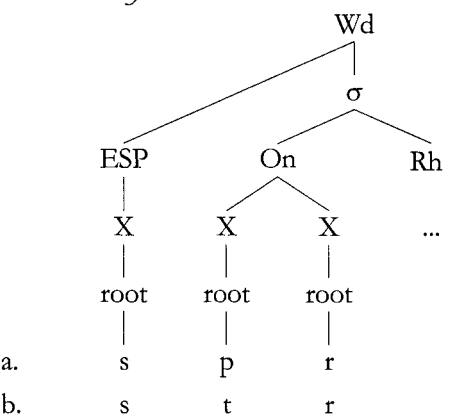
[22] Words like *ets* 'etching' must be analysed as having a bipositional rhyme, followed by an appendix, /ɛt-s/. Because the SSP is not obeyed, the final /s/ cannot be analysed as an extrasyllabic consonant.

(24) *Appendix*



where ERP = Extrarhymal position, and Wd = Word

(25) *Initial extrasyllabic consonants*



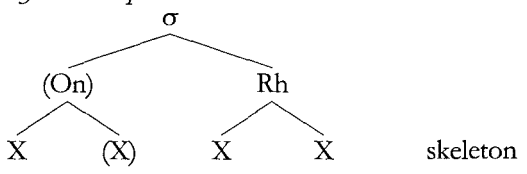
where ESP = Extrasyllabic position

The fourth way in which syllable structure is restricted is by language-specific constraints on the possible combinations of segments. For example, although Dutch allows bipositional onsets consisting of an obstruent plus a liquid, /tl/ clusters are not allowed, even though they obey the Sonority Sequencing Principle. There are also positive exceptions, e.g., /fn/ and /kn/ clusters.[23] I will come back to these language-specific onset constraints in chapter 4.

The following template for Dutch syllables is proposed by Kager & Zonneveld (1986):

[23] These are usually analysed like /s/ plus obstruent clusters; that is, they are analysed as having an extrasyllabic first consonant.

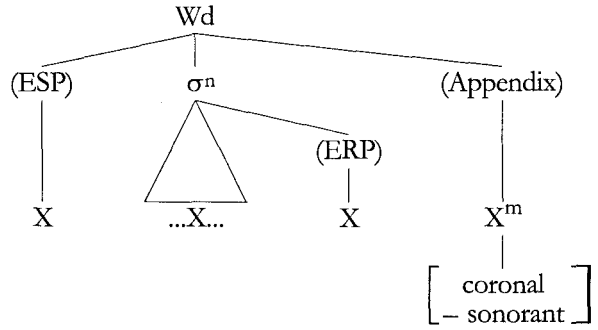
(26) *Dutch syllable template:*



( ) indicates optionality of the onset

Prosodic words consist of one or more of those syllables optionally followed by an extrarhymal consonant and/or an appendix, and optionally preceded by an extrasyllabic consonant, as is schematised in (27):

(27) *Prosodic word in Dutch*



where n ≥ 1; 0 ≤ m ≤ 3; Wd = Word, ESP = Extrasyllabic position; ERP = Extrarhymal position, and X = Skeletal position.

3.4. Length and weight in Dutch

As shown above, vowel length is contrastive in Dutch: long vowels are bipositional; short vowels monopositional. However, although Dutch is a quantity-sensitive language long vowels behave as light for stress purposes (for an overview see Kager 1989, and references cited there). In the onset-rhyme analysis of Dutch syllable structure weight is computed by an interpretative procedure: directly branching rhymes, i.e., a rhyme branching into a nucleus and a coda, contribute to the weight of a syllable. However, there are two problems with this account. First, diphthongs are considered to be heavy for stress purposes. Second, syllables ending in VVC are considered to be superheavy, although they do not have a directly branching rhyme: the final consonant is in extrarhymal position, as shown in (20).[24]

[24] See chapter 6 for a description of Dutch stress.

As I will show in chapters 5 and 7, in child language the following generalisations seem to hold: (i) long vowels and diphthongs behave similarly, both with respect to phonotactic restrictions and stress; (ii) any closed syllable counts as heavy, whether it is closed by a coda consonant or an extrarhymal consonant (which is part of the syllable, although it lies outside the rhyme); (iii) children do not seem to make a distinction between heavy and superheavy syllables. In chapter 7 I propose an analysis for Dutch stress which slightly departs from the standard analysis in that all and only closed syllables are interpreted as heavy. I propose the interpretative weight parameter given in (28):

(28) *Weight parameter*
Closed syllables are heavy. Yes/No

The underlined value is the value required for Dutch. The default value is No.

In other words, heavy syllables have no unique representation; rather, different representations can result in heavy syllables. Length is directly represented in the representation of the syllable, but weight is not. If diphthongs are represented by a branching nucleus which is linked to two root nodes (as in (14c)), they are by definition light. Alternatively, diphthongs could be analysed as directly branching rhymes, where the second part of the diphthong is in the coda, and therefore analysed as a glide, rather than a vowel. However, as I will show in chapter 5, the child language data argue in favour of the former analysis.

Moraic theory generally assumes that in quantity-sensitive languages in which vowel length is contrastive, long vowels are bimoraic while short vowels are monomoraic (Hyman 1985, McCarthy & Prince 1986, Davis 1988, Hayes 1989). Although Dutch is a quantity-sensitive language in which vowel length is contrastive, long vowels behave as light (monomoraic) for stress purposes. Thus, Dutch has an interesting syllable weight distinction: open syllables with long (non-diphthongal) vowels are light, and closed syllables and syllables with diphthongs are heavy. That is, long vowels, which occupy two skeletal positions linked to one root node, are monomoraic. To express this, Lahiri & Koreman (1988) assume both a skeletal tier to express length and a moraic tier to express weight. Kager (1989), on the other hand, solves this dilemma by making use of the notion 'melodic complexity'. Melodic complexity refers to the number of root nodes linked to the skeletal positions of the syllable. He assumes that long vowels are bimoraic, but since *all* syllables are bimoraic, weight distinctions cannot be measured by the number of moras. Therefore, quantity distinctions have to be defined on the next level, the level of the root nodes. Kager assumes that if a syllable contains two moras linked to one root node (that is, a long vowel), the syllable is melodically simplex (14b), and therefore light. If the

two moras are each linked to a root node the syllable is melodically complex (14c), and therefore heavy. Crucially, moras can then no longer be used as weight units, which was the key motivation for having moras in the first place (Hyman 1985).

In Kager's view, weight is measured by roots in Dutch, not by moras; however, positional constraints, like the minimal and maximal rhyme constraints, are stated on the mora level. We will see that the compensatory lengthening phenomena found in child language are difficult to explain in terms of melodic complexity. Moreover, the fact that diphthongs and long vowels behave similarly with respect to weight in child language poses another problem for this account (cf. Trommelen & Zonneveld 1989).

3.5. The core syllable in Dutch

As was shown above, Dutch has a vowel length contrast; that is, long vowels are said to occupy two skeletal positions whereas short vowels occupy only one position. However, this vowel length contrast only manifests itself in closed syllables, since short vowels are not allowed in open syllables. Together with the claim that long vowels occupy two skeletal positions, this has as a consequence that Dutch (like German) does not allow the 'universal' core syllable CV. This, however, contradicts the claim that the CV syllable *is* universal. Yet, the primacy of the simple open CV syllable is commonplace in the literature (cf. Jakobson 1941/68, Bell 1971, Greenberg 1978), the idea being that the existence of all other types of syllables presupposes the existence of the CV syllable. In other words, it functions as the default syllable. Prince & Smolensky (1993) assume that "no language may prohibit the syllable .CV. Thus, no language prohibits onsets or requires codas." However, they do not mention vowel length. In Jakobson's view, too, the universal CV syllable consists of a consonant followed by *any* vowel, either short or long, although he does not state this explicitly. Crucial is the fact that core syllables are open syllables. The acquisition data of Dutch give support for this view, in that the CV syllable is the first syllable produced by the children, in which the vowel can be both long and short. Vowel length is non-distinctive at the early stages (see chapter 5). An important observation is the fact that this syllable can constitute a word on its own. In McCarthy & Prince's view, the core syllable is a monomoraic syllable with a single onset:[25] this syllable therefore

[25] McCarthy & Prince (1986) interpret the core syllable σ_c to include $\sigma = V$ in languages which allow optionality of onsets. This is irrelevant to the point of discussion here.

crucially consists of a short vowel preceded by a consonant, since long vowels have two moras underlyingly. In other words, the contradiction that Dutch does not have the universal default CV syllable only exists in the moraic view of the syllable. On the other hand, if long vowels are light (or monomoraic), as I assume, then Dutch does have monomoraic light syllables, or core syllables.

One could try to argue that adult Dutch does not allow CV syllables as words because of a minimal word constraint, which argues that the minimal (content) word equals a foot; that is, they minimally have two moras (see section 1.2 in chapter 1). There are two arguments against the minimal word hypothesis. First, not only are CV syllables disallowed as words, they are never allowed word-internally either (contrary to English, for example). Thus, words like */hɪ.aːt/ are prohibited in Dutch, while /hi.aːt/ 'hiatus' is allowed. Second, Dutch does allow words consisting of one CVV syllable. Since long vowels behave as light for stress purposes (as we will see below), I assume that they are monomoraic,[26] as are CV syllables. Since a minimal word consists of at least two moras, we must conclude that Dutch allows subminimal content words.[27] Since CV and CVV are not different in this respect (they are both monomoraic), and Dutch does allow CVV words, the lack of CV words remains unexplained. Therefore, the fact that Dutch does not allow CV syllables has to be stated as a syllable constraint, not a minimal word constraint.

A related question is the following: since the child starts with the universal default CV syllable, how do children learn to ban the CV syllable from their inventory? This can only be learned on the basis of negative evidence, since no positive evidence is available to the child. The data clearly point out that vowel length distinctions are mastered rather late, as will be shown in chapter 5, indicating that at the early stages the child sticks to the universal core syllable. These observations have led me to a close examination of the acquisition of rhyme constraints.

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[26] In Kager's view the minimal word constraint could explain why Dutch allows CVV words, but not CV words, since he assumes that long vowels have two moras, while short vowels have one. In McCarthy & Prince's view, the bimoraic minimum ensures that the minimal word consist of one syllable it is a heavy one (bimoraic); light syllables cannot constitute a foot on their own (or form a degenerate foot at most).

[27] Nouveau (1992) argues that Dutch *has* a minimal word constraint, and that content words therefore have to consist of two moras. Her solution involves the adaptation of the parameter of catalexis (as first proposed by Kiparsky (1992), although a similar proposal can be found in Giegerich (1985)), which is roughly speaking the counterpart of extrametricality. Instead of making peripheral elements 'invisible', catalexis 'creates' a peripheral element (a mora, in this case). Although in this way Dutch does not allow subminimal words, this account would predict that catalexis would also make CV bimoraic. However, CVV words are allowed, but CV words are not. This still needs to be accounted for.

With this brief introduction to Dutch syllable structure in mind, let us now turn to the *acquisition* of syllable structure. Although the syllable is often mentioned in literature on child language this is often done in a very general way (e.g., Fudge 1969, Moskowitz 1971, Branigan 1976, Berman 1977, Ingram 1978, Shibamoto & Olmsted 1978). I examine the developmental patterns that occur during the acquisition of syllable structure in detail in the next two chapters.

Unlike the syllable template in adult languages, the child's template is in constant development. As outlined in chapter 1, I assume that at the initial stage of acquisition all parameters have their default value, which means that children only have default or core CV syllables. The acquisition of types of syllables other than the CV syllable involves the setting of syllable parameters from the unmarked (default values) to the marked values on the basis of evidence in the input data. It will be shown that the inventory of syllables in the child's language initially is a subset of the syllables allowed in adult Dutch. The inventory expands gradually along parametric dimensions. However, children can vary in the order in which they set the parameters.

Central in the next two chapters is the question of what constitutes a well-formed syllable in the children's language at different stages of development. I first deal with the acquisition of onsets in chapter 4. In chapter 5, the acquisition of rhymes will be discussed.

4 The Acquisition of Syllable Structure: the Onset

THIS CHAPTER AIMS at giving a detailed description of the developmental patterns that occur in the acquisition of onsets. It will be shown that there are three stages in the acquisition of single onsets: (i) at stage I onsets are obligatory, and invariably produced as plosives; (ii) at stage II onsets can be empty; (iii) at stage III different types of segments are produced in onset position. These stages will be described in section 4.1. The results are summarised and discussed in section 4.2.

Section 4.3 deals with the acquisition of complex onsets. Each subsection discusses how different target complex onsets are produced by the children and describes the developmental patterns that can be found. It will be shown that a typical characteristic of the child's first complex onsets is that the two members of the onset differ maximally in sonority. It will further be shown that there are three different stages in the acquisition of obstruent-sonorant clusters: (i) at the first stage obstruent-sonorant clusters are simplified to single obstruents; (ii) at the next stage they are simplified to single sonorants; and (iii) finally, they are produced as obstruent-sonorant clusters. The second stage seems to be optional for some children, but not for others. A striking finding is that, while most children start with obstruent-sonorant clusters, some children have /s/-obstruent clusters before they have obstruent-sonorant clusters. The results are summarised in section 4.4 and discussed in section 4.5.

I will not discuss below the details of each child's development separately, but rather describe the development of one child in detail, and only mention the other children insofar as they differ from his development. The description is based on onsets of stressed syllables, which implies that mostly word-initial onsets are regarded.

4.1. Simple onsets, empty onsets and the core syllable

In Jarmo's development three stages can be distinguished: (i) at the first stage onsets are obligatory and invariably realised as plosives (stage I); (ii) at the next stage onsets can be empty (stage II), and (iii) at stage III other

types of onsets occur. After plosives, nasals are the next type of segment to appear as onsets in all children's production forms. However, children differ greatly in their further expansion of their system.

Stage I: obligatory onsets

As can be seen in (1), Jarmo has only CV (core) syllables in the first recording session (1;4.18), i.e., all syllables have an onset, and the onset is invariably a plosive.

(1)

	Jarmo				
a.	daar	/daːr/	→	[dɑ]	(1;4.18)
	poes	/puːs/	→	[puː]	(1;5.2)
	tok	/tɔk/	→	[kɔ]	(1;5.27)
b.	klaar	/klaːr/	→	[kaː]	(1;5.2)
c.	auto	/ˈoːtoː/	→	[ˈtaːtoː], [ˈtoːtɔ]	(1;6.27)
			→	[ˈtɛtoː], [ˈtɛtɔ]	(1;7.15)
	apie	/ˈaːpiː/	→	[ˈtaːpiː]	(1;7.15)

Three strategies can be detected. First, Jarmo uses the selection strategy (see section 1.1.1.4): he has only selected adult words that start with a plosive for his production at the earliest stage, as can be seen in (1a). No words starting with fricatives, nasals, liquids or glides are selected for production. However, he also has selected for production adult target words with complex onsets containing a plosive. He uses the repair strategy 'simplify' for the production of these forms: they are reduced to single plosives (1b). Initial plosives are never replaced by other manners of articulation. At the start of stage II he also takes for production adult target words beginning with a vowel. For the production of these forms he uses the repair strategy 'add an onset', as can be seen in (1c).[1] He still does not select words beginning with other manners of articulation for production.

Tom, Leonie and Noortje also have obligatory onsets at the initial stages in their development. Onsetless adult words are realised with onsets by Tom and Leonie by the same repair strategy as used by Jarmo, 'add an onset', as shown in (2a, b). Leonie invariably adds a plosive, but Tom can also add an /h/. Noortje avoids adult words without onsets: she only selects words with onsets.

[1] There are different strategies for filling the empty onset position: (a) the default plosive /t/; (b) the default consonant /h/, or reduplicating a consonant (typically a plosive) from elsewhere in the word (see also (2)).

(2)						
	a.	*Tom*				
		aai	/aːj/	→	[hɔj]	(1;2.27)
		aap	/aːp/	→	[hɑuΦ]	(1;2.27)
		auto	/ˈoːtoː/	→	[ˈtoːtoː]	(1;2.27)
		aap	/aːp/	→	[baːp]	(1;3.24)
	b.	*Leonie*				
		aap	/aːp/	→	[paːp]	(1;9.15)
		auto	/ˈoːtoː/	→	[ˈtʌtoː]	(1;10.4)
		appel	/ˈɑpəl/	→	[ˈpaːpuː]	(1;10.29)

Stage II: empty onsets

At 1;6.13 the first (word-initial) onsetless syllables are allowed in Jarmo's system. Until 1;6.13 no adult target words lacking an initial onset are attempted. Again, this might be due to a selection strategy: the child only selects adult target words for his own production which fit into his phonological system. That is, he is avoiding those adult targets that do not match his phonological system; in this case, he does not try to produce onsetless adult words, because in his system words have to start with an onset. From 1;6.13 adult onsetless words are selected for production by the child. However, in most cases these words are subject to a repair strategy, i.e., they are produced with an onset, as in (1c), clearly reflecting that syllables with onsets are preferred over syllables which lack an onset. However, onsetless child productions do sometimes appear, as shown in (3). The child is learning that syllables can lack an onset and in the further development, at 1;9.23, the repair strategy 'add an onset', is abandoned. Once the minimal onset parameter is set from the default value (onsets are obligatory) to the marked setting, allowing zero onsets, the repair strategy is no longer needed, and will thus disappear.

(3)					
	Jarmo				
	auto	/ˈoːtoː/	→	[ˈaːtoː],[ˈoːtoː]	(1;6.13)
	aap	/aːp/	→	[ɑp], [aːp]	(1;7.15)

The same is true for Tom and Leonie: they also have a few onsetless words, as shown in (4a, b), although the repair strategy is clearly favoured. Noortje, however, avoids adult words without onsets: she only selects words with onsets. However, once onsetless words are selected for production, they are produced without onsets. She does not utilise the repair strategy. The other children already had onsetless productions of adult onsetless targets at the first recording session, indicating that this parameter is learned very early.

(4)

a.	*Tom*				
	aap	/aːp/	→	[aːβ]	(1;2.27)
	uit	/œyt/	→	[auf]	(1;2.27)
b.	*Leonie*				
	aap	/aːp/	→	[ɑp]	(1;9.15)
	uit	/œyt/	→	[œut]	(1;9.21)

Until 1;9.9 adult target onsets other than plosives are either realised with an initial plosive, (5a), or deleted by Jarmo (5b). They are not realised with the manner of articulation in the adult target word. Since the child's system now allows words beginning with a plosive and words beginning with a vowel, these are the two possible repair strategies, with the first (replacement by plosive) preferred over the second, deletion of the onset.

(5)

	Jarmo				
a.	vogel	/ˈvoːχəl/	→	[toː]	(1;7.15)
	wap	/ʋɑp/	→	[paː]	(1;7.15)
	vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈtiːtɑ]	(1;7.29)
	wipwap	/ˈʋɪpˌʋɑp/	→	[ˈpiːbaː]	(1;8.26)
b.	schaap	/sχaːp/	→	[aːp]	(1;7.15)
	haan	/haːn/	→	[aːm]	(1;7.29)
	huis	/hœys/	→	[œys]	(1;8.12)
	fiets	/fiːts/	→	[iːs]	(1;9.9)
	vis	/vɪs/	→	[ɪs]	(1;9.9)
	visje	/ˈvɪs͡jə/	→	[ˈiːs͡jə]	(1;9.9)

Initial /h/ in the adult target words is often deleted by Jarmo (6a). Only from 2;2.6 is target /h/ regularly produced as /h/ and no longer deleted. On the other hand, /h/ is sometimes produced instead of an empty onset (6b). Also, from 1;8.26 /h/ appears as a substitute for consonants that are not yet produced by the child, such as fricatives and glides, as shown in (6c). It seems that /h/ is in free variation with an empty onset. However, from 1;11.20 /h/ no longer appears in target words without onsets.

(6)

	Jarmo				
a.	haan	/haːn/	→	[ɑŋ]	(1;7.29)
	huis	/hœys/	→	[ɛiʃ]	(1;7.29)
b.	apie	/ˈaːpiː/	→	[ˈhaːpiː]	(1;9.9)
	uit	/œyt/	→	[hœt]	(1;9.9)
c.	fietsen	/ˈfiːtsə[n]/	→	[ˈhiːsə]	(1;9.23)
	schaar	/sχaːr/	→	[haː]	(1;10.9)
	Willy	/ˈʋɪliː/	→	[ˈhiːliː]	(1;10.9)

Stage III: other types of single onsets

At the next stage other types of onsets start to appear. From 1;9.9 onsets, if realised, can also be nasals, and /h/, as in (7a). However, the repair strategy is also available (7b). From 2;3.9 nasals are produced as nasals. The repair strategy is no longer needed.

(7) *Jarmo*

a.	maan	/maːn/	→	[mɔm],[maːn]	(1;9.9)
	Monkey	/ˈmɔŋkiː/	→	[mɔŋ]	(1;9.9)
	konijntje	/koːˈnɛin͡tʃə/	→	[ˈnɛi͡tʃə]	(1;9.23)
	meer	/meːr/	→	[miː]	(2;0.28)
b.	muis	/mœys/	→	[œys]	(1;9.9)
	konijn	/koːˈnɛin/	→	[hɛi]	(1.9.23)
	konijntjes	/koːˈnɛin͡tʃəs/	→	[ˈkɛi͡tʃəs]	(1;10.23)
	nu	/nyː/	→	[tyː]	(1;11.20)
	muis	/mœys/	→	[pœys]	(2;1.22)
	muts	/mʉts/	→	[tyːtst]	(2;1.22)
	mais	/mɑjs/	→	[pɔis]	(2;2.6)

So far, the developmental pattern is similar for all children: they start with obligatory onsets, which must be plosives at stage I. At stage II onsets can be empty. At stage III, nasals first appear in all children's systems. (8a) gives data from Elke in which nasals appear in onset position, and (8b) shows that she uses the same repair strategy as Jarmo.[2]

(8) *Elke*

a.	mij	/mɛi/	→	[mɛ], [mɑ], [mɪ]	(1;7.8)
	banaan	/baːˈnaːn/	→	[naː]	(1;7.22)
b.	muis	/mœys/	→	[boːs]	(1;7.8)
	meisje	/ˈmɛi͡ʃə/	→	[ˈbɛi͡ʃɛ]	(1;10.7)

The observation that children start with plosives in onset position, and subsequently have nasals in this position, was made by Jakobson (1939/62, 1941/68). The first contrast to appear is that between a vowel and a consonant, a plosive being the most prototypical consonant. The contrast is maximal: a complete closure (preferably a labial) followed by a wide opening for the vowel (preferably a low vowel /a/). The first contrast within the system of *consonants* is the one between oral and nasal consonants (*m* versus *p*). Jakobson (1939/62), in an article titled 'Why papa and mama?' argues that this universal order of development provides the answer to the

[2] Nasals are not used as repairs for other consonants.

question why *papa* and *mama* are used for 'father' and 'mother' in many (unrelated) languages. However, Jakobson does not mention /h/. We have seen that /h/ appears earlier than nasals, although for a long time it is not used distinctively, and merely occurs in free variation with an empty onset. I therefore hypothesise that /h/ has not yet been acquired as a segment of Dutch.

The next step is variable for the children. In Jarmo's data fricatives appear earlier than liquids and glides. The first initial fricatives appear at 2;0.4 in Jarmo's production forms, as shown in (9):

(9)

	Jarmo			
vogel	/ˈvoːχəl/	→	[ˈfoːχɔ], [ˈχoːχɔ]	(2;0.4)
visjes	/ˈvɪs͡jəs/	→	[ˈfɪs͡jɪs]	(2;0.4)
vast	/vɑst/	→	[fɑst]	(2;1.8)
vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈfiːtœyχ]	(2;1.8)
zo	/zoː/	→	[ʃɔ]	(2;1.8)
schuur	/sχyːʀ/	→	[ˈχuːʁɑ]	(2;2.6)
glij	/χɫɛi/	→	[sɛi], [χɛi]	(2;2.27)

Before that age (and at the start of this stage) initial fricatives were either replaced by plosives or /h/, or were deleted (5a, 6c and 5b, respectively). This repair strategy remains at work until 2;2.6, as can be seen in the data in (10). From 2;2.27 target fricatives are produced as such, and the repair strategy is given up.

(10)

	Jarmo			
fiets	/fiːts/	→	[tiːts]	(2;0.4)
vogel	/ˈvoːχəl/	→	[ˈtoːχɔ]	(2;0.4)
Groover	/ˈχroːvər/	→	[ˈoːχə]	(2;0.4)
gevallen	/χəˈvɑɫə[n]/	→	[ˈkɑɫə]	(2;0.28)
gezien	/χəˈziːn/	→	[diːn]	(2;1.8)

Adult target words with initial liquids are selected for production by Jarmo from 1;11.20. However, the target liquid is produced as a plosive (11a). From 2;1.8 Jarmo produces liquids as such (11b):

(11)

		Jarmo			
a.	*Liquids selected but replaced by plosives*				
	regen	/ˈreːχə(n)/	→	[ˈteːχə]	(1;11.20)
	regent	/ˈreːχənt/	→	[ˈteːχʉt]	(1;11.20)

b.	*Liquids produced as such*				
	lekker	/ˈlɛkər/	→	[ˈlɛχkə]	(2;1.8)
	rijden	/ˈrɛidə(n)/	→	[ˈlɛijə]	(2;1.8)
	leeuw	/leːw/	→	[leːw]	(2;1.22)
	leuk	/løːk/	→	[løːk]	(2;2.27)
	ballon	/bɑˈlɔn/	→	[lɔn]	(2;2.27)

Finally, if target words with initial glides are selected for production they are initially either produced as plosives or /h/, as in (12a); the next step is that they are produced as liquids (liquids are mastered before glides), as shown in (12b). From 2;3.9 they are produced either as liquids or as glides (12c):

(12) *Jarmo*

a.	*Glides selected for production but replaced by plosives or /h/*				
	wipwap	/ˈʋɪpˌʋɑp/	→	[ˈpiːpɑ]	(1;8.12)
	Willy	/ˈʋɪliː/	→	[ˈhiːliː]	(1;10.9)
	water	/ˈvaːtər/	→	[ˈcaːtə]	(2;0.4)
	wortel	/ˈʋɔrtəl/	→	[ˈtɑtɔw]	(2;1.8)
b.	*Glides selected for production but replaced by /l/*				
	Willy	/ˈʋɪliː/	→	[ˈliːliː]	(2;1.8)
	wipwap	/ˈʋɪpˌʋɑp/	→	[ˈliːpaː]	(2;1.8)
c.	*Glides produced as such*				
	weg	/ʋɛχ/	→	[ʋɛχ]	(2;3.9)
	yogi	/ˈjoːχiː/	→	[ˈjoːχiː]	(2;3.9)
	water	/ˈvaːtər/	→	[ˈvaːtə]	(2;4.1)

The chart in (13) gives an overview of Jarmo's development of simple onsets. It gives the age at which certain classes of sounds are selected for production and the way they are produced if selected.

Not all children display the same order for the addition of segment types to the system,[3] although the following generalisations hold for *all* children. There is a stage at which onsets are obligatory and invariably realised as a plosive (stage I). Plosives are produced as such from the start, and are never replaced by other manners of articulation. Empty onsets and /h/ also appear quite early, although /h/ often only occurs as a variant of an empty onset; it is not used distinctively. Thus the parameter 'onsets are optional' is set quite early (stage II). At stage III other types of consonants appear. Nasals are the next category of segments appearing in onset position for all

[3] Appendix D provides the charts of the development of simple onsets of the other children.

(13) *Simple Onsets in Jarmo's speech*

Adult targets:	P	Ø	h	N	F	L	G
Age:	Child's forms						
1;4.18	P						
1;6.13	.	Ø/P					
1;7.15	.	.			Ø/P		P
1;7.29	.	.	Ø		.		.
1;8.26	.	Ø/P/h	h/Ø		P/Ø/h		P/h
1;9.9	.	.	.	N/P/Ø/h	.		.
1;9.23	.	Ø/h	.	.	.		.
1;11.20	.	Ø	.	N/P	P	P	.
2;0.4	.	.	.	.	P/F	.	.
2;1.8	.	.	.	.	.	L	P/L
2;2.6	.	.	h	.	.	.	.
2;2.27	.	.	.	.	F	.	.
2;3.9	.	.	.	N	.	.	L/G

Where P=Plosive, Ø=Empty onset, h=/h/, F=Fricative, N=Nasal, L=Liquid, and G=Glide.

first appearance of target sound in the child's forms
. indicates that no change has occurred
avoidance of target sound by the child

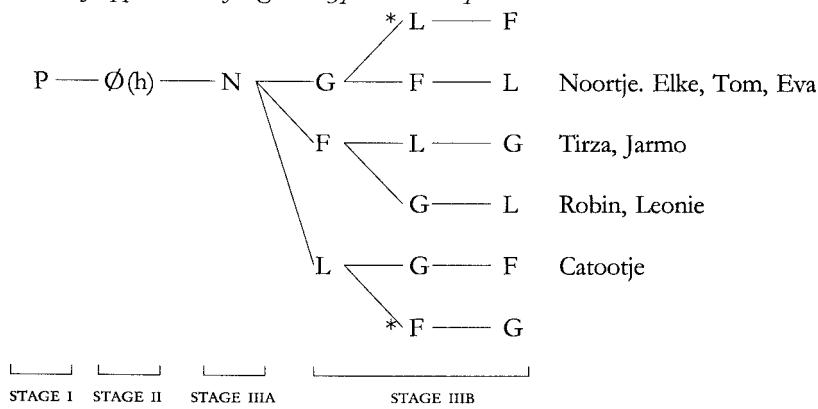
children (stage IIIa). Liquids, glides and fricatives are mastered later, but children vary greatly with respect to order in which these types of segments appear (stage IIIb).

Some children expand their system, after plosives and nasals, with fricatives, e.g., Jarmo, Tirza, Leonie and Robin. In Jarmo's and Tirza's systems liquids appear before glides. Robin and Leonie, however, have glides before liquids.

Other children, e.g., Noortje, Tom, Elke and Eva, add glides to their system before liquids and fricatives, but fricatives before liquids. Catootje, on the other hand, has liquids before fricatives and glides; and glides before fricatives. Of the six possible developmental orders two are not attested. This, however, might be an accidental gap. The following schema summarises the results for all children:[4]

[4] The other children not mentioned in the table already had the different types of single onsets from the onset of recording. Therefore, no developmental order could be detected.

(14) *Order of appearance of segment types in onset position*



As I argued above, at the early stages, /h/ is used as a variant of the null onset (see (6) and appendix D). It often replaces other manners of articulation, especially oral fricatives, liquids and glides. When target /h/ is systematically produced as /h/ by Jarmo and Leonie, it no longer functions as a substitute for other consonants, nor does it fill an empty onset. However, Robin and Tirza still use /h/ as a substitute for liquids and glides. For most other children /h/ is systematically produced as /h/ around the same time as oral fricatives are accurately produced. However, /h/, unlike oral fricatives, is never replaced by plosives, which gives it a different status from fricatives. More research is required to clarify the status of /h/ is child language.

The first split, i.e., that between plosives and nasals, is the same for all children. This is in agreement with Jakobson's observation that the split between oral and nasal plosives is acquired first. It seems that in onset position the first contrast to be learned is a split between obstruents and sonorants. Four of the children, Tirza, Jarmo, Robin and Leonie, continue their development with a split in the obstruent class, between plosives and fricatives. The other children focus on the sonorants, that is, they expand their system with liquids or glides. However, in both cases the contrast learned is one between complete closure (oral and nasal plosives) and stricture; or stated differently, the next split is one between [+continuant] and [−continuant]. This development can be schematised as follows:

(15) *Acquisition of Manner Features in Onset Position*

STAGE I	(−sonorant)	(−continuant)	Plosives
STAGE IIIa	+ sonorant		Nasals
STAGE IIIb		+ continuant	other manners

where ( ) indicates that no contrast might not be learned yet. The bracketed values seem to be the default values in onset position.

Six of the nine children have glides earlier than liquids; three have the reverse order. I have no explanation to offer for the lack of the orders L-F-G and G-L-F. I expect that these are just accidental gaps. Since it lies outside the scope of this dissertation to discuss the implications for the representation of manner features, I will leave the issue for further research.

It is clear from the patterns in (14) that the developmental order in which the different types of segments appear in onset position do not follow the sonority scale, since we would have expected to find fricatives quite early, and glides invariably late.

4.2. Summary and discussion

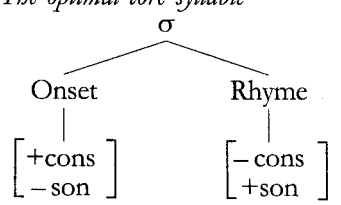
In spite of variability in the developmental order in which different segment types appear in the onset, there are also clear generalisations. There are three stages in the development of single onsets. Only during the third stage does variation occur in the developmental patterns of the different children. I first provide a summary of the findings before discussing them.

Stage I: obligatory onsets

1. The data from Jarmo, Noortje and Tom, whom I started recording at the onset of speech, give evidence for an initial stage at which all syllables have obligatory onsets.

2. The optimal core syllable consists of a minimally sonorous onset, a plosive, followed by a maximal sonorous element, a (low) vowel, as represented in (16):

(16) *The optimal core syllable*



max C = P *max son = V*

where cons = Consonantal, son = Sonorant, P = Plosive, V = Vowel;
max C = P: maximal consonantal segments are plosives;
max son = V: maximal sonorous segments are vowels.

3. There are three kinds of onsets in adult target words that do not match the ultimate core syllable: onsetless syllables, syllables with an onset cluster, and syllables with simple onsets other than plosives. These words are either subject to

(a) *a selection strategy*, by which some children avoid these target words for production; or

(b) *a repair strategy*, which can be one of the following types:

  (i) Onsetless syllables in the adult target are repaired by adding a plosive to fill the onset position in the child's production form, as in (1c) and (2).

  (ii) Initial onset clusters in the adult target are simplified in the child's production form, as in (1b).[5]

  (iii) Onsets other than plosives in the adult target are replaced by plosives or /h/ in the child's production form, as in (5a), (6c), or deleted (5b), (6a).

Stage II: optional onsets

4. At the next stage onsets become optional: now onsets can either be realised (in which case they are realised as plosives) or can be empty, although the repair strategy (3b(i)) is still found.[6]

5. The transition from one stage to the next is gradual. At the point in time when onsetless syllables start to occur in a child's vocabulary, we also often find cases of onsetless adult targets which are repaired in the child's production forms: they are produced with onsets.

Stage III: other types of single onsets

6. The next step in the development of all children is that other types of segment start to appear in onset position in the children's production forms (stage IIIa). Invariably, nasals are the first type of segment to appear (after plosives). /h/ does appear earlier than nasals, but not as a segment of Dutch.

7. Again the transitions are gradual: at the point that nasals appear in onset position in the child's production forms, the repair strategy ('replace nasals with plosives') is still attested. The same is true for other manners of articulation. For example, Jarmo first substitutes plosives for glides; later, when liquids are part of his system, glides are replaced by liquids; still later,

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[5] The acquisition of onset clusters will be discussed in detail in section 4.3.

[6] /h/ seems to be in free variation with empty onsets for many of the children, especially in the early stages, as was shown in Jarmo's data in (6).

glides are produced as glides, although sometimes liquids may appear instead of glides.

8. Fricatives, liquids, and glides are produced in onset position. There is no fixed order in which these types of segments appear: children differ greatly in the way they expand their system after nasals are acquired. The different attested orders are schematised in (14). The order of development is not based on the sonority scale.

After this summary, let us now discuss the findings. Below I argue for a developmental pattern based on parameter setting. In terms of default parameter values the observations that all syllables in the child's production forms start with onsets (see (1) and (2)), and moreover, that an onset is added to all onsetless target syllables in the child's production forms (1c), indicate that the parameter value 'onsets are obligatory' has to be the default value for the onset parameter. Every other setting is more marked and requires the setting of some parameter. The literature on syllable parameters is in accordance with these acquisition facts. For example, Clements & Keyser (1983) argue that since all languages have syllables with onsets, and some languages only have syllables with onsets, the default parameter should be 'onsets are obligatory'. This means that languages that only allow syllables with onsets form a subset of the languages that also allow onsetless syllables. The subset principle (see chapter 1) demands that children start with the subset, since positive evidence can be gained for the marked setting. That is, in this particular case, if the child encounters onsetless syllables, s/he has positive evidence for the marked setting of the parameter.

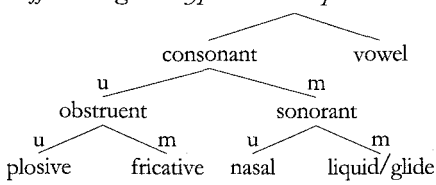
Assuming the marked value to be present from the start does not explain the pattern of development, that is, the transition from stage I to stage II remains unexplained and is unexpected. Furthermore, assuming that the marked value is present from the start also poses learnability problems for children learning languages with more restricted syllable templates. For example, a child learning a language in which onsets are obligatory might then produce onsetless words, but will never receive positive evidence that such words are not allowed by the language. In other words, s/he is confronted with the 'no negative evidence problem' (Bowerman 1983, 1988). I will come back to issues of this sort in section 4.5.3 where I discuss the acquisition of language-specific constraints, such as the one for Dutch which disallows initial /tl/ clusters. The fact that no child first has syllables without onsets clearly favours the above-mentioned default setting for onsets.

Dutch has the marked setting for this parameter, that is, in adult Dutch onsets are optional. Dutch contains many words without onsets, so that there is abundant positive evidence available in the input to the children for them to change the default value to the marked value of the parameter. This

parameter setting is learned quite early. However, it is remarkable that the major step in the development, after the ultimate core syllable is produced, is the production of empty onsets, before expanding on the types of segments that can occur in the core syllable. Apparently, knowing nothing about onsets, the child, guided by UG, produces the optimal core syllable (16). Before exploring what can be in the onset, the child first focuses on what constitutes a minimal onset. In a sense, one could say that this involves learning of a maximal contrast in the Jakobsonian sense: a maximal consonantal onset (plosive) versus no onset at all. It is important to note that the child at this stage is already starting to learn language-particular aspects of the grammar, whereas the previous stage is universal.

Besides learning what a minimal onset in Dutch is, the child also has to learn what can form an onset in Dutch. Assuming that the child strives for the maximal contrast between the onset and the rhyme, he first chooses a plosive–vowel contrast, that is, complete closure followed by opening of the jaw. Apparently, the next step is to have no onset at all. This is a maximal contrast within the onset: a maximal consonantal onset (plosive) versus no onset at all. The next type of segment to appear in onset position for all children is the nasals. In other words, the next step is a split between oral and nasal stops, or between obstruents and sonorants (15). This step is widely reported in the literature (cf. Jakobson 1941/68). However, children differ greatly in the choice of the next type of segment to occur in onset position, as evidenced by (14). Some children first expand their system in the obstruent class; others in the sonorant class. It seems that in both cases the opposition between complete closure (oral and nasal plosives) and partial closure (fricatives, glides and liquids) is learned. It is also clear that the sonority hierarchy has nothing to do with it: if this were the case, we would have expected fricatives to follow plosives in the developmental order. However, invariably nasals are acquired after plosives in onset position. Thus, the first distinction made is the one between consonants and vowels. Consonants are then split into obstruents (with plosives as unmarked expansion) and sonorants (with nasals as unmarked expansion). Children seem to differ with respect to which branch they explore next: some children focus on the marked obstruent type, fricatives; other children focus on the marked sonorant type, approximants. This is schematised in (17):

(17) *Different segment types in onset position*



The transition from stage I to stage II involves the setting of a syllable parameter, one which I will call the 'minimal onset' parameter, from the default value to the marked value; that is, the contrast 'presence' versus 'absence' of onsets is being learned. The transition from stage II to stage III involves the learning of the different manners of articulation, such as the difference between oral and nasal plosives (the acquisition of the contrast between obstruents and sonorants) and the difference between continuants and non-continuants. This does not involve syllable parameters, but involves the representation of segments (which may also be parametrised), although there clearly is a relation between the two. This setting of onset parameters is schematised in (18):

(18) *Setting of simple/empty onset parameters*

	P1	P2	P3
STAGE I	(default)	(default)	(default)
STAGE II	marked value	(default)	(default)
STAGE IIIA		marked value	(default)
STAGE IIIB			marked value

P1: Minimal Onset Parameter: 'Are onsets obligatory?' YES/NO
P2: 'Is there a contrast between obstruents and sonorants in onset position?'YES/NO
P3: 'Can onset consonants contrast in continuancy?' YES/NO
where the default value is underlined

	parameter is in the default value
	parameter is set to the marked value
	nothing can change once the parameter is set

The transition from an obligatory onset (stage I) to an optional onset (stage II) is gradual. That is, onsetless adult targets are realised with an onset at the first stage of development. Since the child's system only allows syllables with onsets and, furthermore, these onsets have to be plosives, all other target syllables are either subject to a selection strategy (they are avoided for production) or to a repair strategy, such that they obey the constraints of the child's phonological system. Following this stage there is a period in which onsetless targets are sometimes produced with an onset, and sometimes without an onset. The default value can apparently overrule the required marked setting for a while. What is important is that the reverse does not occur. Adult targets with onsets are hardly ever produced without onsets. At the early stage, where the child allows no null onset, this follows from the parameter setting; but once the child allows a null onset, the child

could in principle use it to avoid consonants, which are not yet mastered. However, even if fricatives, for example, are not mastered in onset position, they are usually not deleted, but rather replaced by plosives (especially at the early stages), indicating that the default value 'obligatory onsets' is preferred to the null onset.[7] Not only parameters and templates are at stake here, but also preferences which seem to follow the general markedness patterns involved at the stages. Only later are onsetless targets consistently produced without onsets. The parameter is fixed in the marked setting, and the repair strategy is no longer necessary. The same is true for every transition. For example, once Jarmo has selected target words with a glide as onset for production, he first replaced this glide by a plosive, since this is the only (or least marked) onset filler. However, in the course of development he also masters liquids. Once liquids are mastered they are a more appropriate substitute for glides than plosives: both are sonorous elements without a complete closure. Still later, he learns to produce glides as glides, although the repair strategy remains at work for a while.

The fact that transitions are gradual raises the question as to why this should be so. If change in grammar is caused by setting parameters to the marked value (thereby establishing new templates), we might have expected change to be instantaneous and across the board. One hypothesis is that 'old' words, i.e., words the child already uses, might be produced in terms of the older stage, and are slower to change. This is in fact what the output-as-input model predicts, since these words are already stored in the child's lexicon, whereas new words are subject to analysis and hypothesis testing. This is governed by the child's grammar at that stage. Therefore, the new parameters will be immediately applied to the new words, which need not be the case for the 'older' words. This would explain the appearance of gradualness. Another hypothesis is that the child is first testing a new setting before fixing it. Before the new setting is fixed we may expect both forms typical of the previous stage and forms typical of the new stage. This is in line with idea that the child as a conservative learner, who only fixes marked values of parameters once s/he is sure about them. If this hypothesis is correct we expect that the child may decide that the new setting is not the desired one, and therefore not fix the marked value of that parameter. Although I have not attested many situations in which this actually occur, I provide some data in support of this hypothesis in chapter 7.

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[7] There are very few cases in which onsets were deleted instead of replaced; some of them are given in (5b). One of them consists of a cluster of two fricatives. However, empty onsets are less marked than complex onsets. Thus, even in these cases the child goes for a less marked option.

4.3. Complex onsets

Two main patterns are found in the acquisition of complex onsets.[8] Most children first acquire clusters consisting of an obstruent plus a sonorant. However, Robin and Noortje start acquiring /s/-obstruent clusters before obstruent-sonorant clusters. Before turning to the significance of this difference in development, I first discuss the realisation and developmental pattern for each type of cluster, by describing Jarmo's development in detail, and the other children briefly.[9] Then I focus on the difference in development of Robin and Noortje versus the other children.

4.3.1. Plosive–liquid clusters

As we saw in (1b), complex target onsets are subject to a repair strategy in such a way that they obey the child's template. The onset template of the child initially only allows onsets realised as plosives. All other onsets are either subject to selection or to repair strategies. We already saw that complex onsets of the type plosive–liquid are not avoided, but until 1;8.12 all complex target onsets are repaired by Jarmo, as shown in (19), i.e., they are produced as single plosives. They are not avoided, since, for example the word *klaar* /klaːr/ 'ready' already appears at 1;4.18 as [kɑ].

(19)

Jarmo: STAGE 1				
klaar	/klaːr/	→	[kɑ]	(1;4.18)
klok	/klɔk/	→	[kɒk]	(1;6.27)
treintje	/ˈtrɛin͡tjə/	→	[ˈtɑɪ̯tɑ]	(1;7.15)
trommel	/ˈtrɔməl/	→	[ˈpɑbaː]	(1;7.15)
Dribbel	/ˈdrɪbəl/	→	[ˈdɛΦɔ]	(1;7.15)

From 1;6.13 onsetless syllables start appearing in Jarmo's production forms, as was shown in section 4.1. In principle then, the onset could be completely deleted since the child's template allows onsetless syllables at this stage. However, it is clear from the almost complete lack of data in which the onset is deleted that he clearly prefers syllables with onsets, that is, core syllables. This is indeed true for *all* children, without exception, adding support to the hypothesis that the default value for the onset parameter is 'onsets are obligatory'. And furthermore, simplex onsets are less marked than complex onsets, since all children go through a stage at which plosive–liquid clusters are reduced to plosives. Data from other children are given in (20):

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[8] Appendix E gives an overview of the clusters found in adult Dutch.

[9] Appendix D gives information on the development of other children.

(20) *Reduction of plosive–liquid clusters*

a. *Tom:* STAGE I

klok	/klɔk/	→	[koːk]	(1;5.28)
trommel	/ˈtrɔməl/	→	[ˈtɑmɔ]	(1;5.28)
bloem	/bluːm/	→	[puːm]	(1;6.11)

b. *Noortje:* STAGE I

trui	/trœy/	→	[tœy]	(2;1.17)
trein	/trɛin/	→	[tɛi]	(2;2.7)
broek	/bruːk/	→	[byːk]	(2;3.7)

c. *Læon:* STAGE I

bloemen	/ˈbluːmə[n]/	→	[ˈbuːmə]	(1;10.1)
krullen	/ˈkrʉlə[n]/	→	[ˈkyːʋə]	(1;10.1)
trein	/trɛin/	→	[tɛin]	(1;10.1)

d. *Enzo:* STAGE I

kleuren	/ˈkløːrə[n]/	→	[ˈkøːʀə]	(1;11.8)
blok	/blɔk/	→	[kɔk]	(1;11.8)
paraplu	/ˌpaːraːˈplyː/	→	[ˈpɑtuː]	(1;11.15)

This repair strategy (cluster reduction) is what we expect given the core syllable hypothesis.

The first bipositional onsets appear in Jarmo's production at 1;8.12. Examples are given in (21a, b). Jarmo's first complex onsets have the form plosive–liquid (21a), and later also plosive–glide (21b), all corresponding to adult target onsets of the form plosive–liquid.

(21) *Jarmo*

a.

klaar	/klaːr/	→	[kʀaː], [kʁaː]	(1;8.12)
trein	/trɛin/	→	[tlɛi][10]	(1;10.9)
draaien	/ˈdraːjə(n)/	→	[ˈkʀaːjə]	(1;10.9)
klaar	/klaːr/	→	[klaː]	(1;11.6)
blaadjes	/ˈblaːt͡jəs/	→	[ˈtlaːt͡jəs]	(2;1.8)
trein	/trɛin/	→	[tʀɛin]	(2;1.22)
draaien	/ˈdraːjə(n)/	→	[ˈtlaːjə]	(2;2.27)
trommel	/ˈtrɔməl/	→	[ˈtlɑmɔ]	(2;2.27)
drie	/driː/	→	[tʀiː]	(2;3.9)
drinken	/ˈdrɪŋkə[n]/	→	[ˈtlɪŋkɑ]	(2;4.1)

[10] In section 4.5.3 I will come back to cases with /tl/ clusters when discussing the acquisition of language particular constraints.

b.	bril	/brɪl/	→	[pʋl]	(2;3.9)
	broek	/bruːk/	→	[pʋuːk]	(2;3.9)
	blokjes	/ˈblɔk͡jəs/	→	[ˈpʋɔχ͡jəs]	(2;3.9)
	clowntje	/ˈklɑun͡tjə/	→	[ˈkʋaːm͡tjə]	(2;3.9)
	kleien	/ˈklɛijə[n]/	→	[ˈkʋɛilə]	(2;4.1)
	klok	/klɔk/	→	[kʋɔk]	(2;4.1)

The data in (22) show that the repair strategy remains available, indicating that the child is 'working' on the setting of the relevant parameter. Once again, not all target words requiring a complex onset of the type plosive–liquid are produced as such across the board; rather, the gradualness of development, as reported in the previous section, is also apparent here.

(22) *Jarmo:* STAGE 1

klaar	/klaːr/	→	[kɑ]	(1;8.26)
trein	/trɛin/	→	[tɛi]	(1;8.26)
draaien	/ˈdraːijə[n]/	→	[ˈtɛijə]	(1;10.9)
blokken	/ˈblɔkə[n]/	→	[ˈkɔkɔ]	(1;10.23)
bloemen	/ˈbluːmə[n]/	→	[ˈbuːmə]	(2;1.22)
drinken	/ˈdrɪŋkə[n]/	→	[ˈtɪŋkə]	(2;2.6)
bril	/brɪl/	→	[bɪ]	(2;3.9)

The following developmental trends can be detected in Jarmo's data. First, until 1;8.12 all clusters are reduced to single plosives, as in the data in (19) and (20). From 1;8.12 clusters are sometimes produced (as plosive–liquid clusters), although reduction is still preferred. The percentage of adult target clusters that are produced as clusters becomes gradually larger, from 0% at stage 1[11] to 83% at stage 3. Second, at stages 2′[12] and 2 the cluster, if produced, is most likely a plosive followed by a liquid. At stage 3 clusters of the form plosive–glide are preferred. This is illustrated in (23):

(23) *Jarmo's realisation of adult plosive–liquid onset*

STAGE	*Age*	P	as cluster	PL	PG
1	1;4.18 – 1;7.29	100% (25/25)	0%	0%	0%
2′	1;8.12 – 2;0.4	69% (31/45)	31% (14/45)	93% (13/14)	7% (1/14)
2	2;0.28 – 2;2.27	51% (18/35)	48% (17/35)	76% (13/17)	24% (4/17)
3	2;3.9 – 2;4.1	17% (5/29)	83% (24/29)	25% (6/24)	75% (18/24)

[11] This stage 1 bears no relation to stage I in the previous section. It refers solely to stages in the acquisition of plosive–liquid clusters.

[12] I use the prime notation to indicate an intermediate stage not found in the development of all children.

Two observations need to be made. First, liquids and glides appear in clusters before they are produced as simplex onsets. Second, in order to maintain a maximal sonority contrast between the singleton onset and the nucleus, the child seems to favour less sonorant onsets than liquids and glides. In this case the child is striving for a maximal contrast between the (single) onset and the rhyme by realising the plosive, not the liquid. In clusters, Jarmo seems to favour a large contrast in sonority between the two members of the onset, rather than a large contrast in sonority between the onset and the nucleus. This is an argument for the onset as a constituent. In a moraic theory without onsets as constituents one would have to say that the child strives for a maximal contrast in sonority between non-moraic elements, but why this should be so would remain unclear.

The fact that Jarmo has plosive–liquid clusters before he has plosive–glide clusters may reflect the fact that liquids are mastered before glides. As long as glides are not part of his phonological system, plosive–liquid clusters have the largest sonority contrast between the two members of the cluster. We saw in section 4.1 that single glides are also replaced by liquids (12b). Once glides are added to the system they are favoured over liquids, as is the case at stage 3. However, at some point the child must return to his earlier forms, those with plosive–liquid clusters, since these are required by the target words. At the end of the recording period Jarmo was still at stage 2, but the hypothesis is that the next step in the development will be the realisation of plosive–liquid clusters. Evidence in support of this hypothesis come from the data from Catootje and Elke.

Catootje, who, as opposed to Jarmo, acquired singleton liquids before glides, produced plosive–liquid clusters as either plosives (24a) or as a cluster consisting of a plosive plus a glide (24b) in the first recording sessions, suggesting that she is also striving for the largest contrast between the two members of the cluster. Otherwise, she would have produced plosive–liquid clusters to begin with, since liquids are part of her system much earlier than glides.

(24) *Catootje*

a. STAGE 1

bloemen	/ˈbluːmə[n]/	→	[ˈboːmɪ]	(1;10.11)
broek	/bruːk/	→	[buːk]	(1;10.11)
brand	/brɑnt/	→	[baːnt]	(1;10.11)
krijtje	/ˈkrɛi̯t͡ʃə/	→	[ˈkeːtiː]	(1;10.11)
plant	/plɑnt/	→	[bɑnt]	(1;10.11)
trui	/trœy/	→	[tɛi]	(1;10.11)
klok	/klɔk/	→	[kɔt]	(1;10.11)
		→	[pɔk]	(1;10.25)
bril	/brɪl/	→	[bɛi]	(1;10.25)
draak	/draːk/	→	[daːk]	(1;10.25)

b. STAGE 2

krant	/krɑnt/	→	[kjɑnt]	(1;11.9)[13]
trein	/trɛin/	→	[tjeːn]	(1;11.9)
trui	/trœy/	→	[tjœy]	(1;11.24)
draak	/draːk/	→	[djaːk]	(2;0.6)
krijtje	/ˈkrɛi͡tjə/	→	[ˈkjɛitə]	(2;0.6)
klein	/klɛin/	→	[kjɛin]	(2;0.20)
geplakt	/χəˈplɑkt/	→	[pjaːkt]	(2;0.20)

From 2;1.25 these clusters are either produced as plosive plus glide (25a) or as plosive plus liquid (25b), indicating that she is learning that the target clusters consist of a plosive followed by a liquid. From 2;3.28 these clusters are invariably produced as plosive–liquid clusters.

(25) *Catootje*

a. STAGE 2

trein	/trɛin/	→	[tjɛin]	(2;1.25)
trui	/trœy/	→	[tjɛi]	(2;1.25)

b. STAGE 3

blokken	/ˈblɔkə[n]/	→	[ˈblɔkə]	(2;1.25)
broek	/bruːk/	→	[bluːk]	(2;1.25)
Claartje	/ˈklaːrtjə/	→	[ˈklaːtiː]	(2;1.25)
clown	/klɑun/	→	[klɑun]	(2;1.25)
kroon	/kroːn/	→	[kloːn]	(2;1.25)
trein	/trɛin/	→	[tʀɛin]	(2;1.25)

Elke's data show a similar pattern. First, she uses the selection strategy (stage 0). From 1;8.13 she selects words with plosive–liquid clusters for production; however, they are reduced to P at this stage (26a) (stage 1). From 2;0.11 they are sometimes produced as plosive–glide clusters (26b) (stage 2). The next step is that they are produced as plosive–liquid clusters (26c) (stage 3), although during the whole recording period reduction of clusters is most common.

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[13] From 1;11.9 until 2;1.25 Catootje also often realises an epenthetic vowel between the two members of the cluster, as shown in (i):

(i)

bril	/brɪl/	→	[bɪˈjɛi]	(1;11.9)
druif	/drœyf/	→	[ˈdiˈjɑuχ]	(1;11.9)
trein	/trɛin/	→	[ˈtɪjɛin]	(1;11.9)
		→	[ˈtɪjɛin]	(2;0.6)
clown	/klɑun/	→	[kiːˈjaun]	(2;0.6)

(26) *Elke*

a.	STAGE 1				
	trein	/trɛin/	→	[tɛi]	(1;8.13)
	broodje	/ˈbroːt͡ʃjə/	→	[poːt͡ʃ]	(1;8.31)
	klaar	/klaːr/	→	[kaː]	(1;9;10)
	brood	/broːt/	→	[puːt]	(1;10.7)
b.	STAGE 2				
	klok	/klɔk/	→	[kvɔk]	(2;0.11)
	draaien	/ˈdraːjə[n]/	→	[tjaːn]	(2;0.11)
	drinken	/ˈdrɪŋkə[n]/	→	[ˈtjɪnɪ]	(2;2.6)
c.	STAGE 3				
	trein	/trɛin/	→	[tʀɛin]	(2;3.27)
	clown	/klɑun/	→	[kʀɑŋ]	(2;4.15)
	plas	/plɑs/	→	[plɑs]	(2;4.15)

With respect to the acquisition of single onsets, glides are present in Elke's system before liquids. However, at the stage at which clusters with liquids and glides appear, both glides and liquids are already present as single onsets in Elke's phonology, which was not the case for Jarmo.

Although the developmental patterns of Catootje and Elke seem to be different from the developmental patterns found for Jarmo, the difference might only be apparent, because, in particular, Catootje seems to be further in her phonological development than Jarmo in all respects. Catootje's system contains both glides and liquids at the stage at which target plosive–liquid clusters are selected for production, while Jarmo's system does not have glides. However, as soon as glides are part of his system he prefers plosive–glide clusters to plosive–liquid clusters. In other words, he seems to have one more intermediate stage (stage 2′), assuming that in later development he will also have plosive–liquid clusters (stage 3).

If glides are more sonorous than liquids, these data show that the three children strive for a maximal contrast in sonority between the two members of the onset. This tendency to strive for maximal sonority contrast between the two members of clusters is not found for all children. Although Tom, for example, has glides before liquids, he does not realise plosive–liquid clusters as plosive–glide clusters. One possible explanation is that he assigns the same sonority value to liquids and glides. This is true for most children: they first reduce plosive–liquid clusters to plosives (as in 19); the next step is that they produce the cluster accurately, i.e., they produce a plosive and a liquid, not a glide. Some examples are given in (27):

(27)

a.	*Tom:* STAGE 3				
	bloem	/bluːm/	→	[blɔm]	(1;7.9)
	klok	/klɔk/	→	[klɔk]	(1;7.9)
	bloemen	/ˈbluːmə[n]/	→	[ˈblɔmaː]	(1;7.23)
	broem	/bruːm/	→	[blʉm]	(1;7.23)
b.	*Tirza:* STAGE 3				
	clown	/klɑun/	→	[tlɑun]	(2;2.12)
	blazen	/ˈblaːzə[n]/	→	[ˈblaːsə]	(2;2.12)
	bloemen	/ˈbluːmə[n]/	→	[ˈtluːmɛ]	(2;2.12)
	trommels	/ˈtrɔməls/	→	[ˈtlʌmərs]	(2;2.12)
c.	*Enzo:* STAGE 3				
	broek	/bruːk/	→	[bʀuːk]	(1;11.8)
	plas	/plɑs/	→	[plɑt͡s]	(1;11.8)
	kleuren	/ˈkløːrə[n]/	→	[ˈkløːʀə]	(1;11.8)
	trein	/ˈtrɛin/	→	[ˈtʀɛinə]	(1;11.8)

In other words, some children seem to assign different sonority values to liquids and glides. These children initially favour maximal contrast in sonority between the two members of the onset. Other children seem to assume the same sonority value for liquids and glides. Crucially, no child replaces a plosive–liquid cluster with a plosive–nasal cluster. In principle this could have been possible, since (i) (some) plosive–nasal clusters are allowed in Dutch, (ii) nasals are acquired relatively early, (iii) plosive–nasal clusters obey the sonority hierarchy, and (iv) the contrast in sonority between the onset on the one hand and the rhyme on the other hand is larger for plosive–nasal clusters than for plosive–liquid/glide clusters. However, the reverse is true: plosive–nasal clusters in the target words are often replaced by plosive–liquid clusters, as we will see shortly. Apparently, the plosive–nasal clusters are more marked than plosive–liquid/glide clusters, possibly because the distance in sonority between the two members of the cluster is too small. I will discuss the acquisition of plosive–nasal clusters below in section 4.3.3.

Some children use a selection strategy: they simply do not select adult target words containing onset clusters for their own production forms. For example, Elke (as we saw above) and Tom do not select adult target words with initial clusters for production. From 1;5.0 Tom no longer avoids adult target words with initial clusters. Like Jarmo, Tom reduces adult target clusters consisting of a plosive plus a liquid to plosives (as shown in 20a). From 1;5.28 plosive–liquid clusters are still often reduced, but sometimes both members of the cluster are produced with an epenthetic vowel, as

shown in (28) (see also footnote 13 for similar data for Catootje). Unlike Jarmo, Tom does not substitute the liquid in the cluster for a glide. From 1;7.9 plosive–liquid clusters are now produced as such (as shown in (27a)), although both reduction and epenthesis still occur.

(28) *Tom*

blauw	/blɑu[w]/	→	[pəˈlɑw]	(1;6.25)
klok	/klɔk/	→	[kəˈlɔk]	(1;6.25)
trein	/trɛin/	→	[təˈʀɑ]	(1;6.25)

Tirza shows the same development, although she does not use the selection strategy: target onsets of a plosive plus a liquid are reduced to plosives until 2;1.17. From 2;2.12 plosive plus liquid target clusters are starting to be produced as such. However, she, too, often realises an epenthetic vowel between the two parts of the cluster (29):

(29) *Tirza*

trap	/trɑp/	→	[təˈʀɑp]	(2;3.12)
kraan	/krɑːn/	→	[kəˈʀɑːn]	(2;3.12)
trein	/trɛin/	→	[dəˈʀɛin]	(2;3.12)

Epenthesis is frequently mentioned in the literature on child language. Epenthesis generally occurs at the next stage after reduction of plosive–liquid clusters to plosives. Suppose that the child's template still does not allow complex clusters, i.e., the parameter value for the onset parameter is not yet set to the marked value, which allows complex onsets. We saw that the most likely repair strategy is cluster reduction. However, another repair strategy is production of both consonants, triggering epenthesis. Since the child's syllable template cannot accommodate two consonants in the onset (maximally one position is allowed), one of the two consonants does not fit into the template. The only way to realise the liquid (or glide) is to make it an onset on its own. Since syllables have to have a head, epenthesis is the result.[14] A similar analysis is given in Itô (1989) for epenthesis in adult languages. Remarkably, epenthesis only occurs during a short period. It is only found in the child's production forms of target plosive–liquid clusters, the first clusters produced. Apparently, when the 'maximal onset' parameter is set to the marked value ('complex onsets are allowed'), the child's template has a bipositional onset and therefore the repair strategy 'epenthesis' no longer occurs.[15]

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[14] This repair strategy is not very common, because it creates an unstressed first syllable. We will seen in chapter 6 that unstressed initial syllables are frequently prone to deletion.

[15] Since epenthesis is a repair strategy, we might expect that it be called on whenever there is a 'difficult' cluster. However, as we will see, this does not happen. Rather, the child uses the strategy of producing a cluster that s/he is able to produce.

Leonie seems to utilise another strategy for dealing with clusters. She first focuses on the plosive part of the clusters (30a); subsequently, she pays attention to the second part of the cluster, the sonorant: that is, she sometimes produces just a liquid (or nasal),[16] as shown in (30b), before producing both in a cluster (30c).

(30) *Leonie*

a. *Cluster reduced to plosive:* STAGE 1

broek	/bruːk/	→	[buːk]	(1;9.21)
trein	/trɛin/	→	[kɛŋ]	(1;9.21)
klaar	/klaːr/	→	[kaː]	(1;10.15)
plassen	/ˈplɑsə[n]/	→	[ˈpaːsə]	(1;10.15)

b. *Cluster reduced to sonorant:* STAGE 2

(i) drinken	/ˈdrɪŋkə[n]/	→	[ˈliːkɛ]	(1;10.29)
klap	/klɑp/	→	[lɑp]	(1;10.29)
klok	/klɔk/	→	[lɔk]	(1;11.12)
(ii) broek	/bruːk/	→	[muːk]	(1;10.29)
draaien	/ˈdraːjə[n]/	→	[ˈmaːjə]	(1;10.29)

c. *Cluster produced as cluster:* STAGE 3

bloemen	/ˈbluːmə[n]/	→	[ˈbluːmɛ]	(1;11.12)
kleur	/kløːr/	→	[klœ]	(1;11.12)

I will postpone the discussion of this strategy until section 4.3.4. We will see below that the same strategy is used by Leonie for fricative–liquid clusters and plosive–nasal clusters. Jarmo also seems to use this strategy for the acquisition of fricative–liquid clusters, as we will see shortly.

Finally, Robin, Eva and Noortje reduce plosive plus liquid target clusters to plosives during all recording sessions. Enzo and Leon already have plosive–liquid clusters in the first recording session, although they still use the reduction strategy in the early recording sessions, as shown in (20c, d). The developmental patterns for all children are summarised in (31). (31a) shows the strategy used by Jarmo, Catootje and Elke: from reducing the complex target onset to a singleton onset in which the least sonorous consonant is produced (stage 1), to a bipositional onset in which both members contrast maximally in sonority (stage 2), to the adult target cluster (stage 3). (31b) shows the other strategy, used by Leonie, Enzo, Leon, Tom and Tirza, although only Leonie goes through all three stages: from reducing the complex target onset to a singleton onset in which the least sonorous

[16] Liquids are produced as either stops, nasals or liquids from 1;10.29 by Leonie. See appendix D.

consonant is produced (stage 1), to an optional stage at which a singleton onset in which the consonant deleted at the previous stage is realised (stage 2), to the adult target cluster (stage 3). In other words, stage 1 and stage 3 are similar for all children, but children differ at stage 2: some produce plosive–glide clusters at that stage, other children produce a single sonorant.

(31) *Realisation and development of initial plosive–liquid clusters*

	STAGE 1	STAGE 2	STAGE 3
a.	P	PG	PL
b.		[L]	

where [ ] indicates optionality.

Finally, (32) shows a third strategy, which partly overlaps the two mentioned in (31): from realising the least sonorous member of the cluster (stage 1), to realising both members, however, not within the same onset, but rather by assigning both consonants an onset of their own, in which case epenthesis takes place (stage 2), to combining both consonants in one onset (stage 3).

(32) *Epenthesis*

STAGE 1	STAGE 2	STAGE 3
P	PvA	PA

where A = Approximant (Liquids and Glides), v = Vowel.

4.3.2. Plosive–glide clusters

Adult target words with plosive–glide clusters are not very frequent. Even less frequent is the selection for production by the children of adult target words with plosive–glide clusters: they often use the selection strategy. However, if they are selected for production they are realised as single plosives at the initial stage (stage 1). At the next stage, they are often realised as plosive–liquid clusters (stage 2) before they are realised correctly (stage 3). These stages are exemplified in Jarmo's data in (33), although based on limited data.

(33) *Jarmo*

a.	STAGE 1				
	kwak	/kʋak/	→	[kaː]	(1;7.15)
b.	STAGE 2				
	twee	/tʋeː/	→	[tʀeː]	(2;2.6)
c.	STAGE 3				
	twee	/tʋeː/	→	[tʋeː]	(2;2.6)

Plosive–glide clusters are reduced to plosives by most children at the initial stage. Robin, for example, reduces plosive–liquid clusters to plosives during the period of recording, as shown in (34).

(34) *Robin:* STAGE 1

kwak	/kʋɑk/	→	[kɑk]	(2;1.26)
twee	/tʋeː/	→	[deː]	(2;3.10)

Enzo, for example, initially reduces these clusters to plosives (35a). At the next stage these clusters are produced as plosive–liquid clusters (35b), and subsequently as plosive–glide clusters (35c). In other words, he and Jarmo show a similar developmental pattern.

(35) *Enzo*

a. STAGE 1

kwaak	/kʋaːk/	→	[kɑk]	(1;11.8)
barbecuen	/ˈbɑrbəˌkjuːwə[n]/	→	[ˈbɛˌkyːwə]	(1;11.15)

b. STAGE 2

twee	/tʋeː/	→	[tRɛː]	(1;11.15)
kwijt	/kʋɛit/	→	[klɛit]	(1;11.29)

c. STAGE 3

kwijt	/kʋɛit/	→	[kʋɛit]	(2;3.28)
twee	/tʋeː/	→	[tʋeː]	(2;4.25)

We must keep in mind that there are very few forms; therefore, the proposed stages are tentative, and need to be checked against more data. Most children show a developmental trend in the acquisition of plosive–liquid clusters from plosive → plosive–glide → plosive–liquid, while in the acquisition of plosive–glide clusters they show just the opposite order, i.e., from plosive → plosive–liquid → plosive–glide. I used the argument that the child strives for maximal contrast within the onset to explain the first order. The second order seems to undermine the value of this argument; it seems to be a counterexample, since the child first achieves a less maximal contrast in order to acquire the maximal contrast. We must, however, keep in mind that plosive–liquid clusters are acquired much earlier than plosive–glide clusters. It might therefore be the case that the child, in acquiring a new type of cluster, relies on the acquisition of clusters which already form part of his or her system, that is plosive–liquid clusters, rather than on maximal contrasts. It seems that only at the initial stage when the child starts producing clusters do the two members of the cluster differ maximally in sonority value. Once target plosive–liquid clusters are acquired

and produced as such, the child relies on these forms. Moreover, not all children seemed to make a distinction in sonority value between liquids and glides. Since the developmental patterns for plosive–liquid clusters are based on more data from more children, I will assume that these patterns reflect the unmarked order.

(36) gives the (tentative) developmental patterns in the acquisition of plosive plus glide onset clusters for the different children:

(36) *Realisation and development of initial plosive–glide clusters (tentative)*

STAGE 1	STAGE 2	STAGE 3
P	PL	PG

4.3.3. Plosive–nasal clusters

Plosive–nasal clusters are also infrequent, and only involve /kn/ clusters. The developmental pattern in the acquisition of plosive–nasal clusters seems to resemble that of the acquisition of plosive–liquid and plosive–glide clusters. Since there are only two instances of a word with a plosive–nasal onset cluster in Jarmo's productions, given in (37), we have to look at the data from other children.

(37) *Jarmo*

a. knippen /ˈknɪpə[n]/ → [ˈkɛpɔ] (2;2.6)
b. knippen /ˈknɪpə[n]/ → [ˈkjiːpə] (2;2.6)

For most children stage 1 is the stage at which these clusters are reduced to plosives (38).

(38) a. *Elke:* STAGE 1
knikkers /ˈknɪkərs/ → [ˈkiːkɪs] (2;4.29)
knoop /knoːp/ → [koːp] (2;4.29)
b. *Noortje:* STAGE 1
knoopjes /ˈknoːp jəs/→ [ˈpɑupɪs] (2;8.1)
knoopjes /ˈknoːp jəs/→ [ˈpoːpiːs] (2;8.1)

If the child's system has nasals in onset position, s/he could in principle produce either a plosive or a nasal, as Robin's data show (39). He first seems to realise the nasal (39a), and only later the plosive (39b). However, the data in (39) are the only examples found, and so no firm conclusions can be drawn.

(39) *Robin*

a. STAGE 1a: *Plosive–nasal → nasal*

knoeien	/ˈknuːjə[n]/	→	[ˈnuːjə]	(2;0.4)
knopje	/ˈknɔp͡jə/	→	[ˈmɔpjə]	(2;1.7)

b. STAGE 1b: *Plosive–nasal → plosive*

knuppel	/ˈknʉpəl/	→	[ˈkɪpɔ]	(2;3.10)
knip	/ˈknɪp/	→	[ˈkɪp]	(2;4.8)

For most children the next step is the realisation of /kn/ clusters as plosive–liquid (or as plosive–glide), as is shown in (40). Plosive–nasal clusters are produced as plosive plus liquids by Tom from 1;8.20, by Catootje from 1;11.23, and by Leon from the initial recording session, as shown in (40a–c):

(40) a. *Tom:* STAGE 3[17]

knopje	/ˈknɔp͡jə/	→	[ˈklɔt͡jə]	(1;8.20)
knuf	/knʉf/	→	[kluːf]	(1;10.8)

b. *Catootje:* STAGE 3

knikkers	/ˈknɪkər/	→	[ˈkʀiːkoːs]	(2;0.6)
knopen	/ˈknoːpə[n]/	→	[ˈkloːpən]	(2;4.26)
knot	/knɔt/	→	[klɔt]	(2;6.7)

c. *Leon:* STAGE 3

knoopje	/ˈknoːp͡jə/	→	[ˈkloːpk̟͡jə]	(1;11.12)
knoopjes	/ˈknoːp͡jəs/	→	[ˈkloːpəs]	(1;11.12)

At the next stage /kn/ clusters are produced accurately.

Leonie shows an interesting intermediate stage: a stage at which she produces just a liquid (which I will call optional stage 2). The data in (41) show the three stages that can be found in her data:

(41) *Leonie*

a. STAGE 1

knippen	/ˈknɪpə[n]/	→	[ˈpɪp]	(1;9.15)

b. STAGE 2

knip	/knɪp/	→	[liːp]	(1;9.21)
knoopje	/ˈknoːp͡jə/	→	[ˈlyːpʂ͡jə]	(1;9.21)
		→	[ˈlɔpʂ͡jə]	(1;10.4)

c. STAGE 3

knoopje	/ˈknoːp͡jə/	→	[ˈplɔpʃən]	(1;10.15)
knip	/knɪp/	→	[blɪp]	(1;10.29)

[17] I will refer to this as stage 3, and not stage 2, for reasons which will be made clear shortly.

She showed a similar pattern of development in the acquisition of plosive–liquid clusters (30). This means that plosive–nasal clusters are treated just like plosive–liquid clusters. It will be shown in the next section that a similar strategy is used for the acquisition of fricative–liquid clusters.

Tirza goes through the same stages: first, she realises plosive–nasal clusters as plosives (stage 1); second, she realises them as liquids (stage 2), and finally, she combines both stages and produces a plosive–liquid cluster (stage 3). Data representing stage 4 are not recorded, but are hypothesised to have appeared in her speech at a later point. Her development is given in (42):

(42) *Tirza*

a.	STAGE 1				
	knoop	/knoːp/	→	[poːp]	(1;10.22)
	knietje	/ˈkniːt͡jə/	→	[ˈtiːt͡jə]	(2;1.2)
b.	STAGE 2				
	knoopjes	/ˈknoːp͡jəs/	→	[ˈloːp͡jəs]	(2;1.17)
	knoopje	/ˈknoːp͡jə/	→	[ˈlɑup͡jɪ]	(2;1.17)
c.	STAGE 3				
	knap	/knɑp/	→	[klɑp]	(2;2.0)

Finally, plosive–nasal clusters are realised as such (stage 4). Enzo's data exemplify the three (non-optional) stages mentioned above. First plosive–nasal clusters are reduced to plosives (43a); second, they are produced as plosive–liquid clusters (43b); and, third, they are produced accurately (43c):

(43) *Enzo*

a.	STAGE 1: /*kn*/ → /*k*/				
	knikkeren	/ˈknɪkərə[n]/	→	[ˈkeːkənaː]	(2;3.14)
	knip	/knɪp/	→	[kɪp]	(2;3.28)
b.	STAGE 3: /*kn*/ → /*kl*/				
	knip	/knɪp/	→	[klɪp]	(2;3.28)
	knoopje	/ˈknoːp͡jə/	→	[ˈkloːp͡jə]	(2;4.11)
c.	STAGE 4: /*kn*/ → /*kn*/				
	knoopjes	/ˈknoːp͡jəs/	→	[ˈknoːps/ʃəs]	(2;5.9)
	knikkers	/ˈknɪkərs/	→	[ˈknɪkəs]	(2;6.11)
	knippen	/ˈknɪpə[n]/	→	[ˈknɪpə]	(2;6.11)

The developmental patterns in the acquisition of plosive–nasal clusters is given in (44).

(44) *Realisation and development of initial plosive–nasal clusters*

STAGE 1	STAGE 2	STAGE 3	STAGE 4
P	[L]	PL	PN

4.3.4. Fricative–liquid clusters

Since fricatives are generally mastered late as single onsets, it should come as no surprise that clusters with fricatives also appear relatively late.[18] Moreover, children differ greatly in the order in which fricatives appear, as was shown in (14). Furthermore, children also differ in the way they deal with initial fricatives.[19] Nevertheless, they are the first type of clusters to follow the plosive–liquid clusters in most children's systems.

Clusters consisting of a fricative plus a liquid show the following pattern of development in Jarmo's system: first, they are replaced by plosives (stage 1), as shown in (45). Singleton fricatives too are replaced by plosives, as was shown in (5a). In other words, this stage is comparable with stage 1 in (19): clusters are reduced to the least sonorous element, which gets replaced by the least sonorous element in the child's system.[20] As we saw in section 4.1, at the earliest stages only plosives are allowed as onsets. Therefore, fricatives are subject to the repair strategy: replacement by plosives.

(45) *Jarmo:* STAGE 1

slapen	/ˈslaːpə[n]/	→	[ˈtaːpə]	(2;0.28)
vliegtuig	/ˈvliː ɣ ˌtœy ɣ /*	→	[ˈtiːtœyf]	(2;1.8)
groot	/ɣ roːt/*	→	[toːt]	(2;1.22)
vlinder	/ˈvlɪndər/	→	[ˈkɪnɐ]	(2;2.6)

Eva also realises fricative–liquid clusters as plosives at the initial stage (46a), when single fricatives are also replaced by plosives (46b):

[18] It will be recalled that appendix D provides details on the acquisition of both singleton and complex onsets.

[19] Some of the differences are due to the fact that we started recording the children at different ages.

[20] It could also be the case that onsets which are impossible in the child's system are replaced by unmarked onset, plosives. This analysis only assumes one repair strategy instead of two (reduction and substitution). On the basis of the data it is not possible to decide what exactly is happening.

(46) *Eva*

a. *Fricative–liquid clusters realised as plosives:* STAGE 1

sloffen	/ˈslɔfə[n]/	→	[ˈpɔfə]	(1;4.12)
fles	/flɛs/	→	[dɛs]	(1;6.1)
glijden	/ˈχlɛijə[n]/	→	[ˈbɛijə]	(1;7.15)

b. *Single fricative onsets realised as plosives*

fiets	/fiːts/	→	[piːt]	(1;4.12)
vis	/vɪs/	→	[dɪs]	(1;6.1)
voet	/vuːt/	→	[puːt]	(1;6.1)

However, not all children show the same strategy. For example, Noortje realises adult target fricatives as /h/ (47b), although this stage is preceded by a short stage at which she replaces fricatives by plosives. With regard to clusters consisting of a fricative plus a liquid, they too are realised as /h/, as shown in (47a). In other words, it looks as if the cluster is reduced to the least sonorous one, which is then treated as a single onset. However, single liquids in onset position are also replaced by /h/. She does not show further development during the period of recording.

(47) *Noortje*

a. *Fricative–liquid clusters realised as /h/:* STAGE 1

fles	/flɛs/	→	[hɛis]	(2;3.7)
slak	/slɑk/	→	[hɑk]	(2;4.4)
grote	/ˈχroːtə/	→	[ˈhɑukə]	(2;5.23)

b. *Singleton fricative onsets realised as /h/*

fiets	/fiːts/	→	[hiːt]	(2;3.7)
zon	/zɔn/	→	[hɔn]	(2;3.7)
geit	/χɛit/	→	[hɛit]	(2;6.19)

Catootje shows a similar pattern: fricative–liquid clusters are reduced to /h/ at the first stage, as shown in (48a); target singleton fricatives are replaced by /h/ as well (48b):

(48) *Catootje*

a. *Fricative–liquid clusters realised as /h/:* STAGE 1

slak	/slɑk/	→	[hɛk]	(1;10.25)
vlieg	/vliːχ/	→	[ˈhiːχə]	(1;10.25)
slapen	/ˈslaːpə[n]/	→	[ˈhaːpaː]	(1;11.9)

b. *Singleton fricative onsets realised as /h/*

fiets	/fiːts/	→	[hiːts]	(1;10.11)
gitaar	/χiːˈtaːr/	→	[ˈhiːtaː]	(1;10.11)
sok	/sɔk/	→	[hɔk]	(1;10.11)

Jarmo's data show that at the second stage, fricative–liquid clusters are realised as liquids (49). After focusing on the least sonorous part, he shifts attention to the second part of the adult target cluster, the liquid.

(49) *Jarmo:* STAGE 2

vlinder	/ˈvlɪndər/	→	[ˈlɪŋɯ]	(2;2.27)
slapen	/ˈslaːpə[n]/	→	[ˈlaːpə]	(2;3.9)

For Leonie this also is the second stage, as shown in the data in (50). It will be recalled that Leonie showed a similar developmental pattern for plosive–liquid (30) and plosive–nasal clusters (41).

(50) *Leonie:* STAGE 2

slapen	/ˈslaːpə[n]/	→	[ˈlaːpə]	(1;9.15)
slaap	/slaːp/	→	[laːp]	(1;10.15)

Catootje too realises the liquid at the second stage, although her first stage differs from that of Jarmo and Leonie's, indicating that /h/ in Catootje's production forms indeed replaces the fricative part of the cluster. On the other hand, she has liquids in onset position before she has fricatives. This might have triggered the transition from stage 1 to stage 2. Some data are given in (51):

(51) *Catootje:* STAGE 2

fluit	/flœyt/	→	[lœyt]	(1;11.22)
slapen	/ˈslaːpə[n]/	→	[ˈlaːpə]	(1;11.22)
slak	/slɑk/	→	[lɑk]	(1;11.22)

Of course, a prerequisite is that children have liquids in onset position in the first place. If this is not the case, they will realise the obstruent. If they have liquids in onset position, but do not yet have onset clusters, they can realise either the obstruent or the liquid.

The next stage that can be distinguished in Jarmo's data is a stage at which he again realises the least sonorous first part of the target cluster, however, now realising it as a fricative instead of a plosive (52). At this point in the development singleton fricatives are part of his system, as shown in (9).

(52) *Jarmo:* STAGE 3

slapen	/ˈslaːpə[n]/	→	[ˈsaːpə]	(2;3.9)
vlinder	/ˈvlɪndər/	→	[ˈsɪnɑ]	(2;4.1)
glijbaan	/ˈχlɛiˌbaːn/	→	[ˈχɛiχaːn]	(2;4.1)

In the last recording session Leonie produced one target fricative–liquid cluster as a fricative: she realises the word *vrouw* /vrɑu[w]/ as [fɑu], perhaps indicating that this will be her next step in the development towards the target fricative–liquid cluster as well.

Robin, Eva and Elke do not have stage 2: their first stage involves reduction of the fricative–liquid cluster and replacement of the fricatives by plosives; the next step is the realisation of a fricative, that is, stage 3. Some data are given in (53):

(53)

a.	*Robin:* STAGE 3				
	Groover	/ˈχroːvər/	→	[ˈfoːfə]	(1;9.24)
	slapen	/ˈslaːpə[n]/	→	[ˈvaːbə]	(1;9.24)
	vliegen	/ˈvliːχə[n]/	→	[ˈfiːχ͡jə]	(1;9.24)
b.	*Eva:* STAGE 3				
	glijbaan	/ˈχlɛiˌbaːn/	→	[ˈsɛimaː]	(1;8.22)
	vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈfiːˈtœyχ]	(1;8.22)
	Groover	/ˈχroːvər/	→	[ˈsoːfeːɪ]	(1;9.3)
c.	*Elke:* STAGE 3				
	fles	/flɛs/	→	[fɑʃ]	(1;10.21)
	sleutel	/ˈsløːtəl/	→	[ˈsɛcoː]	(2;1.16)
	grote	/ˈχroːtə/	→	[ˈχoːtə]	(2;3.27)

At Jarmo's final stage fricative–liquid clusters are produced as a fricative plus liquid (54) (stage 4).

(54)

Jarmo: STAGE 4				
flesje	/ˈflɛs͡jə/	→	[ˈslɛs͡jɔ]	(2;4.1)
slak	/slɑk/	→	[flɑk], [slɑk]	(2;4.1)

Jarmo's development reflects the acquisition of single onsets (see (5a) and (11) in section 4.1), where fricatives and liquids were replaced by plosives at the first stages. Liquids are produced as liquids across the board before fricatives are realised as fricatives across the board, although fricatives appear before liquids in Jarmo's productions (see 13)). Apparently, Jarmo is first focusing on one part of the cluster (the least sonorous); the next step is to pay attention to the second part of the cluster (the liquid), before combining the two. Note that /sl/ clusters do not behave differently from /fl/ and /χl/ clusters. I will come back to this point in section 4.5.3.

Leonie also seems to go through the same stages as Jarmo for fricative–liquid clusters. (55) provides a summary of the stages: she first reduces the clusters to plosives (55a), then to liquids (55b), and finally to fricatives (55c). She does not yet have fricative–liquid clusters in the last recording session, but the hypothesis is that this would be the next step.[21]

[21] Possibly there is one step in between the stage at which fricative–liquid clusters are realised as such, and the stage at which fricative–liquid clusters are reduced to fricatives. At this intermediate stage, fricative–liquid clusters are realised as plosive–liquid clusters. I will come back to this shortly.

(55) *Leonie*

a.	STAGE 1				
	grapje	/ˈχrɑp͡jə/	→	[ˈkɑpə]	(1;9.21)
b.	STAGE 2				
	slapen	/ˈslaːpə[n]/	→	[ˈlaːpə]	(1;10.29)
c.	STAGE 3				
	vrouw	/vrɑu[w]/	→	[fɑu]	(1;11.12)

Robin produces adult target clusters consisting of a fricative plus a liquid as plosives until 1;11.21 (56a); however, from 1;9.10 they start being produced as fricatives (56b).

(56) *Robin*

a.	STAGE 1 (1;7.13 – 1;11.21): *Fricative–liquid → plosive*				
	vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈtœiˌtœi]	(1;7.13)
	slapen	/ˈslaːpə[n]/	→	[ˈpaːtə]	(1;7.27)
	sloffen	/ˈslɔfə[n]/	→	[ˈboːfə]	(1;10.21)
	glijbaan	/ˈχlɛiˌbaːn/	→	[ˈkɑˌkaːn]	(1;11.21)
b.	STAGE 3 (1;9.10 – 2;4.29)*: Fricative–liquid → fricative*				
	Groover	/ˈχroːvər/	→	[ˈfoːfɪ]	(1;9.10)
	groot	/χroːt/	→	[zoːt]	(1;9.10)
	slapen	/ˈslaːpə[n]/	→	[ˈfaːpə]	(1;10.7)
	vlokken	/ˈvlɔkə[n]/	→	[ˈfɔkə]	(2;0.18)

(56A) is in itself remarkable, since fricatives in onset position are produced accurately as singleton onsets (from 1;6.12). Moreover, single liquids in onset position are replaced by either fricatives or by plosives. I have no ready explanation for the data in (56a), but somehow it seems that he has analysed these onsets as clusters. It is often mentioned that if the child's system expands in one direction, this can have the effect that in another direction there is a temporary regression. In this case this could mean that although single fricatives in onset position are produced accurately, fricatives in clusters are replaced by plosives, even if the cluster is realised as a singleton onset.[22]

Elke uses the selection strategy. She does not select words with a fricative–liquid cluster until 2;1.16, at which age she realises them as fricatives. At this age target initial fricatives are realised as such across the board. Her data do not show other stages.

[22] One hypothesis could be that the child considers fricative–liquid clusters to be some sort of complex segment, and not a regular fricative followed by a liquid, and so replaces it with the default consonant, i.e., plosive.

Tirza first reduces fricative–liquid clusters to fricatives, which are already part of her system (stage 3) (57a). From 2;2.1 she realises these adult target clusters as plosive plus liquid (stage 4) (57b). From 2;3.12, besides these realisations, she also has fricative–liquid clusters (stage 5) (57c). From 2;6.12 fricative–liquid clusters are always produced as such.

(57) *Tirza*

a. STAGE 3 (1;9.11 – 2;2.12): *Fricative–liquid → fricative*

slapen	/ˈslaːpə[n]/	→	[ˈsaːpə]	(1;9.11)
groot	/χroːt/	→	[χoːt]	(1;10.8)
sleutel	/ˈsløːtəl/	→	[ˈχøːtoː]	(1;10.22)
vlieg	/vliːχ/	→	[siːχ]	(1;10.22)
glijbaan	/ˈχlɛiˌbaːn/	→	[ˈsɛiˌpɑn]	(2;0.5)

b. STAGE 4′ (2;2.0 – 2;5.21): *Fricative–liquid → plosive–liquid*

glijden	/ˈχlɛijə[n]/	→	[ˈtlaːjə]	(2;2.0)
vlees	/vleːs/	→	[tleːs]	(2;2.0)
slak	/slɑk/	→	[tlaːk]	(2;2.12)
vlinder	/ˈvlɪndər/	→	[ˈtlɪndɪ]	(2;3.12)

c. STAGE 4 (2;3.27 – ...): *Fricative–liquid → fricative–liquid*

glijbaan	/ˈχlɛiˌbaːn/	→	[ˈslɛiˌbaːn]	(2;3.27)
vlinder	/ˈvlɪndər/	→	[ˈslɪndɪ]	(2;3.27)
vlecht	/vlɛχt/	→	[slɛχt]	(2;5.5)
groente	/ˈχruːntə/	→	[ˈχʁuːntɪ]	(2;6.12)
vlinders	/ˈvlɪndərs/	→	[ˈflĩdəs]	(2;6.12)

Tom does not select clusters until 1;5.0 (selection strategy). Once they are selected for production, he first reduces these clusters, and realises them as plosives (stage 1). Subsequently they are reduced but produced as fricatives (stage 3). From 1;7.9 they are produced as clusters consisting of plosive plus liquid (stage 4′). From 1;11.12 they are realised as fricative plus liquid (stage 4). The development is given in (58a–d):

(58) *Tom*

a. STAGE 1

vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈtiːtœy]	(1;5.28)
framboos	/ˌfrɑmˈboːs/	→	[ˈbɑˈpoːf]	(1;6.11)
slak	/slɑk/	→	[pɑf]	(1;6.11)

b. STAGE 3

vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈfiːkɔŭkə]	(1;6.11)
vlinder	/ˈvlɪndər/	→	[ˈfɛmə]	(1;6.11)

c.	STAGE 4′				
	vlinder	/ˈvlɪndər/	→	[ˈɾlɪn]	(1;6.25)
	slak	/slɑk/	→	[plɑɻ]	(1;6.25)
d.	STAGE 4				
	vliegtuig	/ˈvliːɻˌtœyɻ/	→	[ˈfleːfaːi]	(1;7.23)
	fles	/flɛs/	→	[flɛs]	(1;7.23)
	slapen	/ˈslaːpə[n]/	→	[ˈslaːpə]	(1;10.8)

Finally, although Enzo has fricative–liquid clusters in his production forms from the start, nevertheless forms from previous stages can still be found in the first recording session, although they are not frequent, as shown in (59):

(59) *Enzo*

a.	STAGE 1				
	groen	/ɻ ruːn/	→	[kuːn]	(1;11.8)
b.	STAGE 3				
	groen	/ɻ ruːn/	→	[ɻ uːn]	(1;11.8)
c.	STAGE 4				
	vlees	/vleːs/	→	[pleit]	(1;11.8)
d.	STAGE 5				
	vlag	/vlɑɻ/	→	[flɑt]	(1;11.8)

A summary of the strategies found in the data from the different children with respect to the acquisition of fricative–liquid clusters is given in (60).[23]

(60) *Realisation and development of initial fricative–liquid clusters*

STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 4′
P/h	[L]	F	[PL]	FL

Where [ ] indicates optionality. Stage (2) is found in the data from Jarmo, Catootje and Leonie; Step (4′) is found in the data from Tom and Tirza.

Children who have plosive–liquid clusters at stage 4′ all have a preceding stage at which a single fricative was realised. However, this fricative does not show up directly in clusters. Rather, in the realisation of the cluster the earlier acquired and less marked plosive is favoured. Note that, on the assumption that fricatives are more sonorous than plosives, this could also be explained by the child's tendency to strive for maximal sonority contrasts between the two members of the cluster. However, this never results in fricative–glide clusters at stage 4, where the fricative is realised in a cluster. An explanation in terms of sonority cannot account for the lack of these

[23] Appendix D shows the developmental pattern for each child.

clusters, and at the same time the appearance of fricative–liquid clusters. Possibly fricatives and glides are too much alike with respect to stricture (manner) features.[24] However, this exploration of the behaviour and development of manner features lies outside the scope of this dissertation and must await further research.

Another observation is that epenthesis to break up fricative–liquid clusters is hardly found. At the stage at which the child produces these target clusters as clusters, the maximal onset parameter already has the marked setting: the child's structural template allows clusters, although not all clusters are allowed. In principle, the clusters that are not yet mastered by the child could undergo epenthesis as a repair strategy. However, this seldom happens. Rather, children seem to favour another strategy: replace the 'difficult' clusters by 'simpler' ones, i.e., clusters that the child is able to produce. Therefore, the repair strategy 'epenthesis' is not necessary: the child is able to produce two consonants within the onset. This indicates that epenthesis is a repair strategy that applies to the child's structural template. It should further be noted that not all children use epenthesis as a strategy, even at the early stages.

The fact that there is no single developmental pattern for all children reflects the fact that the order of acquisition of initial fricatives and liquids is not the same for all children. On the other hand, there are clearly also developmental trends common to all children's systems.

4.3.5. Fricative–nasal clusters

Fricative–nasal clusters are restricted to /sn/ and /sm/ clusters. Adult target words starting with these clusters are not often attempted by children. We saw in section 4.3.3 that plosive–nasal clusters are treated like plosive–liquid clusters at the initial stages. We may hypothesise that, similarly, fricative–nasal clusters are treated as fricative–liquid clusters. We saw in section 4.3.4 that fricative–liquid clusters are first reduced to plosives, subsequently they may be realised as liquids, before they are realised as fricatives. We may therefore expect that fricative–nasal clusters are reduced to plosives at the initial stage. However, this hypothesis is not borne out by the data.

The reason the fricative–nasal clusters are treated differently from fricative–liquid clusters may lie in the fact that, unlike liquids and fricatives, nasals are invariably acquired early in onset position, as was shown in

[24] Fricative–glide clusters are almost absent in adult Dutch. They only occur in a few infrequent loan words.

section 4.1. Therefore, children may start reducing fricative–nasal clusters to the 'known' consonant, the nasal (stage 1′), especially since fricatives are not yet part of their system. Evidence for this idea comes from the data from Eva, Tom and Catootje (61).[25]

(61) a. *Eva*: STAGE 1′

snuit	/snœyt/	→	[nœys]	(1;6.1)

b. *Tom:* STAGE 1′

snoep	/snu:p/	→	[mu:n]	(1;6.11)
snoepjes	/ˈsnu:p͡jəs/	→	[ˈnu:mɑ]	(1;6.11)
sneeuw	/sne:w/	→	[ne:w]	(1;6.25)

c. *Catootje:* STAGE 1′

snavel	/ˈsna:vəl/	→	[ˈna:fɔ]	(2;3.26)
sneeuw	/sne:w/	→	[me:w]	(2;4.23)

That these children realise a nasal instead of a stop shows that the child tries to come as close to the adult target as is possible, given his or her system. Once fricatives are part of the system, they are produced instead of nasals, as shown by Eva.

Eva starts with the nasal (stage 1′) (61a); she then reduces the cluster to fricatives (stage 1), as shown in (62a). Leon, who has single fricatives in onset position from the first recording session, reduces /s/-nasal clusters to fricatives (stage 1) (62b).

(62) a. *Eva:* STAGE 1

Snoopy	/ˈsnu:pi:/	→	[ˈzu:pi:]	(1;9.8)

b. *Leon:* STAGE 1

sneeuw	/sne:w/	→	[se:w]	(1;10.29)
snoep	/snu:p/	→	[su:p]	(1;10.29)

We saw that during the acquisition of plosive–nasal and fricative–liquid clusters there is an optional stage at which the second part of the cluster (the sonorant) is produced before combining the two parts of the cluster (stage 2).

Leonie realises target /s/-nasal cluster as liquids. This should no longer be surprising, given her treatment of fricative–liquid clusters and of plosive–nasal clusters, which are also realised as liquids at some point in

[25] Eva and Tom's data present clear evidence for the stage 1′. Tom does not have the intermediate stage 1. His data could therefore reflect stage 2. However, since I started recording him from the onset of speech, it seems more likely that the data represent stage 1′. However, with respect to the data of Catootje, who is in several respects further in her development, they could reflect stage 2, instead of stage 1′, since no data representing stage 1 are attested.

development. The hypothesis is that prior to the forms in (63) the cluster is produced as a plosive (or a nasal). The next step in the development, after the forms in (63), is presumably the realisation of the cluster as a fricative before the cluster is produced as a fricative–liquid or fricative–nasal cluster. However, these forms are not attested in the database.

(63) *Leonie:* STAGE 2

snoep	/snu:p/	→	[lu:p]	(1;10.4)
snoepje	/'snu:p͡sjə/	→	['lu:ps͡jə]	(1;11.25)

Robin first reduces the /s/-nasal clusters to fricatives (stage 1); he then focuses on the second part of the cluster and realises the clusters as nasals (stage 2). This development resembles that of fricative–liquid clusters and is given in (64):

(64) *Robin*

a. STAGE 1

snoepje	/'snu:p͡jə/	→	['fu:pi:]	(1;10.21)
		→	['su:pi:]	(2;0.4)

b. STAGE 2

sneeuw	/sne:w/	→	[ne:w]	(2;1.7)
snor	/snɔr/	→	[nɔɹ]	(2;1.7)

Tirza reduces fricative–nasal clusters to fricatives at the earliest sessions (stage 1), fricatives being already present in her system at the first recording session. At stage 2 she realises just the nasal part, although few data are available, as shown in (65):

(65) *Tirza*

a. STAGE 1

smeerkaas	/'smeːr̩ˌkaːs/	→	['sʁkaːs]	(2;0.18)
sneeuw	/sneːw/	→	[seːw]	(2;3.12)
snuit	/snœyt/	→	[sœy]	(2;5.5)

b. STAGE 2

snotneus	/'snɔtˌnøːs/	→	['nɔ'nœys]	(2;3.27)

Enzo also first reduces these clusters to fricatives at stage 1, and subsequently to nasals (stage 2). This is shown in (66a, b):

(66) *Enzo*

a. STAGE 1

sneeuwen	/'sneːwə[n]/	→	['sɑuwə]	(2;1.3)
snuit	/snœyt/	→	[sœyt]	(2;3.14)

b. STAGE 2

sneeuw	/sneːw/	→	[neːw]	(2;3.14)

It looks as if stage 2 and stage 1′ are the same. However, this is only apparent, since none of the children who exhibit data typical of stage 1′ have single fricatives at that stage, but have single nasals in onset position. It is not that they focus on the second part of the cluster, but rather they select that part of the cluster which is part of their system. Stage 2, on the other hand, seems to be a real intermediate stage, since this stage is also found in the production of other types of clusters.

From 1;7.9 /s/-nasal clusters are produced as fricative–liquid clusters by Tom (67a) (stage 3). Apparently, although nasals are part of his system very early, he does not have clusters containing nasals. Only liquids (and later also glides) can be the second part of a cluster. He seems to treat the nasal in fricative–nasal and plosive–nasal clusters the same way, namely as a liquid. If a cluster is realised many children seem to favour fricative–liquid clusters over fricative–nasal clusters, fricative–liquid clusters both being acquired earlier and displaying a greater sonority contrast then fricative–nasal clusters.

(67) a. *Tom:* STAGE 3

Snoopy	/ˈsnuːpiː/	→	[ˈsluːpiː]	(1;7.9)
		→	[ˈslʉpiː]	(1;11.12)

b. *Leon:* STAGE 3

snoepje	/ˈsnuːpjə/	→	[ˈsluːkjə]	(2;0.10)
snottebel	/ˈsnɔtəˌbɛl/	→	[ˈslɔtəʀˌbɛl]	(2;5.13)

Leon's stage 3 is followed by stage 4 at which fricative–nasal clusters are produced as such (68a). However, not all children have the intermediate stage 3. Catootje reduces the clusters to nasals until 2;0.20 (61c). Then she realises them as fricative–nasal clusters (68b) (stage 4). This is the same strategy she used for fricative–liquid clusters, which she first reduced to liquids (the sonorant part), and then produced as fricative–liquid clusters. At 2;0.20 she starts to produce single fricatives in onset position, while nasals and liquids are mastered earlier. Robin does not have stage 3 either. After stage 1, at which he produces fricative–nasal clusters as a fricatives, and stage 2, at which he produces these clusters as nasals, he combines the two in a fricative–nasal cluster (stage 4) (68c). The same is true for Enzo. When he starts to produce the target cluster as bipositional onsets, they consist invariably of a fricative plus a nasal (stage 4), as shown in (68d). In other words, he does not have the intermediate stage at which a fricative–liquid cluster is produced either.

(68)

a.	*Leon:* STAGE 4				
	snorhaar	/ˈsnɔrˌhaːr/	→	[ˈsnɔʀaːˌhaːɳ]	(2;8.5)
	snoepje	/ˈsnuːp͡jə/	→	[ˈsnuːp͡jə]	(2;8.19)
b.	*Catootje:* STAGE 4				
	sneeuw	/sneːw/	→	[snyː]	(2;4.23)
	snaren	/ˈsnaːrə[n]/	→	[ˈsnaːʀə]	(2;5.23)
c.	*Robin:* STAGE 4				
	sneeuw	/sneːw/	→	[sneːw]	(2;2.27)
	snavel	/ˈsnaːvəl/	→	[ˈsnɑufəl]	(2;2.27)
d.	*Enzo:* STAGE 4				
	smeren	/ˈsmeːrə[n]/	→	[ˈfmeːʀə]	(2;5.9)
	snoepje	/ˈsnuːp͡jə/	→	[ˈsnuːp͡jɛ]	(2;6.11)

To summarise, at stage 1 children produce target fricative–nasal clusters either as fricatives, or as nasals in case fricatives are not yet part of their system. As soon as fricatives become part of their system, they are produced instead of nasals. Apparently, the child first produces the head of the complex onset, the obstruent, unless that obstruent is not yet part of his or her system, and the sonorant is. Both stage 2, at which the sonorous part of the cluster is produced, and stage 3, at which fricative–liquid clusters are produced for target fricative–nasal clusters, are optional. Finally, at stage 4 the target cluster is produced correctly. This is schematised in (69):

(69) *Realisation and development of initial fricative–nasal clusters*

STAGE 1′	STAGE 1	STAGE 2	STAGE 3	STAGE 4
[N]	F	[N/L]	[FL]	FN

4.3.6. Fricative–glide clusters

The only adult target words with a fricative–glide cluster are those beginning with /zv-/. Fricative–glide clusters are reduced to fricatives by most children, if they have words with this cluster at all, and if fricatives are part of their system, as shown in (70):

(70)

a.	*Enzo:* STAGE 1				
	Zwitserland	/ˈzvɪtsərˌlant/	→	[ˈsɪtsɪˌlant]	(1;11.8)
	zwart	/zvart/	→	[fat]	(2;3.14)
	zwembad	/ˈzvɛmˌbat/	→	[ˈsamˈbat]	(2;3.14)
b.	*Robin:* STAGE 1				
	zwemmen	/ˈzvɛmə[n]/	→	[ˈfɪmə]	(1;10.21)
	zwaaien	/ˈzvaːjə[n]/	→	[ˈfaːjə]	(2;0.4)
	zwart	/zvart/	→	[sart]	(2;3.22)

Tirza has a second stage, at which she focuses on the sonorant part of the cluster, which she realises as a liquid (stage 2), before producing a cluster (stage 3). This resembles the acquisition of fricative–nasal clusters (65). Once clusters are produced they again take the form of a fricative–liquid cluster, being less marked than a fricative–glide cluster. The stages are given in (71):

(71) *Tirza*

a.	STAGE 1				
	zwembad	/ˈzvɛmˌbɑt/	→	[ˈsɪmbɑt]	(2;0.18)
b.	STAGE 2				
	zwart	/zvɑrt/	→	[lɑt]	(2;2.0)
c.	STAGE 3				
	gezwaaid	/χ əˈzvaːjt/	→	[slaːjt]	(2;5.21)

Catootje's development resembles that of Tirza, except that there are no data representing stage 1 (fricative–glide → fricative). Note that she has liquids and glides before fricatives. Recall that in the acquisition of fricative–liquid clusters, she first had liquids, followed by a stage at which she had fricative–liquid clusters, while there was no stage at which she produced just fricatives instead of clusters. Moreover, fricative–nasal clusters are produced as nasals (61c). In other words, it seems that there are no data representing stage 1. At her first stage (which I will nevertheless refer to as stage 2) she realises fricative–glide clusters as glides, before realising them correctly at stage 4 (stage 3, the optional stage at which a fricative–liquid cluster is produced, is skipped).

(72) *Catootje*

a.	STAGE 2				
	zwarte	/ˈzvɑrtə/	→	[ˈvɑtə]	(2;4.9)
	zwaan	/zvaːn/	→	[ˈvaːn]	(2;5.9)
b.	STAGE 4				
	zwanen	/ˈzvaːnə[n]/	→	[ˈzvaːnən]	(2;5.9)
	zwaan	/zvaːn/	→	[zvaːn]	(2;5.9)

Recall that Catootje also realised the liquid in plosive–liquid clusters as glides, before they were produced as liquids.

The developmental patterns are given in (73):

(73) *Realisation and development of initial fricative–glide clusters*

STAGE 1	STAGE 2	STAGE 3	STAGE 4
F	[G/L]	[FL]	FG

4.3.7. /s/-plosive clusters

We already saw in section 3.3 that /s/-plosive clusters are analysed differently from plosive–liquid clusters in the adult language, but the question here is how children acquire these clusters. *All* children first reduce these clusters to a plosive (stage 1), the least sonorous consonant and the one acquired earliest. For example, clusters consisting of an /s/ plus a plosive are invariably reduced to the plosive by Jarmo, even from 2;2.27, when fricatives are invariably produced as fricatives in onset position, as shown in (74):

(74) *Jarmo:* STAGE 1

stoel	/stuːl/	→	[tyː]	(1;9.23)
		→	[tuː]	(2;0.4)
spelen	/ˈspeːlə[n]/	→	[ˈteːlə]	(2;1.8)
stuk	/stʉk/	→	[tyːs]	(2;1.22)
stoel	/stuːl/	→	[tuːf]	(2;3.9)

Clusters of an /s/ plus a plosive are reduced even in the final recording section at 2;4. They clearly behave differently from clusters consisting of an obstruent and a liquid. Let us now turn to the other children.

Like Jarmo, Enzo,[26] Eva and Leonie reduce /s/-plosive clusters to plosives during all recording sessions. This seems to be the first step for all children. For most children the next step is the production of the whole /s/-plosive cluster. However, Tirza has an intermediate stage at which she realises only the /s/. At stage 3 she realises the cluster correctly. Her development is illustrated by the data in (75):

(75) *Tirza*

a. STAGE 1

stukken	/ˈstʉkə[n]/	→	[ˈtœkɪ]	(1;11.8)
ingestopt	/ˈɪnχəˌstɔpt/	→	[ˈʔɑχəˌtɔpt]	(1;11.8)
step	/stɛp/	→	[tɛp]	(1;11.19)

b. STAGE 2

stoel	/stuːl/	→	[suː]	(2;0.5)
staart	/staːrt/	→	[ʃaːt]	(2;1.17)
spuit	/spœyt/	→	[sœyt]	(2;2.25)

[26] Enzo has some interesting production forms for adult target words with /sp/ onsets. The word *spelen* /ˈspeːlən/ is produced by him as [ˈplaːmə]. Thus he produces a cluster, but one of the obstruent–liquid type which are already part of his system. Other forms are *stok* /stɔk/ which he produces as [kʀɔk], and *sterretje* /ˈsterə͡ʧjə/, produced as [ˈtʀɑʀə͡ʃjə].

c. STAGE 3

staart	/staːrt/	→	[staːt]	(2;5.5)
spoken	/ˈspoːkə[n]/	→	[ˈspoːkə]	(2;5.5)
spijker	/ˈspɛikərs/	→	[ˈspɛikɪs]	(2;5.21)

The developmental patterns in the acquisition of /s/-plosive clusters are given in (76):

(76) *Realisation and development of initial /s/-plosive clusters*

STAGE 1	STAGE 2	STAGE 3
P	[s]	sP

4.3.8. /s/-fricative clusters

The only /s/-fricative cluster in Dutch is the /s χ/ cluster. Since this cluster consists of two fricatives, the prediction is that it behaves as a fricative at the initial stages. This is exactly what we find. Let us first investigate how Jarmo treats these clusters. The /s χ/ clusters behave just as single fricatives: they are replaced by /h/ or plosive at the initial stage (77a); from 2;2.27 they are produced as fricatives, as shown in (77b). In all cases the /s/ is deleted. For Jarmo we did not record any correct productions of /s χ/ clusters.

(77) *Jarmo*

a. STAGE 1

schaar	/s χ aːr/	→	[haːɹ], [taːɹ]	(1;10.9)
schildpad	/ˈs χ tɪˌpɑt/	→	[ˈtiːtaːt]	(1;11.20)
schoenen	/ˈs χ uːnə[n]/	→	[ˈkuːŋə]	(2;0.4)

b. STAGE 2

schoenen	/ˈs χ uːnə[n]/	→	[ˈ χ uːnə]	(2;2.27)
schommel	/ˈs χ ɔməl/	→	[ˈ χ ɔmoːɹ]	(2;2.27)

Eva generally replaces /s χ/ clusters by /h/ at the initial stage (stage 1). Subsequently, she realises them as fricatives (stage 2). Elke and Robin first realise these /s χ/ clusters as plosives (stage 1), and subsequently as fricatives (stage 2). Tom, Leon and Tirza, realise them as fricatives (stage 2), and at the next stage as /s χ/ clusters (stage 3). Examples are given in (78):

(78) a. STAGE 1

(i) *Eva*

schoenen	/ˈs χ uːnə[n]/	→	[ˈhɔŋə]	(1;4.26)
schommel	/ˈs χ ɔməl/	→	[ˈhɔmɔ]	(1;6.15)

(ii) *Elke*

schoen	/sχuːn/	→	[tuːʃ]	(1;6.25)
schoenen	/ˈsχuːnə[n]/	→	[ˈpuːmə]	(1;9.24)

(iii) *Robin*

schoen	/sχuːn/	→	[puːm]	(1;7.27)
schoen	/sχuːn/	→	[puːn]	(1;8.19)

b. STAGE 2

(i) *Eva*

schoen	/sχuːn/	→	[suːn]	(1;9.8)
schaap	/sχaːp/	→	[saːp]	(1;9.8)

(ii) *Elke*

schommel	/ˈsχɔməl/	→	[ˈfoːΦə]	(1;11.28)
schildpad	/ˈsχɪlˌpɑt/	→	[ˈχɪpɑt]	(2;3.27)

(iii) *Robin*

school	/sχoːl/	→	[zoː]	(1;9.10)
schoppen	/ˈsχɔpə[n]/	→	[ˈfɔpɪ]	(1;10.21)
schep	/sχɛp/	→	[sɛp]	(2;4.29)

(iv) *Tirza*

schoenen	/ˈsχuːnə[n]/	→	[ˈχuːnə]	(1;9.11)
schelp	/sχɛlp/	→	[seːp]	(1;10.22)
schop	/sχɔp/	→	[χɔp]	(1;10.22)

c. STAGE 3

(i) *Tirza*

schommelen	/ˈsχɔmələ[n]/	→	[ˈsχɔmələ]	(2;3.27)
schaap	/sχaːp/	→	[sχaːp]	(2;3.27)

(ii) *Leon*

schep	/sχɛp/	→	[sχɛp]	(2;5.13)
school	/sχoːl/	→	[sχoːl]	(2;8.5)

Noortje reduces all clusters consisting of an /s/ plus a fricative to /h/, as she does with all fricatives in initial position. This is also the first step in Catootje's development. However, she skips the second stage (/sχ/ → /χ/). The next step for Catootje is very interesting: she has a /s-h/ cluster, of which the /s/ is syllabified with the previous syllable, if any (79a); otherwise, the /s/ is deleted (79b); syllabified on its own (79c) or an epenthetic vowel is inserted before the /s/, as shown in (79d):

(79) *Catootje*

a.	nieuwe schoenen	/ˈniːwə ˈsχuːnə[n]/	→	[ˈnyːz ˈhuːnə]	(2;4.12)
	inschenken	/ˈɪnˌsχɛŋkə[n]/	→	[ˈɪns ˈhɪŋkə]	(2;4.26)
	handschoentjes	/ˈhɑnˌsχuːn͡tʃəs/	→	[ˈɑnsˈhuːn͡tsəs]	(2;5.22)
b.	schoenen	/ˈsχuːnə[n]/	→	[ˈhuːnə]	(1;11.23)

c.	schep	/sχ ɛp/	→ [sːˈhɛp]	(2;4.12)
d.	schoenen	/ˈsχ uːnə[n]/	→ [əsˈhuːnə]	(2;5.8)
	schapen	/ˈsχ aːpə[n]/	→ [əsˈhaːpə]	(2;5.8)
	schommel	/ˈsχ ɔməl/	→ [əzˈhɔmə]	(2;5.22)

There are a few other forms with epenthesis in the data: the forms in (80) have an epenthetic vowel inserted between the /s/ and the following obstruent:

(80) a. *Robin*

stoel	/stuːl/	→ [sʉˈtuː]	(1;8.24)
skateboarden	/ˈskeːtˌbɔːrdə[n]/	→ [ˈsɪkəˈbɔɹlə]	(2;4.29)
		→ [səˈkeːˈbɔɹlə]	(2;4.29)

b. *Jarmo*

sturen	/styːr/	→ [səˈtyːlə]	(2;2.27)

Finally, Leonie realises these clusters as nasals (81), presumably by a harmony process.[27]

(81) *Leonie*

schoenen	/ˈsχ uːnə[n]/	→ [ˈŋuːŋɪ]	(1;10.29)
schommel	/ˈsχ ɔməl/	→ [ˈnɔmɪ]	(1;11.25)

(82) summarises the developmental patterns in the acquisition of /sχ/ clusters:

(82) *Realisation and development of initial /s/-fricative (/sχ/) clusters*

STAGE 1	STAGE 2	STAGE 3
h/P	F	sF

4.3.9. Clusters consisting of three consonants

Finally, there are clusters consisting of three consonants: /stɾ/, /spɾ/, /spl/ and /sχr/. These clusters behave like a combination of plosive–liquid clusters and /s/-plosive clusters. At the initial stage, they are reduced to plosives by all children, as shown in (83):

[27] Nasal harmony has been reported in the literature (cf. Waterson 1971, 1987), but is rarely found in the Dutch data.

(83) a. *Jarmo:* STAGE 1

struisvogel	/ˈstrœysˌvoːχəl/	→	[ˈtœysˈfoː	oːl] (2;1.22)

b. *Tirza:* STAGE 1

straat	/straːt/	→	[taːt]	(2;0.18)

c. *Robin:* STAGE 1

springen	/ˈsprɪŋə[n]/	→	[ˈpɪŋnoː]	(1;10.21)
straat	/straːt/	→	[taːt]	(1;11.7)

If plosive–liquid clusters are produced as such by the child, but /s/-plosive clusters are not, then /s/-plosive–liquid clusters are reduced to plosive–liquid clusters (84).

(84) a. *Jarmo:* STAGE 2a

strand	/strɑnt/	→	[tlœynt]	(2;3.9)

b. *Tirza:* STAGE 2a

strooien	/ˈstroːjə[n]/	→	[ˈtʀoːjə]	(2;3.27)

c. *Catootje:* STAGE 2a

springen	/ˈspʀɪŋə[n]/	→	[ˈpʀɪŋə]	(2;4.9)
strakjes	/ˈstrɑk͡jəs/	→	[ˈdʀɔk͡jəs]	(2;5.23)

However, if plosive–liquid clusters are not yet produced as such, but /s/-plosive clusters are, then /s/-plosive–liquid clusters are treated as if they were /s/-plosive clusters, as shown in (85):

(85) *Robin:* STAGE 2b

springen	/ˈsprɪŋə[n]/	→	[ˈspɪnə]	(2;1.26)
straks	/strɑks/	→	[stɑks]	(2;3.22)
struisvogel	/ˈstrœysˌvoːχəl/	→	[ˈstɑusˈfoːχə]	(2;3.22)
strand	/strɑnt/	→	[stɑnt]	(2;4.29)

At the final stage the clusters are produced as in the adult target, as in (86):

(86) a. *Tirza:* STAGE 3

stroop	/stroːp/	→	[stʀoːp]	(2;6.12)

b. *Leon:* STAGE 3

straat	/straːt/	→	[stʀaː]	(2;3.18)
strand	/strɑnt/	→	[stʀɑnt]	(2;4.15)

(87) summarises the different developmental paths that are possible:

(87) *Realisation and development of initial /s/-plosive–liquid clusters*

	STAGE 1	STAGE 2	STAGE 3
a.	P	PL	sPL
b.		sP	

4.4. Summary

Again, despite variation in the developmental order and the exact stages through which development takes place, there are clear generalisations.

1. The following provides a summary of the developmental patterns found in the acquisition of a certain cluster type (horizontal rows). Note that the stages for each cluster type are not stages in real time. However, the vertical columns give a broad idea of the way different stages in the development of a particular cluster type correspond to those of other cluster types, although one has to keep in mind that this picture generalises over the patterns of all children. For example, Robin only has /s/-plosive clusters; plosive–liquid clusters are not produced. However, this is not reflected in (88). I will show below (point 7 of this section) for each child in more detail what the order is in which cluster types are acquired.

(88) *Overview of developmental patterns in the acquisition of onset clusters*

A

	target	STAGE 1	STAGE 2	STAGE 3	
1	**PL**	P	[L]	[PG] PL	
2	**PG**	P		PL PG	
3	**PN**	P	[L]	PL PN	

B

	target	STAGE 1	STAGE 2	STAGE 3
1	**FL**	P F	[L]	[PL] FL
2	**FG**	F	[G/L]	FL FG
3	**FN**	F	[N/L]	FL FN

C

	target	STAGE 1	STAGE 2	STAGE 3
1	**sP**	P	[s]	sP
2	**sF**	P F		sF

D

	target	STAGE 1	STAGE 2	STAGE 3
1	**sPL**	P	PL or sP	sPL

Several observations can be made from (88):

a. The development of onset clusters consisting of an obstruent plus a sonorant (88A, B) goes through three stages: (i) only the least sonorous element is produced (stage 1); (ii) the other element (the more sonorous

one) is produced on its own (stage 2); (iii) a cluster is produced (stage 3). Not all stages are obligatory; not all children go through all stages; stage 2, especially, is often skipped. Children seem to adopt different strategies in acquiring a cluster: some have an intermediate stage 2 at which they realise only the more sonorous element of the cluster, before combining both (for example Leonie and Tirza). Others skip this stage.

A similar pattern is found for /s/-plosive clusters (88C): (i) at the first stage these clusters are reduced to plosives; (ii) there is an optional stage at which /s/ is realised; (iii) the cluster is produced as such.

Tripositional clusters also show three main stages: (i) at the first stage these clusters are reduced to plosives; (ii) at the second stage they are either produced as plosive–liquid clusters or as /s/-plosive clusters; (iii) at the final stage these clusters are produced as tripositional onsets. We will see below that /s/-obstruent clusters differ in a principled way from obstruent–sonorant clusters.

b. The initial stage in the acquisition of all cluster types is similar: all clusters are reduced to plosives. At a later point during stage 1 fricatives also occur. Target plosive–liquid clusters are the first type of cluster actually produced as clusters by the children. Some of the children realise the cluster as a plosive–glide cluster before realising the target cluster correctly. The next type of cluster that is produced correctly by the child are fricative–liquid clusters. Since children already have plosive–liquid clusters, target fricative–liquid clusters are sometimes, prior to the correct realisation, produced as plosive–liquid clusters. Similarly, plosive–glide and plosive–nasal are also produced as plosive–liquid clusters, and fricative–glide and fricative–nasal clusters are produced as fricative–liquid clusters before being produced correctly.

c. (88) further shows that the second stage for fricative–liquid clusters starts later than the second stage in plosive–liquid clusters. The same is true for the third stage. (88) also shows that /s/-obstruent clusters in general are acquired late; moreover, /s/-fricative and tripositional clusters are mastered even later than /s/-plosive clusters.

2. That cluster reduction is a commonly found phenomenon is implicit in the core syllable hypothesis, in which the core syllable consists of a single consonant followed by a vowel. (89) schematises the repair strategy used for complex onsets consisting of a plosive plus a liquid. Only one consonant fits into the template and the child favours the least sonorous consonant to maximise the sonority difference between the two members of the syllable. The liquid then simply does not fit into the child's template and is deleted. The cluster is never deleted, even if optional onsets are part of the child's system, giving support to the core syllable hypothesis.

(89) *Repair strategy for complex onsets (plosive–liquid)*

Adult target onset		Onset in the child's production form
PL	→	P

The repair strategy 'replace' is often used to deal with segment types and/or clusters which are not yet part of the child's system. For example, fricative–liquid clusters are reduced to a single consonant at the early stages. If fricatives are not part of the child's system, the child uses the same repair strategy as for singleton fricatives: they are often replaced either by plosives or by /h/. Only in the acquisition of fricative–nasal clusters do children sometimes behave differently. Instead of producing the fricative (or its substitute) at stage 1, some children prefer the nasal. After plosives, nasals are the first type of segment to appear in onset position. Nasals invariably appear much earlier than fricatives in onset position, and children who produce a nasal at this stage do not have fricatives yet, which explains the variation shown in section 4.3.5.

3. Sometimes epenthesis takes place before the cluster is produced, indicating that the maximal onset parameter is not yet set so as to allow clusters, but that the child realises that two consonants are needed for a correct production of the adult target. This can be seen as a repair strategy: in order to accommodate two consonants, while the onset allows only one, epenthesis of a vowel makes it possible to create two onsets. That this is a repair strategy can be seen by the lack of epenthesis in clusters acquired later: here the onset already can absorb two consonants, which makes the repair strategy 'epenthesis' redundant. Although not yet all types of consonant cluster are produced correctly, the child nevertheless realises two consonants. S/he now applies another repair strategy for clusters that are not yet mastered: replacing them by clusters that s/he is able to produce.

4. The first clusters to be produced tend to show a maximal sonority contrast between the members of the cluster. Not all children make a distinction between liquids and glides with respect to sonority, but none of the children produces target plosive–liquid or plosive–glide clusters as plosive–nasal clusters. All children differentiate between nasals on the one hand and approximants (liquids and glides) on the other. Not all children differentiate between liquids and glides. However, if they do, they prefer plosive–glide clusters over plosive–liquid clusters (as was shown for Catootje, Jarmo and Elke). However, once plosive–liquid clusters are acquired (eventually after a stage at which they were produced as plosive–glide clusters), children no longer replace liquids by glides in other clusters, but rather prefer liquids as the second member of the onset. Both

plosive–nasal and plosive–glide clusters are produced as plosive–liquid clusters. It seems that the child's own system plays an important role in further development of his or her phonological system. This issue will come back at various points in the dissertation.

5. The child language data shows sometimes clusters that are not allowed in adult Dutch, for example, /tl/, /dl/, /pv/ and /fm/ clusters. What these clusters have in common is that they share place of articulation. These clusters are not allowed in Dutch (and many other languages). Examples of these clusters in child language data can be found in (21).

6. Most children start with obstruent–sonorant clusters. However, Noortje and Robin have /s/-plosive clusters before obstruent–sonorant clusters. The way in which these clusters are acquired is different from the way obstruent–sonorant clusters are acquired. This is especially clear in the way Catootje deals with /s/-obstruent clusters: the /s/ is syllabified in the previous syllable if possible, or epenthesis takes place before the /s/, not between the two members of the cluster.

7. The following schema gives the order in which clusters are produced accurately by each child.

(90) *Order in which cluster types (adult target cluster types) are acquired per child*

a.	sP										(Robin, Noortje)
b.	PL	>	FL	>	PG	>	sP	>	sF		(Tom)
	PL	>	FL	>			sP	>	sF		(Tirza)
	PL	>					sP				(Elke)
	PL	>	FL	>			sP				(Catootje)
	PL	>	FL	>	PG	>	PN	>	FN		(Enzo)
	PL	>	FL								(Jarmo)
	PL	>	FL	>	PG	>	sF,sP	>	FG,PN		(Leon)

8. That some children start with /s/-plosive clusters while most other children start with plosive–liquid clusters is also reflected in the way they deal with /s/-plosive–liquid clusters. The first group of children reduce these clusters (after an initial stage, shared by all children, at which these clusters are reduced to plosives) to /s/-plosive clusters. On the other hand, the second group of children reduce these clusters to plosive–liquid clusters.

After this description of onsets in the children's language, let us now turn to the explanation of the different observations.

4.5. Discussion

In section 4.2, I argued for a developmental pattern for single onsets based on parameters. The transition from single onsets to complex onsets can also be viewed as a change in the setting of the parameter which I will call the 'maximal onset' parameter (section 4.5.1). In section 4.5.2, I will focus on the difference in the acquisition of complex onsets between Noortje and Robin, both of whom start with /s/-plosive clusters, and the other children, who all start with obstruent–sonorant clusters. We will see below that the two groups of children start setting different parameters to the marked value. In section 4.5.3, I discuss the different types of obstruent–sonorant clusters and relate them to the language-particular constraints for onset clusters in Dutch. Finally, in section 4.5.4 I give a summary of the parameters discussed in this chapter.

4.5.1. The 'maximal onset' parameter

Since all languages have syllables with simple onsets, but not all languages allow complex onsets, the parameter setting 'onsets are maximally binary' is more marked than 'onsets are maximally unary'. Furthermore, all children acquire complex onsets much later than singleton onsets and empty onsets. That is, no child has complex onsets but lacks onsetless syllables. In other words, the parameter setting which allows complex onsets is set after the parameter which allows onsets to be optional. It seems that the child first focuses on the minimal extension of the syllable (onsets can be empty), and then on the maximal extension of the syllable (onsets are maximally binary). I will refer to these parameters as the 'minimal onset' and the 'maximal onset' parameters respectively. These two parameters can in principle define four types of languages. First, there are languages which only allow syllables with onsets, but do not allow complex onsets (91a). This seems to be the default option for both the minimal and the maximal onset parameter. The first stage in the acquisition of onsets is a stage at which all syllables have onsets, and all onsets are singleton, that is, both parameters have the default value. Second, there could be languages which do not allow complex onsets, but in which onsets are not obligatory (91b). These have the default value for the onset maximality parameter, but the marked value for the onset minimality parameter. This seems to be the second stage in the acquisition of onsets. Third, there could be languages which allow complex onsets, and allow onsetless syllables (91c). That is, they have the marked value for both the onset maximality parameter and the onset minimality parameter. This is the third stage in the development of onsets. Fourth, there could be languages

which allow complex onsets, but do not allow onsetless syllables (91d). These have the marked value for the maximality parameter, and the default value for the minimality parameter. The possibilities are given in (91):

(91)

	MINIMAL ONSET PARAMETER			MAXIMAL ONSET PARAMETER	
a.	1	$\leq$	Onset positions	$\leq$	1
b.	0	$\leq$	Onset positions	$\leq$	1
c.	0	$\leq$	Onset positions	$\leq$	2
d.	1	$\leq$	Onset positions	$\leq$	2
	DEFAULT VALUE: 1			DEFAULT VALUE: 1	

The data give evidence for intermediate grammars in which (91a, b, c) are true. However, (91d) is not attested. No child had complex onsets without having optional onsets. This seems to suggest that the two parameters are not independent, but that they are ordered. We have to be careful, since we are dealing with only twelve children and one language. If it appears that there are children who have complex onsets without having optional onsets, the parameters could be independent of each other. Also, if the four kinds of languages described above all exist, the two parameters are not ordered but independent. However, to my knowledge no language requires the parameter settings of (91d). Furthermore, the acquisition data suggest that if the fourth option (91d) is attested, it is a more marked state of affairs, since this state of affairs is not attested in child language, while the other three (91a, b, c) are. Therefore, the two parameters seem to be dependent. In fact, they can be stated as a single parameter with three values, as in (92) The most marked value (92c) implies the less marked values (92a) and (92b). The marked value (92b) implies the unmarked or default value (92a). This can be stated as follows:

(92)

	'Onset parameter'	
a.	Number of onsets is equal to 1:	On = 1
b.	Number of onsets is equal to or smaller than 1:	On $\leq$ 1
c.	Number of onset positions is equal to or smaller than 2:	On $\leq$ 2
*d.	Number of onset positions is equal to or smaller than 2, but larger than 1.	1 $\leq$ On $\leq$ 2

where **c** $\Rightarrow$ **b** $\Rightarrow$ **a**, and $\Rightarrow$ means 'implies'

Without assuming onsets as linguistic primitives, one would have to replace 'number of onset positions' in (92) by 'number of consonants preceding the first mora of the syllable and being part of that same syllable' or in terms of (91) that syllables can start with vowels (minimality parameter), and maximally with two consonants (maximality parameter). If the onset is not

a constituent one significant observation is hard to account for: the fact that the first complex onsets are those in which the two consonants differ maximally in sonority. We already saw that children first produce CV syllables in which the C is the least sonorous consonant, a plosive. This is the maximal contrast in sonority within the constituent, the syllable. When onset clusters are first produced the two members of the clusters differ maximally in sonority. That is, the two members of the constituent 'onset' differ maximally in sonority. If there is no onset constituent we would have to say that the distance in sonority should be maximal between the two consonants preceding the first mora of the syllable, but why this should be so is unclear. Rather, the optimal consonant cluster could just as well have been one consisting of a plosive plus a nasal, since then the sonority increases gradually towards the peak of the syllable. Crucially, however, plosive–nasal clusters appear only very late, and if they are selected for production they are frequently produced as plosive–liquid clusters by most children.

4.5.2. Branching onsets or extrasyllabic consonants?

Most children acquire plosive–liquid clusters before /s/-obstruent clusters, as was shown in (90). Thus, most children show the same development for onsets as Jarmo, whose development is schematised in (93) (see 90b):

(93) *Onset development of Jarmo*

C	→	(C)	→	PL	→	FL
		1;6.13		1;8.12		2;4.1

However, Robin and Noortje differ in this respect because they first have /s/-plosive clusters (90a). (94) schematises their development patterns for the acquisition of onsets.

(94) *Onset development of Noortje and Robin*

C	→	(C)	→	/s/-P
1;7.14		2;1.17		2;9.26

How can we account for this difference in developmental patterns? Generally, it is assumed that syllables obey the Sonority Sequencing Principle (henceforth SSP) (see chapter 3). Obstruent–sonorant clusters obey this principle, but /s/-obstruent clusters clearly do not. They form a notorious problem for a theory in which the SSP plays a central role in defining the well-formedness of syllables. Nevertheless, these clusters are accepted in language after language. In the literature we find different

solutions to handle these clusters, which I will now review briefly.

On the assumption that the SSP is a universal principle, there are three possible analyses of /s/-obstruent clusters: (i) /s/-obstruents are viewed as COMPLEX SEGMENTS (Fudge 1969, Fujimura & Lovins 1978, Ewen 1982, Selkirk 1982, Broselow 1991, van de Weijer 1993); (ii) they are regarded as a simple onset (the obstruent) preceded by a consonant (/s/), which is outside the scope of the onset (or syllable), i.e., it is EXTRASYLLABIC (Trommelen 1983 for Dutch); (iii) /s/ forms an exception to the sonority hierarchy (as Booij (to appear) assumes for Dutch). Alternatively, (iv) the SSP as universal principle is given up. Cairns & Feinstein (1982) and Cairns (1988) replace the SSP by a theory of segmental markedness, which determines what the unmarked fillers for each structural position in the syllable are. In such a theory /s/ is the unmarked segment type to fill the leftmost position of a tripositional cluster.

Since the importance of the sonority hierarchy in child language has already been shown, I will first review the possibilities on the assumption that the SSP is a universal primitive. I will give arguments from child language against the complex onset analysis for /s/-obstruent clusters. Then I will argue that the extrasyllabicity analysis can give an adequate account of the data. This is not true for an analysis in which /s/ is marked as an exception. The latter analysis poses difficulties for learnability theories, which assume that exceptions are learned late. Why this is so, and how exceptions are learned, will be discussed in chapter 7. Furthermore, an analysis which simply marks /s/ as an exception to the SSP is neither falsifiable, nor does it make interesting predictions. Therefore, I will not discuss this possibility here. Finally, I will show that the analysis of Cairns (1988) does not make the right predictions, and is therefore falsified. Although the child language data can be better described in terms of the theory proposed by Cairns & Feinstein (1982), I will show that it does not have enough explanatory power.

If the sonority hierarchy is a linguistic primitive, and therefore part of UG, the child is endowed with it. As soon as branching onsets are allowed, we expect onsets of the type obstruent–sonorant. Most children indeed learn these clusters before they learn /s/-obstruent clusters. Since the latter type of clusters are typically reduced to the obstruent part when obstruent–sonorant clusters are produced as clusters, children apparently consider these clusters to be of a different type. However, this is not learned knowledge, but follows from the universal SSP: /s/-obstruent clusters simply cannot be 'real' clusters because they do not obey the sonority hierarchy. However, how do we explain the fact that there are children who first acquire /s/-plosive clusters?

The two theories, the one assuming that /s/ is extrasyllabic, the other assuming that /s/ plus obstruent form a complex segment, make different

predictions with respect to acquisition.

Theories in which /s/-plosive clusters are viewed as complex segments must allow a particular view of the SSP to account for the behaviour of clusters consisting of two fricatives, /sχ/ clusters, which are usually *not* viewed as complex segments. In this view of the SSP, the sonority hierarchy must, first of all, assign different sonority values to plosives and fricatives, and second, in such a view the first consonant of an onset cluster may not be higher on the sonority hierarchy than the second, but it may be of equal sonority value, allowing clusters consisting of two fricatives. Moreover, we expect /s/-plosive clusters to behave differently from /sχ/ clusters, which should pattern with the obstruent–sonorant clusters. However, /sχ/ clusters clearly pattern with the /s/-plosive clusters in child language. That is, the /s/ is generally deleted.

There is another argument against the complex segment analysis. It is an implicational universal that if a language has complex segments like the ones we are talking about here, it also has fricatives. However, even those children, for example Noortje and Catootje, who have /s/-plosive clusters do not necessarily have initial fricatives. Initial fricatives are often replaced by plosives /h/.

Furthermore, if /s/ plus plosive is a complex segment, epenthesis is not expected. Nevertheless, we find a few cases in which a vowel is inserted between the /s/ and the following obstruent, as shown by the data in (80), here repeated as (95), arguing against the complex segment analysis:

(95)					
	stoel	/stuːl/	→ [sʁˈtuː]	*Robin*	(1;8.24)
	skateboarden	/ˈskeːɪˌbɔːrdə[n]/	→ [ˈsɪkəˈbɔɹlə]	*Robin*	(2;4.29)
			→ [səˈkeːˈbɔɹlə]	*Robin*	(2;4.29)
	sturen	/styːr/	→ [səˈtyːlə]	*Jarmo*	(2;2.27)

If the complex segment is reduced it can in principle be reduced to either a plosive or to a fricative. However, it is almost invariably the plosive part that is retained if reduction takes place. If the two members of clusters can be of the same sonority value, we would furthermore expect more clusters of that type.

Moreover, Catootje's data, in which we often find an epenthetic vowel before the /s/ in both /s/-plosive clusters and /sχ/ clusters (96), but not before other clusters, are not easy to explain, assuming the complex segment analysis. First, if epenthesis occurs before a (complex) segment like /st/, why does it not occur before other segments? Moreover, if it occurs before a /sχ/ cluster (which has to be viewed as a bipositional cluster obeying the SSP, we would expect that epenthesis occurs before other onset clusters as well. However, these data are not attested, while epenthesis before /sχ/ clusters and before /s/-plosive clusters *is* attested (96):

(96) *Catootje*

a.	schapen	/ˈsχaːpə[n]/	→	[əsˈhaːpə]	(2;5.8)
	schoen	/sχuːn/	→	[əsˈhuːn]	(2;5.8)
	schildpad	/ˈsχɪlˌpɑt/	→	[əsˈhøːlˌpɑt]	(2;5.8)
	misschien	/mɪˈsχiːn/	→	[ˌmɨsˈhiːn]	(2;5.22)
b.	staart	/staːrt/	→	[əsˈtaːt]	(2;5.8)
	stoel	/stuːl/	→	[əsˈtuːl]	(2;5.22)

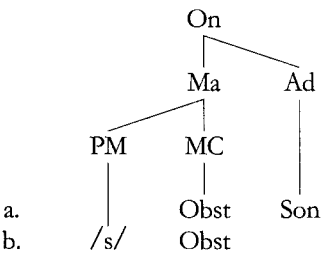
These findings clearly argue against a complex segment analysis of /s/-obstruent clusters.

This leaves us with the second possibility, that is, /s/-obstruent clusters are not real clusters. That is, the /s/ is not part of the syllable, but instead is EXTRASYLLABIC. In this view, children who start with /s/-obstruent clusters do not have branching onsets at all, but do allow extrasyllabic consonants. Only those consonants which do not obey the sonority hierarchy can be made extrasyllabic. Extrasyllabicity is not used as a repair strategy: Robin and Noortje do not produce obstruent–sonorant clusters at all. These are simplified to a single segment. However, it could have been the case that these clusters were analysed as a single onset plus an extrasyllabic consonant, and thus produced as a cluster. However, this is never the case, clearly arguing that only segments that do not obey the sonority hierarchy lie outside the scope of the syllable. Further evidence for this view comes from Catootje, in (96), who inserts a vowel before the /s/ and clearly has a syllable boundary between the /s/ and the following obstruent. This epenthesis particularly applies to /s/-fricative clusters (96a). Catootje does not have fricatives in initial position. Initial fricatives in the adult targets are usually replaced by /h/. This is also the case with the /χ/ in /sχ/ clusters. However, /h/ is only produced in syllable-initial position. The /χ/ in the cluster must therefore be in onset position, while the /s/ is outside the scope of the syllable. On the other hand, children who do not have /s/-obstruent clusters, but only allow obstruent plus sonorant clusters, do not allow extrasyllabic consonants. The possibility of having extrasyllabic consonants must be defined by a parameter, just like the possibility of allowing complex onsets. These parameters seem to be independent. Some children first set the extrasyllabicity parameter to the marked value, while others first set the 'maximal onset' parameter to the marked value. In this analysis no adjustments to the SSP have to be made: both /s/-plosive and /s/-fricative clusters form exceptions to this principle, which explains why these clusters pattern together. Furthermore, the epenthesis data in (95) and (96) are regarded as a repair strategy in this analysis: the /s/ cannot be incorporated in the syllable, and can therefore only be realised by making

it either the onset or the coda of a new syllable. We saw above that epenthesis in obstruent–sonorant clusters occurs before the parameter which allows onset clusters is set. The same logic applies to the epenthesis data in (95) and (96). This analysis also explains the lack of epenthesis before other clusters and before single onsets: they are incorporated into the syllable. Therefore, no repair strategy is needed. It can be concluded that the extrasyllabicity analysis is superior to the complex segment analysis. However, let us also review the fourth possibility: allowing tripositional onset templates.

A theory in which the onset contains subconstituents can easily express the difference between the two sorts of consonant clusters. Cairns & Feinstein (1982) argue for a hierarchically structured onset, as shown in (97):[28]

(97)



On = Onset
Ma = Margin
Ad = Adjunct
PM = Premargin
MC = Margin Core
Obst = Obstruent
Son = Sonorant
/s/ = /s/

This theory does not rely on the sonority hierarchy as a theoretical primitive, but instead is connected to a theory of markedness. Obstruents are the unmarked members in the Margin Core, although in principle this position can be filled by any consonant. That is, if only one consonant is produced as an onset, it fills the Margin Core, which is the head of the onset. The /s/ in /s/-obstruent clusters is the unmarked member in Premargin and sonorants (and more specifically liquids) are the unmarked members in the Adjunct position. Thus, in obstruent–sonorant clusters the obstruent fills the Margin Core, while the sonorant occupies the Adjunct position (97a). In /s/-obstruent clusters the /s/ fills the Premargin, while the obstruent fills the Margin Core (97b). /s/-obstruent clusters are not related to obstruent–sonorant clusters in this model. This means that children can choose to expand onsets in two different ways: (i) by allowing Margin Core-Adjunct clusters, that is, obstruent–sonorant clusters; or (ii) by allowing Premargin-Margin Core clusters, that is, /s/-obstruent clusters. This is in fact what the data show. Some children start with /s/-obstruent clusters, while (most) others start with obstruent–sonorant clusters. Cairns & Feinstein therefore take the onsets along the first parameter (obstru-

[28] See also van Zonneveld (1988), who proposes a slightly different analysis on the basis of acquisition data.

ent–sonorant) to be a category of onsets which is distinct and independent from the onsets along the second parameter (/s/-obstruent). They give the following phrase structure rules for onsets, along with the markedness values:

(98)					
	a.	On	→	Ma	Unmarked
	b.	On	→	Ma Ad	Marked
	c.	Ma	→	MC	Unmarked
	d.	Ma	→	PM MC	Marked

These rules express that the least marked onset consist of only the Margin Core, that is a single onset. There are two equally marked options, as given in (98b, d): onsets consisting of a Margin Core and an Adjunct (98b), and onsets consisting of the Premargin and the Margin Core (98d).

In principle, /sl/, /sn/ and /sm/ clusters can constitute either a PM-MC cluster or a MC-Ad cluster. Cairns & Feinstein argue that universal markedness dictates that the Premargin is filled only by an /s/, but not that every /s/ is in the Premargin position; it can be in the Margin Core as well. The predictions the theory makes are (i) that children who have expanded their onset in such a way that they allow MC-Ad clusters, but not PM-MC clusters, treat these /s/-sonorant clusters just as other obstruent–sonorant clusters, and (ii) that children who expand their template such as to allow PM-MC clusters, but not MC-Ad clusters, are predicted to treat /s/-sonorant clusters as PM-MC clusters, under the assumption that the child tries to come as close to the adult target as is possible, given his or her template. However, only the first prediction is borne out by the data. It has been shown that Jarmo, who only has MC-Ad clusters treats, /sl/ clusters like the other fricative–liquid clusters (see section 4.3.4), and differently from /s/-obstruent clusters (see sections 4.3.7 and 4.3.8). However, the data from Noortje, who only has PM-MC clusters, point to the same conclusion. /s/-sonorant clusters are treated like other fricative–sonorant clusters, as shown in (99a, b). Nevertheless, she realises the /s/ as such in /s/-plosive clusters, as shown in (99c). Apparently, fricatives (or rather /s/) can be realised in the Premargin, but not in the Margin Core: they are invariably replaced by /h/ in that position during all recording sessions.

(99) *Noortje*

a. *Fricative–sonorant* → */h/*

fles	/flɛs/	→	[hɛs]	(2;3.7)
vlieger	/ˈvliːχər/	→	[ˈhiːχaː]	(2;8.15)
glijbaan	/ˈχlɛiˌbaːn/	→	[ˈhɛimˌpaːm]	(2;9.12)

b.	*/s/-sonorant* → */h/*				
	slak	/slɑk/	→	[hɑk]	(2;4.4)
	snoep	/snuːp/	→	[huːp]	(2;5.23)
	zwemmen	/ˈzvɛmə[n]/	→	[ˈhɛmɑ]	(2;8,1)
c.	*/s/-obstruent* → */s/-obstruent*				
	stuur	/styːr/	→	[styː]	(2;11.0)

The same is true for Robin (100). Fricative–liquid clusters are produced as fricatives by Robin (100a). /s/ plus liquid clusters behave in the same way (100b) and, furthermore, they behave differently from /s/-obstruent clusters, which are realised as clusters (100c):

(100) *Robin*

a.	*Fricative–sonorant* → *fricative*				
	vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈfiːsɑχ]	(2;1.26)
	mevrouw	/məˈvrɑuw/	→	[fɑ]	(2;2.27)
b.	*/s/-sonorant* → */s/*				
	slapen	/ˈslaːpə[n]/	→	[ˈsaːpə]	(2;2.27)
	sloot	/sloːt/	→	[soːt]	(2;3.10)
c.	*/s/-obstruent* → */s/-obstruent*				
	spin	/spɪn/	→	[speːn]	(2;1.26)
	stuk	/stʉk/	→	[stʌk]	(2;1.26)
	springen	/ˈsprɪŋə[n]/	→	[ˈspɪnə]	(2;1.26)
	schop	/sχɔp/	→	[sχɔp]	(2;3.10)

Although it is not impossible to express the above-mentioned patterns in the theory of Cairns & Feinstein, it presupposes that the child has an 'analysis' of the different onset clusters in the adult targets. That is, although in principle /s/ plus sonorant clusters can be analysed as PM-MC clusters, the child treats them as if they are MC-Ad clusters. However, since these latter clusters are not allowed by the child's template, they are repaired, that is, they are reduced. Crucially, they are never repaired in such a way that /s/-sonorant clusters are realised as clusters, nor is the sonorant replaced by an obstruent. However, assuming that the child tries to come as close as possible to the adult target, and given that s/he already has PM-MC clusters, we would expect that s/he would realise the cluster as a PM-MC cluster. On the other hand, if the child has analysed these clusters as MC-Ad clusters (or as not PM-MC clusters), why does s/he not realise these clusters as such? Furthermore, if these clusters can be analysed as PM-MC clusters which are allowed in the child's system, why does s/he not produce them as such? The same is true for children who start with the so called

MC-Ad clusters. They have to have an analysis for /s/-obstruent clusters, to treat them differently from obstruent plus sonorant clusters. It seems that this theory is not restrictive enough to explain the acquisition facts.

One solution would be to stipulate that the Premargin can only contain segments that do not obey the SSP. However, Cairns & Feinstein crucially do not accept the SSP as a universal principle.

In Cairns (1988) the view that PM-MC and MC-Ad clusters are equally marked is given up. He assumes that fricative–obstruent clusters presuppose obstruent–liquid clusters. In other words, (98d) is said to be more marked than (98b). This theory is less adequate, since it cannot handle the acquisition data at all. This theory predicts that if the child has clusters consisting of an /s/ plus an obstruent, it has also clusters consisting of an obstruent plus a sonorant. This, however, is empirically falsified by the data. If anything, the child language data argue in favour of the older view.

Stipulating a tripositional onset template in which the leftmost position can only be filled by /s/ and only if it is an exception to the SSP, as for example assumed in Booij (to appear), has the advantage that the distinction between /sl/ and /s/-plosive clusters is made on the basis of whether a cluster obeys the sonority hierarchy or not. It is expected that /sl/ clusters are treated just like other fricative–liquid clusters, which is borne out. However, we now have to assume that children who acquire /s/-plosive clusters before plosive–liquid clusters are learning exceptions before they are learning the regular patterns, which is odd from the perspective of a learnability theory. Chapter 7 deals with learnability theories in detail. I refer the reader to this chapter for the elaboration of the argument. Moreover, if /s/ can be an exception to the sonority hierarchy, why can other segments not form exceptions?

To summarise, four proposals have been considered. Children who start with /s/-obstruent clusters can have learned one of four things: they have learned that onsets can be bipositional, but do not have to obey the sonority hierarchy; that is, they have either learned (a) that Premargin–Margin Core onsets are allowed, but not Margin Core–Adjunct clusters or (b) that /s/ forms an exception to the sonority hierarchy; alternatively, they have not learned that onsets can branch, but rather, (c) that there is an extrasyllabic consonant, namely the consonant which does not obey the sonority hierarchy or (d) that /s/-plosive clusters are complex segments.

I have given the following arguments against the first possibility, the Premargin-Margin Core hypothesis. First, a theory which allows onset-internal constituency has to assume that the child has an analysis of the adult onsets, but nevertheless, allows only one type of onset (Premargin–Margin Core clusters); that is, even clusters which could in principle be analysed as Premargin-Margin Core clusters, such as /sl/ clusters, are

analysed as Margin Core-Adjunct clusters, but since the child's template only allows Premargin–Margin Core clusters, they are reduced. This is very counterintuitive and furthermore, we would expect to find repair strategies, which are not attested. Second, if the sonority hierarchy as a linguistic primitive is given up, other consonant clusters, for example those not obeying the sonority hierarchy are expected, but not attested. Third, it remains unclear why epenthesis applies before the Premargin, but not before the Margin Core. Furthermore, /s-h/ clusters, as found in the data from Catootje (96a), are very marked in this theory. However, they are attested at the early stages in phonological acquisition. Fourth, the theory is not restrictive. It does not make the right predictions, although it can handle all cases descriptively.

To simply stipulate that clusters can be tripositional but that the leftmost element of the cluster, usually /s/, can be an exception to the sonority hierarchy, does not provide insights as to why this can be so. From a learnability perspective, one has to assume that children who have /s/-obstruent clusters before obstruent–sonorant clusters start by learning exceptions. This is not unproblematic, as we will see in chapter 7. Moreover, if tripositional onsets are possible, we might as well expect clusters consisting of the type obstruent–nasal–liquid, which are never attested either in adult Dutch or in the Dutch child language data.

The complex segment analysis was rejected on the basis of the following arguments. First, /s/ plus plosive and /s/ plus fricative are treated by the children as if they have the same structure; if reduced, both clusters are reduced by deleting the /s/. If realised, both /s/-plosive and /s/-fricative clusters are realised. However, in the complex segment analysis /s/-plosive 'clusters' are viewed as complex segments, whereas /sχ/ clusters are bipositional onsets. The similar behaviour of /s/-plosive clusters and /sχ/ clusters is unexpected, as is the different behaviour of plosive–liquid clusters and /sχ/ clusters. Second, a vowel is sometimes inserted between the /s/ and the following obstruent, thus breaking up a single, though complex, segment. Third, the existence of affricates presupposes the existence of fricatives (Jakobson 1941/68), but this is not borne out by the data. Children having /s/-plosive 'clusters' do not necessarily have fricatives. Fourth, if complex segments (/s/-plosive 'clusters') are reduced they are invariably reduced to plosives, while we would expect to find fricatives as well. Fifth, the complex segment analysis must allow a version of the SSP which allows clusters of two consonants with the same sonority value. However, /sχ/ clusters are the only type of cluster with this characteristic. No other clusters with two consonants of the same sonority value are attested. Sixth, the data in (96) show that epenthesis only occurs before /s/-obstruent

'clusters' and not before any other clusters nor before single segments. On the assumption that /s/-plosive 'clusters' are complex segments, it remains unexplained why epenthesis does not occur before other single onsets. Why epenthesis only occurs before /s/-fricative clusters and not before any other clusters is not accounted for. Moreover, it is unclear why /s/-plosive clusters and /s/-fricative clusters pattern together in this respect.

Finally, arguments in favour of the extrasyllabic nature of the /s/ in /s/-obstruent clusters are the following. First, the sonority hierarchy as a linguistic primitive restricts the extrasyllabic consonant to /s/ preceding obstruents, and explains why only clusters not obeying the sonority hierarchy are treated differently. The prediction is that, for example, /sl/ and /kn/ clusters are treated differently from /s/-obstruent clusters because the former obey the sonority hierarchy, while the latter do not. This is borne out by the data. Second, the /s/ is often syllabified as the coda of the previous syllable if it is followed by an obstruent in the data from Catootje (79, 96). If there is no previous syllable, one is supplied by inserting a vowel before the /s/, as in the data from Catootje. This does not happen to single fricatives or fricatives followed by a sonorant: these fricatives in initial position are replaced by /h/ in Catootje's data. Third, the second fricative in /sχ/ clusters is also replaced by /h/ while /h/ is only realised in onset position. Therefore, the /χ/ must be in onset position.

Therefore, I conclude that besides the onset parameter given in (92), there is an independent parameter for extrasyllabicity, given in (101), in which the default value is underlined:

(101) *Extrasyllabicity parameter*
Can consonants at the left edge, which violate the Sonority Sequencing Principle be extrasyllabic? Yes/<u>No</u>

That is, the default setting for the extrasyllabicity parameter is that initial extrasyllabic consonants are not allowed. To set the parameter to the marked value positive evidence is required, and is available in the case of Dutch.

That the onset and the extrasyllabicity parameters are independent can also be seen in the way tripositional /s/-plosive–liquid clusters are treated. Children who have set parameter (92) to the marked setting (c), that is, their template allows complex onsets, and (101) to the unmarked setting, that is, they do not allow extrasyllabic consonants at the left edge of the syllable, realise these clusters as plosive–liquid clusters, while children who have the default value for parameter (92), that is, they do not allow clusters, and the marked value for (101), that is, extrasyllabic consonants are allowed, reduce these clusters to /s/-plosive clusters. If both parameters are default (unmarked), the result is a plosive, while if both parameters are in the

marked setting the cluster is produced correctly. All four possibilities are found in the data, although, of course, not all are found in the data from one child.

4.5.3. Language-specific onset constraints

In the previous section I have argued for a maximally branching onset, both of whose members have to obey the SSP. Segments that do not obey this principle can only be licensed by extrasyllabicity. This means that for Dutch the only segment that can be extrasyllabic is /s/. However, only the /s/ in /s/-obstruent clusters can be made extrasyllabic, not the /s/ in /s/-sonorant clusters. How does this proposal relate to proposals in the established literature?

So far, I have distinguished /s/-obstruent clusters from obstruent–sonorant clusters, as if these were the only two types of clusters. Although this is largely true, there is some disagreement on certain cluster types. For example, Trommelen (1983) argues that /s/ followed by *any* consonant is extrasyllabic. This claim is also made for /k/ followed by /n/. The argument for this comes mainly from medial clusters which are divided over two syllables, that is, which do not behave as onset clusters, as can be seen in (102):

(102)	a.	Os-lo	*O-slo	'Oslo'
		is-lam	*i-slam	'Islam'
		ac-ne	*a-cne	'acne'
		jas-mijn	*ja-smijn	'jasmine'
	b.	*mat-ras	ma-tras	'mattress'
		*cyc-lus	cy-clus	'cycle'
		*mat-roos	ma-troos	'sailor'

That /s/ in clusters behaves differently is further supported by the fact that the only fricative that can be followed by a nasal is /s/. Furthermore, the only other obstruent which can combine with a nasal in the onset is /k/. These distributional arguments leads Trommelen to the conclusion that the initial consonants in these clusters are extrasyllabic, although they obey the SSP.

However, the acquisition data do not give much support for this view: as we saw above, /sl/ clusters behave just like other fricative–liquid clusters, and differently from /s/-obstruent clusters. Furthermore, /kn/ clusters are also treated as plosive–liquid clusters by all children, even those children who have /s/-plosive clusters before plosive–liquid clusters.

The analysis of Trommelen is less restrictive from a learnability point of view than the position I assumed above, namely that only consonants at the

edge that do not obey the sonority hierarchy can be extrasyllabic. Given Trommelen's analysis the child has to learn language-specific properties that do not follow from other principles, but which have to be deduced from distributional patterns. This does not necessarily mean that Trommelen's analysis of Dutch is wrong. It may still be valid for adult Dutch. However, it is clear from the acquisition data that children start with a more general approach, namely, that only segments which violate the sonority hierarchy can be extrasyllabic. It might be the case that at a later stage the child is able to deduce from distributional patterns that initial /s/ in all clusters and /k/ in /kn/ clusters are extrasyllabic. This would require implicit negative evidence, since no positive evidence will be available. To deduce the evidence, children need to have medial clusters in words like *Oslo*, *acne*, etc. These words are typically absent in the children's vocabulary at least until the age of three (at which point I stopped recording).

Although one could say that all obstruent–sonorant clusters are of one type, the fact that not all combinations of obstruents and sonorants constitute well-formed onsets needs to be explained. The syllable template of Dutch is constrained in several ways, as was discussed in sections 3.1 and 3.3. Not only sonority requirements and the number of available skeletal positions but also language-specific constraints restrict the possible syllable types. To repeat the above-mentioned example, although plosive–nasal clusters obey the sonority hierarchy and are not totally prohibited, because, although /kn/ is a possible onset cluster, /pn/, /bn/, /tn/ and /dn/ clusters are not allowed. On the other hand, although almost all combinations of obstruent–liquid are allowed, /tl/ and /dl/ are not,[29] but they are frequently produced by children, unlike clusters with a nasal as its second member, which are rare in child language. It is often claimed that /tl/ and /dl/ clusters, and for that matter, /pv/, /bv/, /fv/ and /fm/ clusters, are prohibited in adult Dutch because of the Obligatory Contour Principle (OCP) (Booij to appear), which states that adjacent identical elements on the melodic tier are prohibited (Leben 1973, McCarthy 1986, 1989). In the examples above, both members of the clusters have the same place feature specification: in the first case both elements are coronal, while in the second case both elements are labial.[30] Although it is true that Dutch has a constraint which prohibits onset clusters of which both members share

[29] /sr/ is not allowed on the surface, although some researchers claim that it is, since many people produce /sχr/ clusters as /sr/ clusters. Trommelen (1983) assumes that /str/ is underlying /sr/. The /t/ is an intrusive stop. Since these clusters play a marginal role in child language I will not discuss them further.

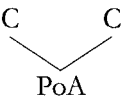
[30] This does not explain why the OCP does not hold for /tr/ and /dr/ clusters, of which both elements are also coronal. Yet these clusters occur freely. Again, this issue must await further research.

place of articulation features, these clusters can only be ruled out by the OCP if we assume the representation in (103a). However, since coda clusters often share place of articulation features and are not prohibited by the OCP, they should have the representation in (103b). It remains unclear why onset consonants and coda consonants are represented differently. Moreover, since obstruents in onset clusters may not differ in there specification for the feature [voice], i.e., /sb/ clusters are prohibited, it seems that in this case representation (103b) with respect to voice is required for onsets. More generally, the OCP does not prohibit adjacent segments from sharing features, but prohibits two adjacent segments with the same place of articulation (103a). In other words, (103a) is prohibited, but not (103b):

(103) a.

PoA = Place of Articulation

b.



Homorganic onset clusters would have to be represented as (103b), although Dutch has a constraint prohibiting such representations for place of articulation in onset clusters, since plosives and sonorants in onset clusters which share place of articulation features are generally prohibited.

However, as Levelt (1993, to appear) has pointed out, children seem to favour words with one single place of articulation per word at the early stages of acquisition. She argues against a consonant harmony account or a planar segregation account (McCarthy 1989, McDonough & Meyers 1991), and gives strong arguments for a consonant–vowel interaction account and for an account in which templates play a crucial role. The consonant–vowel interaction account explains why consonants preceding front vowels (which are [coronal] in Levelt's account) often have a coronal place of articulation, while consonants preceding round vowels (which are considered to be [labial]) are often labial. Examples of both cases are given in (104a, b):

(104) *Eva's CV-interaction data*

a.	brood	/broːt/	→	[boːp]	(1;4.12)
	poes	/puːs/	→	[puːf]	(1;4.12)
	slof	/slɔf/	→	[pɔf]	(1;4.12)
	koffie	/ˈkɔfiː/	→	[ˈpɔfiː]	(1;6.1)
b.	bed	/bɛt/	→	[dɛt]	(1;4.12)
	bijten	/ˈbɛitə[n]/	→	[ˈdɛitə]	(1;4.26)
	Bert	/bɛrt/	→	[dɛt]	(1;4.26)
	vis	/vɪs/	→	[dɪs]	(1;6.1)

Crucial for the discussion here is that in child language place features are often specified for a string of segments. Words with many different places of articulation are mastered only quite late. This same tendency is found in clusters, as is shown in the data in (105).[31]

(105)		*Jarmo*				
	a.	trein	/trɛin/	→	[tlɛi]	(1;10.9)
		strand	/strɑnt/	→	[tlœynt]	(2;3.9)
		drinken	/ˈdrɪŋkə[n]/	→	[ˈtlɪŋkɑ]	(2;4.1)
	b.	broek	/bruːk/	→	[pʋuːk]	(2;3.9)
		blokjes	/ˈblɔk͡jəs/	→	[ˈpʋɔχ͡jəs]	(2;3.9)[32]

In other words, the child has to learn to segmentalise the place features.[33]

It is important to note that the child receives no positive evidence for the clusters in the child's production forms in (105). Yet they are frequently produced at the early stages. The child has to discover that these clusters are absent in the target language, i.e., s/he has to make use of indirect negative evidence. The child has to learn from the absence of onset clusters which share place of articulation that Dutch has a constraint which prohibits such onset clusters. Such evidence is available to the child, since his production forms with homorganic onset consonants never match the adult target forms. This constraint is clearly learned later than the parameter setting which allows complex onsets. This confirms the hypothesis that language-specific constraints lie outside the scope of the core grammar, which means that these constraints are not learned on a parametric basis. It is crucial that

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[31] This in itself is an argument against the planar segregation account of consonant harmony in which consonants and vowels are on different planes, which explains why consonants can spread across vowels without violating the crossing constraint (association lines may not cross; Goldsmith 1976a, b). However, crucial in this account is that the child's syllable template is restricted in such a way that given a string of consonants and a string of vowels the linear order of consonants with respect to vowels is entirely predictable. This is arguably not the case if the child's template already allows complex clusters. See Levelt (1993, to appear) for further discussion.

[32] These data also illustrate the templatic constraints mentioned in Levelt (1993, to appear): if [labial] is mapped onto a word template it will preferably map onto the left edge of the word, while [dorsal] is preferred at the right edge. [coronal] is considered the default place of articulation. The reader is referred to Levelt (1993, to appear) for an extensive discussion of this process.

[33] It could be the case that it is much harder to process words which contain segments with different places of articulation. That is, the fact that children favour one single place feature per word could be a performance constraint rather than a competence constraint. Nevertheless, the child has to learn that these clusters are not allowed in the language. Although the constraint is found in many languages, it is by no means universal.

parameter values are learned on the basis of positive evidence only, but that implicit negative evidence is required to learn language-specific constraints. Even if the child were to get explicit negative evidence as to the ungrammaticality of homorganic onset clusters, it has never been shown that this kind of evidence works. Rather, the only way to 'recover' from these 'disallowed' clusters is by using implicit negative evidence. Thus, the child has to deduce from the data that consonant clusters sharing one place of articulation cannot be in a single onset.[34]

A different but related issue is the fact that all obstruent–sonorant adult targets are produced as obstruent–liquid/glide by most children. That is, obstruent–liquid/glide clusters seem to be the least marked cluster type for onsets. Obstruent–nasal clusters are first realised as obstruent–liquid (or glide) clusters, the members of which often share place of articulation at the early stages. This may explain why we often find /pʋ/ clusters and /tl/ clusters. Since there are no labial liquids, we often find a glide instead after labials. However, /tn/ clusters do not occur, although they also share place of articulation features. It seems that in order to change the cluster from the unmarked $(\text{obstruent–approximant})_{\text{place}}$ to obstruent–nasal or obstruent–glide clusters in which both members have their own place of articulation there has to be positive evidence available to the child.[35] Therefore, we do not expect to find overgeneralisations of obstruent–nasal clusters to obstruents other than /k/ and /s/. These are not attested either. Universally, obstruent–liquid clusters are less marked than obstruent–nasal clusters (Cairns 1988). In other words, to allow obstruent–nasal clusters the marked option for clusters must be chosen. This is done on the basis of positive evidence. Thus, the non-existence of, for example, /pn/ clusters is of a different nature than the non-existence of /pʋ/ or /tl/ clusters.

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[34] If we assume that the OCP is a universal parameter, rather than a principle, then the child language data seem to indicate that the unmarked value for this parameter is the one underlined in (i), since the child is producing clusters with one place of articulation.

(i) *Obligatory Contour Parameter*
Are identical adjacent elements on melodic tier X allowed? Yes/No
(X = Place of Articulation features)

The question now is 'how can the child receive positive evidence on the basis of which s/he is able to change the parameter value from the unmarked default value to the marked value?' I think that the answer is that s/he can never receive such positive evidence. Therefore, I assume that the OCP is a language-particular constraint which has to be learned on the basis of implicit negative evidence. This explains why this constraint is learned rather late.

[35] I use the term approximant to refer to both liquids and glides.

4.5.4. Summary of the parameters

Let us now summarise the parameters we have discovered so far. We have seen that the 'minimal onset' and the 'maximal onset' parameters are not independent, but rather form one parameter, as shown in (92), here repeated as (106). The child starts with the parameter in the default setting (a). On the basis of positive evidence, the existence of onsetless syllables, the parameter can be switched to (b), but not directly to (c), since (c) implies (b). Evidence in the data for the marked setting (c) comes from onset clusters.

(106) *'Onset parameter'*

a. Number of onsets is equal to 1: $On = 1$
b. Number of onsets is equal to or smaller than 1: $On \leq 1$
c. Number of onset positions is equal to or smaller than 2: $On \leq 2$

where **c** ⇒ **b** ⇒ **a**

This parameter excludes (107), which would be possible if the 'minimal onset' and the 'maximal onset' parameters were independent:

(107) *Number of onset positions is equal to or smaller than 2, but larger than 1: $*1 \leq On \leq 2$.

The 'extrasyllabicity' parameter has been shown to be independent of the one in (106). This parameter is repeated here as (108):

(108) *Extrasyllabicity parameter*
Can consonants at the left edge which violate the Sonority Sequencing Principle be extrasyllabic? Yes/<u>No</u>

The default value of the parameter is the one underlined in (108). Evidence for the marked setting comes from consonant clusters that do not obey the sonority hierarchy. Only consonants that do not obey the universal SSP can be licensed by extrasyllabicity.

We have further seen that language-particular constraints, such as the one which prohibits homorganic consonants in onsets, are learned on the basis of implicit negative evidence: the absence of homorganic onset clusters leads to the acquisition of such constraints. These language-specific constraints lie outside the scope of the core grammar, which is fixed by parameter setting, and are typically learned later.

Finally, in section 4.2 we saw that the acquisition of different manner of articulation features can also be parametrised (109). Although the issue of acquisition of manner features is not the main topic of this dissertation, and more research is needed to complete the parametrisation, it nevertheless seems that the first steps are general. As with the onset parameters, the different manner of articulation parameters also seem to be dependent. That

different manner of articulation parameters also seem to be dependent. That is, the value of (109a) represents the default manner of articulation: plosives. Evidence for the marked setting comes from syllables with nasals in onset position (109b). The marked setting (109b) implies the setting of (109a). Similarly, the marked setting (109c) implies that also nasals are present.

(109) *Parameters of manner of articulation features in single onsets*

a. Onsets are non-continuant obstruents (plosives)

b. Onsets can be non-continuant sonorants (nasals)

c. Onsets can be continuant consonants (other manners of articulation)

where **c** ⇒ **b** ⇒ **a**

This relationship between or dependency of the parameters can be represented in a tree structure like the one in (17). However, I will leave this issue for future research.

After this elaborate discussion of onsets let us now turn to the acquisition of rhymes and rhyme constraints.

5 The Acquisition of Syllable Structure: the Rhyme

IN THIS CHAPTER I focus on developmental patterns in the acquisition of rhymes. Rhyme structure in Dutch has several characteristics that children have to learn (see also chapter 3). First, Dutch syllables can be closed by any consonant except /h/. Second, Dutch has both long and short vowels. Third, the vowel length contrast only manifests itself in closed syllables; in open syllables only long vowels occur. This is captured by the minimal rhyme constraint (see (12) in chapter 3), which states that Dutch rhymes are minimally bipositional. Thus, Dutch has syllables ending in VC, VVC and VV, but V rhymes are disallowed, as shown in (1).

(1)

	Closed Syllable	*Open Syllable*
Short vowel	–VC	*–V
Long vowel	–VVC	–VV

In section 5.1 I give a description of the stages found in the acquisition of rhymes. We already saw in chapter 4 that children start with a core syllable template consisting of a consonant followed by any vowel (stage I). It was mentioned in chapter 3 that at this stage the vowel length contrast is not yet mastered.[1] This will be confirmed in this chapter. Since the vowel length contrast in Dutch only exists in closed syllables, I hypothesise that children first have to acquire final consonants before they can learn the vowel length contrast.[2] This hypothesis is confirmed in section 5.1.

However, the matter is slightly more complicated. We will see that when final consonants first appear, they are exclusively realised as obstruents (stage II). Moreover, I will show that not only are sonorants acquired later

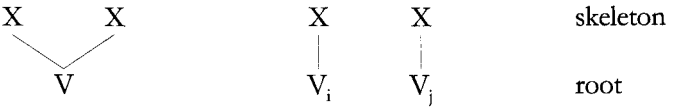
[1] Length has been transcribed on the basis of auditory judgements by the trained listener; not by measurement.

[2] Stress facts cannot guide the child in the acquisition of the vowel length contrast, since, although Dutch is a quantity-sensitive language, long vowels do not count as heavy, but as light (see sections 3.4 and 5.5, and chapter 7).

(at stage III), but they also behave differently from obstruents in another respect. Sonorants show a strong relationship with the preceding vowel, while no such relationship exists for obstruents. I will argue in section 5.3 that obstruents are in the coda; sonorants in the nucleus. I will further show that at stage III children begin to represent vowel length in some, but not all circumstances. I will argue that, since at this stage rhymes are maximally bipositional, reflecting the fact that the maximal rhyme constraint (see (16) in chapter 3) is important at the early stages of acquisition, the vowel length contrast does not show up before obstruents. Moreover, long vowels never show up before sonorants in the child's output forms. At stage IV the vowel length contrast is represented in all environments. I will argue that at this stage the extrarhymal position is also learned.

Besides short and long vowels, Dutch also has diphthongs. It was argued in chapter 3 that short vowels followed by a consonant (VC), long vowels (V_iV_i) and diphthongs (V_iV_j) all occupy two positions in the rhyme. The difference between long vowels and diphthongs is that the former have one feature matrix which is shared by both skeletal slots, while the latter have two feature matrices, one for each skeletal slot. This can be represented as follows (see also section 3.3):

(2) a. *Long vowel* b. *Diphthong*



Diphthongs can either be represented as a sequence of two vowels, or as a short vowel followed by a glide. Given the standard analysis of Dutch syllable structure, the former would be represented by a branching nucleus; the latter by a rhyme branching into a nucleus and a coda. However, as we will see in section 5.3, in child language sonorant consonants appear to be in the nucleus, contrary to the standard analysis of adult Dutch. Moreover, I will show that diphthongs pattern with long vowels both with respect to phonotactic restrictions and with respect to weight. In section 5.5 I anticipate the results of chapter 7, where we will see that, once the child has set the quantity-sensitivity parameter, short vowels followed by sonorants behave as heavy, but diphthongs (and long vowels) as light.

Another characteristic of Dutch syllable structure is that VVC and VCC only occur word-finally. Non-final rhymes are minimally and maximally bipositional (Kager 1989, among others): they either consist of a short vowel closed by a consonant, VC, or of a long vowel, V_iV_i, or diphthong, V_iV_j. Word-finally, a bipositional rhyme can be followed by another consonant. In chapter 3, I argued that this consonant is directly linked to the syllable node if it obeys the Sonority Sequencing Principle (SSP); i.e., it is extra-

rhymal, but not extrasyllabic. The difference between extrarhymal and extrasyllabic consonants lies in the fact that the former obey the SSP, but the latter do not. Moreover, in chapter 7 it will be shown that in child language syllables ending in VVC are considered to be closed, and therefore heavy. If the final consonant were outside the scope of the syllable, syllable structure could not directly express this fact. I will show that this extrarhymal position is only acquired late (stage IV).

In adult Dutch, the presence of an extrarhymal consonant makes a syllable superheavy (see chapter 6). However, children do not seem to have a weight distinction between heavy syllables (VC) and superheavy syllables (VVC and VCC). Both are regarded as heavy. I therefore propose a weight parameter which interprets closed syllables as heavy. Weight is not uniquely represented in the syllable structure, but rather interpreted on the basis of syllable structure: syllables ending in a consonant are heavy.

The extrarhymal consonant can be followed by an appendix (which is extrasyllabic). I argue that these consonants, which do not obey the SSP, are in the appendix. The appendix maximally consists of three coronal obstruents. In this respect initial extrasyllabic consonants (see chapter 4) and final appendices are similar. They do not obey the SSP, and are outside the scope of the syllable. They are therefore adjoined at the level of the word (see chapter 3), not to the syllable node. Both initial and final extrasyllabic consonants are coronal obstruents (see also chapter 4). The appendix is only acquired very late: very few children produced forms with an appendix.

The organisation of this chapter is as follows. I give a description of the characteristic properties of each stage of the development in section 5.1. Section 5.2 summarises the results. Section 5.3 provides a discussion of the stages and gives a formal account. In section 5.4 I discuss the predictions for final and medial consonant clusters. In section 5.5 issues regarding diphthongs, length and weight are discussed. Section 5.6 briefly compares some aspects of the acquisition of singleton onsets with single final consonants. Finally, section 5.7 gives a summary of the main results and the parameters discussed.

5.1. Developmental stages in the acquisition of rhymes

The description of the developmental stages in the acquisition of rhymes is based on final stressed syllables. This means that the discussion is mostly restricted to monosyllabic words and words with stress on the final syllable, such as *konijn* /koːˈnɛin/, *giraf* /ʃiːˈraf/ and *kalkoen* /ˌkalˈkuːn/. Single intervocalic consonants will not be discussed, since it is hard to know whether the stressed syllable in words like *mama* /ˈmamaː/ and *papa*

/'pɑpaː/ is regarded as closed by the child.[3] However, I discuss the acquisition of medial consonant clusters in section 5.4.2. I will discuss Jarmo's development in detail, and mention other children briefly. Appendices F and G provide information about some of the other children.

5.1.1. Stage I: the core syllable

In chapter 4, I presented some evidence for the core syllable hypothesis, i.e., the hypothesis that children start with core syllables, which consist of a vowel preceded by precisely one consonant. In this section more evidence will be given in support of this hypothesis, since at the initial stages of acquisition the child produces no forms with final consonants.

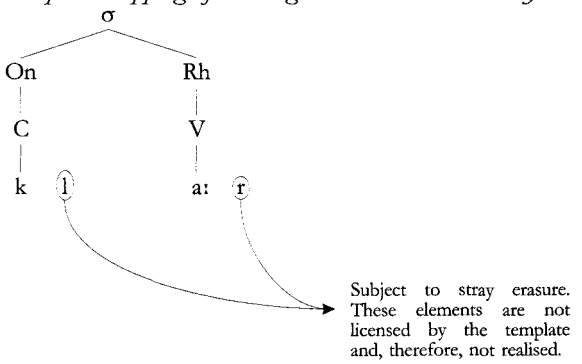
Jarmo has only open syllables until 1;6.13, at which age final consonants appear for the first time. Before the age of 1;6.13, adult target words with final consonants are 'repaired', that is, final consonants are not realised. Examples are given in (3):

(3)

	Jarmo				
a.	klaar	/klaːr/	→	[kɑ], [kaː]	(1;4.18)
b.	daar	/daːr/	→	[daː], [dɑ]	(1;5.2)
c.	poes	/puːs/	→	[puː]	(1;5.2)
d.	dit	/dɪt/	→	[tɪ], [tiː]	(1;5.2)
e.	tok	/tɔk/	→	[kɔ], [kaː]	(1;5.27)

Since Jarmo's syllable template at this stage does not allow final consonants, they simply cannot be mapped onto the child's template, and are subject to 'stray erasure': that is, they are not produced. This is shown in (4):

(4) *Template mapping of the target* klaar *onto the core syllable template*



[3] Recall that in adult Dutch it is regarded as closed: it is closed by an ambisyllabic medial consonant (see section 3.3).

In chapter 4, we saw that the core syllable, which consists of a consonant followed by a vowel, plays a crucial role in the acquisition of onsets: all syllables have onsets at the early stages of development. Thus, the default value for the onset parameter is that onsets are obligatory. Here again, the core syllable seems to determine the output of the initial stages, in that no syllable may be closed at the initial stages.

Another characteristic of the core syllable is that a consonant may be followed by any vowel. Crucially, core syllables are open syllables. Jarmo's data in (3) indeed show that final consonants are deleted no matter what kind of vowel precedes them. Moreover, words like *klaar* (3a) and *daar* (3b), which have long vowels in the adult target forms, are produced both with short and long vowels; and words like *dit* (3d) and *tok* (3e), which have short vowels in the adult target forms, are produced with long and short vowels as well. It is, therefore, clear that vowel length distinctions are not used systematically. There is no evidence then that long vowels are represented as bipositional at this stage. Therefore, I assume that all vowels are represented by one V slot at this stage and that length is purely phonetic.

Noortje (5a) and Tom (5b), too, have only core syllables during the first recording sessions. Both single final consonants and final consonant clusters are deleted, because they do not fit into the core syllable template. Again, vowel length contrast does not seem to be acquired.

(5)

a.	*Noortje*				
	woef	/vuːf/	→	[huː], [hʉ]	(1;7.14)
	koe	/kuː/	→	[kuː]	(1;8.26)
	gemaakt	/χə'maːkt/	→	[mɑ][4]	(2;0.10)
b.	*Tom*				
	paard	/paːrt/	→	[pɑ], [paː]	(1;1.7)
	broem	/bruːm/	→	[buː]	(1;1.21)
	dat	/dɑt/	→	[taː], [tɑ]	(1;2.27)

The other children already produce words with final consonants during the first recording session, indicating that the fact that the language allows closed syllables is learned early. However, although Elke sometimes realises codas at the first recording sessions, the fact that deletion of codas is still frequently attested in the data indicates that at a previous stage codas were not allowed. (6) gives some examples of final consonant deletion:

(6)

Elke				
dit	/dɪt/	→	[tɪ]	(1;6.4)
taart	/taːrt/	→	[taː]	(1;6.4)

[4] Final clusters will be discussed in section 5.4.1.

To summarise, the characteristics of stage I are that (i) the child only has core syllables, consisting of a consonant followed by any vowel, either long or short; (ii) final consonants are not realised; and (iii) vowel length is not yet represented; all vowels are represented by one V slot.

5.1.2. Stage II: the appearance of final obstruents

At stage II final obstruents appear in the child's production forms. From 1;6.13 syllable-final fricatives appear in Jarmo's forms (7):

(7) *Jarmo's final fricatives*

a. *Target fricatives*

deze	/ˈdeːzə/	→	[tɛiʃ]	(1;6.13)
deze	/ˈdeːzə/	→	[deːs]	(1;6.27)
poes	/puːs/	→	[puːs]	(1;7.29)

b. *Substitutions by fricatives*

paard	/paːrt/	→	[paːs]	(1;7.15)
bal	/bɑl/	→	[bɑΦ]	(1;8.12)
boot	/boːt/	→	[pɑuf]	(1;8.26)

At 1;7.15 final plosives appear in Jarmo's production forms, as shown in (8):

(8) *Jarmo: Final plosives*[5]

aap	/aːp/	→	[ɑp], [aːp]	(1;7.15)
eend	/eːnt/	→	[aːt]	(1;7.15)
schaap	/sχaːp/	→	[haːp], [hɑp]	(1;7.15)
eend	/eːnt/	→	[ɑt]	(1;7.29)

Sonorants are not yet produced in syllable-final position. They are most often not realised at all (9a); alternatively, they are replaced by fricatives (9b). Replacement is however far less frequent than deletion.

(9) *Jarmo*

a. *Deletion of final sonorants*

daar	/daːr/	→	[daː], [dɑ]	(1;6.27)
klaar	/klaːr/	→	[kaː]	(1;6.27)
bal	/bɑl/	→	[bɑ]	(1;7.15)
boom	/boːm/	→	[bɑu]	(1;7.29)

[5] Final plosives are found in onsetless adult words first (see Fikkert (in preparation) for a full discussion of the appearance of onset and coda consonants).

b. *Substitution of final sonorants*

bal	/bɑl/	→	[bɑΦ], [bɑf]	(1;8.12)
boom	/boːm/	→	[boːχ]	(1;8.12)
oor	/oːr/	→	[ɔχ]	(1;9.9)
leeuw	/leːw/	→	[heːŭf]	(1;11.20)

That fricatives are favoured in syllable-final position over other consonant types becomes clear if we consider the following observations. (i) Once fricatives are allowed in the child's template final fricatives are hardly ever subject to deletion. (ii) Fricatives are never replaced by other types of consonants in syllable-final position. However, fricatives in *onset* position are often replaced by plosives (see section 4.1). Forms like those in (10) are not attested:

(10)	poes	/puːs/	→	*[puːt], *[puːn], but [puːs]
	vis	/vɪs/	→	*[fɪt], *[fɪn], but [pɪs] or [piːs]

(iii) Fricatives often replace other types of consonants in syllable-final position, as is shown in (7b), (9b) and (11):

(11)	*Jarmo*			
	pad	/pɑt/	→	[pɑχ]	(1;8.26)
	fiets	/fiːts/	→	[piːs]	(1;9.9)
	hond	/hɔnt/	→	[hɔs]	(2;1.22)

(iv) A fricative is sometimes realised in the child's production form of an adult target word which consists of an open syllable, as shown in (12):

(12)	*Jarmo: Addition of a fricative in coda position*			
	ei	/ɛi/	→	[ɛis]	(1;10.9)
	bij	/bɛi/	→	[bɑç]	(2;1.8)

Finally, (v) at the initial stages of Jarmo's development a large percentage of the final consonants in his production forms are fricatives (about 60%), while a much smaller percentage are plosives (about 25%).

However, although final obstruents are now more often realised, the repair strategy, deletion, is also still utilised for final plosives, as shown in (13), indicating that the child is working on the relevant setting of the parameter, and that the default setting, 'closed syllables are not allowed', often takes precedence over the marked setting.

(13)	*Jarmo: Repair strategy*			
	kwak	/kvɑk/	→	[kaː], [kɔ]	(1;7.15)
	paard	/paːrt/	→	[paː]	(1;7.15)
	Dick	/dɪk/	→	[tɪ]	(1;8.12)
	paard	/paːrt/	→	[baː]	(1;8.12)
	boot	/boːt/	→	[poː]	(1;8.26)
	pad	/pɑt/	→	[pɑu]	(1;8.26)

That the default value can overrule the marked value for some time was also shown in chapter 4; for example, even when onsetless syllables have already been produced, the default setting for the onset parameter, 'onsets are obligatory', often overrules the marked setting, resulting in consonant-initial child production forms for onsetless adult target words.[6]

Let us briefly turn to the other children. When Elke starts realising final consonants, she also favours fricatives over any other type of consonants, as can be seen in (14a). The same is true for Noortje (14b) and Tom (14c):

(14)

a.	*Elke*				
	bad	/bɑt/	→	[bɑʃ]	(1;6.4)
	dit	/dɪt/	→	[diːʃ]	(1;6.4)
	kind	/kɪnt/	→	[kɪʃ]	(1;6.4)
	poes	/puːs/	→	[puːʃ]	(1;6.4)
	schoen	/sχuːn/	→	[tuːʃ]	(1;6.4)
	tas	/tɑs/	→	[tiːʃ]	(1;6.4)
	fiets	/fiːts/	→	[tiːʃ]	(1;6.25)
	uit	/œyt/	→	[tœyʃ]	(1;6.25)
b.	*Noortje*				
	bal	/bɑl/	→	[puːs]	(2;1.17)
	boom	/boːm/	→	[puːf]	(2;1.17)
	fiets	/fiːts/	→	[tiːs]	(2;1.17)
	poes	/puːs/	→	[puːs]	(2;1.17)
	stoel	/stuːl/	→	[tuːs]	(2;1.17)
c.	*Tom*				
	aap	/aːp/	→	[hɑuΦ]	(1;3.10)
	boek	/buːk/	→	[pœys]	(1;3.10)
	uit	/œyt/	→	[hœyΦ]	(1;3.10)
	boot	/boːt/	→	[boːf]	(1;6.11)
	hoed	/huːt/	→	[hʉs]	(1;6.11)
	stout	/stɑut/	→	[tɑuʃ]	(1;6.11)
	slak	/slɑk/	→	[pɑf]	(1;6.11)
	geit	/χɛit/	→	[tɛis]	(1;6.25)

The data in (14) show (i) that fricatives are produced as fricatives and (ii) that fricatives replace other manners of articulation. The other children did

[6] Recall from chapter 4 that two hypotheses were suggested: (i) the forms that still are subject to repair typically are older words in the child's vocabulary than the forms that are produced in accordance to the new parameter setting(s), and are slower to change; (ii) before fixing the parameter in the marked setting there is a period of hypothesis testing in which both the old forms and the new forms are produced.

not show this kind of substitution. They either already had different kinds of consonant types during the first recording session, or simply avoided words ending in consonants other than fricatives at the initial stages.[7]

As in Jarmo's data, sonorant consonants are replaced by fricatives (14) by both Elke and Noortje, or, alternatively, they are deleted (15). Examples of deleted sonorants are given in (15a) for Elke and (15b) for Noortje:

(15) a. *Elke: Deletion of sonorant consonants*

bal	/bɑl/	→	[bɑu]	(1;6.4)
daar	/daːr/	→	[dɑ]	(1;6.4)
banaan	/baˈnaːn/	→	[naː]	(1;7.8)
staan	/staːn/	→	[tɑ]	(1;7.8)
beer	/beːr/	→	[peː]	(1;7.22)
trein	/trɛin/	→	[tɛi]	(1;7.22)

b. *Noortje: Deletion of sonorant consonants*

boom	/boːm/	→	[puː]	(2;1.17)
stoel	/stuːl/	→	[kuː]	(2;1.17)
daar	/daːr/	→	[taː]	(2;1.17)
trein	/trɛin/	→	[tɛi]	(2;1.17)

I hypothesised that vowel length distinctions can only be learned when the child has closed syllables. At this stage closed syllables indeed occur, although they are invariably closed by an obstruent. Does the child also represent vowel length distinctions at this stage?

Let us look at the percentages of vowel length errors at this stage, which I assume to be from 1;6.13 (when the first closed syllables appear) until 1;9.23, when final sonorants are realised correctly in more than a few instances (see section 5.1.3).[8]

(16) *Jarmo's percentages of vowel length errors at stage II in the production of target closed syllables*

$V \rightarrow VV$	$V_iV_i \rightarrow V$	$V_iV_j \rightarrow V$	$V_iV_j \rightarrow V_iV_i$
61% (22/36)	32% (34/107)	35% (11/31)	10% (3/31)

Where: V = short vowel, VV = long vowel or diphthong, V_iV_i = long vowel and V_iV_j = diphthong. A → B means: target A is produced as B by Jarmo.

[7] See appendix F, which shows the development of simple codas for the different children.

[8] The division of the recording sessions into stages is partially based on clear changes in the child's system, and partially based on more practical reasons: each stage should contain a reasonably large amount of data. For example, although the first nasals appear at 1;7.29 in Jarmo's data, they are very infrequent. Only from 1;9.23 are sonorants (i) more likely to be selected for production and produced, and (ii) behaving differently dependent on the length of the preceding vowel. Therefore, I have decided that at this age stage III begins, although this is a fairly arbitrary boundary (see also chapter 1).

The following observations can be made. (i) The percentage of vowel length errors is very high: long vowels and diphthongs are frequently shortened and short vowels are even more frequently lengthened. Vowel length is more or less random, that is, vowel length distinctions have not yet been mastered. (ii) Short vowels are more prone to lengthening than long vowels and diphthongs are to shortening. (iii) On the basis of frequency of vowel length errors we can conclude that diphthongs pattern together with long vowels, rather than with short ones: diphthongs and long vowels are both shortened in about 30% of the cases. This is an argument against the hypothesis that diphthongs should be represented as short vowels followed by a coda consonant.

Can we find an explanation for the fact that short vowels are more prone to lengthening than long vowels to shortening? Target words with long vowels are more often selected for production than target words with either short vowels or diphthongs. This may reflect the higher frequency of input forms with long vowels, and may explain the fact that long vowels are preferred over short ones. Moreover, Dutch has more long vowels than short vowels. Furthermore, long vowels can appear in open syllables, but short vowels must be followed by a consonant. In this sense short vowels can be argued to be more marked. If we look at adult target words ending in a stressed open syllable,[9] of which, however, only a few are produced by the child,[10] we see that vowel length in open syllables is not randomly distributed: target words with stressed open syllables are almost exclusively produced with long vowels by Jarmo:

(17)

Jarmo				
ei	/ɛi/	→	[ɛi]	(1;7.29)
koe	/kuː/	→	[kuː]	(1;11.6)
trui	/trœy/	→	[tlœy]	(1;11.6)

Although this seems to suggest that in open syllables vowel length is mastered, this need not be the case. It may reflect the child's preference for long vowels.

In (18a) examples are given of the shortening of target long vowels. Short vowels are frequently produced as long vowels, as shown in (18b). (18c) gives examples of target diphthongs that are shortened in the child's production forms; (18d) of diphthongs realised as long vowels.

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[9] In unstressed open syllables vowel shortening often takes place, such as in *telefoon* which is often produced as /ˌtləˈfoːn/ instead of /ˌteːləˈfoːn/. Therefore, these forms are not considered. I have also not counted onomatopoeic words, and words like *ja* 'yes', *nee* 'no', *die* 'this/these'.

[10] This is probably due to the fact that such words are not very frequent.

(18) *Jarmo*

a. *Shortening of target long vowels*

aap	/aːp/	→	[ɑp]	(1;7.15)
schaap	/sχaːp/	→	[ɑp]	(1;7.15)
oog	/oːχ/	→	[ɔχ]	(1;9.9)
poes	/puːs/	→	[pʉs]	(1;9.23)

b. *Lengthening of target short vowels*

ik	/ɪk/	→	[iːk]	(1;7.29)
vis	/vɪs/	→	[hiːʃ]	(1;8.12)
bof	/bɔf/	→	[bɑuf]	(1;8.26)
vis	/vɪs/	→	[iːʃ]	(1;9.9)

c. *Shortening of target diphthongs*

uil	/œyl/	→	[œ]	(1;9.23)
uit	/œyt/	→	[ɑt]	(1;9.23)

d. *Target diphthongs realised as long vowels*

huis	/hœys/	→	[haːs]	(1;9.9)
trein	/trɛin/	→	[teːn]	(1;9.23)

To summarise, (i) at stage II the child realises closed syllables. (ii) However, these syllables are invariably closed by obstruents. (iii) Fricatives appear before plosives in syllable-final position. (iv) Moreover, fricatives often replace other manners of articulation. They are seldom deleted, and are never replaced by consonants with other manners of articulation. They are furthermore the most frequent type of consonant in word-final position. (v) Sonorants are either deleted, or replaced by obstruents. (vi) Vowel length distinctions have not yet been mastered at this stage. (vii) Furthermore, diphthongs behave like long vowels, rather than short vowels followed by a sonorant. (viii) Finally, we have seen that the marked setting 'closed syllables are allowed' can for a time be overruled by the unmarked setting 'no closed syllables'. The transition from stage I to stage II is gradual.

5.1.3. Stage III: the appearance of final sonorants and vowel length

At 1;7.29 nasals also appear in final position in Jarmo's production forms, as shown in (19a), although nasals are still frequently subject to deletion (19b):

(19) *Jarmo: Final nasals*

a.

boom	/boːm/	→	[bɔm]	(1;7.29)
haan	/haːn/	→	[hɑm]	(1;7.29)
bom	/bɔm/	→	[pɔm]	(1;7.29)
haan	/haːn/	→	[ɑn]	(1;8.12)

b.	boom	/boːm/	→	[bɑu]	(1;7.29)
	haan	/haːn/	→	[au]	(1;8.12)
	trein	/trɛin/	→	[tɛi]	(1;8.26)

Some of the other children have nasals at the first recording session. However, the children who do not have nasals at the first recording session typically use them *later* than obstruents in syllable-final position, clearly reflecting the following order of acquisition in syllable-final position: fricative-plosive-nasal (see appendix F).

From 1;11.20 Jarmo sometimes produces a liquid in syllable-final position, as shown in (20a). However, liquids are more often deleted than realised. Sometimes they are not deleted, but substituted, as shown in (20b):

(20) *Jarmo*

a.	bal	/bɑl/	→	[bɑl]	(1;11.20)
	bril	/brɪl/	→	[pʋl]	(2;3.9)
b.	bal	/bɑl/	→	[bɑɸ]	(1;8.12)
	uil	/œyl/	→	[ɛn]	(1;7.29)

Note that the fact that sonorants are produced in onset position does not necessarily mean that they can also occur in coda position.[11] I will come back to this in sections 5.3 and 5.6.

Although the child's template is able to accommodate final consonants of the adult target in his/her own template, sonorants in final position are usually not realised as such at stage II, and they are frequently deleted at stage III as well. However, if we look at the environment at which sonorants are deleted an interesting pattern arises, as shown in (21):

(21) *The percentages/raw scores of deleted final consonants in Jarmo's data*

Target:	VC_{obst}	VVC_{obst}	VC_{son}	VVC_{son}
Stage II	15% (3/20)	10% (6/62)	81% (13/16)	70% (53/76)
Stage III	10% (4/40)	8% (6/77)	53% (10/19)	78% (49/63)

Where: II=1;6.13–1;9.23, III=1;10.9–2;1.8; C_{obst}=Obstruent, C_{son}=Sonorant.

We see in (21) that at stage II sonorants are more often deleted than produced after both long and short vowels. However, at stage III the percentage of deleted sonorants decreases when short vowels precede. It remains high for sonorants following long vowels. Obstruents are far less prone to deletion at both stages II and III. There is a difference in the

[11] Jakobson (1941/68) makes a distinction between acquisition along the paradigmatic dimension and the syntagmatic dimension. In child language this difference is often neglected, but see Waterson (1971, 1987) for an elaborate account of the difference between the two in child phonology.

correlation of vowel length and the deletion of obstruents versus the deletion of sonorants. Whether or not obstruents are deleted is not related to the length of the preceding vowel: the percentages of deleted obstruents after long and short vowels are very similar. However, whether or not a sonorant is realised *is* largely dependent on the length of the preceding vowel. If this is true, the child must begin to represent vowel length before sonorants at this stage. Let us therefore first have a closer look at vowels at this stage. (22) gives the percentages of vowel length errors at stage II (repeated from section 5.1.2) and III.

(22) *Jarmo's percentages of vowel length errors at stage II and III in the production of target closed syllables*

	$V \rightarrow VV$	$V_iV_i \rightarrow V$	$V_iV_j \rightarrow V$	$V_iV_j \rightarrow V_iV_i$
stage II	61% (22/36)	32% (34/107)	35% (11/31)	10% (3/31)
stage III	32% (19/59)	15% (14/91)	16% (8/49)	16% (8/49)

The following observations can be made: (i) although vowel length is not produced completely randomly, it is still not fully mastered at stage III; (ii) the percentage of vowel length errors decreases in all environments at stage III in comparison with stage II; (iii) the percentage of lengthened target short vowels is still considerably higher than the percentage of shortened long vowels and diphthongs; (iv) diphthongs and long vowels are equally likely to be shortened at this stage as well.

If we look at the *environment* in which vowel length errors occur, the following pattern arises:

(23) *Jarmo's vowel length errors with and without final consonants*

Target:	VVC_{obst}		VC_{obst}		VVC_{son}		VC_{son}	
Jarmo's form	V	VC	VV	VVC	V	VC	VV	VVC
stage III	8% (1/12)	92% (11/12)	20% (2/10)	80% (8/10)	20% (2/10)	80% (8/10)	89% (8/9)	11% (1/9)

If we first consider vowel length errors in the child's production forms of target words ending in obstruents we see that for stage III most of the vowel length errors occur when the final consonant is retained. That is, in the child's production forms long vowels are shortened and short vowels lengthened in closed syllables. There seems to be no relationship between vowel length errors and final obstruent deletion. Although we observe in (23) that long vowels are shortened when the final consonant is retained, we do *not* observe that short vowels are lengthened just in those cases where the final consonant is deleted. Moreover, we saw in (21) that deletion of final obstruents is equally frequent after long and short vowels.

In (24a) examples of vowel lengthening from stage III are given; in (24b) examples of vowel shortening from stage III are given. Examples from stages II are given in (18a, b).

(24) *Jarmo: Vowel length errors before obstruents at stage III*

a. *Vowel lengthening*

pad	/pɑt/	→	[taːt]	(1;11.20)
		→	[paːt]	(1;11.20)
vis	/vɪs/	→	[teːs]	(1;11.20)
bad	/bɑt/	→	[taːt]	(2;0.4)

b. *Vowel shortening*

huis	/hœys/	→	[ɑʃ]	(1;10.9)
kous	/kɑus/	→	[kɑs]	(1;10.9)
poes	/puːs/	→	[pʉs]	(1;10.23)
uit	/œyt/	→	[hɑt]	(1;11.6)
boot	/boːt/	→	[tɔt]	(1;11.20)
koek	/kuːk/	→	[kɔk]	(2;0.4)
kijk	/kɛik/	→	[kɑk]	(2;0.4)

Vowel length errors go in both directions and are independent of final consonant deletion. It seems, therefore, that vowel length is not completely mastered before obstruents.

In contrast, if we look at vowel length errors in the child's production of adult target words ending in a sonorant, a different picture arises. Long vowels before sonorants are shortened if the final sonorant is produced. This is similar to shortening of long vowels before obstruents. However, short vowels are lengthened when final sonorants are *not* produced. This pattern is crucially different from the lengthening of short vowels before obstruents. In general, the picture is the following:

(25) *Environments for vowel length errors*

a.	VVC_{son}	→	VC_{son}
	VC_{son}	→	VV
b.	VVC_{obst}	→	VC_{obst}
	VC_{obst}	→	VVC_{obst}

If we take the results of (21), final consonant deletion, and (23), the environments for vowel length errors, together, we see that target VVC_{son} is either produced as VV (21) or as VC_{son} (23), but far less frequently as VVC_{son} or V. VC_{son} targets are either produced correctly or are produced as VV; however, these targets are generally not produced as either V or VVC_{son}. No such relationship between vowel length errors and final consonant deletion is found for obstruents and the preceding vowel. Rather VC_{obst} and VVC_{obst} are both produced as either VC_{obst} or VVC_{obst}; not as V or VV. The results of combining (21) and (23) are shown in (26):

(26) *Jarmo's production of VVC_{son}, VC_{son}, VVC_{obst} and VC_{obst} targets at stage III*

target VVC_{son}		target VC_{son}		target VVC_{obst}		target VC_{obst}	
child's form		child's form		child's form		child's form	
VV	75% (47/63)	VV	42% (8/19)	VV	6% (5/77)	VV	5% (2/40)
VC	13% (8/63)	VC	47% (9/19)	VC	14% (11/77)	VC	70% (28/40)
V	3% (2/63)	V	5% (1/19)	V	1% (1/77)	V	5% (2/40)
VVC	9% (6/63)[12]	VVC	5% (1/19)	VVC	78% (60/77)	VVC	20% (8/40)

The following picture can be deduced from (26):

(27)

	Adult target	→	*Child's production form*
a.	VVC_{son}	→	VC_{son} or VV
	VC_{son}	→	VC_{son} or VV
b.	VVC_{obst}	→	VC_{obst} or VVC_{obst}
	VC_{obst}	→	VC_{obst} or VVC_{obst}

Whether or not the final sonorant is produced is largely dependent on the length of the preceding vowel: if a long vowel is produced, sonorants are generally deleted. If a short vowel is produced, sonorants are often produced; or stated differently, if a final sonorant is produced, the vowel is short, while if the final sonorant is not produced, the vowel is long. It seems that long vowels are represented in some manner bipositionally in certain environments. The following examples illustrate the possibilities:

(28) *Jarmo's production of targets ending in a sonorant at stage III*

a. *VVC_{son} → VV*

trein	/trɛin/	→	[tɛi]	(1;10.9)
stoel	/stuːl/	→	[tyː]	(1;10.9)
daar	/daːr/	→	[daː]	(1;10.9)
boom	/boːm/	→	[boː]	(1;10.9)
boom	/boːm/	→	[boː]	(2;0.4)

b. *VVC_{son} → VC_{son}*

maan	/maːn/	→	[mɑm], [mɔm]	(1;10.9)
uil	/œyl/	→	[œʋ]	(1;10.9)
haan	/haːn/	→	[hɑm]	(1;10.23)
boom	/boːm/	→	[bɔm]	(2;0.4)
		→	[pɔm]	(2;0.4)

[12] The forms realised as VVC are not necessarily produced with a final sonorant in Jarmo's forms, as shown by the following data:

(i)	konijn	/koːnɛin/	→	[nɛit]	(1;10.9)
	bal	/bɑl/	→	[boːɬ]	(1;10.23)

c.	$VC_{son} \rightarrow VC_{son}$				
	bal	/bal/	→	[pav]	(1;10.23)
			→	[bal]	(1;11.20)
	bim	/bɪm/	→	[mɪm]	(2;0.4)
	bam	/bam/	→	[bam]	(2;0.4)
	ballon	/ba'lɔn/	→	[pɔm]	(2;0.28)
d.	$VC_{son} \rightarrow VV$				
	bal	/bal/	→	[bo:]	(1;10.9)
	bal	/bal/	→	[bau]	(1;10.9)

Although sonorants are often deleted and there are many vowel length errors, the output forms all have two positions. It seems that the child has a bipositional template for syllables ending in sonorants. There is no relationship between vowel length and final obstruent deletion. Since vowel length errors before obstruents mainly occur in closed syllables, and involve both shortening and lengthening, we may conclude that vowel length is non-distinctive before obstruents: all vowels are monopositional in this position. It this is correct, than the child has a (minimal and maximal) bipositional rhyme template at this stage. I will come back to this in section 5.3.

To summarise, at stage III the following changes occur. (i) Sonorants in final position appear; first nasals and, slightly later, liquids. However, sonorants are still deleted far more often than obstruents. (ii) Moreover, sonorants following long vowels are more prone to deletion than sonorants following short vowels at stage III. (iii) Sonorants act as a constituent together with the preceding vowel: the child produces target syllables ending in sonorants either as a short vowel plus a sonorant, *or* as a long vowel. No such relationship exists between obstruents and the preceding vowel. Vowel length errors before obstruents occur mainly in closed syllables and go in both directions: short vowels are lengthened and long vowels are shortened. The number of vowel length errors has, however, decreased from stage II to stage III. Furthermore, at stage III, as at stage II, diphthongs show a similar behaviour to long vowels.

5.1.4. Stage IV: mastering vowel length and extrarhymal consonants

At stage IV two major changes occur. First, the percentage of deleted obstruents *increases* after long vowels. Second, the first final clusters appear in Jarmo's production forms. Examples of final obstruent deletion after long vowels are given in (29):

(29) *Jarmo: Deletion of obstruents after long vowels*

boek	/buːk/	→	[tuː]	(2;2.6)
daag	/daːχ/	→	[daː]	(2;2.6)
kijk	/kɛik/	→	[kɛi]	(2;3.9)
boot	/boːt/	→	[boː]	(2;3.9)
vijf	/vɛif/	→	[fɛi]	(2;3.9)
buik	/bœyk/	→	[bœy]	(2;4.1)
kijk	/kɛik/	→	[kɛi]	(2;4.1)
vijf	/vɛif/	→	[sɛi]	(2;4.1)
uit	/œyt/	→	[œy]	(2;4.1)

Examples of final consonant clusters are given in (30):

(30) *Jarmo: Final consonant clusters*

hand	/hɑnt/	→	[hɑnt]	(2;3.9)
strand	/strɑnt/	→	[tlɑnt]	(2;3.9)

The acquisition of consonant clusters will be discussed in detail in section 5.4.1. Here, I focus on the first phenomenon: the increase in deleted obstruents after long vowels at stage IV. (31) shows the percentages of deleted final obstruents and sonorants after both long and short vowels at stage III (repeated from section 5.1.3) and IV:

(31) *The percentages (and raw scores) of deleted final consonants in Jarmo's data*

Target	VC_{obst}	VVC_{obst}	VC_{son}	VVC_{son}
Stage III	10% (4/40)	8% (6/77)	53% (10/19)	78% (49/63)
Stage IV	13% (7/54)	26% (6/24)[13]	25% (6/24)	73% (61/84)

Where: III = 1;10.9–2;1.8 and IV = 2;1.22–2;4.1.

The following observations can be made from (31): (i) the percentage of deleted obstruents after long vowels increases; (ii) the percentage of deleted sonorants after short vowels decreases; and (iii) the percentage of deleted sonorants after long vowels decreases slightly, but remains high. The last two observations show that the pattern described in the previous section continues at stage IV: sonorants after long vowels are generally deleted (32a), although they are now sometimes produced under preservation of vowel length (32b); sonorants after short vowels are less prone to deletion. They are now usually produced (32c), although vowel lengthening under deletion of the final sonorant still occurs.

[13] Remarkably, the number of selected target words ending in VVC_{obst} has decreased substantially here. This may be due to a selection strategy, indicating that these words can no longer be accommodated into the child's template. If they are selected for production they undergo the repair strategy, 'delete final consonant'.

(32) *Jarmo*

a. $VVC_{son} \rightarrow VV$

daar	/daːr/	→	[taː]	(2;1.22)
gitaar	/χ iːˈtaːr/	→	[taː], [kaː]	(2;1.22)
trein	/trɛin/	→	[tlɛi]	(2;1.22)
deur	/døːr/	→	[tyː]	(2;2.6)
tuin	/tœyn/	→	[tœy]	(2;2.6)
haan	/haːn/	→	[haː]	(2;3.9)
kalkoen	/ˌkɑlˈkuːn/	→	[ˈkɛmˌkuː]	(2;4.1)

b. $VVC_{son} \rightarrow VVC_{son}$

haan	/haːn/	→	[haːm]	(2;2.6)
kalkoen	/kɑlˌkuːn/	→	[kuːŋ]	(2;2.6)
schuur	/s χ yːr/	→	[χ uːʀ]	(2;2.6)
tuin	/tœyn/	→	[tœyn]	(2;2.27)
daar	/daːr/	→	[taːɓ]	(2;3.9)
banaan	/baːˈnaːn/	→	[naːn]	(2;3.9)

c. $VC_{son} \rightarrow VC_{son}$

ballon	/bɑˈlɔn/	→	[tɔn]	(2;1.22)
mam	/mɑm/	→	[mɑm]	(2;1.22)
bim	/bɪm/	→	[bɪm]	(2;2.6)
bam	/bɑm/	→	[pɑm]	(2;2.6)
bril	/brɪl/	→	[pʋl]	(2;3.9)

Since sonorants following short vowels are now produced, this predicts that the percentage of vowel length errors decreases at stage IV. (33) shows that this prediction is indeed borne out.

(33) *Jarmo's percentages of vowel length errors at stage III and IV in the production of target closed syllables*

	$V \rightarrow VV$	$V_iV_i \rightarrow V$	$V_iV_j \rightarrow V$	$V_iV_j \rightarrow V_iV_i$
stage III	32% (19/59)	15% (14/91)	16% (8/49)	16% (8/49)
stage IV	18% (14/78)	8% (11/140)	9% (5/53)	9% (5/53)

At stage IV long vowels are produced correctly most of the time. Short vowels are still lengthened in 18% of the cases, although this is considerably less frequent than at stage III. Again, diphthongs seem to pattern with long vowels. If we look at the relationship between vowel length errors and final consonant deletion, there are several differences in comparison with stage III (see (26)):

1. VVC_{son} is more often produced correctly at stage IV than at stage III (21% at stage IV versus only 9% at stage III).
2. VC_{son} is more often produced as VC_{son} (67%) rather than VV (21%) at stage IV. At stage III VC_{son} was equally likely to be produced as VV (42%) and VC_{son} (47%).
3. VVC_{obst} is often produced as VV (25%) or VC_{obst} (38%) at stage IV. VVC_{obst} is far less frequently produced correctly (38% correct versus 78% at stage III). At stage III VVC_{obst} was often produced correctly. Only occasionally was it produced as VV (6%) or VC_{obst} (14%).
4. VC_{obst} is far less likely to be produced as VVC_{obst} at stage IV. At stage IV only 9% VVC_{obst} forms were produced for target VC_{obst}, while at stage III this was 20%.

The relationship between final consonant deletion/production and vowel length at stage IV is given in (34):

(34) *Jarmo's production of VVC_{son}, VC_{son}, VVC_{obst} and VC_{obst} targets at stage IV*

target VVC_{son}		target VC_{son}		target VVC_{obst}		target VC_{obst}	
child's form		child's form		child's form		child's form	
VV	70% (59/84)	VV	21% (5/24)	VV	25% (6/24)	VV	4% (2/54)
VC	6% (5/84)	VC	67% (16/24)	VC	38% (9/24)	VC	78% (42/54)
V	2% (2/84)	V	4% (1/24)	V	0% (0/24)	V	9% (5/54)
VVC	21% (18/84)	VVC	8% (2/24)	VVC	38% (9/24)	VVC	9% (5/54)

It looks as if the child also begins to represent the vowel length distinctions before obstruents at this stage. Although VVC_{obst} targets were very often produced correctly at stage III (see (26)), we see that at stage IV the percentage of correctly produced forms decreases drastically. Moreover, VVC_{obst} is often realised as either VV and VC_{obst}. This behaviour looks very much like that for VVC_{son} at stage III. VC_{obst} targets are less likely to be produced as VVC_{obst} at stage IV than at stage III. I therefore conclude that the child is representing the vowel length contrast before obstruents at this stage. Or, stated differently, it looks as if the child allows only two positions in the rhyme: either a short vowel plus a consonant, or a long vowel or diphthong. Target syllables consisting of a long vowel followed by an obstruent either undergo final obstruent deletion under preservation of vowel length (29) or the final obstruent is realised under shortening of the vowel (35):

(35) *Jarmo: Vowel shortening at stage IV*

kijk	/kɛik/	→	[kɑk]	(2;1.22)
uit	/œyt/	→	[ɑt]	(2;1.22)
niet	/niːt/	→	[nɪχ]	(2;2.6)
vlieg	/vliːχ/	→	[tɪχ]	(2;2.27)
kijk	/kɛik/	→	[kɛk]	(2;4.1)

However, VVC_{obst} is still produced correctly in 38% of the cases. Moreover, the observations that VVC_{son} is more often produced correctly at stage IV has to be accounted for, as well as the appearance of final consonant clusters. These observations seem to suggest that the child is beginning to allow an extra position after a bipositional rhyme.

With respect to the VVC_{obst} cases, it might be that they are produced correctly due to the fact that vowel length is not yet completely mastered; in other words, it may be that these forms are produced as at stage III. Alternatively, the child is beginning to explore the possibility of having an extra syllable-final position. As noted above, the child produces the first clusters at this stage, also indicating that a third position becomes available at this stage. However, I postpone the discussion of final clusters until section 5.4.1.

To sum up: at stage IV the following changes occur in Jarmo's system. (i) Obstruents are more often deleted after long vowels than at stage III; they are more often deleted after long vowels than after short vowels. (ii) Alternatively, the obstruent is realised after a target long vowel; however, this triggers shortening of the target vowel. (iii) The observations under (i) and (ii) are largely similar to those for sonorants after long vowels at stage III. They seem to show that the child allows two positions in the rhyme: either a long vowel or a short vowel plus an obstruent. The child seems to recognise the relationship between vowel length and the possibility of having a final obstruent. Or, stated differently, it seems that vowel length is contrastive before obstruents at this stage. (iv) However, three additional observations need to be explained: first, VVC_{son} is more often produced correctly at this stage than at stage III; second, the first final consonant clusters appear at this stage; and third, VVC_{obst} is still often produced correctly. This seems to indicate that the child is learning that, word-finally, three positions are allowed. (v) Again, diphthongs are treated as a special kind of long vowel.

5.2. Summary

To summarise, I have distinguished four stages in the development of rhymes. Below, I briefly summarise the characteristics of each stage.

Stage I. The characteristics of stage I are the following:
1. The child only has core syllables, consisting of a consonant followed by *any* vowel, either long or short. Vowel length is completely non-distinctive at this stage.
2. Final consonants are not realised, regardless of the nature of the consonants and the length of the vowel.

Stage II. Stage II is characterised by the following:
1. The child realises closed syllables for the first time. However, these syllables are invariably closed by obstruents. Sonorants are either deleted, or replaced by obstruents. Sonorants are deleted, independently of the length of the preceding vowel.
2. Fricatives appear earlier than plosives in syllable-final position. Moreover, fricatives often substitute for other manners of articulation. They are now *never* deleted or replaced. They are the most frequent type of final consonant in the child's production forms.
3. Sometimes obstruents (especially plosives) are deleted independently of the length of the preceding vowel.
4. Vowel length distinctions are not yet mastered at this stage. Vowel length is still non-distinctive. Target long vowels are shortened, and target short vowels are lengthened in the child's production forms, although the latter is more frequent than the former. Furthermore, diphthongs behave like long vowels, rather than like short ones followed by a sonorant.

Stage III. At stage III the following changes occur in the child's system:
1. Sonorants in final position appear. First, nasals appear in syllable-final position, and slightly later, liquids are also produced.
2. However, although sonorants are now sometimes realised, they are deleted far more often than obstruents. Moreover, sonorants following long vowels are more frequently prone to deletion than sonorants following short vowels, indicating that the vowel length distinction becomes relevant in the child's system.
3. Sonorants show a close relationship with the length of the preceding vowel: the child produces target syllables ending in sonorants either as a short vowel plus a sonorant, or as a long vowel. Vowel length errors are very systematic: short vowels are lengthened if the final sonorant is *not* produced, while long vowels are shortened precisely when the final sonorant *is* produced.
4. No such relationship exists between obstruents and the preceding vowel. Vowel length errors before obstruents mainly occur in closed syllables and go in both directions: short vowels are lengthened and long vowels are shortened, indicating that vowel length is not yet fully mastered before obstruents. That is, vowel length seems to be non-distinctive before obstruents. Obstruent deletion is not frequent. When it occurs, it does not trigger vowel lengthening.

5. The number of vowel length errors has decreased from stage II to stage III. However, vowel length distinctions are not yet fully mastered. It is furthermore shown that at stage III, as at stage II, diphthongs show similar behaviour to long vowels.

Stage IV. At stage IV the following changes occur in Jarmo's system:
1. Obstruents are more often deleted after long vowels than at stage III.
2. Obstruents are more often deleted after long vowels than after short vowels.
3. Alternatively, the obstruent is realised after a target long vowel; however, this triggers shortening of the target vowel.
4. At stage IV VC_{obst} is far less prone to undergo vowel lengthening than at stage III.
5. The observations under (1)–(4) are largely similar to those of final sonorants at stage III. They seem to indicate that the child allows two positions in the rhyme: either a long vowel or a short vowel plus an obstruent. In other words, the child seems to recognise the relationship between vowel length and the possibility of having a final obstruent.
6. However, three additional observations need to be explained: first, VVC_{son} is more often produced correctly at this stage; in general, the percentage of vowel length errors before sonorants and the percentage of final sonorant deletion are decreasing at this stage; second, the first final consonant clusters appear at this stage; and third, VVC_{obst} is still often produced correctly. This seems to indicate that the child is beginning to learn that word-final rhymes may contain three positions.
7. At stage IV vowel length errors are not frequent in either environment. It seems that the child has more or less mastered vowel length distinctions.

One observation which holds for all stages is that transitions are gradual, as we have already seen in chapter 4. For example, even if the final position is becoming available in the child's template, it is not always realised. The default setting still often takes precedence over the marked value, indicating that the marked value is not yet fixed.

After this summary of the findings, let us now discuss them. In the following, I argue for a developmental pattern based on parameter setting. The settings of the parameters define the child's template.

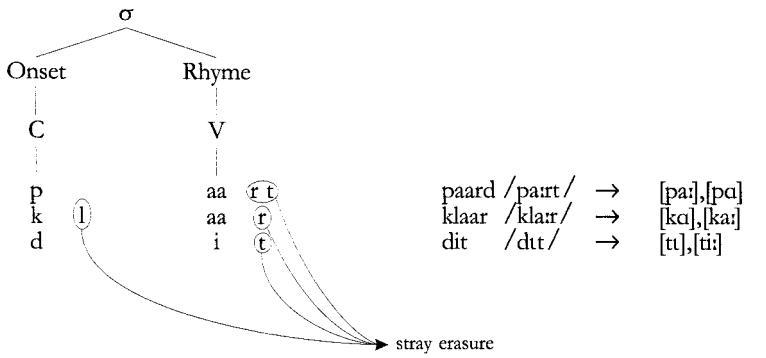
5.3. Discussion and formal account

5.3.1. Stage I: no codas

Recording of Jarmo, Noortje, Tom and Elke began at or near the onset of speech. The data from these children give evidence for an initial stage in

which no syllable is closed by a consonant. Thus, at stage I only open syllables occur. Adult targets with closed syllables are either avoided (selection strategy) or subject to the repair strategy 'delete final consonant'. Since final consonants simply do not fit into the core syllable template, they are deleted by stray erasure, as shown in (36):

(36) *Stray erasure of final consonants*



There is no deletion rule: the child just maps as much information of the adult target onto his or her template as possible. Elements that do not fit into the template are not realised. Final consonant deletion is frequently reported in the literature (Leopold 1947, Fudge 1969, Smith 1973, Ingram 1974, 1976, 1978, 1989a, b, Menn 1977). This is further support for the default status of the core syllable CV.

The fact that at the initial stage no syllable is closed by a consonant gives evidence for the default setting 'no closed syllables allowed'. This follows from the core syllable hypothesis, since the core syllable typically is an open syllable. Codas in the adult target forms are invariably deleted in the child's production of these targets at the initial stage. Again, the literature on syllable parameters is in accordance with these facts. For example, Jakobson (1939/62), quoted in Clements & Keyser (1983), argues that all languages that have closed syllables also have open syllables, but that the reverse is not true. There are languages which only allow open syllables. In terms of the subset principle this means that the parameter value 'no closed syllables' generates a subset of the forms which would be generated if the value had been 'closed syllables allowed'. 'No closed syllables' is therefore the default or unmarked value. The subset principle demands that children begin with the subset, that is, children should start with the value 'no closed syllables', since positive evidence can be gained for the marked setting. A child learning Dutch, which has closed syllables, will receive positive evidence for the marked value of the 'closed syllable' parameter from the beginning. If evidence for the marked value, 'closed syllables are allowed', is available

from the start, why do we find stage I at which closed syllables are not allowed? The answer lies in the fact that the first stage is universal, while the production of closed syllables by the child reflects that s/he has already learned properties of the adult target language s/he is learning.

On the assumption that the marked value, 'closed syllables are allowed', is available from the start, the transition from stage I (no codas) to stage II (codas are allowed) remains unexplained as well as the repair strategy which deletes codas. Moreover, children learning a language that only allows open syllables will never receive positive evidence for the unmarked setting; they have to deduce this value from negative evidence: the lack of closed syllables in the language. The fact that no child has closed syllables without having open syllables favours the default setting 'no closed syllables'. Since Dutch clearly demands the marked setting, the child receives abundant positive evidence for the marked setting, and therefore, the parameter is set quite early to the marked value.

Vowel length at this stage seems to be completely random. Target long vowels are produced as both long and short; the same is true for target short vowels. There is no evidence that long vowels are represented as bipositional. I therefore assume that all vowels are represented by one skeletal slot.

It should be noted that the default/marked values for onsets and closed syllables are exactly the opposite: for onsets the default value is 'onsets are obligatory', while for codas the default value is 'no closed syllables allowed'. The marked value for onsets is 'onsets are optional', while the marked value for final consonants is 'syllables can be closed'. This is schematised in (37):

(37) *Default and marked values for the onset and 'closed syllable' parameters*

	Default value	*Marked value*
Onset parameter	C	Ø
'Closed syllable' parameter	Ø	C

At stage I both parameters have the default value, resulting in a core syllable template.

5.3.2. Stage II: branching rhymes

At stage II final obstruents appear. The child's system now allows closed syllables. At the start of this stage, only fricatives can occur in syllable-final position (stage IIa); later plosives are also allowed (stage IIb). The optimal

coda consonant is the fricative, followed by the plosive (stage IIb).[14] Target words ending in other consonants are either replaced by fricatives or deleted, as was shown in section 5.1.2. In any event, at this stage the final consonant is an obstruent.

We know from section 5.1 that the child has not yet mastered vowel length distinctions at stage II, and therefore represents all vowels as one V slot. Obstruents following target long and short vowels therefore are in the same position: they are mapped onto the child's VC rhyme template.

Once closed syllables are allowed, the repair strategy which deletes final consonants should cease to exist. If the child's template can accommodate final consonants of the adult target words the repair strategy 'delete' has become redundant. However, although this is largely true for obstruents, it does not hold for sonorants. If final consonants are now allowed, why are sonorants more often deleted than realised at this stage? Apparently, obstruents can be accommodated into the child's template, while sonorants cannot.[15]

Since obstruents are universally never part of the nucleus, they *have* to be in the coda. I assume that the child is learning that rhymes can be branching into a nucleus and a coda.[16] That is, the child is learning the marked value [Yes] for the parameter 'can rhymes branch'. The default value is [No], as shown in the previous section. The rhyme parameter is given in (38):

(38) *Branching rhyme parameter*
Rhymes can branch into a nucleus and a coda [Yes/<u>No</u>]

The underlined value is the default value.

At this stage, however, the coda position seems to be restricted to obstruents. It looks as if the child is again striving for a maximal sonority contrast between nucleus and coda by realising a vowel followed by an obstruent. Although it is not clear why fricatives are favoured over plosives, it is clear that obstruents are favoured over sonorants.

From the fact that sonorants are not realised at this stage, I conclude that

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[14] For a possible explanation and a comparison of final consonants with onset consonants see section 5.6.

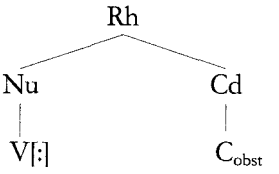
[15] There are two possible explanations for the fact that sonorants are not yet realised at this stage. (i) Sonorants are not yet mastered in final position (section 5.6); i.e., some segment types are acquired later than others. Similar observations were made for the acquisition of different segment types in onset position (chapter 4). (ii) Sonorants are not represented in the coda position, but are part of the nucleus. I will provide evidence for the latter hypothesis in section 5.3.3. However, the two explanations do not contradict each other.

[16] Alternatively, we could hypothesise that the child is learning that elements outside the scope of the core syllable are licensed by extraprosodicity. However, the prediction is that this is true for both obstruents and sonorants. That is, we do not expect the observed difference between obstruents and sonorants: both would be in extraprosodic position.

they are not represented in the coda, although, in principle, they could be.[17] More evidence for this conclusion will be given in the next section.

The child seems to have a maximally bipositional rhyme template, in which the rhyme can branch into a nucleus and a coda, which is realised as an obstruent, as in (39):

(39) *Branching rhyme*



This template explains why sonorants are deleted at this stage: they cannot be mapped onto the template unless the sonorant is replaced by an obstruent.

It should be noted that the development of onsets and codas is complementary in two ways: (i) the first contrast in both positions is that between the presence and absence of consonants. In onset position the default value is the presence of a consonant, while in coda position the default value is the absence of a consonant (stage I); (ii) the default consonant in onset position is a [–continuant] obstruent (a plosive); in coda position it is a [+continuant] obstruent (a fricative) (stage IIa).

The transition from stage I to stage II involves the setting of a syllable parameter, which I will call the 'branching rhyme' parameter, from the default value to the marked value; that is, the contrast 'presence' versus 'absence' of codas is being learned. Furthermore, the child has to determine what consonants can fill the coda position. Only obstruents are realised in syllable-final position at stage II. The transition from stage IIa (final fricatives) to stage IIb (final plosives) involves the learning of a difference in manner of articulation: the difference between continuants and non-continuants. This does not involve syllable parameters, but involves the representation of segments (which may also be parametrised), although there clearly is a relation between the two. At this stage the child is learning a contrast in continuancy between fricatives and plosives in coda position.

[17] Appendix G–2 shows that Robin represents nasals in the coda, but not other sonorant consonants. This illustrates that the binary distinction between obstruents and sonorants is not fully adequate: rather, more detailed research is likely to show that the distinction between coda consonants and consonants represented in the nucleus can be made at various points on the sonority scale.

5.3.3. Stage III: branching nuclei and the maximal rhyme constraint

At stage III sonorants appear in final position: nasals are first produced, followed by liquids, although especially the latter are deleted more often than not. Liquids are also mastered late as single onsets, and they often appear earlier in consonant clusters than as single consonants. Apparently, children regard liquids as more vowel-like or less consonantal than other consonants. Liquids are represented as more vowel-like consonants in many systems of segmental representation (see Anderson & Ewen 1987, van der Hulst, 1991, 1993, among others). Nasals are more ambiguous in this sense: (i) they appear very early in onset position (after plosives); (ii) they are replaced by liquids if they are part of a cluster in the target form; (iii) they appear later than obstruents in final position; (iv) they are deleted more often than obstruents (see also Piggott 1987, 1989, 1991, 1992).

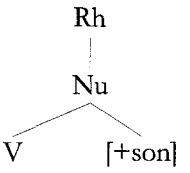
At this stage there are clear differences between obstruents and sonorants in syllable-final position in the child's production forms: (i) obstruents are generally produced in final position, while sonorants are often deleted; (ii) whether sonorants are produced is largely dependent on the length of the preceding vowel at stage III. Sonorants after long vowels are more prone to deletion than sonorants after short vowels. No such relation holds for obstruents and the preceding vowel: if obstruents are deleted they are equally likely to be deleted after long and short vowels. In onset position there seems to be no such division between obstruents and sonorants. Rather the order of development in onsets is 'plosives–nasals–fricative, liquids and glides'; i.e., obstruents and sonorants are interspersed.

However, the fact that sonorants are sometimes realised indicates that they can now be accommodated into the child's template. Moreover, the fact that they behave differently from obstruents in that they show a close relationship with the preceding vowel suggests that they are in a different position from obstruents. I therefore propose that they are not in the coda, but are part of the nucleus. Apparently, the child is setting the nucleus parameter to the marked value [Yes]. The unmarked value [No] indicates that the nucleus is non-branching. That is, all nuclei, and thus all vowels, occupy one skeletal position. The nucleus parameter is given in (40). The underlined value is the default value.

(40) *Branching nucleus parameter*
The nucleus can be branching [Yes/<u>No</u>]

In other words, the child now has a template in which the nucleus can branch, as represented in (41), as well as the template in (39).

(41) *Branching nucleus*



where [+son] either is filled by a sonorant consonant or by the second part of a long vowel or diphthong

Target rhymes consisting of a short vowel and a sonorant can now be mapped onto the child's template. However, target rhymes consisting of a long vowel and a sonorant cannot; hence, the final sonorant is usually deleted. However, there are other possibilities available to the child: target VC_{son} rhymes can also be realised as long vowels, which fill both positions in the nucleus. Target rhymes consisting of a long vowel plus a sonorant can also be realised as a short vowel plus a sonorant, again filling both positions in the nucleus. However, VC_{son} and VVC_{son} target rhymes are generally not produced as VVC_{son} or V. This suggests that the child's template is *minimally* and *maximally* bipositional. How both positions are filled is not dictated by the template; hence, we find much variation in realising a bipositional template.

If the maximal rhyme constraint is indeed universal, as claimed by Kaye & Lowenstamm (1981), it is expected that rhymes in the child's output forms do not exceed the bipositional maximum. However, the input to the child contains many monosyllabic words which on the surface violate the maximal rhyme constraint, since many monosyllabic Dutch words have in addition to a bipositional rhyme an extrarhymal consonant and/or an appendix.[18] It therefore seems that crucial evidence for the existence of the maximal rhyme constraint is lacking. However, since the children's output forms clearly obey this constraint, I conclude that it is universal, and need not to be learned. What need to be learned are language-particular deviations from this constraint.

However, the minimal rhyme constraint, according to which rhymes are minimally bipositional (see chapter 3) is language-specific, and has to be learned on the basis of indirect negative evidence. This property of Dutch is typically learned late: children frequently produce rhymes consisting of a short vowel, especially in final unstressed syllables, and still do so in the final recording sessions. The minimal rhyme constraint has to be learned on the basis of indirect negative evidence; that is, the absence of rhymes consisting of short vowels. Such evidence is available, since the child will never find a match when comparing his or her output forms containing V

[18] This is certainly true for the input forms that the child uses for his or her output.

rhymes with the input forms. The complete absence of matching between output forms with V rhymes and target words constitutes the (indirect) evidence for learning this language-particular constraint.

In the production of VVC_{son} either vowel length is preserved, triggering final sonorant deletion, or the final sonorant is preserved, triggering vowel shortening, showing that the child aims at realising two positions in the rhyme. If vowel length before sonorants did not matter, i.e., were not represented, then the fact that target VC_{son} rhymes are not produced as VVC_{son} rhymes by the child is purely accidental. However, the child produces both long and short vowels before obstruents. What needs to be explained is the fact that the strong relationship between a sonorant and the preceding vowel is not observed between an obstruent and the preceding vowel.

I will argue that the observed patterns can be described by assuming that (i) vowel length is more or less mastered; (ii) sonorants are in the nucleus, obstruents in the coda; (iii) rhymes are maximally bipositional and (iv) the earlier branching rhyme template (39) is preferred over the newly acquired branching nucleus template (41).

At stage III obstruents after long vowels are generally not deleted. Moreover, the child's data contain vowel length errors before obstruents that go in both directions: long vowels are shortened before obstruents, and short vowels are lengthened before obstruents. There is no relation between final obstruent deletion and vowel length errors. Although VVC_{obst} is sometimes produced as VC_{obst}, VC_{obst} is also frequently realised as VVC_{obst}. Final obstruent deletion is rare at this stage, but if it occurs if is equally likely to occur before long and short vowels. It therefore seems that the child realises a vowel and the coda consonant. However, if the coda consonant is realised, the preceding vowel can only occupy one position in the nucleus, given a maximal bipositional rhyme. Thus, although vowel length distinctions may be mastered, they cannot be represented in all positions. That is, vowel length cannot be represented at the same time as obstruents (or sonorant consonants). While a branching nucleus can either be filled by a short vowel plus a sonorant consonant or a long vowel, a branching rhyme can only be filled by a vowel and an obstruent.

On the assumption that the child allows maximally two positions in the rhyme we may expect to find the same relationship between vowels and obstruents as between vowels and sonorants: preservation of vowel lengthening, triggering final obstruent deletion, and vowel shortening if the final obstruent is realised. However, this is not exactly what we find. Although target long vowels are sometimes shortened before obstruents in the child's output forms, the reverse also occurs, i.e., lengthening of target short vowels before obstruents. Lengthening under deletion of the obstruent is, however, not attested. It seems that all vowels are monopositional before obstruents. Apparently, the representation that is acquired earlier, i.e., the

one with a rhyme branching into a nucleus and a coda (39), is preferred to one acquired later, i.e., the one in (41) with a branching nucleus, explaining the lack of compensatory lengthening under deletion of obstruents.

The alternative hypothesis would be that obstruents following long vowels are not in the coda, but are in extrarhymal position. However, if the child's template has an extrarhymal position at this stage, why are sonorants following long vowels not produced in that position? The only requirement for consonants in extrarhymal position is that they have to obey the Sonority Sequencing Principle (SSP) (see chapter 3, section 3.3). Sonorants following long vowels do obey the SSP, just like obstruents following long vowels. If the latter are produced in extrarhymal position, why not the former? Moreover, if this position is available, and VC_{son} is allowed by the child's template, we also expect to find final clusters consisting of a sonorant plus an obstruent. These are not attested at this stage. Furthermore, if this position is available, why are obstruents after long vowels more prone to deletion at stage IV than at stage III? We would expect the reverse. Therefore, I conclude that the extrarhymal position is not yet available in the child's template at stage III.

We can then assume that obstruents are in the coda. If vowel length were represented before obstruents, we would expect that: (i) long vowels would be shortened before obstruents, but not the reverse: short vowels would not be lengthened before obstruents; (ii) short vowels would be lengthened only if the final obstruent were deleted; (iii) final obstruents would be deleted if they followed a long vowel. However, these predictions are not borne out: vowel length errors go in both direction, and moreover, whether or not final obstruents are deleted seems to be independent of vowel length; obstruents after long vowels are not more prone to deletion than obstruents after short vowels at stage III. However, we will see in the next section that these predictions are borne out at stage IV. I therefore conclude that at stage III vowel length is still not represented before obstruents, because of the maximal rhyme constraint.

Additional evidence for the fact that vowel length is not represented before obstruents comes from yet another repair strategy: a final consonant is sometimes produced after a long vowel in the production of VVC_{son} targets. However, the final sonorant is replaced by an obstruent in these cases, as shown in (42):

(42) *Substitution of final sonorants by obstruents*

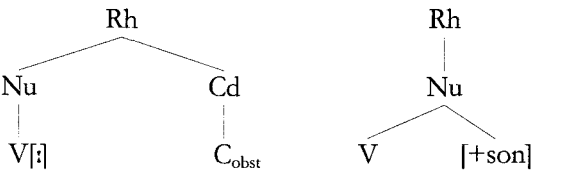
konijn	/koːˈnɛin/	→	[nɛit]	(1;10.9)
boom	/boːm/	→	[boːχ]	(1;10.23)

Vowels still seem to occupy one skeletal position before obstruents. If this is true, the child's rhyme template seems to be bipositional at this stage, and is either represented as in (39) or as in (41). That is, the child either has a

branching rhyme or a branching nucleus, but not both at the same time. Therefore, long vowels before obstruents are not represented as bipositional at stage III. More evidence will be given in the next section.

To summarise, Jarmo makes a difference between obstruents and sonorants, in that sonorants following long vowels are more often deleted than (i) both obstruents and sonorants following short vowels, and (ii) obstruents following long vowels at stage III. The child has the following bipositional rhyme templates at this stage:

(43) *Rhyme templates at stage III*



where V(:) stands for both short and long vowels; and, [+son] is either a sonorant consonant or the second part of a long vowel or diphthong

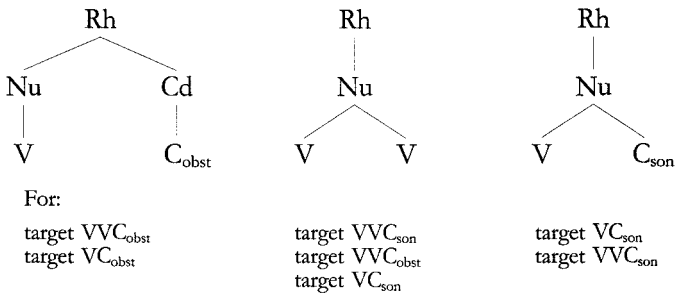
5.3.4. Stage IV: extrarhymal consonants

Characteristic of stage IV is that, after long vowels, but not after short ones, obstruents are now more often deleted than at stage III. This indicates that vowel length is being represented before obstruents as well. At stage IV, VVC_{obst} is often produced as either VV or VC_{obst}. This bears resemblance to production of VVC_{son} at stage III: VVC_{son} was produced as either VV or VC_{son}.

Moreover, although VC_{obst} was sometimes produced as VVC_{obst} at stage III, this is far less likely at stage IV. VC_{obst} is produced correctly most of the time. It is seldom produced as V or VVC_{obst}. In other words, the data seem to show that vowels and obstruents show a similar relationship as do vowels and sonorants at stage III: the rhyme is maximally binary, but there are now different ways of realising a binary rhyme. One option is not found, however: vowel lengthening under deletion of an obstruent, i.e., $VC_{obst} \rightarrow$ VV, is not attested. Apparently, compensatory lengthening is restricted to nuclei, providing further evidence for the claim that obstruents and sonorants are in different positions in the syllable. It is also an argument for having nuclei as constituents. In other respects, the representations in (39) and (41) are equivalent, in that there is no clear preference for either one. A long vowel occupies two positions, and the final obstruent following the long vowel therefore cannot be part of the rhyme, but has to be in extrarhymal position. Apparently this position is not yet always present in the child's template, and, hence, final obstruents following long vowels are

often deleted in the case that long vowels are represented as bipositional. That is, the following mappings now exist:

(44) *Different rhyme structures at stage IV*



However, although VVC_{obst} is often produced as either VV or VC_{obst}, as shown above, it is produced correctly in many instances. Moreover, the percentage of correctly produced VVC_{son} targets also increases at this stage. Furthermore, the first final clusters appear at this stage too. It seems that the child is learning to represent final consonants after a long vowel or after a combination of a short vowel plus a sonorant. That is, the child's template can now accommodate three positions. However, the newly acquired position is often overruled by the child's previous templates: the bipositional rhyme templates of stage III. If this third position in the rhyme were already present at stage III, the increase of deleted obstruents only after long vowels at stage IV is unexpected. Moreover, we would expect to find correctly produced VVC_{son} targets, and also final clusters at stage III (see section 5.4.1), but this is not attested at stage III.

Apparently rhymes are optimally binary, as shown above. A long vowel occupies two positions, and therefore the final obstruent following the long vowel cannot be part of the rhyme. Since universally rhymes are maximally bipositional, the obstruent has to be in extrarhymal position. Apparently this position is just becoming available in the child's template at stage IV, and, hence, final obstruents following long vowels are sometimes produced and sometimes not. That is, the bipositional template can still sometimes overrule the newly acquired template in two ways: (i) it may be the case that at stage IV vowel length before obstruents is not always represented; in other words, the child assumes the templates and preferences available at stage III; or (ii) VVC is mapped onto any bipositional rhyme template. In that case the final consonant is deleted, or the vowel is shortened, as shown in (44).

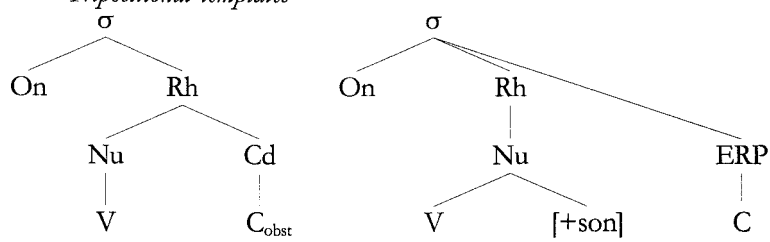
The extrarhymal position is becoming part of the child's template, but is often not yet realised. We have seen before that a new position or template is not used immediately across the board, but there is a transition stage at which either both the 'old' parameter values are at work, and the new value

is tested; or the old values are still assigned to previously acquired words, while newly acquired words are analysed as having the new values. In any event, at stage IV the following parameter is being set, with the default value is [No] (underlined) and the marked value [Yes]:

(45) *Extrarhymal parameter*
A (final) bipositional rhyme can be followed by an extra consonant as long as it obeys the Sonority Sequencing Principle. [Yes/<u>No</u>]

When this parameter is set to the marked value the child has the following templates:

(46) *Tripositional templates*



As was argued in section 3.3 on adult Dutch syllable structure, consonants following long and short vowels are in different positions in adult Dutch: a consonant following a short vowel is part of the rhyme, whereas a consonant following a long vowel is in an extrarhymal position adjacent to the rhyme, since rhymes are argued to be maximally bipositional (Kager 1989, among others). Extrarhymal consonants have to obey the sonority sequencing principle (SSP), as opposed to extrasyllabic consonants, which crucially do *not* obey the SSP (see chapter 3). Therefore, the extrarhymal consonant is not present after VC_{obst} rhymes: it does not obey the SSP, since there are no consonants of a lower sonority value than obstruents, unless we differentiate between fricatives and plosives. In the next section, we will see, however, that the child does not yet have any fricative-plosive clusters. Therefore, I assume that the child has not yet differentiated between the two kinds of final obstruents with respect to sonority, and that the extrasyllabic position is not yet available. Moreover, the child does not realise clusters consisting of a liquid followed by a nasal either. I therefore assume that the child simply distinguishes obstruents from sonorants. The extrarhymal position in (46) is filled with an obstruent after a VC_{son} or a VV rhyme. However, sonorants after long vowels also occupy this position. At stage IV Jarmo begins to acquire this aspect of Dutch syllable structure.

To summarise, at stage IV Jarmo learns two new aspects of Dutch syllable structure: (i) vowel length is represented before obstruents as well as before sonorants, and (ii) a bipositional rhyme can be followed by an extrarhymal position, which has to obey the Sonority Sequencing Principle.

5.4. Consonant clusters

The analysis presented above makes predictions as to the occurrence of final and medial consonant clusters. It is predicted that final clusters only appear at stage IV. I show in section 5.4.1 that this prediction is borne out. It is also predicted that, if extrarhymal positions are restricted to word edges, no VVC rhymes occur word-internally. This prediction is also borne out, as will be shown in section 5.4.2.

5.4.1 Final consonant clusters

The analysis given in the preceding sections makes the prediction that final consonant clusters are deleted at stage I, since the child has a core syllable template. However, adult target words with complex codas are not attempted before 1;7.15 by Jarmo. This might be due to the 'selection' strategy. When these words are no longer avoided by the child, but are actually selected for production, Jarmo uses the 'repair' strategy: the clusters are reduced, either totally (47a) or partially (47b). Total reduction occurs less frequently than partial reduction, which is expected, since at stage II the child already has a coda in his syllable template.

(47) *Jarmo*

a. STAGE I (forms typical of stage I, occurring at stage II)

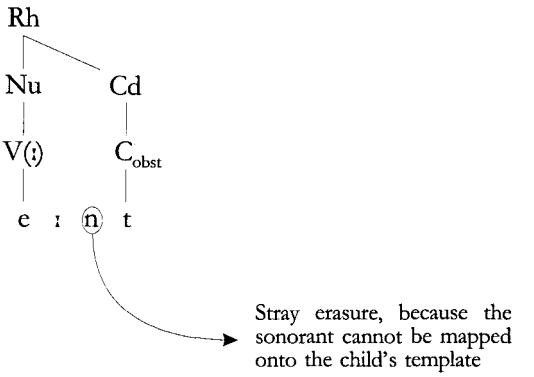
paard	/paːrt/	→	[pɛi], [paː]	(1;7.15)
		→	[baː]	(1;8.12)
		→	[paː]	(1;8.26)

b. STAGE II

paard	/paːrt/	→	[paːs]	(1;7.15)
paard	/paːrt/	→	[paːc]	(1;7.15)
eend	/eːnt/	→	[aːt]	(1;7.15)
		→	[ɑt]	(1;7.29)
		→	[ɛt]	(1;9.9)
fiets	/fiːts/	→	[piːs]	(1;9.9)
huilt	/hœylt/	→	[hœyt]	(1;9.23)
fiets	/fiːts/	→	[fiːs], [hɪʃ]	(1;9.23)

With striking regularity, the realised final consonant is an obstruent. As we saw above, at this stage Jarmo has a syllable template which allows a branching rhyme, that is, he has a coda which only can be occupied by obstruents. Sonorants cannot be mapped onto this template and, as a result, they are deleted, as shown in (48).

(48) *Cluster reduction at stage II*



Note also that vowel length errors occur, as predicted, since vowel length distinctions are not distinctive at stage II.

The interesting stage is stage III, where Jarmo has both branching rhymes and branching nuclei. I argued that obstruents are in the coda, and sonorants in the nucleus, but that they cannot both occur in the same syllable. I assumed above that Jarmo has a bipositional rhyme at this stage, because of the deletion of sonorants after long vowels, which apparently cannot be realised in the coda for two reasons: first, sonorants are not allowed in the coda, and second, the rhyme is maximally bipositional. Moreover, vowel length errors before target sonorants typically occur in two environments: (i) long vowels in the adult target are shortened in the child's produced form if the following sonorant is realised; (ii) short vowels in the adult target are lengthened in the child's production form if the following sonorant is not realised. Since vowel length distinctions are not systematically realised before obstruents, I argued that vowel length is not represented before obstruents, and thus that a branching rhyme (nucleus-coda) also has two positions. Another argument for the claim that rhymes are maximally bipositional at this stage is the absence of final consonant clusters. If the child's template can have both a branching rhyme and a branching nucleus in the same syllable at this stage, $VC_{son}C_{obst}$ and VVC_{son} rhymes are expected. These are, however, not attested at this stage. The absence of VVC rhymes has been described and explained above. Here I will describe how children treat target words with final clusters.

Unfortunately, there are not many target words with final clusters produced by the child, but let us look at the available data at stage III. The target forms in (49a) all end in sequence of a long vowel, a sonorant and an obstruent; those in (49b) in a short vowel preceding the sonorant-obstruent cluster.

(49) *Jarmo*: STAGE III

a.	paard	/paːrt/	→	[paːp]	(1;10.9)
	eend	/eːnt/	→	[eːt], [ɛt]	(1;11.20)
	paard	/paːrt/	→	[taːt]	(2;0.4)
	taart	/taːrt/	→	[taːt]	(2;0.28)
b.	olifant	/ˈoːliːˌfɑnt/	→	[ˈɔtuːˈtaːt]	(1;11.20)
	hond	/hɔnt/	→	[hɔt]	(2;0.28)
	zand	/zɑnt/	→	[tɑm]	(2;1.8)

The following observations can be made. (i) Clusters are never produced as such at stage III. (ii) In all but one form, only the obstruent is realised. The one exception is the word *zand* /zɑnt/, produced as [tɑm]. If all vowels before obstruents are represented by one V slot, then none of the forms has a tripositional rhyme, confirming the hypothesis that at stage III the child has a bipositional rhyme template, either realised by a branching rhyme or a branching nucleus, but not both. That is, there is no clear evidence that the child allows an extra position after a bipositional rhyme at this stage.

If we look at the production forms of these target forms at stage IV (50) similar observations can be made. Again, there is only one form in which the cluster is reduced to a sonorant (nasal); the other clusters, with two exceptions, are reduced to plosives. Vowel length errors occur in the productions of target words with short vowels (50b), but not in those with long vowels (50a). Deletion of the sonorant does not necessarily trigger lengthening of the preceding vowel (50c), although frequently it does (50b). (50d) gives the only two production forms with a sonorant–obstruent cluster. Note that in neither of these two cases are vowels lengthened.

(50) *Jarmo*: STAGE IV

a.	eens	/eːns/	→	[yːs]	(2;2.6)
	taart	/taːrt/	→	[taːt]	(2;2.6)
	staart	/staːrt/	→	[taːt]	(2;3.9)
	paard	/paːrt/	→	[paːt]	(2;4.1)
b.	hert	/hɛrt/	→	[haːp]	(2;1.22)
	hond	/hɔnt/	→	[hoːs]	(2;1.22)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈhoːˈtɑut]	(2;1.22)
	melk	/mɛlk/	→	[maːk]	(2;2.27)
			→	[maːk]	(2;3.9)
c.	hert	/hɛrt/	→	[hɛt]	(2;1.22)
	bord	/bɔrt/	→	[pɔs]	(2;2.27)
	hond	/hɔnt/	→	[hɔt]	(2;2.27)
	hert	/hɛrt/	→	[hɛt]	(2;4.1)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈhɔntəˈflɑŋ]	(2;4.1)
d.	hand	/hɑnt/	→	[hɑnt]	(2;3.9)
	strand	/strɑnt/	→	[tlɑnt]	(2;3.9)

The fact that the only vowel length errors involve the lengthening of short vowels when a sonorant is deleted (although deletion does not necessarily trigger vowel lengthening) is unlikely to be accidental. This seems to point to the following conclusions. (i) At stage IV the child has mastered vowel length distinctions; all long vowels are represented as bipositional. (ii) The fact that consonants after long vowels are often produced indicates that the child's template allows that an extra final consonant is added to the bipositional rhyme template. Moreover, the two cases in which a nasal–plosive cluster is produced (without lengthening of the preceding vowel) provide crucial evidence for the fact that a bipositional rhyme can be followed by an extra consonant.

In section 5.3.4 I argued that characteristic of stage IV is the fact that the child's template allows an extrarhymal consonant. This consonant obeys the SSP. In chapter 4 I argued that only consonants that do not obey the SSP are outside the scope of the syllable, and therefore in extrasyllabic position. As will be shown shortly, at stage IV no violations of the SSP are attested; there is thus no evidence for assuming an extrasyllabic final position in the child's template.[19]

Assuming that a bipositional rhyme can be followed by an extra consonant that has to obey the SSP, it is expected that the child will *not* produce target words ending in a short vowel followed by two obstruents as such: in that case the SSP is violated. Let us look then at words ending in two obstruents.

The data from stage III show that these clusters are usually reduced to a single obstruent (51a, b):

[19] An additional argument against the presence of an extrasyllabic final consonant is the following: consonants in the appendix are restricted to coronal obstruents. However, the child produces also sonorants after a bipositional rhyme (ii,a). Moreover, obstruents following long vowels can be either labial, coronal or dorsal, as shown in (ii, b, c, d):

(ii)

	Jarmo			
a.	haan	/haːn/	→ [haːm]	(2;1.22)
	maan	/maːn/	→ [maːn]	(2;1.22)
b.	jeep	/d͡ʒiːp/	→ [tiːp]	(2;1.22)
	aap	/aːp/	→ [aːp]	(2;2.6)
c.	staart	/staːrt/	→ [taːt]	(2;1.22)
	neus	/nøːs/	→ [nøːs]	(2;1.22)
d.	boek	/buːk/	→ [puːk]	(2;1.22)
	kijk	/kɛik/	→ [kaːk]	(2;1.22)

(51) *Jarmo*: STAGE III

a.	fiets	/fiːts/	→	[tiːt]	(2;0.4)
	fiets	/fiːts/	→	[tɪt], [diːt]	(2;0.28)
	loopt	/loːpt/	→	[hoːp]	(2;0.28)
b.	kast	/kɑst/	→	[kɑs]	(2;0.28)
	vast	/vɑst/	→	[tɑt], [taːt]	(2;1.8)

At stage III only one form is produced with what looks like a cluster, although it is more likely to be an affricate (52a), since in all other cases the cluster consisting of two obstruents is reduced. Moreover, final plosives are sometimes produced as affricates too, as shown in (52b).

(52) *Jarmo:* STAGE III

a.	fiets	/fiːts/	→	[tiːt͡s]	(2;0.4)
b.	uit	/œyt/	→	[ɑt͡s]	(1;9.9)
	poes	/puːs/	→	[pyːt͡s]	(1;11.6)
	poes	/puːs/	→	[puːt͡s]	(2;1.8)

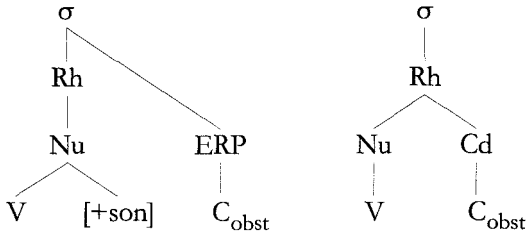
Similar observations can be made for stage IV: in almost all cases the cluster is reduced (53a). In three cases a cluster is produced, but in all three cases it is /ts/, which might also considered to be an affricate (53b).

(53) *Jarmo:* STAGE IV

a.	vracht	/vrɑχt/	→	[fɑχ]	(2;1.22)
	acht	/ɑχt/	→	[ɑp]	(2;2.6)
	geweest	/χəˈveːst/	→	[neːs]	(2;2.27)
	rijst	/rɛist/	→	[lɛis]	(2;2.27)
	geweest	/χəˈveːst/	→	[leːs]	(2;4.1)
	hoofd	/hoːft/	→	[hoːf]	(2;4.1)
b.	muts	/mʉts/	→	[tyːt͡s]	(2;1.22)
	fiets	/fiːts/	→	[tɪt͡s]	(2;2.6)
	muts	/mʉts/	→	[mʉt͡s]	(2;2.27)

I argued above that at this stage the child indeed considers long vowels to be bipositional. Moreover, I argued that the child's template allows an extrarhymal consonant after a bipositional rhyme. On the assumption that /ts/ is an affricate, and thus a single segment, no further stipulations have to be made: the attested patterns all follow from the constraints on the child's templates, repeated in (54). Since no adult target words ending in a rhyme consisting of a vowel followed by two obstruents (other than /ts/) are attested, I conclude that Jarmo's syllable (or word) template does not yet license an appendix (extrasyllabic consonant(s)), and that extrarhymal consonants obey the SSP. If the coda is filled with an obstruent, the extrarhymal position cannot be filled: this would violate the SSP.

(54) *Stage IV: Extrarhymal position after sonorants, but not after obstruents*



This explains why sonorant-obstruent clusters appear before clusters consisting of two obstruents. The latter require an appendix.

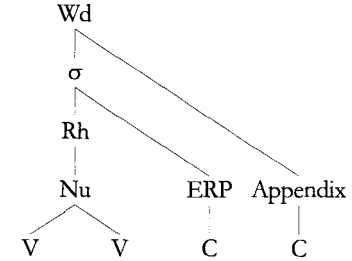
There is one remarkable case clearly arguing for the more marked status of clusters consisting of two obstruents: Jarmo produced an adult target ending in a cluster of two obstruents with a nasal-plosive cluster, as shown in (55):

(55) *Jarmo*

muts	/mʉts/	→	[mʉnt]	(2;3.9)

However, if we assume that /ts/ is a cluster, the matter is more complicated. Then the child's template must have a bipositional rhyme, followed by an extrarhymal position, which is followed by an appendix to explain the first case of (53b) and the form in (52a), as schematised in (56):

(56) *Bipositional rhyme plus extrarhymal position plus appendix*



(t)	y	ː	t	s	muts	/mʉts/	→	[tyːt͡s]
(t)	i	ː	t	s	fiets	/fiːts/	→	[tiːts]

In the other two cases of (53b), there is a bipositional (branching) rhyme and an appendix. The only evidence for an appendix are the forms given above ending in /ts/. Moreover, since we find both shortening of a long vowel before /t͡s/ (57a), and lengthening of a short vowel (57b), the production of /t͡s/ is not dependent on the length of the preceding vowel, although the /t/ is in different position after short and long vowels.

(57)

	Jarmo				
a.	fiets	/fiːts/	→	[tiːt͡s]	(2;0.4)
	fiets	/fiːts/	→	[tsɪt͡s]	(2;2.6)
b.	muts	/mʉts/	→	[tyːt͡s]	(2;1.22)
	muts	/mʉts/	→	[mʉt͡s]	(2;2.27)

Therefore, I will assume that /ts/ has to be considered an affricate, and thus occupies one skeletal position: either the extrarhymal position or the coda.

To summarise, there is no clear evidence that the child has an extrarhymal position in the syllable template before stage IV, when final clusters consisting of a sonorant plus an obstruent occur. Moreover, at this stage vowels are regularly lengthened when the sonorant of the sonorant–obstruent cluster is deleted. From 2;0.4 /ts/ occasionally occurs in the child's forms, but these cases have been analysed as ending in an affricate. In that case, only one single obstruent is allowed. Thus, at stage IV the child allow a bipositional rhyme to be followed by an extrarhymal consonant at word edges.

One additional observation should be made. There are two production forms of a target word ending in a cluster of two sonorants. These are given in (58):

(58)

	Jarmo				
	worm	/vɔrm/	→	[sɔm]	(2;1.22)
			→	[mɔm]	(2;3.9)

As predicted, two sonorants cannot be accommodated into the child's template, because it would violate the SSP, and therefore, the cluster is reduced. Again, no vowel length errors occur.

Do clusters following a short vowel behave differently from those following a long vowel? All clusters, both sonorant-obstruent and obstruent–obstruent, following a long vowel are reduced to a single obstruent, while there is variation in the case that a sonorant–obstruent cluster follows a short vowel: then, three different patterns are attested: (i) the cluster is reduced to an obstruent, (ii) the cluster is reduced to the sonorant (which is always the nasal); or (iii) the cluster is produced as a cluster. We saw that in the latter two cases no vowel length errors occur, whereas if clusters are reduced to obstruents this frequently triggers lengthening of the preceding vowel. This is taken as additional evidence that the child allows an extra position at word edges at stage IV.

Let us now look at the production of final clusters by other children. Elke's data on the acquisition of rhymes are largely comparable with Jarmo's (see appendix G). She has only branching rhymes at the first stage, where the coda can only be filled by obstruents. Moreover, vowel length is not mastered. At the next stage (stage 2), sonorants appear. They show the same

close relationship with vowels as we saw in Jarmo's data. Vowel length is non-distinctive before obstruents, but is distinctive before sonorants at this stage. In other words, Elke seems to have a minimal and maximal bipositional rhyme template at stage II. The main difference between Jarmo and Elke is that Elke shows no increase in final obstruent deletion in the next stage (Elke's stage III). At that stage vowel length errors no longer occur before obstruents, indicating that Elke has mastered vowel length distinctions in all environments. Since final obstruents are not deleted, and long vowels are represented as bipositional, she has an extra position after the bipositional rhyme, which seems to be restricted to obstruents, since sonorants after long vowels are generally not realised, unless the vowel is shortened. The prediction is that at this stage final clusters appear.

At stage I and II all final sonorant-obstruent clusters following target short vowels are reduced to obstruents (59a, b). Only at stage III does deletion of sonorants systematically trigger vowel lengthening (59c). At stage III clusters appear, as predicted (59d).

(59) *Elke's sonorant-obstruent clusters after short vowels*

a.	STAGE I				
	kind	/kɪnt/	→	[kɪʃ]	(1;6.25)
	hond	/hɔnt/	→	[hɔt]	(1;8.31)
			→	[ɔt͡ʃ]	(1;9.10)
b.	STAGE II				
	hond	/hɔnt/	→	[ɔt]	(1;10.21)
	tent	/tɛnt/	→	[tɛt]	(1;10.21)
	valt	/vɑlt/	→	[fɑt͡ʃ]	(1;10.21)
	hond	/hɔnt/	→	[ɔt͡ʃ]	(1;11.7)
			→	[hɔt]	(2;0.25)
	Gert	/χɛrt/	→	[χɛt]	(2;2.6)
	spons	/spɔns/	→	[pɔs]	(2;3.27)
	vork	/vɔrk/	→	[fɔk]	(2;3.27)
	hond	/hɔnt/	→	[hoːt͡ʃ]	(1;10.21)
	valt	/vɑlt/	→	[fɑɪt]	(1;10.21)
	hond	/hɔnt/	→	[ɑut]	(1;11.7)
	hond	/hɔnt/	→	[oɪt]	(1;11.28)
c.	STAGE III: *Compensatory lengthening*				
	melk	/mɛlk/	→	[mɛuk]	(2;2.21)
	hond	/hɔnt/	→	[hoːt]	(2;3.27)
	valt	/vɑlt/	→	[fɑut]	(2;4.15)
	melk	/mɛlk/	→	[mɛuk]	(2;4.29)

d.	STAGE III: *Final clusters*				
	brand	/brɑnt/	→	[bɑnt]	(2;3.27)
	hond	/hɔnt/	→	[hɔnt]	(2;3.27)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈoːfəˈfɑnt]	(2;3.27)
			→	[ˈoːfɑnt]	(2;3.27)
	worst	/vɔrst/	→	[vɔʀs]	(2;4.15)
	ɑnk	/ɑŋk/	→	[ˈɑŋk]	(2;4.29)
	drinkt	/ˈdɪŋkt/	→	[dɪŋt]	(2;4.29)
	klimt	/klɪmt/	→	[kɪmt]	(2;4.29)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈoːflɑnt]	(2;4.29)

Elke seems to have acquired an extra consonant position word-finally at stage III: a bipositional rhyme can be followed by an extra consonant. Since these final consonants are either coronal or dorsal (59c, d),[20] they are probably in the extrarhymal position, rather than in the appendix. If this is correct, we do not expect final clusters consisting of two obstruents (they violate the SSP), nor do we expect sonorant–obstruent clusters following long vowels. The latter indeed do not occur: most clusters are reduced to obstruents. At stage III one form with a final cluster is produced; however, the target long vowel is shortened, as shown in (60):

(60) *Elke: Sonorant–obstruent clusters after long vowels*

a.	STAGE I				
	eend	/eːnt/	→	[ɑt], [ɛt]	(1;8.31)
	kaars	/kaːrs/	→	[kɛs], [taːʃ]	(1;8.31)
	eend	/eːnt/	→	[ɑt͡ʃ]	(1;9.24)
	paard	/paːrt/	→	[pɑt]	(1;9.24)
b.	STAGE II				
	eend	/eːnt/	→	[eːt], [aːt͡ʃ]	(1;10.21)
			→	[hɛt]	(1;11.7)
	paard	/paːrt/	→	[paːt͡ʃ]	(1;11.7)
	eend	/eːnt/	→	[eːt͡s]	(2;1.16)
	huilt	/hœylt/	→	[hœyt], [haus]	(2;2.6)
	eend	/eːnt/	→	[eːt]	(2;3.27)
c.	STAGE III				
	eend	/eːnt/	→	[ɪnt]	(2;3.27)

[20] There seems to be a general tendency to link labial consonants at the beginnings of words, while dorsals are preferred word-finally (see Levelt, to appear).

These data indicate that Elke does not have an appendix *and* an extrarhymal position. Let us look at final obstruent–obstruent clusters to decide which of the two positions she actually has. Elke does not select target words containing obstruent-obstruent clusters following short vowels at stage I, but target words with long vowels and an obstruent-obstruent cluster are selected for production.[21] They are invariably reduced to a single obstruent, as shown in (61a). The same is true for stage II and III (61a, b):

(61) *Elke: Reduction of final obstruent-obstruent clusters*

a.	STAGE I				
	fiets	/fiːts/	→	[tiːʃ]	(1;7.8)
			→	[fiːʃ]	(1;9.10)
b.	STAGE II				
	dicht	/dɪχt/	→	[tɪs]	(1;10.21)
	muts	/mʉts/	→	[muːt]	(2;0.11)
			→	[mʉt]	(2;0.11)
	fiets	/fiːts/	→	[tɪt], [tiːt]	(2;0.11)
	echt	/ɛχt/	→	[ɑχ]	(2;2.6)
c.	STAGE III				
	muts	/mʉts/	→	[mɪs], [mɛs]	(2;2.21)
	dicht	/dɪχt/	→	[dɪs]	(2;3.27)
	echt	/ɛχ/	→	[ɛχ]	(2;3.27)
	fiets	/fiːts/	→	[fiːs]	(2;4.15)
	beest	/beːst/	→	[beːs]	(2;4.29)

However, she produces two forms with a final cluster at stage III, as shown in (62):

(62) *Elke: Final clusters at stage III*

kast	/kɑst/	→	[kɑst]	(2;3.27)
worst	/vɔrst/	→	[vɔst]	(2;4.15)

Although these forms might indicate that Elke has an appendix, this is not necessarily the case: if she regards plosives as less sonorous than fricatives, these forms are not violating the SSP, and may be analysed with an extrarhymal position, following the rhyme consisting of a nucleus and a coda.

Robin's data are also very similar to Jarmo's and Elke's. However, they differ in two respects. First, nasals seem to be represented in the coda. Vowel length errors before nasals invariably occur in closed syllables. For

[21] I have no explanation for this selection strategy.

vowel length errors before liquids the same pattern is attested as for Elke and Jarmo. Only liquids are part of the nucleus. Second, although Robin acquires the vowel length distinction fairly late before obstruents and nasals (at stage IV beginning at age 2;1.26, see appendix G), the extrarhymal position is available quite early. He starts producing final sonorant-obstruent clusters from 1;9.24 (63). The data in (63) clearly show that vowel length has not been mastered.

(63) *Robin: Final clusters*

bank	/bɑŋk/	→	[bɑŋk]	(1;9.24)
brand	/brɑnt/	→	[baːnt]	(1;10.7)
zand	/zɑnt/	→	[sɑnt]	(1;10.21)
plons	/plɔns/	→	[pɔns]	(1;10.7)
wind	/ʋɪnt/	→	[fɪnt]	(1;10.7)
zand	/zɑnt/	→	[zaːnt]	(1;10.21)
grond	/χrɔnt/	→	[suːnt]	(1;10.21)
plons	/plɔns/	→	[puːnt]	(1;10.21)

Clusters are not always produced as such. Sometimes they are reduced, as shown in (64), either to the plosive (64a) or to the nasal (64b):

(64) *Robin's cluster reduction*

a.	brand	/brɑnt/	→	[bɑt]	(1;11.21)
	denk	/dɛŋk/	→	[tɪk]	(1;11.21)
b.	brant	/brɑnt/	→	[bɑn]	(2;1.7)
	land	/lɑnt/	→	[lɑn]	(2;1.7)

Although obstruent–obstruent clusters are frequently reduced to single obstruents (65a), he also has a few final fricative–plosive clusters from 2;0.18 (65b):

(65) *Robin's production of target final obstruent-obstruent clusters*

a. *Cluster reduction*

dicht	/dɪχt/	→	[dɪs]	(1;8.24)
feest	/feːst/	→	[fɪs]	(1;9.24)
hoofd	/hoːft/	→	[hoːt]	(1;9.24)
vracht	/vrɑχt/	→	[tɑt]	(1;11.7)
		→	[fɑχ]	(1;11.21)
dicht	/dɪχt/	→	[dɪχ]	(2;0.18)

b. *Realisation of clusters*

dicht	/dɪχt/	→	[tɪχt]	(2;0.18)
verstopt	/vərˈstɔpt/	→	[puːft]	(2;0.18)
feest	/feːst/	→	[fɪst]	(2;0.18)

These data suggest that vowel length need not be mastered before the extrarhymal position can be learned. Rather, it seems that Robin first acquires a branching rhyme (nucleus-coda), where the coda can be filled by an obstruent or a nasal (stage I). The next step in his development seems to be the acquisition of an extrarhymal position in his template (stage II), rather than the acquisition of a branching nucleus. However, Robin has branching nuclei at stage IV. From this pattern of development we have to conclude that the branching nucleus parameter and the extrarhymal parameter are completely independent. The order in which these parameters are fixed can vary for different children.

Let us now look at the production of medial clusters in adult target words to see whether the extrarhymal position is only available at word endings.

5.4.2. Medial consonant clusters

The prediction for word-internal clusters is that at stage I all word-internal syllable-final consonants are deleted, since the child only has a core syllable template. Again, medial clusters are avoided by Jarmo until 1;7.15, probably due to a selection strategy. At stage II, where obstruents are usually realised in syllable-final position, the data show that this is never the case with word-medial obstruents (66a). At stage III a similar pattern is found (66b):

(66) *Jarmo*

a.	STAGE II				
	wipwap	/ˈʋɪpˌʋɑp/	→	[ˈpiːpɑ]	(1;8.12)
			→	[ˈbiːpaː]	(1;8.26)
	vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈtiːtɑ]	(1;7.29)
	fietsen	/ˈfiːtsə[n]/	→	[ˈpiːʃə]	(1;9.23)
b.	STAGE III				
	fietsen	/ˈfiːtsə[n]/	→	[ˈpiːʃə]	(1;11.20)
	poetsen	/ˈpuːtsə[n]/	→	[ˈtuːtə]	(1;11.20)
	wipwap	/ˈʋɪpˌʋɑp/	→	[ˈpɪpɑ]	(2;0.4)
	vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈtiːtœyf]	(2;1.8)
			→	[ˈfiːtœyf]	(2;1.8)

At stage IV there are two target words with a medial cluster consisting of two obstruents, which are sometimes realised with a medial cluster by Jarmo (67a), although reduction also occurs (67b):

(67) *Jarmo*: STAGE IV

a.	struisvogel	/ˈstrœysˌvoːχəl/	→	[ˈtœysˈfoːχoː]	(2;1.22)
	vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈtɪχˈtœyχ]	(2;2.27)
b.	struisvogel	/ˈstrœysˌvoːχəl/	→	[ˈtœyˈχoːχoː]	(2;1.22)
	aardbei	/ˈaːrtˌbei/	→	[ˈaːpei]	(2;2.6)

These, however, all are compounds, and, given the level stress, probably considered as two words by the child. However, Jarmo's production of *aardbei* indicates that he considers this as a single word. The fact that the whole syllable-final cluster is deleted in this case supports the hypothesis that extrarhymal consonants are not allowed word-medially.

Unfortunately, no words with a medial cluster of two obstruents preceded by a short vowel are selected for production by Jarmo. These forms would be able to tell us whether codas are allowed word-internally in the child's system. Therefore we cannot conclude that Jarmo realises the coda position word-internally.[22]

There are far more words with word-medial clusters consisting of a sonorant and an obstruent, although they only occur at stages III and IV. At stage III these clusters are reduced to a single consonant: the obstruent. This obstruent seems to be the onset of the second syllable. All available data from stage III are given in (68):

(68) *Jarmo:* STAGE III

a.	tanden	/ˈtɑndə[n]/	→	[ˈtɑtə]	(1;11.20)
	drinken	/ˈdrɪŋkə[n]/	→	[ˈkɪkə]	(2;0.28)
	varkens	/ˈvɑrkəns/	→	[ˈkɑkəs], [ˈfɑkəs]	(2;0.28)
b.	drinken	/ˈdrɪŋkə[n]/	→	[ˈteːkə]	(1;10.23)
	pinda	/ˈpɪndaː/	→	[ˈkiːkaː]	(2;0.28)
	Monkey	/ˈmɔŋkiː/	→	[ˈkoːgiː]	(2;0.28)
	wortel	/ˈvɔrtəl/	→	[ˈtoːtɔ]	(2;1.8)

It can be observed that (i) the word-medial syllable-final sonorant is never produced; rather, the obstruent is always produced, and (ii) in half of the cases vowel lengthening occurs, probably compensatory lengthening (68b). That is, the position of the sonorant is sometimes realised in the child's template (a bipositional rhyme or nucleus), but is filled by spreading the vowel. However, vowel lengthening does not always occur (68a). These data resemble the patterns found for word-final sonorant–obstruent clusters. Whether the rhymes in the first syllables of the words in (68a) are bipositional or monopositional is hard to tell. It could be the case that the realised obstruents are ambisyllabic; i.e., they are both the coda of the first syllable and the onset of the second.

At stage IV three patterns can be observed: (i) the clusters is now produced (69a); (ii) the sonorant is deleted, triggering vowel lengthening (69b), and (iii) the nasal is produced (69c):

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[22] The absence of word-internal codas is not predicted by the theory. However, it may be the case that the complexity of words is restricted in some other ways. It may, for example, be the case that if a word contains more than one or two syllables, the produced syllables are relatively simple, whereas if the child only produces one syllable, it may be fairly complex. However, further research into these matters is required.

(69) *Jarmo:* STAGE IV

a.	drinken	/ˈdrɪŋkə[n]/	→	[ˈtɪŋkə]	(2;2.6)
	Selma	/ˈsɛlmaː/	→	[ˈʃɛlmaː]	(2;3.9)
	drinken	/ˈdrɪŋkə[n]/	→	[ˈtlɪŋkɑ]	(2;4.1)
	kalkoen	/ˌkɑlˈkuːn/	→	[ˈkɛmˈkuːn]	(2;4.1)
b.	ganzen	/ˈχɑnsə[n]/	→	[ˈhaːsə]	(2;2.6)
	Selma	/ˈsɛlmaː/	→	[ˈnɛumaː]	(2;2.6)
	drinken	/ˈdrɪŋkə[n]/	→	[ˈsiːkə]	(2;2.6)
	Jarmo	/ˈjɑrmoː/	→	[ˈdoːmoː], [ˈnoːmoː]	(2;3.9)
	Selma	/ˈsɛlmaː/	→	[ˈsɛumaː]	(2;3.9)
	varken	/ˈvɑrkən/	→	[ˈfaːkɔ]	(2;4.1)
c.	vlinder	/ˈvlɪndər/	→	[ˈkɪnə]	(2;2.6)
	andere	/ˈɑndərə/	→	[ˈɑnə]	(2;4.1)
	vlinder	/ˈvlɪndər/	→	[ˈsɪnɑ], [ˈt͡sɪnɑ]	(2;4.1)

Vowel lengthening never occurs when the medial cluster is realised; neither does it occur when the medial cluster is reduced to the nasal, indicating that the nasal is part of the rhyme of the first syllable, and functions as the onset of the second syllable as well in (69c). Vowel length errors typically occur when the medial cluster is reduced to the obstruent: again, it seems that the position of the sonorant is realised, but that it is filled by lengthening the vowel. From the data the only conclusion we can draw is that branching nuclei are allowed word-medially. There is no evidence that codas are allowed word-medially, although there is no evidence that codas are *not* allowed either. There is little evidence that extrarhymal consonants are not allowed word-internally.

Robin's data illustrate that codas are allowed word-medially. However, they do not show that extrarhymal positions are produced, since he has not mastered vowel length distinctions. Therefore, since all vowels are monopositional until stage IV, his template does not represent vowel length. Therefore, long vowels followed by obstruents and nasals are analysed as (bipositional) branching rhymes, as in (70).

(70) *Robin: medial VVC*

speeltuin	/ˈspeːlˌtœyn/	→	[ˈdyːnˈdœyn]	(1;9.10)
vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈfiːχˈdɑχ]	(1;9.24)

In most cases, medial clusters are reduced, as shown in (71a, b); around the age of 2 he starts producing medial clusters (71c, d):

(71) *Robin*

a. *Cluster reduction: sonorant–obstruent*

andere	/ˈɑndərə/	→	[ˈɑŋə]	(1;8.7)
speeltuin	/ˈspeːlˌtœyn/	→	[ˈtoːtœn]	(1;9.24)
eenden	/ˈeːndən/	→	[ˈeːtə]	(1;10.7)
drinken	/ˈdrɪŋkə[n]/	→	[ˈtɪkə]	(1;11.7)

b. *Cluster reduction: obstruent–obstruent*

vliegtuig	/ˈvliːχˌtœyχ/	→	[ˈtiːtaː]	(1;8.24)
fietsen	/ˈfiːtsə[n]/	→	[ˈfɪtə]	(1;9.10)
tractor	/ˈtrɛktɔr/	→	[ˈtɑkɑ]	(1;10.7)
wipwap	/ˈʋɪpˌʋɑp/	→	[ˈʋɪpɑp]	(1;10.21)

c. *Medial clusters: sonorant–obstruent*

winkel	/ˈʋɪŋkəl/	→	[ˈʋɪŋkɯ]	(2;0.18)
vakantie	/vaːˈkɑnsiː/	→	[tɑntiː]	(2;1.7)
honkballen	/ˈhɔŋkˌbɑlə[n]/	→	[ˈhɔŋˈbɑlə]	(2;1.7)
mensen	/ˈmɛnsə[n]/	→	[ˈmɛnsə]	(2;1.7)

d. *Medial clusters: obstruent–obstruent*

kasteel	/ˌkɑsˈteːl/	→	[ˈtɑsˈteːɯ]	(2;1.7)
dokter	/ˈdɔktər/	→	[ˈdɔktəɹ]	(2;1.7)
pasta	/ˈpɑstaː/	→	[ˈpɑstaː]	(2;4.8)

Elke's data are similar to Jarmo's. At the early stages all medial clusters are reduced to obstruents, as shown in (72a). At stage II we find medial clusters consisting of a sonorant and an obstruent (72b), although reduction still occurs, often now triggering compensatory lengthening (72c). Only at stage III do two obstruents occur word-medially; however, they are produced as a geminate (72d).

(72) *Elke's production of targets with medial clusters*

a. *Cluster reduction*

dansen	/ˈdɑnsə[n]/	→	[ˈtesɑ]	(1;10.21)
Elke	/ˈɛlkə/	→	[ˈɛkə]	(1;11.28)
fietsen	/ˈfiːtsən/	→	[ˈsiːsə]	(1;11.28)

b. *Sonorant–obstruent clusters*

Elke	/ˈɛlkə/	→	[ˈɑlkə]	(2;2.6)
winkel	/ˈʋɪŋkəl/	→	[ˈhɪŋkɔ]	(2;3.27)
drinken	/ˈdrɪŋkə[n]/	→	[ˈdɪŋkə]	(2;4.15)

c. *Cluster reduction with compensatory lengthening*

Elke	/ˈɛlkə/	→	[ˈaːkə], [ˈɛikɯ]	(2;2.6)
dansen	/ˈdɑnsə[n]/	→	[ˈdaːsə]	(2;3.27)
schildpad	/ˈsχɪlˌpɑt/	→	[ˈχiːpɑt]	(2;4.29)

d. *Obstruent–obstruent clusters*

opruimen	/ˈɔpˌrœymə[n]/	→	[ˈɔpˈpœymə]	(2;4.15)
taxi	/ˈtɑksiː/	→	[ˈkɑs.siː]	(2;4.29)

The data in (72d) provide clear evidence that word-medially codas are allowed. However, no such evidence exists for word-medial extrarhymal consonants.

5.4.3. Summary and discussion

From the way final clusters are treated by Jarmo we may conclude that at stage IV bipositional rhymes can be followed by an extrarhymal consonant at word edges, since at stage IV (i) rhymes consisting of a short vowel followed by a sonorant–obstruent cluster are produced; (ii) if a final sonorant–obstruent cluster is reduced to the obstruent, lengthening of the target short vowel often occurs. If final sonorant–obstruent clusters are reduced to nasals, vowel lengthening does not occur, indicating that the sonorant is in the nucleus, rather than in the coda. The possibility that the child's template consists of a bipositional rhyme optionally followed by an appendix is excluded for the following reasons. (i) Dorsal and labial consonants as well as sonorants appear after a bipositional rhyme, excluding the possibility of an appendix, since in the appendix only coronal obstruents are allowed. (ii) If there were an appendix in the child's template, we would have expected final clusters consisting of two obstruents as well, which is not attested. The only cases that could support the existence of an appendix are child's production forms ending in [ts]. However, there is good reason to assume that these have to be analysed as complex segments, rather than clusters.

Whether coda consonants (obstruents) can only appear at the edges of words or also word-internally could not be decided on the basis of Jarmo's data, because of the lack of relevant data. Elke's data at the final stage show that they are just appearing at around 2;4. Robin's data clearly show word-medial codas.

The study of the acquisition of medial clusters has brought to light that although Jarmo did not produce word-medial syllable-final sonorants at stage III, their position is often realised by lengthening of the preceding vowel. At stage IV syllable-final word-medial sonorants are produced, although reduction of the medial cluster still occurs. However, if the sonorant is deleted, the preceding vowel is lengthened, whereas if the nasal is realised, vowel lengthening is never attested. These data clearly support the conclusion of the preceding sections, namely, that sonorants are part of the nucleus. Similar conclusions can be drawn from Elke's data.

However, Robin's data showed that nasals are part of the coda, and that only liquids are part of the nucleus. There is no evidence that the extra-rhymal position exists word-internally. Therefore, I conclude that it is restricted to word edges.

5.5. Diphthongs, long vowels and weight

In chapter 3 we saw that both long vowels and diphthongs occupy two positions in the rhyme in adult Dutch. The difference between long vowels and diphthongs is that the former have one feature matrix which is shared by both V slots, while the latter have two feature matrices, one for each V slot (see (2)). According to Kager (1989) diphthongs and short vowels followed by a consonant pattern together in that both are heavy with respect to syllable weight. If weight is represented by syllable structure we could hypothesise that diphthongs are considered as short vowels followed by a glide. However, as we saw above, short vowels followed by a sonorant (glide, liquid and/or nasal) have almost the same representation as long vowels, the difference being that long vowels have one root node, while short vowels followed by a sonorant have two.

In the previous sections it has been shown that at stage II vowel length is not yet represented: all vowels occupy one skeletal position. Evidence for this position comes from the fact that both long vowels are shortened and short vowels are lengthened, the latter being more frequent, as was shown in (16) in section 5.1.2. If diphthongs are considered as short vowels plus a glide, we expect them to pattern with the short vowels. On the other hand, if diphthongs are regarded as long vowels we expect to find them to pattern with the long vowels. (73) gives Jarmo's realisation of diphthongs at the relevant stages:

(73) *Jarmo's realisation of diphthongs*

Stage	II	III	IV
% as diphthongs	55% (17/31)	67% (33/49)	81% (43/53)
% as long vowels	10% (3/31)	16% (8/49)	9% (5/53)
% as short vowels	35% (11/31)	16% (8/49)	9% (5/53)

The percentages of vowel length errors for target long and short vowels are given in (74):

(74) *Jarmo's lengthening and shortening of different target vowels*

	Stage	**II**	**III**	**IV**
Target	**Child's production**			
long vowels	% short vowels	32% (34/107)	15% (14/91)	8% (11/140)
short vowels	% V: and V_i V_j	61% (22/36)	32% (19/59)	18% (14/78)

If we compare the production of diphthongs to the percentages of vowel length errors for target long and short vowels, the following observations can be made:

(i) Diphthongs pattern with long vowels with respect to vowel length errors. Diphthongs are produced as short vowels in respectively 35%, 16% and 9% of the cases at the different stages, while long vowels are shortened (32%, 15% and 8%, respectively). The percentages are very similar.

(ii) Short vowels are produced as long vowels or diphthongs in 56%, 32% and 18% of the cases, respectively, while diphthongs are produced as long vowels or diphthongs in respectively, 65%, 84% and 91% of the cases.

From this we may conclude that long vowels and diphthongs pattern together, and that diphthongs have to be regarded as long vowels, not as short vowels followed by a glide.

In chapter 7, I discuss the acquisition of quantity in detail, but here I want to anticipate the results. It will be shown first that long vowels and diphthongs are not treated differently by children: they are both regarded as light. Second, children regard any closed syllable as heavy, no matter what consonant closes the syllable. Third, children do not differentiate between heavy (VC) and superheavy (VVC and VCC) syllables, a difference often proposed for adult Dutch (see chapters 3, 6 and 7).

From these findings the conclusion can be drawn that weight cannot be directly expressed in terms of syllable structure: on the one hand, we find that rhymes that have similar representations may differ in weight (for example, V_iV_j versus VC_{son}); on the other hand, different representations for rhymes may be equivalent with respect to weight (for example, VVC versus VC). As we will see in chapter 7, Dresher & Kaye propose a weight parameter based on whether branching rhymes or branching nuclei make a syllable heavy. However, it is not possible to interpret either a branching rhyme or a branching nucleus as heavy in child language: although all branching rhymes are heavy, it is not the case that all heavy syllables have branching rhymes. Neither rhymes ending in a short vowel followed by a sonorant nor rhymes ending in a long vowel followed by a consonant have a branching rhyme: rather, they have a branching nucleus, in the latter case followed by an extrarhymal position. Moreover, some branching nuclei are heavy, but others are not: syllables ending in long vowels and diphthongs are considered to be light, whereas syllables ending in a short vowel plus a sonorant consonant are heavy.

I will therefore propose the following Weight parameter, on the basis of which weight is interpreted:

(75) *Weight parameter*
Closed syllables are heavy. [YES/NO]

As we saw in chapter 3, in the standard moraic theory (Hayes 1989) long vowels are represented as bimoraic in languages that are quantity-sensitive

and have a vowel length distinction. However, although Dutch fulfils both requirements, long vowels behave as light for stress purposes, but as bipositional in phonotactic restrictions. In the standard moraic theory, however, weight and length are represented by the same means. It, therefore, runs into problems describing the stages found in child language, because there is no way to formally distinguish between length and weight. This difference turns out to be very important in both child and adult Dutch.

Kager (1989) tries to solve these problems by making use of a different way to determine syllable weight in Dutch, but assuming a moraic theory of syllable structure. He claims that, since all rhymes are minimally and maximally bipositional, all syllables are bimoraic. Therefore, weight cannot be determined at the moraic level, but has to be determined at the root level. He argues that the difference between long vowels on the one hand and diphthongs and short vowels followed by consonants on the other is that the latter are melodically complex, because each mora is linked to a separate root node. Long vowels are melodically simplex because both moras are linked to one root node. However, since in child language long vowels and diphthongs pattern together with respect to weight in that both are light, melodic complexity is not the right means to measure quantity in child language. Although diphthongs are melodically complex, whereas long vowels are not, both have the same weight, i.e., both are considered light. On the other hand, VC and diphthongs both are melodically complex, but the former is heavy, the latter light in child language. I therefore assume that weight can better be determined on the basis of an interpretation procedure of syllable structure, rather than on the basis of melodic complexity.

5.6. Onsets versus final consonants

The development of simple final consonants can be summarised as in (76).

Most children have the same order in which segment types occur in final position (see appendix F). Fricatives are the type of segments that occur very early in syllable-final position in most children's template. They also frequently replace segments by other manners of articulation, and are the least prone to deletion. Plosives are the next type of segments that occur in syllable-final position, followed by nasals. This order is found for Tom, Jarmo, Elke, Noortje and Robin. Liquids and glides are mastered relatively late by all children. This is schematised in (77).

(76) *Simple final consonants by Jarmo*

Adult targets:	P	F	N	L	
Age	Child's forms				
1;4.18	Ø			Ø	STAGE i
1;6.13	.	F		.	STAGE IIA
1;7.15	P/Ø	.		.	STAGE IIb
1;7.29	.	.	N/Ø	.	STAGE IIIa
1;9.23	P	.	.	.	
1;11.20	.	.	.	L/Ø	stage IIIb
2;0.28	P/Ø	.	.	.	

	means adult target is avoided
	means first correct realisation of adult target
.	means no change compared to the previous age

Where P = Plosive, Ø = Empty coda, F = Fricative, N = Nasal, L = Liquid.

(77) *Order of appearance of final consonants*

Ø → F → P → N → L
STAGE I STAGE IIa STAGE IIb STAGE IIIa STAGE IIIb

The first split, i.e., that between the absence and the presence of a final consonant, is the same for all children. This is in agreement with the core syllable hypothesis. The next contrast is between continuant and non-continuant obstruents. This split is followed by one between obstruents and sonorants. This development can be schematised as follows:

(78) *Acquisition of manner features in syllable-final position*

STAGE IIa	(+continuant)	(−sonorant)	Fricatives
STAGE IIb	−continuant		Plosives
STAGE IIIa		+sonorant	Nasals

where ( ) indicates that no contrast might be learned yet. The bracketed values seem to be the default values in syllable-final position.

This developmental pattern of manner features in syllable-final position is different from that in onset position. In onsets the first split was also between the presence and absence of a consonant. However, the default values are different in syllable-initial and syllable-final position. The next contrast was one between obstruents (plosives) and sonorants (nasals). Only

after this contrast was the contrast between continuants and non-continuants made.

As mentioned in chapter 4, the optimal core syllable consists of a labial plosive and a low open vowel, i.e., /pa/, as predicted by Jakobson (1941/68). However, he did not predict that in syllable-final position fricatives are preferred, because he did not consider different positions in the word. The observation that fricatives occur very early after vowels was also made by Ferguson (1975, 1976) for English children. The fact that in syllable-initial position plosives are preferred, while in syllable-final position fricatives are preferred seems to be related to the phenomena *fortition* and *lenition* (e.g., Donegan & Stampe 1979). Moreover, in Fikkert (in preparation) I show that the difference is not between syllable-initial and syllable-final consonants, but rather between foot-initial and foot-internal (or foot-final). Foot-initially, the strongest obstruents, plosives, are preferred, while foot-internally the weakest obstruents, fricatives, are preferred. It may therefore be the case that at the stage that the child only has plosives in onset position and fricatives in coda position the continuancy contrast is not represented in the feature geometry, but results from the fact that plosives and fricatives are in different positions in the word. The continuancy contrast is first learned syllable-finally, however, while syllable-initially (or rather foot-initially) the contrast between obstruents and sonorants is learned first.

Another important observation is that if a particular segment (type) is acquired in one position in the word, it does not necessarily mean that it is also produced in other positions. Nasals, for example, are acquired early in onset position, but relatively late in syllable-final position. For building theories of the development of segments and features in child language it is important to consider different positions in the word (Ferguson & Farwell 1975, Shibamoto & Olmsted 1978, Stoel-Gammon & Cooper 1984, Waterson 1971, 1989, Levelt to appear).[23]

A frequently mentioned reason for the fact that sonorants, especially liquids, are mastered late is that they require a complex articulation, while obstruents are relatively 'easy to articulate' (cf. Stampe 1973). However, the 'ease of articulation' argument is not a particularly strong one. Although nasals appear later in coda position than obstruents, they appear later than plosives but before fricatives in onset position. Nasals as such are not mastered late. Similarly, although liquids are produced late as single onsets

[23] In Fikkert (in preparation) I also show that there are also 'sonority constraints' on the consonants of a word. It looks as if the first consonant cannot have a lower sonority value than the second one. As a result, a word like *muis* /mœys/ is often produced as [pœys] at the early stages, even though nasals can occur in onset position, and *Monkey* /ˈmɔŋkiː/ often as [ˈmɔmuː], rather than for example [ˈmɔkiː].

and codas, they do appear in clusters. Finally, that the 'ease of articulation' is not a strong argument is also clear from the behaviour of schwa in child language. At the initial stages in child language the schwas in the adult targets are usually realised as full vowels (see also Allen & Hawkins 1980 for a similar observation). This shows that the 'ease of articulation' argument is not an important argument in explaining acquisition. Although it has been argued that schwas are articulatorily easy to pronounce, this does not lead to the early realisation of schwas. On the contrary, they are often replaced by full vowels at the early stages of acquisition, as shown in (79), while full vowels are never produced as schwas.

(79) *Jarmo*

trommel	/ˈtrɔməl/	→	[ˈpɑbaːɪ]	(1;7.15)
kikker	/ˈkɪkər/	→	[ˈkiːkɑ]	(1;7.29)
blokken	/ˈblɔkə[n]/	→	[ˈkɔkoːɪ]	(1;10.23)
wortel	/ˈʋɔrtəl/	→	[ˈtoːɪɔ]	(2;1.8)
vogel	/ˈvoːχəl/	→	[ˈfoːχoːɪ]	(2;1.22)

Even if it were true that the 'ease of articulation' argument explains why sonorants are mastered late and are more often subject to deletion, it still does not explain the fact that sonorants after long vowels are more prone to deletion than those after short vowels. I gave an independent explanation for the fact that sonorants are mastered late: sonorants are to be analysed as part of the nucleus. Since branching nuclei are acquired late, sonorants cannot be represented until the child has branching nuclei. At that stage sonorants can in principle be represented, although especially sonorants after long vowels cannot, because both positions of the branching nucleus are filled by the long vowel. Thus I offer an explanation for the different behaviour of sonorants from obstruents in terms of the child's syllable template.

5.7. Summary and conclusions

In this chapter I have discussed the following syllable parameters:

(80) *Syllable parameters*

a. *Branching rhyme parameter:*
Rhymes can branch into a nucleus and a coda [No/Yes]

b. *Branching nucleus parameter:*
The nucleus can be branching [No/Yes]

c. *Extrarhymal parameter:*
A (final) bipositional rhyme can be followed by an extra consonant [No/Yes]

where the default value is underlined

At stage I the child has set no syllable parameters: the child has the default core syllable CV. Vowel length is not distinctive, because the branching nucleus parameter still has the default value.

At stage II the child sets the branching rhyme parameter (8oa) to the marked value. The trigger experience is the recognition of adult targets with final closed syllables. No child first fixes the branching nucleus parameter before the branching rhyme parameter, indicating that these parameters are ordered: the branching rhyme parameter is fixed earlier than the branching nucleus parameter. However, although in principle the coda can be filled by any consonant, most children restrict the set of coda consonants to the class of obstruents, disallowing sonorants. Robin, however, also allows nasals in coda position, but not other sonorants. Apparently, there is a 'coda parameter' that determines which subset of the whole set of consonants can fill the coda position. Different children may choose different subsets. However, the whole set of consonants is divided in two, obeying the sonority scale: i.e., some children allow only obstruents in the coda; others allow obstruents and nasals, but no child allows for example liquids and fricatives in the coda, while disallowing plosives and nasals.

On the other hand, sonorants can be part of the nucleus, but obstruents are universally disallowed in the nucleus. One could say that the child again strives for a maximal contrast in sonority between the nucleus and the coda, and therefore only allows obstruents in that position.

At this stage, vowel length still is non-distinctive, since the branching nucleus parameter has the default value. When at stage III sonorants are mastered in syllable-final position, the child has to decide whether these sonorants are represented in the coda or in the nucleus. Apparently, Jarmo (and most other children) represents sonorants in the nucleus at stage III, thus setting the branching nucleus parameter (8ob) to the marked setting. I do not know what exactly triggers this setting. In principle, sonorants could have been represented in the coda as well. The child could, however, have discovered that vowels in adult targets can be either long or short. This discovery may trigger the setting of the branching nucleus parameter to the marked setting. If sonorants are mastered at the same time, the child may represent sonorants in the nucleus, which can now be branching. Robin's data support this hypothesis: when he starts producing nasals syllable-finally, he still has not learned the vowel length distinction. Nasals may therefore be represented in the coda. However, more research is needed to determine what comes first: sonorant consonants or the vowel length distinction?

In any event, at stage III vowels and the following sonorant always occupy two positions in Jarmo's system, indicating that the rhyme (or nucleus) is maximally bipositional. Final obstruents are never deleted: the coda position is present, and therefore the child produces obstruents,

because they are licensed by the template. Since vowel length errors before obstruents go in both directions and are not related to final consonant deletion, I argued that vowel length distinctions are not represented before obstruents yet. That implies that all vowels before obstruents are monopositional, and that all rhymes are maximally binary. Since the adult target data do not provide clear positive evidence for the maximal rhyme constraint I assumed that this constraint is universal and need not be learned. On the assumption that this constraint plays a role from the start in the child's phonology, it follows that vowel length cannot be represented if final consonants are realised.

Final sonorants are often deleted, triggering vowel lengthening. However, since final obstruent deletion never triggers vowel lengthening I assumed that compensatory lengthening only occurs within a constituent: the nucleus. The fact that the deletion of sonorants does trigger compensatory lengthening, but the deletion of obstruents does not, was taken as evidence for the different positions of obstruents and sonorants (or approximants, in Robin's case). In other words, it provides support for the constituents 'nucleus' and 'coda'.

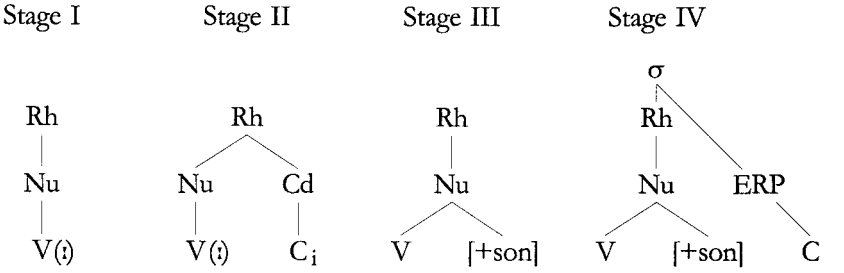
At stage IV vowel length errors are infrequent, indicating that vowel length distinctions have now been mastered. We saw that in Jarmo's system final obstruents are now more prone to deletion when following a long vowel than at stage III, although they too are still frequently realised. I argued that at this stage the child is learning that a bipositional rhyme can be followed by an additional (word-final) consonant. That is, at this stage the third parameter, the extrarhymal parameter (80c) is set to the marked value, allowing syllables ending in VVC. However, the presence of an extrarhymal position also predicts the occurrence of words ending in $VC_{son}C_{obst}$. This hypothesis is borne out by the data.

To summarise, the parameters are set in the order given in (80) by Jarmo. However, Robin's data show an interesting difference: like Jarmo, he first fixes the branching rhyme parameter. However, before setting the branching nucleus parameter, he first sets the extrarhymal parameter. In other words, he has final consonant clusters before vowel length is mastered. Apparently, the latter two parameters (80b, c) are independent of each other. However, they seem to require the setting of the branching rhyme parameter (80a).

The parameter settings at each stage define the child's template at each stage. The stages found in Jarmo's development can be represented as in (81).

The child's template determines the relationship between the adult target and the child's production form, i.e., it largely determines how target words are produced by the child. For example, at stage I no final consonants are allowed, because they cannot be mapped onto the child's template. At stage II only the consonants that are licensed by the coda, for most children the obstruents, but for Robin also nasals, appear. Sonorants are generally deleted (or in Robin's case, liquids are deleted), because they cannot be accommodated into the template.

(81) *Developmental stages of Jarmo*



Where V(:) = any vowel, C_i = set of consonants that can appear in the coda (usually obstruents only, but children can differ in the set of consonants they allow in coda position); [+son] = second part of long vowel or diphthong, or sonorant consonant; ERP = Extrarhymal position.

Stage I: No syllable parameters are set. All parameters have the default value.
Stage II: The branching rhyme parameter (rhymes can branch into a nucleus and a coda) has been set to the marked value: [Yes]
Stage III: Branching nucleus parameter (nuclei can branch) is set to the marked value: [Yes].
Stage IV: The extrarhymal parameter (word-finally syllables can contain an extra position) is set to the marked setting: [Yes].

Anticipating the results of chapters 6 and 7, it has, furthermore, been shown that moraic theory encounters several problems in giving an adequate account of the developmental stages. The basic problem is that weight and length have to be differentiated. The data clearly show compensatory lengthening which is not related to weight: that is, length is preserved, not weight. Moreover, diphthongs seem to pattern with long vowels in the acquisition data. However, both diphthongs and long vowels behave as light in the child's system. This cannot be captured in a moraic theory, nor with the notion 'melodic complexity'. Rather, to interpret the weight of a syllable I proposed the weight parameter given in (82):

(82) *Weight parameter*
Closed syllables are heavy [Yes/No]

More justification for this parameter will be given in chapter 7.

The account presented here clearly supports the existence of the subsyllabic constituents rhyme, nucleus, and coda. They are needed to adequately describe the developmental stages in the acquisition of rhymes. They are furthermore related to different parameters, whose settings determine the child's template. In its turn, the template dictates the relationship between the adult input and the child's output forms.

6 The Acquisition of Dutch Stress

ALTHOUGH THE STUDY of suprasegmental phenomena (especially stress) has been very extensive during the last two decades, this is not reflected in the literature on acquisition of phonology, which is still largely devoted to segmental phenomena. As Crystal (1986) points out, developmental phonologists have, with few exceptions, viewed prosodic development (including acquisition of stress) as a sort of residue that is left after segmental phenomena are dealt with. As a result of this, not much attention has been paid to the acquisition of suprasegmental development, including stress and stress-related phenomena like truncation of syllables. This alone would make the study of acquisition of stress worthwhile. It is even more interesting because little is known about the learning of stress parameters. Developmental phonologists have mainly focused on 'rules' specific to child language, such as consonant harmony and reduplication (cf. Ingram 1974, 1986, 1989a, Vihman 1978, Fee & Ingram 1982, Ferguson 1983, Lleo 1990, Berg 1992). However, if the acquisition of (prosodic) phonology involves the setting of parameters, as is claimed in this dissertation, the child's forms differ from those of adults because children have different values for parameters. These parameter values define the child's template, and thus the output forms. There are no rules involved. The study of the acquisition of stress is also interesting because children could, in principle, learn stress on a lexical basis, as Hochberg (1988b) has pointed out: all the words which they use they have heard correctly stressed. There is no need, other than economy, for them to generalise stress rules or to set stress parameters. Nevertheless, I will show that stress is not learned lexically; that is, stress is not a property of vowels. A final motivation for the study of acquisition of stress is that it can function as a test case for current theories, while on the other hand, acquisition data may provide new insights into theories of stress or into analysis of stress patterns in particular languages (in this case Dutch).

Important insights can be gained when child language is analysed within the framework of non-linear phonology. This is not only true for segmental and syllabic phenomena, but also holds for stress and stress-related

phenomena. We have already seen that the acquisition data can be adequately described with a parametric theory of syllable structure. The transitions between different stages in development have been shown to involve the setting of some parameter. I will show in chapter 7 that the various stages in the acquisition of stress, which will be described in this chapter, can also be explained within a parametric theory. In this chapter I will focus on the role of basic prosodic units and principles in early child phonology. The prosodic hierarchy, as proposed by McCarthy & Prince (1986, 1990), implies that stress and segment inventories are largely independent. The child language data clearly show this independence. It also follows from this hierarchy that prosodic categories play a role from the onset of speech. Since the child's phonology is word-based, the minimal expansion of the notion word is a foot. A foot minimally contains one syllable, which, as we have seen, consists of the core syllable at the early stages of acquisition. It will be shown in this chapter (and in chapter 7) that the higher prosodic categories indeed play an important role, in that the child's template is expanded from a core syllable $(CV)_{\sigma}$ to a quantity-insensitive binary foot $(\sigma\ \sigma)_{F}$.[1] At the final stage the child's word template can contain more than one foot.

The organisation of this chapter is as follows. First, I give a review of the literature on the acquisition of stress and stress-related phenomena like truncation in section 6.1. In section 6.2 I give a brief description of stress patterns in adult Dutch.[2] In section 6.3, I give a description of truncation and stress patterns in Dutch child language as far as disyllabic target words are concerned. In section 6.4 a formal account is given in terms of the basic prosodic units and principles. In the following section I examine the predictions which the model makes for words which are longer than two syllables (section 6.5). In section 6.6, I discuss segmental phenomena related to truncated forms.

6.1. Previous research on acquisition of stress

The literature on the acquisition of stress has basically focused on two questions: (1) whether children learn stress lexically or by rule (Klein 1984, Hochberg 1987, 1988b); and (2) whether or not children are biased towards a particular foot type when learning to stress (Allen & Hawkins 1978, 1980,

[1] A foot consists ideally of two core syllables at the early stages (see also Fee, to appear). However, at the earliest stages children only have words consisting of one core syllable. I will argue in chapter 7 that at this stage the notion 'foot' still is irrelevant in child language.

[2] A metrical analysis of Dutch stress will be given in chapter 7.

Hochberg 1987, 1988a). The evidence in both these areas is contradictory. Moreover, the different proposals make different predictions for acquisition. The first question is addressed in section 6.1.1, the second question in section 6.1.2. It is often mentioned in the literature that perceptual biases play an important role in the acquisition process. The bias to word endings is well known (Slobin 1973), but biases to attend to stress (Echols 1987, 1988) and to word beginnings (Peters 1977, 1983) are also mentioned. These are described in section 6.1.3. In section 6.1.4, I discuss segmental approaches to what I call prosodic phenomena. Section 6.1.5 summarises the conclusions.

6.1.1. Lexical learning of stress versus the learning of stress by rule

Hochberg (1987, 1988b) argues that children learn stress rules at all stages, while Klein (1984) concludes that there is lexical primacy during the early stages of learning word stress. The two positions make different predictions as to the kinds of stress patterns to be found in child language. If children learn stress on a lexical basis, systematic errors or deviations from adult stress patterns are not to be expected. If, on the other hand, children learn stress by rule, as Hochberg (1987, 1988b) concludes, we expect to find systematic deviations from stress patterns.

Klein (1984) analysed the polysyllabic utterances of a 2-year-old boy learning English for stress patterns. The largest proportion of the child's words had 'conventional' stress, that is, stress placement was the same as in the adult target word (62%), and since most of the target words were disyllabic words with initial stress, the basic pattern of the child's production forms of these words was trochaic. The fact that almost all adult target words were disyllables with initial stress makes it difficult to draw conclusions from the emerging patterns in the child's language, especially because Klein did not consider the child's monosyllabic renditions of polysyllabic adult words. This is unfortunate, because, as we will see below, truncated forms can provide important insights in the acquisition of stress. However, Klein noted that a great deal of variability appeared both among tokens of individual lexical items, and among different lexical items with the same stress contour. Three other attested stress patterns in the child's output were found which are not expected on the assumption that stress is learned lexically. A fair number of target words were produced with level stress (23%). Some target words were produced with misplaced stress (15%). These forms have to be accounted for if lexical acquisition of stress is assumed. Klein argues that the words with stress misplacement had one feature in common, namely a syllabic consonant. Klein assumes that syllabic consonants are difficult for the child, and that they therefore may attract stress (see also Smith 1973). On the other hand, the child had a number of

disyllabic words with a syllabic nasal in the second syllable which did not show stress misplacement. However, these forms are not discussed by Klein. Stress displacement might thus be due to focus on phonetic properties (see also Hochberg 1988a), in this case: focus on syllabic consonants may cause them to receive stress.

Level stress was found for words that were relatively new to the child, measured against the percentage of spontaneous versus imitated utterances. The use of level stress has been associated with the learning of disyllabic words in general (Leopold 1947, Fudge 1969).[3] Klein's subject, however, did not have problems realising disyllabic words in general. It might be that he applied level stress to new words, but, since he imitated a lot of words, including words which were well known to him, the percentage of spontaneous (42%) versus imitated (58%) words for supposedly new words as opposed to the percentage of spontaneous (65%) versus imitated (35%) words for supposedly known words was not significant. It is hard to decide on other grounds whether a word is new to the child or not, since the child was only recorded three times. Although Klein concludes that the child did not demonstrate the application of a general stress rule, the arguments for this conclusion are not very strong. If she had included words with stress patterns other than trochaic, and shown that these are learned in a similar fashion to the trochaic words the evidence could have been much stronger. In fact, the data could also be explained by assuming that children learn stress by rule, since most words were realised with a trochaic pattern. Klein's conclusion holds for the initial stages of phonological development, that is, in her view, the transition period from single-word to multi-word speech. She remains silent on the question of whether and/or when children eventually start learning stress rules.

In contrast, to test the hypothesis that children learn stress rules, Hochberg (1987, 1988b) used both spontaneous data of 3, 4 and 5-year-old Spanish learners, and data from the same children on an imitation task, where children had to imitate novel Spanish words with minimal contrasts in stress placement. She predicted that if children do learn stress rules, then, (a) they should find words with regular stress easier to imitate than words with irregular stress, and (b) they should tend to regularise stress in words with irregular stress, but not the opposite. Both predictions were borne out, although the findings were less robust for spontaneous data than for the imitated forms. Children made more structure changing errors on irregular patterns with stress shift being the most common, as in the following

[3] I will show below that level stress mainly occurs in the production of some disyllabic words, but not others: disyllabic words that consist of two feet are at some stage produced as disyllables with level stress, but those consisting of one foot are seldom produced with level stress.

spontaneously uttered forms (from Montes Giraldo 1971, cited in Hochberg 1988b) for Spanish learners between 2;3 and 3;4: *cáscara* was realised as /kakála/, *estómago* as /tomágo/, *lámpara* as /pampála/, *fósforo* as /popúlo/, *hipopótamo* as /popotámo/, and *plátano* as /tatáno/. These findings clearly argue against the lexical acquisition of stress. They show an over-generalisation of the 'stress rules'[4] to irregular words. Since Hochberg does not provide data, it is hard to abstract a general rule for stress assignment from her work. The patterns that she describes seem to show that most vowel-final words had penultimate stress when imitated, whereas consonant-final words were most likely to be produced with final stress, the regular pattern for Spanish stress.[5] Hochberg found few age differences, and none that showed an increase of stress rule awareness, suggesting that the most important stress rules were acquired at age 3.[6]

To summarise, the evidence for lexical learning of stress is rather weak. Much stronger are the arguments for the learning of rules (or parameter values) to assign stress: Hochberg's findings could not be interpreted, assuming lexical learning.

Although Allen & Hawkins (1978, 1980) do not explicitly address the question of whether children learn stress by rule or lexically, they assume that children's earliest productions are governed by a universal trochaic constraint. Since universal constraints are innate, they do not involve learning. In fact, their view is in line with Klein's in that there is no stress rule learning at the initial stages. But, unlike Klein, they do not assume that stress is learned lexically. The crucial question is therefore not whether children learn stress by rule or lexically, but whether they learn stress rules or have an innate trochaic bias. Let us now turn to the second question: whether or not children have a bias towards a trochaic foot.

6.1.2. Bias towards trochaic foot versus neutral approach

With respect to the question of whether children start with or without a bias towards a particular foot type, Allen & Hawkins (1978, 1980) found

[4] On the assumption that the stress system of a language is defined by the values for the stress parameters, learning the stress system of a language involves the setting of parameters to the values required by that language. Deviations from the adult stress patterns in the child's production forms can only occur if parameters are not yet set, as we will see in chapter 7.

[5] It seems that the patterns found are largely comparable to those found for Dutch children, that will be described in detail in section 6.3.

[6] It will be shown in chapter 7 that Dutch children also seem to have set (most of) the stress parameters to the value required by the language before age 3.

that English children are biased towards a (possibly universal)[7] trochaic pattern. Hochberg (1988a), however, concludes that children approach the task of stress-learning without a bias towards any particular stress type. Again, the two positions make quite different predictions regarding the stress patterns to be found in child language. If children have a neutral start, stress assignment should be random at the initial stages,[8] while if there is a bias towards a particular stress type, we should find a preponderance of that particular stress type in children's language.

Allen & Hawkins (1978) investigated the role of partial and total reduction of syllables in relation to acquisition of stress in spontaneous speech data from five English learning children, varying in age between 2;2 and 3;9. They found that syllable deletion (also referred to as total syllable reduction and truncation) appears in two environments: (a) word-initially, or (b) next to another light syllable (syllables with a central vowel in Allen & Hawkins' analysis), although this conclusion is rather weak because of the small amount of affirmative data. However, deletion of initial unstressed syllables is commonplace in the literature on acquisition of phonology. Even where the syllable is deleted, some evidence of its existence often remains in the form of its initial consonant as in Eric's (3;1) production form ['po:kio:] for *Pinocchio*. This is argued to support a trochaic bias, since the unstressed syllable is not just deleted because of lack of perceptual saliency. Rather, in order to fit the trochaic form, an initial light syllable must either be made heavy (strong), which is rare, according to the authors, or else be deleted. The data on the acquisition of Dutch stress will show that both strategies appear, the second as the successor to the first.

The other environment for deleting weak syllables is when they occur next to another weak syllable: examples from Julie (3;4) are ['sʌmb͡əɪ] for *somebody*, and ['o:pɪŋ] for *opening*. Allen & Hawkins' interpretation of this type of deletion is again rhythmic: alternating sequences of strong and weak syllables are chosen in favour of non-alternating sequences. And in fact, an ideal trochee consist of two syllables of which the first is stressed.

Three other arguments are given by Allen & Hawkins in favour of a trochaic bias. Allen & Hawkins assume that sibilants (and maybe fricatives in general) behave like weak syllables, because of their high intensity and

[7] Whether the trochaic bias or constraint is truly universal is an important and as yet unanswered question. From a theoretical perspective one could argue that a syllabic trochee is indeed the default foot, since it is the only quantity-insensitive foot in the foot typology of Hayes (1987, 1991) and McCarthy & Prince (1986, 1990). I will take up this issue in chapter 7.

[8] Alternatively, even if children have a neutral start, they could still be influenced very early by the facts of the target language; so, we might expect that children learning different languages (stress systems) show large differences in the output. Since English, Spanish and Dutch are all trochaic languages, the real test for a trochaic bias is a target language which is iambic.

relatively long duration. The fact that voiceless fricatives are preferred after the stressed vowel is seen as an argument in support of the trochaic bias. A stressed syllable followed by a fricative behaves as a stressed syllable followed by a light syllable: the ideal trochee, according to Allen & Hawkins. The trochaic analysis of stressed syllables ending in a fricative also explains metathesised forms like *snow*, realised as /nos/: the former has an iambic pattern, while the latter is claimed to be trochaic. However, little support is gained for this trochaic analysis of stressed syllables ending in fricatives, although children have a preference for final fricatives at the initial stages as was shown in chapter 5. Fricatives do not otherwise behave like syllabic segments. Moreover, in general, if a language has syllabic segments, it is generally the sonorants that will be syllabic, not fricatives.

The trochaic bias further explains why children would have more difficulty in producing weak prefixes than weak suffixes, a finding of Slobin (1973) known as the general perceptual strategy 'pay attention to the end of words'.

The third argument in favour of the bias towards trochees is the abundance of trochaic words in children's early vocabularies. However, it could be the other way around: because of the high frequency of trochaic words in the input, the child may conclude that the foot type of the language is trochaic, which is reflected in the output. That is, children have a trochaic bias because of the fact that the input is largely trochaic, not because they have a natural (innate) bias towards trochaic feet.[9]

Allen & Hawkins (1980) provide additional evidence for a trochaic bias on the basis of experimental pilot data. By asking children to learn to discriminate and reproduce pairs of nonsense words differing primarily in their rhythmic form (the so-called TAKI-test), they found a number of ways in which children perform better on items with a trochaic stress pattern than on items with an iambic stress pattern in production, although the results are not very robust. Some children did show a trochaic bias. They tend to produce iambic forms as trochaic. Some children did not show a bias at all. However, there were also children who seem to have a preference for an iambic pattern, which they nevertheless interpreted as evidence for the trochaic bias, since these words were uttered with emphatic stress on the final syllable, suggesting that these forms were unusual to them.[10] For perception no such bias was found. Children do not seem to have difficulties in perceiving different stress patterns, but in their production they favour trochaic words.[11]

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[9] That the frequency of input patterns plays a role in the acquisition process will be discussed in chapter 7.

[10] A similar kind of argument is used by Klein (1984) to explain stress on syllabic consonants (see above).

[11] Again, since all children were learning English, this could account for the bias, rather than UG.

Hochberg (1988a) argues, contrary to Allen & Hawkins' proposed trochaic bias, that children approach the task of stress-learning unbiased towards any particular foot type. That is, in children's production forms stress is not always on the same syllable. She used longitudinal spontaneous data from four children (between 1;7 and 2;2) acquiring Spanish as a first language, as well as experimental data, which were imitations of nonsense words by the same children. However, polysyllabic pronunciations of monosyllabic adult words and monosyllabic pronunciations of polysyllabic adult words were omitted. She argues that if children have a neutral bias, stress assignment should be random at the beginning, and show an increase in stress accuracy in the course of development, whereas, if children start with a trochaic bias, this pattern should be found from the beginning. Words with final stress should be less likely to be given correct stress if there is a trochaic bias, according to Hochberg.

Hochberg found that for spontaneous data, only one child was consistently better in his production of penultimate-stressed words. The other three were slightly better in the production of final-stressed words. Two points need to be mentioned, however. First, penultimate-stressed words outnumbered final-stressed ones. And second, there were a fair number of inaccurate stress assignments for both types of words (about 40%, which is about the same number as reported in Klein). Although she does not spell out the nature of these inaccuracies, Hochberg accounts for at least some of them by assuming that the children's attention to phonetic or semantic aspects of an unstressed syllable leads them to shift stress to that syllable (as did Klein).

Comparing Hochberg's results with those of Allen & Hawkins, it appears that these are not in principle different. Both found that final-stressed words were less frequent than penultimate-stressed words, and furthermore, in Allen & Hawkins' data, final-stressed syllables were produced as stressed. They argued in favour of a trochaic bias, not because of inaccurate stress assignment, but because of initial syllable deletions, which were not considered by Hochberg. For the imitation data, Hochberg found a different pattern: three children performed better on penultimate-stressed words, while the fourth did not show a preference at all. Again, these results are not very different from Allen & Hawkins' findings on the TAKI-test. However, Hochberg argues for a neutral bias, whereas Allen & Hawkins argue for a trochaic bias.

Hochberg gives further support for the neutral approach from developmental data. The data show an increasing percentage of correct stresses for penultimate-stressed words in the course of development for three of the four children. However, there could be other explanations for increasingly correct stress placement. For example, the child may no longer be focusing on certain phonetic or semantic aspects of unstressed syllables, because

these have been mastered or are no longer new, so that the reason for stress shift has disappeared. It is unfortunate that she did not pay more attention to stress inaccuracies, because they could have revealed more about stress. She did not report on the development of final-stressed words. On this point, the results cannot be compared with Allen & Hawkins, because they do not provide longitudinal data, nor with Klein, since Hochberg does not discuss development.

In summary, the arguments for a neutral bias towards stress are not very strong, as we saw above. Rather, Hochberg's findings do not directly provide arguments against the trochaic bias, nor do Klein's data, which, instead, could be used as an argument for the trochaic bias. The phenomenon of the deletion of initial unstressed weak syllables cannot be accounted for by assuming a neutral bias, nor can many of the stress shift data. Furthermore, the preponderance of words with a trochaic pattern, mentioned in all research, supports a trochaic bias. However, we should bear in mind the relatively high percentage of stress inaccuracies. Four sources of inaccurate stress assignment are mentioned in the literature. First, attention to phonetic or semantic properties of the unstressed syllable might cause stress to shift onto that syllable. Second, newly acquired words might initially occur with level stress. Third, stress might shift towards the initial unstressed syllable, to fit the trochaic template, although no data are given in the literature. And fourth, stress rules might be overgeneralised so as to regularise irregular stressed words, as in *lámpara* produced as /pampála/. The latter two factors, at least, can be argued to support the trochaic bias. I do not think that the first two contradict a trochaic bias, although they do not confirm it either. There could be reasons for overruling a trochaic constraint. However, these stress inaccuracies need to be studied carefully.

However, we have to bear in mind that the studies described all used data from children learning a trochaic language. Patterns of children learning a language with iambic feet would be revealing.[12] I know of no research into the acquisition of stress in iambic languages.

6.1.3. Perceptual biases

A different kind of research addressing the role of stress in relation to truncation in child language is represented by the work of Echols (1987, 1988), who focuses on the relation between perception and production. On the assumption that children produce what is salient and coherent for them in adult words, she analysed spontaneous speech of four children aged

[12] There are, however, other arguments than those based on acquisition data for assuming trochaic feet to be default, as will be shown in chapter 7.

between 1;9 and 1;10 learning English as a first language, to gain more insight into the nature of perceptual biases. On the hypothesis that children have a bias to attend to stressed and final syllables the prediction is that syllables which are stressed in the adult model and word-final syllables will be more likely to appear in the child's production forms and will be more accurately reproduced than will unstressed non-final syllables. Unstressed syllables may be: (a) dropped, (b) reduced, (c) produced as reduplicated or partially reduplicated forms of stressed syllables. Unstressed syllables which are included and are accurately analysed will tend to be word-final syllables in the adult target. Non-final unstressed syllables (or syllables immediately preceding primary stress) will be especially susceptible to deletion.

These predictions were borne out by her data. Echols concludes that the deletion of (particularly unstressed non-final) syllables is the result of a perceptual bias to attend to stressed and final syllables. There are, however, at least four points of criticism which can be raised. First, the argumentation is rather circular. The deletion of initial unstressed syllables is used as an argument for a perceptual bias towards stressed and final syllables. Because of this bias, initial unstressed syllables are deleted. Second, perceptual biases do not provide explanations: in principle, the child could also have a bias towards initial and stressed syllables. Moreover, Peters (1977, 1983) has suggested that children have a bias towards initial, final and stressed syllables (see Gerken 1992a, b, for additional arguments against biases). Third, many questions remain unresolved, such as why there are often segmental traces of the first supposedly omitted syllable, and why medial unstressed syllables in trisyllabic words with final stress are more susceptible to deletion than initial unstressed syllables. And fourth, research by Allen & Hawkins (1980) showed no bias towards a trochaic template in perception. Children did not have difficulties in perceiving different stress patterns. In fact, Echols' perceptual bias is reminiscent of Allen & Hawkins' trochaic bias for production. Despite these criticisms, the idea that stress in adult words helps the child to extract material from the adult word is not in doubt. This will be shown to be the case in the acquisition of Dutch stress as well. The exact nature of the extraction remains unclear, however. Echols' theory does not make predictions as to what the actual stress patterns of children will be. Stress shifts or stress misplacements remain unexplained.

Echols tries to incorporate her findings into an autosegmental model, in the sense that the various levels of the phonological representation can be extracted independently. Thus, a child can extract syllable slots without segmental content. These bare syllable slots are filled by default segments, like schwa, or by spreading of segmental material from the stressed syllable (reduplication), although the exact nature of these operations remains obscure. On the other hand, the stressed syllable is generally selected with segmental content, as is shown in this dissertation, although the segmental

content of the selected syllable (or foot) may differ from that of the target syllable. Moreover, I will show in sections 6.1.4 and 6.6 (for Dutch) that segments of two target syllables are sometimes combined in one syllable in the child's output forms. Echols does not provide a systematic or coherent analysis of data in her dissertation, but merely suggests that an analysis in a non-linear framework is promising. Although her general idea is certainly very interesting, autosegmental phonology is applied in a somewhat ad hoc manner. In this chapter I will give a description of the basic stress patterns found in the acquisition of stress in the light of prosodic categories.

6.1.4. Other approaches

In the literature on acquisition of segmental structure, truncation is a frequently mentioned process, since there are also segmental changes to be accounted for, as in Allen & Hawkins' example in which *Pinocchio* was produced as ['poːkioː]. For example, Smith (1973:18) describes the process of truncation as a combination of two rules. The first deletes an initial or post-consonantal unstressed vowel. Although this rule could also affect non-initial weak syllables, he presumably only means to make reference to initial weak syllables, given his examples. This rule gives rise to a cluster which is reduced by the second rule, which deletes the post-consonantal sonorant (or, alternatively, by a rule which deletes a post-consonantal alveolar consonant). He chooses the first alternative because of his intuition that ['bɔŋ] from *belong* and ['baːnə] from *banana* are the result of the application of the same rule which gives [buː] from *blue*. He claims that there is some evidence for the latter, in that *belong* became ['blɔŋ] as soon as clusters with liquids appeared. However, "unfortunately, the treatment by Amahl of words containing unstressed initial syllables was inconsistent". The following data are examples of the combined effect of these two rules: *tomato* is produced as ['maːduː], *behind* as [aind], *potato* as ['beːduː], *without* as [aut], and *pyjamas* as ['daːmə].

Macken (1979) studied a Spanish child Si, who frequently deleted syllables from age 1;7 to 2;1. She gives the following description. The process of syllable reduction operated to delete either the initial syllable(s) or the medial one. The choice of which one was deleted depended crucially on the consonants in the syllables. Si's goal was to achieve an output form of 'labial plus dental'. If the labial consonant occurred in the correct initial position, then the medial portion of the word was deleted: ['mañna] from *manzana* 'apple' at (1;9), ['mano] *Fernando* at (1;9), and ['pa͡da] from *pelota* 'ball' at (1;8.7). If, however, the labial consonant was in medial position in the adult word, the preceding syllables were deleted: [mən] from *Ramón* (1;8.7),

['pwat͡to] from *zapato* 'shoe' (1;8.7), ['bate, 'pan͡ti] from *elefante* 'elephant' (1;9), and ['pɪt͡də] from *librito* 'little book'. In the cases in which medial segments were deleted, the situation was more complicated than just the deletion of syllables. The general phonetic quality of the vowels that appeared in the output forms suggests that Si tended to retain the vowel of the stressed (penultimate) syllable; this vowel was then combined with the word-initial consonant to form the first syllable of the output form. Macken strongly argues for the existence of word patterns, that is, words are altered in such a way as to fit the possible word patterns of the child. The exact nature of the segmental changes that occur in the process of truncation is not accounted for in the literature, and remains an open question. However, some of the segmental changes that occur in the acquisition of Dutch will be discussed in section 6.6.

The research summarised thus far is either based on small samples (often not longitudinal, with few exceptions) of spontaneous data, or on experimental data. What is missing in the literature is a thorough description of developmental data. To my knowledge, only Ingram tries to discuss developmental trends on the basis of data available in the literature. Ingram (1978) notes that, "unfortunately, the process of unstressed syllable deletion has not received extensive examination. Though children at the earliest stages will reduce some polysyllabic words to monosyllables, they will frequently reduplicate to reproduce the number of syllables in the adult model. At first glance, one could suggest a developmental trend, saying that disyllabic words would first be reduced to monosyllables and later become reduplications." His impression, however, is that reduplication, either complete or partial, is initially preferred to reduction to a single syllable, and reduplication does not always take place to match the polysyllabic pattern of the adult word, but could also serve the function of licensing the production of adult final consonants. He does not relate this to acquisition of stress, however. Ingram (1976, 1989a) gives the following very impressionistic developmental stages for the common process of deletion of unstressed syllables. At first, the child's words are primarily monosyllables (or reduplication of the basic syllable). As a result, some part of adult words with more than one syllable is lost. The part that is lost is the unstressed syllable. Adult words with three syllables are usually not even attempted. The following examples are typical for this stage: *pocket* realised as [bat] (Joan 1;0), *apple* as [œp] (Daniel 1;10), *Blumen* as [bu] (Hildegard 1;0), *blanket* as [ba] (Jennika 1;3). At stage 2, two-syllable productions appear, and two deletion processes occur: (a) initial unstressed syllables are reduced; (b) all unstressed syllables in three syllable words are dropped. During stage 3 the process of deletion of unstressed initial syllables continues, but medial syllables now occur. At the next stage, initial unstressed syllables are attempted in disyllabic words, but not as much as in trisyllabic ones. Finally,

the child achieves an adult-like pronunciation. There is little evidence in the literature for these developmental stages. I will show that Ingram's stage 1 and 2 are indeed attested. However, at stage 1, reduction of initial-stressed disyllabic words is not very frequent. Rather, the child selects only monosyllabic target words for production. Stage 3 is not attested at all.

6.1.5. Summary and conclusions

The following conclusions can be drawn from the literature discussed:

1. Stress is not learned lexically; rather, children seem to learn stress by rule, or rather, as I will argue in chapter 7, by parameter setting. Stress assignment is not random; there are clear patterns in the acquisition of stress, which argues against a lexical learning approach.

2. Children seem to have a bias towards trochaic feet, in the sense that most disyllabic adult targets have initial stress in the child's production of these forms. In disyllabic adult targets with final stress the initial unstressed syllables are often prone to deletion, supporting a trochaic analysis.

3. Stress in the adult target guides the child in the initial productions of polysyllabic words. Other cues that may be important to the child are final syllables, and maybe also initial syllables.

4. There are also segmental phenomena that cooccur with truncation of syllables: sometimes features of the onset of the deleted syllable are realised in the onset of the stressed syllable.

5. The following stages have been reported in the literature (Ingram 1978):

Stage 1: Only monosyllables are produced by the child.
Stage 2: Disyllabic production forms appear, invariably with initial stress. Initial unstressed syllables are deleted.
Stage 3: Trisyllabic words are realised as disyllabic words.
Stage 4: Initial unstressed syllables are attempted in disyllabic words, but not so much as in trisyllabic words.
Stage 5: The child achieves an adult-like pronunciation.

It will be shown, however, that not all these stages are attested in the Dutch acquisition data.

From this summary of research on the acquisition of stress and stress-related phenomena, it becomes particularly clear that more research is needed in order to come to satisfactory answers to all or some of the questions named above. Not only should stress inaccuracies or truncation be taken into account, but the whole range of evidence that may bear on

the issue of the acquisition of stress should be considered. Only by looking at large samples of data, and especially by looking at developmental data, can we hope to gain more insight into the actual acquisition of stress.

In the remainder of this chapter I will discuss the developmental patterns in the acquisition of Dutch stress. But before turning to the child data, I will first give a brief description of stress in adult Dutch.

6.2. Description of Dutch stress

That stress in Dutch is a complicated matter is indicated by the number of different analyses that have been proposed. However, the facts underlying these different analyses are the same. In this section, I will give a description of monomorphemic nouns with full vowels only, based on van der Hulst (1984) and Trommelen & Zonneveld (1989, 1990).[13]

The following generalisations seem to hold regarding main stress in Dutch. First, main stress falls on one of the three final syllables of the word, indicating that stress is not completely free in Dutch, as shown in the following words:

(1) *Location of main stress*

a. Initial	b. Penultimate	c. Final
Panama 'Panama'	spinazie 'spinach'	paraplu 'umbrella'
ananas 'pineapple'	Honduras[14] 'Honduras'	krokodil 'crocodile'

Second, words with superheavy syllables, that is syllables ending in VVC and VCC (in short VXC) attract main stress on the final syllable, almost without exception, as shown by the data in (2):

(2) *Main stress in superheavy final syllables (VXC)*

VVC		VCC	
konijn	'rabbit'	fazant	'pheasant'
kalkoen	'turkey'	insect	'insect'
pelikaan	'pelican'	ledikant	'bed'
kapitein	'captain'	muzikant	'musician'

Third, in disyllabic words main stress is predominantly on the prefinal (or initial) syllable, although there are many exceptions, especially when the final syllable ends in VC. Nevertheless, prefinal stress is taken to be the unmarked pattern in all analyses. Some data are given in (3):

[13] A metrical analysis of the Dutch stress system will be given in the next chapter.

[14] *Honduras* is exceptional, as will be discussed below.

(3) *Stress in disyllabic words*

Initial stress		Final stress	
auto	'car'	cadeau	'present'
baby	'baby'	WC	'toilet'
bamboe	'bamboo'	partij	'party'
panda	'panda'	karwei	'job'
tractor	'tractor'	trompet	'trumpet'
pinguin	'penguin'	kwartet	'quartet'
robot	'robot'	giraf	'giraffe'
motor	'motor'	ballon	'balloon'

In trisyllabic words, prefinal stress is the most common pattern, as in (4a). However, there is one type of exception to this rule: words with an open syllable in the penultimate syllable and a closed syllable in the final syllable predominantly have main stress on the first syllable (see footnote 14). Some data are given in (4b). Trisyllabic words with final stress are marked (except for words with a superheavy final syllable); examples are given in (4c). Trisyllabic words can never get main stress on the first syllable if the prefinal syllable ends in VC.

(4) *Stress in trisyllabic words*

a. Penultimate	b. VV-VC (Initial)	c. Final
andijvie 'endive'	ananas 'pineapple'	paraplu 'umbrella'
flamingo 'flamingo'	Portugal 'Portugal'	boerderij 'farm'
vakantie 'vacation'	almanak 'almanac'	Amsterdam 'Amsterdam'
confetti 'confetti'	caravan 'caravan'	krokodil 'crocodile'

Words consisting of four syllables do not have main stress on the first syllable. They have final stress if the final syllable is superheavy, antepenultimate stress if the final two syllables end in VV-VC, and prefinal stress in all other cases.[15] The following data illustrate these facts:

(5) *Stress in words consisting of four syllables*

a. Final -VXC	b. Antipenultimate -VV-VC	c. Penultimate
locomotief 'locomotive'	aquarium 'aquarium'	macaroni 'macaroni'
literatuur 'literature'	accordeon 'accordion'	televisie 'television'
experiment 'experiment'	catalogus 'catalogue'	limonade 'lemonade'
rozemarijn 'rosemary'	Napoleon 'Napoleon'	monopolie 'monopoly'

[15] The matter is slightly more complicated, but this need not concern us here. The reader is referred to van der Hulst (1984) and Trommelen & Zonneveld (1989, 1990) for a more complete description of the Dutch stress facts.

From this description it clearly follows that Dutch is quantity-sensitive, since superheavy syllables always attract main stress; in trisyllabic nouns stress cannot fall on the initial syllable when the prefinal syllable is closed. Thus, syllables ending in VC are heavier than syllables ending in VV, although not as heavy as superheavy syllables. However, the exact nature of quantity sensitivity in Dutch is still unclear (see also chapters 3 and 5). After this brief description of stress patterns in Dutch, let us now turn to the acquisition data on stress.

6.3. Truncation and stress patterns in Dutch child language

There are several phenomena which can give us insight into the acquisition of stress. First, we can look at the actual stress patterns found in children's language. We can look at what kinds of words are produced with stress errors, and what kinds of words are basically produced correctly. Second, we can look at the process of the truncation of syllables, which is roughly equivalent to the deletion of unstressed syllables. Unstressed, especially non-final, syllables are said to be especially vulnerable to undergo truncation (Ingram 1974, 1976, 1989a, Allen & Hawkins 1978, 1980, Echols 1987, 1988, among others). If the process involved just deletion of unstressed syllables, then we would expect that deletion of such syllables would occur in disyllables with initial stress and final stress, which, as we will see below, is not the case. Third, we can also look at the addition of syllables. It might seem contradictory to have both truncation and its opposite in child language, but as we will see, the environments in which these processes apply are different.

It will be shown in the remainder of this chapter that there is indeed a strong relationship between the acquisition of stress and truncation, as suggested by Allen & Hawkins (1978, 1980). It will be shown that truncation in child language is not a deletion process, but rather involves the mapping of a melody to a specified template. In this way it resembles true templatic systems like that of Arabic, which have been analysed using the device of PROSODIC CIRCUMSCRIPTION (McCarthy & Prince 1990). Truncation is not only commonly found in child language, but is also attested in adult languages, for example in nickname and stump-word formation in English (Jespersen 1922, McCarthy & Prince 1986, 1990) and hypocoristics and abbreviations in Japanese (Poser 1984, 1990, Mester 1988, Itô 1991). English nicknames are formed by mapping the melody of the full name onto the minimal word template (a foot) that may appear alone or with an affix like *-i*, as in *Gert(ie)* from 'Gertrude', *Ed(die)* from 'Edwin' and *Alf* from 'Alfred'.

Truncated forms in child language, however, show an interesting pattern in the development towards the adult targets. On the assumption that all

intermediate stages in the course of language acquisition are constrained by general principles of phonological theory, the hypothesis adopted in this dissertation is that it should be possible to describe these developmental patterns in terms of the basic prosodic categories proposed within current theory: the mora, syllable, foot and prosodic word (McCarthy & Prince 1986, 1990, and others).

Truncation, also referred to as the deletion of unstressed syllables, is frequently mentioned in the literature on child language. Unstressed, particularly non-final syllables are said to be especially vulnerable to truncation (Ingram 1976, 1978, 1989a, Allen & Hawkins 1978, 1980, Gleitman & Wanner 1982, Echols 1987, 1988, Iverson & Wheeler 1987, Gerken 1992a, b, among others). A priori, if the process involved just deletion of unstressed syllables, then we would expect deletion of such syllables to take place both in disyllables with initial stress and in disyllables with final stress. Let us therefore look at the production forms of children for both kinds of disyllabic words.

6.3.1. The special status of disyllabic words with final stress

Initially, most of the child's words are monosyllabic, and in as far as the attempted adult words are also monosyllabic, they cannot tell us anything about stress (stage 0). For disyllabic words there is a contrast between words with initial stress and words with final stress. If we compare disyllabic words with initial stress with disyllabic words with final stress, two observations can be made. First, although disyllabic words with initial stress are occasionally truncated, this is far less common than for disyllabic words with final stress for all children, as Table 1 shows. If the process involves deletion of unstressed syllables, this difference is not expected.[16]

The second observation is that disyllabic words with final stress show more stress errors than disyllabic words with initial stress. Stress errors refer to both stress misplacement and to level stress. These terms will become clear later on. Table 2 gives the percentage of stress errors per word-type. Monosyllabic forms are left out. Thus the percentages refer to disyllabic productions of these word-types.

[16] There are individual differences between the children, but they are largely due to age differences.

	word-type	
Child	s w	w s
Eva	9% (7/78)	100% (27/27)
Elke	4% (6/152)	94% (59/63)
Jarmo	3% (7/219)	92% (46/50)
Tirza	7% (7/106)	62% (37/60)
Noortje	5% (9/188)	57% (41/72)
Robin	1% (3/283)	41% (26/63)
Tom	5% (6/120)	48% (42/87)
Leon	1% (4/274)	29% (35/120)
Leonie	0% (0/41)	14% (4/29)
Enzo	4% (7/194)	13% (14/105)
Catootje	2% (3/130)	11% (16/144)

Table 1. Percentages of truncated forms for disyllabic words in which the unstressed syllable is deleted.

	word-type	
Child	s w	w s
Eva	5% (4/78)	0% (0/27)
Elke	3% (4/152)	5% (3/63)
Jarmo	3% (6/219)	6% (3/50)
Tirza	7% (7/106)	10% (6/60)
Noortje	2% (3/188)	22% (16/72)
Robin	6% (17/283)	30% (19/63)
Tom	5% (6/120)	23% (20/87)
Leon	7% (20/274)	29% (35/120)
Leonie	7% (3/41)	52% (15/29)
Enzo	5% (10/194)	10% (11/105)
Catootje	3% (4/130)	29% (42/144)

Table 2. Percentage of stress errors per word-type

Table 2 shows that in general stress errors are more frequent in disyllabic words with final stress than in disyllabic words with initial stress. The low percentages of stress errors in disyllabic words with final stress in Eva, Elke, Jarmo and Tirza's data can easily be explained if the percentages of truncated forms are taken into account: very few of the final-stressed disyllabic target words are produced as disyllables.

Disyllabic words with final stress clearly behave differently from disyllabic words with initial stress in two ways: (1) they are more prone to truncation; (2) they are more prone to stress errors. From this we can conclude that stress, and therefore foot structure, is crucial in explaining the different behaviour of stress-final disyllables. Before giving an explanation, let us have a closer look at the disyllabic words with final stress, and particularly at how these forms develop.

6.3.2. Developmental stages: description

Four developmental stages can be distinguished in the production of disyllabic words with final stress. Since Robin's data show these stages particularly clearly, his data will be discussed first. At the first stage, he produces stress-final disyllabic words as monosyllables. The stressed syllable of the adult target is invariably the one that is produced, as the data in (6) show:

(6) *Robin:* STAGE 1

ballon	/bɑˈlɔn/	→	[ˈmɔmə], [ˈbɔmə][17]	(1;7.13)
		→	[ˈpɔn̲ə]	(1;7.27)
konijn	/koːˈnɛin/	→	[ˈtɛin], [ˈtæin]	(1;7.27)
trompet	/ˌtʀɔmˈpɛt/	→	[ˈpɪt]	(1;9.4)
banaan	/baːˈnaːn/	→	[ˈpaːn]	(1;10.7)
muziek	/myːˈsiːk/	→	[ˈsiːk]	(2;0.4)
banaan	/baːˈnaːn/	→	[ˈbaːn̲]	(2;1.7)

Although longer forms occur at later stages, monosyllabic realisations of adult disyllabic forms remain until rather late, although their appearance becomes less frequent.[18]

During the second stage, both syllables of the adult word are produced; however, the first syllable receives stress, as the data in (7) show:

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[17] Truncated words are often subject to segmental changes. I will come back to these in section 6.6. Moreover, monosyllabic feet are often augmented with an extra final syllable, as we will see shortly.

[18] Although this is largely due to the fact that development is gradual, these forms remain longer than the forms typical of the subsequent stages, since, as will be shown in chapter 7, stress placement is correct.

(7) *Robin:* STAGE 2

ballon	/bɑˈlɔn/	→	[ˈbuːɔn]	(2;1.7)
gitaar	/χiːˈtaːr/	→	[ˈsiːtaː]	(2;1.7)
		→	[ˈsiːtɑu]	(2;1.26)
giraf	/ʃiːˈrɑf/	→	[ˈʃiːɑf]	(2;1.26)

At the third stage, the words are produced with level stress, that is, both syllables receive an equal amount of stress, as in (8):

(8) *Robin:* STAGE 3

ballon	/bɑˈlɔn/	→	[ˈbɑnˈdɔn]	(2;1.26)
kasteel	/ˌkɑsˈteːl/	→	[ˈtaːsˈteːu]	(2;1.26)
banaan	/baːˈnaːn/	→	[ˈmaːˈnaːn]	(2;2.27)
misschien	/ˌmɪs͡χiːn/	→	[ˈpɪˈziːn], [ˈmɪˈziːn]	(2;3.10)
WC	/veːˈseː/	→	[ˈveːˈseː]	(2;3.22)

At the final stage, the words are produced with an adult-like stress pattern, as in (9):

(9) *Robin:* STAGE 4

meneer	/məˈneːr/	→	[məˈneːɹ]	(2;2.22)
misschien	/ˌmɪs͡χiːn/	→	[ˌmɪˈsiːn]	(2;3.10)
konijn	/koːˈnɛin/	→	[kɔˈnɛin]	(2;4.8)
kameel	/kaːˈmeːl/	→	[ˌkɑˈmeːŭ]	(2;4.29)
muziek	/myːˈsiːk/	→	[ˌmyːˈsiːk]	(2;4.29)

The transitions from stage to stage are always gradual. There will be forms from both the previous and following stage, which may obscure the developmental pattern. Nevertheless, these four stages can be clearly distinguished. They are also attested in the data of other children, although not all children go through all stages. Eva, Jarmo and Elke only have forms typical of stage 1 during the whole period of recording. On the other hand, Catootje has very few forms representing stage 1, but data from stage 2 to 4 are available. This is probably due to the fact that she has already passed stage 1 at the first recording session. The following forms for adult disyllables with final stress are attested at Catootje's first recording session, (1;10.11):

(10) *Catootje*

a. STAGE 1

ballon	/bɑˈlɔn/	→	[ˈboːmɪ]	(1;10.11)
		→	[ˈboːmiː]	(1;10.11)

b. STAGE 2

gitaar	/χiːˈtaːr/	→	[ˈhiːtaː]	(1;10.11)
konijn	/koːˈnɛin/	→	[ˈkɪnaː]	(1;10.11)

In other words, either the final syllable of the adult form is realised (with an extra syllable), or both syllables of the adult target word are produced, with stress, contrary to the adult form, on the first syllable. These forms correspond to stages 1 and 2. During the next session all such words are realised with level stress, which is typical of stage three:

(11) *Catootje:* STAGE 3

ballon	/bɑˈlɔn/	→	[ˈboːˈnaːm]	(1;10.25)
		→	[ˈboːˈnœyn]	(1;10.25)
konijn	/koːˈnɛin/	→	[ˈkoːˈnɛin]	(1;10.25)
		→	[ˈkoːˈnɛn]	(1;10.25)
paleis	/paːˈlɛis/	→	[ˈjɑpˈpɛis]	(1;10.25)
papier	/paːˈpiːr/	→	[ˈpiːˈpaː]	(1;10.25)

In the following sessions we find the first occurrences of adult-like stress patterns (stage 4) in addition to monosyllables (stage 1), in which the final syllable is realised, and of the misplaced stress patterns (stage 2) and level stress patterns (stage 3). Examples are given in (12):

(12) *Catootje*

a. STAGE 1

banaan	/baːˈnaːm/	→	[ˈplaːm]	(1;11.25)
Cato	/kaːˈtoː/	→	[ˈtoː]	(1;11.25)
giraf	/ʃiːˈrɑf/	→	[ˈfiɑfə]	(2;0.6)

b. STAGE 2

banaan	/baːˈnaːm/	→	[ˈbɪ̆jaːm]	(1;11.10)

c. STAGE 3

ballon	/bɑˈlɔn/	→	[ˈpaːˈboːŭn]	(1;11.10)

d. STAGE 4

konijn	/koːˈnɛin/	→	[ˌkoːˈneːm]	(1;11.10)

Especially productions with misplaced stress and monosyllables (with extra syllable) become far less frequent in the course of development, and are replaced by adult-like stressed productions. Productions with level stress still occur, although they also become less frequent in Catootje's production forms. Again we find a development in which level stress productions follow initial stress productions, but precede adult-like productions. Probably there was a stage before the first recording session in which monosyllables were dominant, of which only traces remain.

Tirza shows a similar pattern, although the misplaced stress stage and level stress cases are less clear. First, she has only monosyllables (13a), then disyllables with initial stress, (13b), followed by level stress productions (13c), and finally she arrives at an adult-like stress pattern (13d). Although very few forms were found with stress misplacement and level stress, the

development does not contradict the proposed description of developmental stages.

(13) *Tirza*

a.	STAGE 1				
	meneer	/məˈneːr/	→	[ˈneː]	(1;8.5)
	giraf	/ʃiːˈraf/	→	[ˈlaːf], [ˈcaːp]	(1;10.22)
b.	STAGE 2				
	courgette	/ˌkuːrˈʃɛt/	→	[ˈkoːʃɛt͡θ]	(1;11.19)
	konijn	/koːˈnɛin/	→	[ˈsʉkɛin]	(1;11.19)
c.	STAGE 3				
	giraf	/ʃiːˈraf/	→	[ˈsiːˈaːf]	(2;1.17)
d.	STAGE 4				
	konijn	/koːˈnɛin/	→	[ˌkɔˈnɛin]	(2;2.1)
	giraf	/ʃiːˈraf/	→	[ˌsiːˈʁaːf]	(2;6.12)
	Florien	/floːˈriːn/	→	[ˌlɔˈʁiːn]	(2;3.12)

For Tom a similar pattern can be detected. Again, monosyllabic forms are predominant in the earlier sessions. Some forms with misplaced stress and level stress occur at later stages. Some data are given in (14):

(14) *Tom*

a.	STAGE 1				
	konijn	/koːˈnɛin/	→	[ˈŋɛi], [ˈɲɛiɲ]	(1;5.0)
			→	[ˈlɛin], [ˈnɛɲɛ], [ˈŋɛi]	(1;5.14)
	kameel	/kaːˈmeːl/	→	[ˈmeːŭ]	(1;5.14)
	giraf	/ʃiːˈraf/	→	[ˈfɑ], [ˈvɑfɑ], [ˈvɑf]	(1;5.28)
	kameel	/kaːˈmeːl/	→	[ˈnɛə], [ˈheːŭ]	(1;5.28)
			→	[ˈleːw]	(1;6.11)
b.	STAGE 2				
	kameel	/kaːˈmeːl/	→	[ˈkɔmɛ]	(1;7.9)
			→	[ˈkɛmɑu]	(1;7.23)
	konijn	/koːˈnɛin/	→	[ˈkuːlɑ]	(1;7.23)
c.	STAGE 3				
	konijn	/koːˈnɛin/	→	[ˈkɔˈlɛi], [ˈkɔˈnɛin]	(1;7.23)
			→	[ˈkuːˈnɛi]	(1;8.20)
			→	[ˈkɔnˈtɛi]	(1;10.8)
	kapot	/kaːˈpɔt/	→	[ˈkaːˈpoːt]	(1;11.26)

d. STAGE 4

konijn	/koːˈnɛin/	→	[koːˈlɛin]	(1;8.6)
muziek	/myːˈsiːk/	→	[meːˈsiːk]	(1;10.8)
kalkoen	/ˌkɑlˈkuːn/	→	[daːˈkuːn]	(1;11.26)
kapot	/kaːˈpɔt/	→	[kaːˈpɔt]	(1;11.26)
trompet	/ˌtʀɔmˈpɛt/	→	[tɔˈpɛt]	(1;11.26)
kameel	/kaːˈmeːl/	→	[kaːˈmɛ]	(2;0.17)

For Noortje the same pattern can be detected, as is shown in (15):

(15) *Noortje*

a. STAGE 1

banaan	/baːˈnaːn/	→	[ˈnaːm], [ˈmaːm]	(2;3.7)
konijn	/koːˈnɛin/	→	[ˈkɛin], [ˈkɛi]	(2;3.23)

b. STAGE 2

gordijn	/ˌχɔrˈdɛin/	→	[ˈhɔtɛin]	(2;5.23)
konijn	/koːˈnɛin/	→	[ˈpɔtɛin]	(2;5.23)
ballon	/bɑˈlɔn/	→	[ˈpɑpɔm]	(2;5.23)

c. STAGE 3

konijn	/koːˈnɛin/	→	[ˈtɔˈtɛinə̆]	(2;7.17)
ballon	/bɑˈlɔn/	→	[ˈpɑpˈtɔm]	(2;8.1)

d. STAGE 4

konijn	/koːˈnɛin/	→	[tɔˈtɛinə]	(2;7.17)
kasteel	/ˌkɑsˈteːl/	→	[ˌtaːˈtiːw]	(2;8.1)
giraf	/ʃiːˈrɑf/	→	[hiːˈhɑfː]	(2;8.1)
konijn	/koːˈnɛin/	→	[tɔˈtɛinə], [tɔˈtɛin]	(2;8.29)

To summarise: although there seem to be individual differences, the basic developmental pattern is quite clear. The developmental pattern for disyllabic words with final stress that can be detected from the data is the following:

STAGE 1: Adult disyllables with final stress are truncated to monosyllables. The final syllable, the stressed one, is kept in the child's realisation.

Thus: $(\sigma_w\ \sigma_s)_{Wd} \rightarrow (\sigma_s[\sigma_w])_{Wd}$

STAGE 2: Both syllables of the adult target word are realised. However, contrary to the adult stress pattern, they are produced with initial stress.

Thus: $(\sigma_w\ \sigma_s)_{Wd} \rightarrow (\sigma_s\ \sigma_w)_{Wd}$

STAGE 3: Again both syllables of the adult target word are realised, but receive an equal amount of stress, resulting in productions with level stress.

Thus: $(\sigma_w\ \sigma_s)_{Wd} \rightarrow (\sigma_s\ \sigma_s)_{Wd}$

STAGE 4: The child produces the word in an adult-like manner as far as the number of syllables and stress patterns are concerned. Thus: $(\sigma_w\ \sigma_s)_{Wd} \rightarrow (\sigma_w\ \sigma_s)_{Wd}$

For disyllabic target words with initial stress no developmental pattern can be detected. They are produced correctly insofar as the stress pattern and the number of syllables is concerned. In other words: $(\sigma_s\ \sigma_w)_{Wd} \rightarrow (\sigma_s\ \sigma_w)_{Wd}$ during all stages.

6.4. Formal account

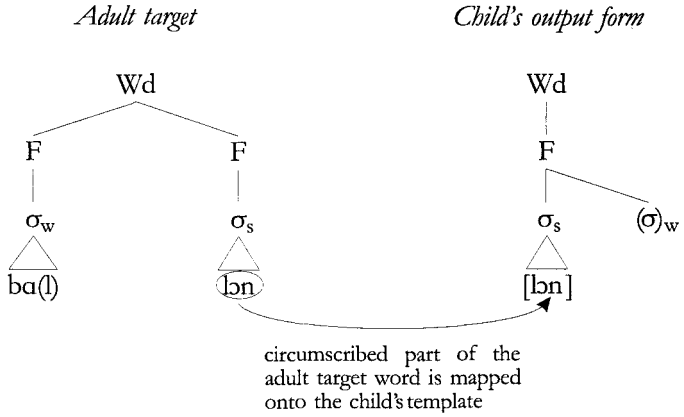
Two observations about the data are crucial. First, the stressed syllable of the adult word is always maintained, and second, the stressed syllable of the adult word need not be stressed in the child's form. These observations indicate that stress in the adult target is important, since it guides the child in selecting material from the adult target; however, these observations also indicates that stress is not learned lexically. Furthermore, they show the importance of non-linear phonology, in that prosodic constituents and segmental content are largely independent. If stress were a segmental property, it should always be on the same syllable, that is, it could never appear on the first syllable of a word like *konijn* 'rabbit' /koːˈnɛin/. But stress can appear on the first syllable of *konijn*, which clearly shows the independence of stress from the strings of segments. Furthermore, if the child picks out a prosodic constituent from the adult target with its segmental material, stress errors are not expected. Let us now review the different stages within the framework of a prosodic theory.

6.4.1. Stage 1

At the first stage, the child selects the segmental material from the most salient syllable, or rather, the *foot* in which this syllable is contained. The fact that disyllabic words with initial stress, which form one foot in the adult target, are rarely truncated suggests that it is indeed a foot that is picked out and not just the stressed syllable. Trisyllabic words with medial stress confirm this, since words like *vakantie* 'holiday' /vaːˈkɑnsiː/ are never truncated to just one syllable. If they are truncated, the last two syllables are realised, as in [ˈkɑnsiː], which forms a foot in the adult target. The base of the truncated forms is invariably the stressed foot in the adult target words. The segmental material of this foot is then mapped onto a trochaic

template, a left-headed foot. This can be said to be a minimal word, Wd_{min}.[19] The process shows resemblance to the process of PROSODIC CIRCUMSCRIPTION. Prosodic circumscription is a general approach to the problem of limiting the domain of rules to less than a morphological constituent. In general, a base is divided into two parts: the KERNEL, a prosodic constituent, and the RESIDUE (McCarthy & Prince 1990). In this case, the child 'prosodically circumscribes' the foot which contains at least a stressed syllable at the right edge, copies the segmental material contained in it (indicated by the large arrow in (16)), and maps this onto a trochaic template (16). The residue of the word is not realised, because it is not prosodically licensed by the template; it is therefore subject to 'stray erasure'.

(16) STAGE I



where: Wd = Word, F = Foot, σ_s = stressed syllable, and σ_w = unstressed syllable; ( ) indicates optionality.

It should be observed that we often find an extra syllable in final position in these forms. This position is available in the foot template. Some data are given in (17):

[19] The child's word at this stage always consists of a foot, which is a minimal word. Therefore, the minimality constraint of prosodic theory, which demands content words to have minimally the size of a foot, is obeyed. However, in some cases the foot can be subminimal, namely, when the circumscribed foot of the adult target contains only one syllable. Addition of extra syllables provides a way to resolve subminimality. If the circumscribed foot contains two syllables, they are both realised. Truncation is not an option here, because a foot cannot be made subminimal (this would require a deletion rule). I will show in chapter 7 that at the earliest stages of acquisition the foot is not a relevant unit. Rather, the child only has words consisting of one core syllable.

(17) *Extra final syllables*

a.	*Robin*				
	ballon	/bɑ'lɔn/	→	['mɔmə], ['bɔmə]	(1;7.13)
			→	['pɔn̪ə]	(1;7.27)
b.	*Catootje*				
	ballon	/bɑ'lɔn/	→	['boːmɪ], ['boːmiː]	(1;10.11)
	giraf	/ʃiː'rɑf/	→	['ɦɑfə]	(2;0.6)
c.	*Tom*				
	konijn	/koː'nɛin/	→	['nɛɲɛ]	(1;5.14)
	giraf	/ʃiː'rɑf/	→	['ʋɑfɑ]	(1;5.28)
d.	*Noortje*				
	konijn	/koː'nɛin/	→	['tɛinə̆]	(2;7.17)
			→	[tɔ'tɛinə]	(2;8.29)

These data confirm that the child does not copy segmental material with its prosodic structure, because there would be no reason to expand the form with material absent in the adult target word. The data provide further evidence for the trochaic template, since an optimal (quantity-insensitive) trochaic foot consists of a strong syllable followed by a weak one. The extra syllable fills the weak branch of the foot. There is no weak branch to fill in disyllabic words with initial stress, since this is already filled. Thus forms like those in (18) are never attested:

(18)	a.	Robin	/'rɔbɪn/	→	*['hɔpɪnə], but ['hɔpɪn]
	b.	robot	/'roːbɔt/	→	*['hoːpɔtɔ], but ['hoːpɔt]

This also makes the prediction that extra syllables can be found in monosyllabic adult target words, which is indeed the case, as shown in (19):

(19)	a.	*Noortje*			
		trein	/trɛin/	→	['tɛinə]	(2;5.23)
		tuin	/tœyn/	→	['tœynɑ]	(2;5.23)
		dik	/dɪk/	→	['kɪkə]	(2;6.5)
		thee	/'teː/	→	['tɛijə]	(2;7.2)
	b.	*Tom*			
		aap	/aːp/	→	['aːpə]	(1;4.14)
		boot	/boːt/	→	[boːtɔ]	(1;5.28)
		beer	/beːr/	→	['piːjaː]	(1;6.11)

Ingram (1978) mentions this phenomenon and suggests that the reason for adding an extra vowel at the end of words is to make the production of the final consonant easier. However, he also mentions that it is frequently not the case that the final consonant is produced. Nevertheless, an extra syllable is often produced by reduplication of the word, as in ['nɛnɛ] for French *nez*.

Furthermore, if the reason for adding an extra vowel to the end of words is to make the realisation of the final consonant easier, then we would expect this to be found in disyllabic words with initial stress ending in a consonant too, like *Robin* and *pinguin*. These forms are non-existent. Finally, an extra syllable can also occur after a stressed syllable ending in a vowel, as shown above.[20]

It should be mentioned that it is not the case that both syllables of the child's foot are obligatorily filled, but if there is a candidate for the second syllable, it is always realised. Disyllabic target forms with initial stress are never truncated. Rather, we find the opposite: a monosyllabic foot is often made disyllabic. However, in some cases the foot can remain subminimal, namely when the circumscribed foot of the adult target contains only one syllable. Addition of an extra syllable provides a way of resolving subminimality. If the circumscribed foot contains two syllables, they are both realised. Truncation is not an option. A foot cannot be *made* subminimal, since this would require a special deletion rule.

It is not the case that just the stressed syllable is realised, since disyllabic words with initial stress are generally not truncated.[21] Thus, we do not find forms like those in (20):

(20) a. baby /ˈbeːbiː/ → *[beː], but [ˈbeːbiː]
b. vakantie /vaːˈkɑnsiː/ → *[kɑn], but [ˈkɑnsiː]

The prosodically circumscribed foot is at the right edge of the adult target word, not at the left edge. We do not find forms like the ones in (21):

(21) a. vakantie /vaːˈkɑnsiː/ → *[ˈvaːkɑn], but [ˈkɑnsiː]
b. olifant /ˈoːliːˌfɑnt/ → *[ˈoːliː], but [fɑnt][22]
c. paraplu /ˌpaːraːˈplyː/ → *[ˈpaːraː], but [pyː]

6.4.2. Stage 2

At the second stage the child realises both syllables of the target word. However, stress falls on the first syllable. The segmental material of both syllables of the adult word is taken out and mapped onto the child's trochaic template as in (22). Foot structure is not copied, otherwise stage 2 and stage 3 cannot be explained, since the stress pattern in the child's form is different from that of the adult target.

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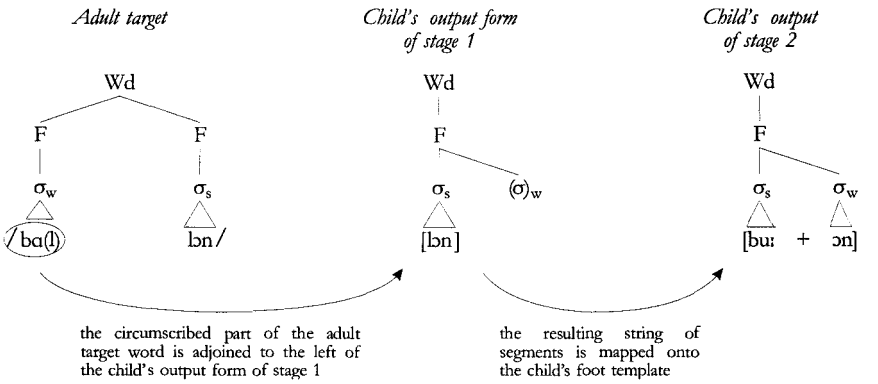
[20] An additional argument against Ingram's analysis is that extra syllables sometimes appear word-medially at stage 3. These will be discussed later.

[21] Truncation of disyllabic words with initial stress only occurs at the earliest stages (see chapters 4, 5 and 7).

[22] Even though *olifant* has initial main stress, the foot with secondary stress in the target word, the rightmost foot is selected for production.

(22) STAGE 2



It is, however, not clear what is circumscribed in this case. It cannot be a foot, since the two syllables do not form a foot in the adult target. It could either be a window of two syllables, which again is not a single prosodic category, or alternatively it could circumscribe the whole word. Although the latter is a prosodic category, this solution does not work either. To see this, we have to examine what happens in trisyllables.[23] It appears to be the case that if trisyllabic words with stress on the first and third syllables, like *ooievaar* /ˈoːjəˌfaːr/ and *krokodil* /ˌkroːkoːˈdɪl/, are truncated to disyllables, the first and the third syllables are produced, suggesting that the child's aim is to realise two syllables. S/he selects the segmental material from the stressed elements. The child does not parse out the syllable adjacent to the previously selected syllable. Thus we do not find forms like the ones in (23):

(23)	a.	olifant	/ˈoːliːˌfɑnt/	→	*[ˈliːfɑnt], but [ˈoːfɑnt]
	b.	pelikaan	/ˌpeːliːˈkaːn/	→	*[ˈliːkaːn], but [ˈpeːkaːn]
	c.	locomotief	/ˌloːkoːmoːˈtiːf/	→	*[ˈmoːtiːf], but [ˈloːtiːf]
	d.	boerderij	/ˌbuːrdəˈrɛi/	→	*[ˈdəʀɛi], but [ˈbuːʀɛi]

Rather, the child parses out the leftmost syllable in addition to the rightmost one. These elements do not form a prosodic unit in the adult target. However, given that the child had already selected one syllable from the target for his or her previous monosyllabic realisation, s/he now only has to select one new syllable. This syllable has to be concatenated to the previous monosyllabic form. The first syllable (the leftmost syllable) of the target is selected, which is then concatenated to the child's form of stage 1. The resulting form is mapped onto the trochaic template, as in (22). This again shows the independence of stress from the melodic tier. Furthermore, the child builds on its own previous representation of the word. From a

[23] I will discuss the child's realisations of trisyllabic adult target words in detail in section 6.5.

theoretical perspective this is important, because otherwise reference would have to be made to non-existent prosodic categories, like the first and third syllable, or syllables with stress. No such problems arise if we assume that the child expands his or her previous form by one prosodic unit (a syllable, as at stage 2, and as we will see shortly, a foot at stage 3). Further evidence for this comes from metathesised and reduplicated forms.

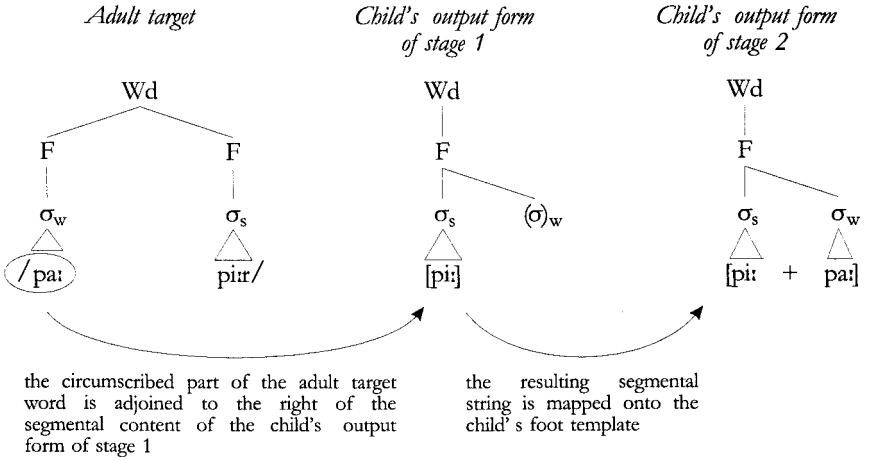
As has been shown, the child can take a new syllable from an adult target word to integrate it into his or her own form. S/he can place the extra syllable in initial position, thereby adopting the order of syllables in the adult word. The other option is to place it after the form which it has already acquired. This, then, results in metathesised forms, like those in (24):

(24) *Catootje's metathesised forms*

ballon	/bɑ'lɔn/	→	['bo:m'ba:n][24]	(1;10.11)
		→	['bo:'na:n]	(1;10.25)
papier	/pa:'pi:r/	→	['pipa:]	(1;10.25)
		→	['pi:'pa:j]	(1;11.10)

These forms cannot be explained by assuming that the prosodic word or a two-syllable window is circumscribed, except by proposing an independent metathesis rule. However, there seems to be no motivation for such a rule. Metathesis can be represented as follows:

(25) *Metathesis*[25]



Another option is to create a disyllabic form by reduplicating the child's own form, as in the examples in (26).

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[24] Some of the forms represent stage 3, but this need not concern us here.

[25] In the metathesised forms it seems that the head-dependent relation of the syllables in the adult word is maintained.

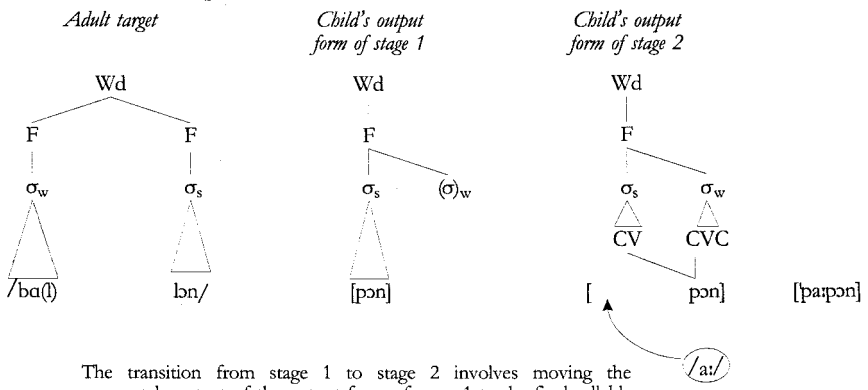
(26) *Reduplicated forms*

a.	*Noortje*				
	ballon	/bɑˈlɔn/	→	[ˈpɑˈpɔm]	(2;5.23)
	konijn	/koːˈnɛin/	→	[ˈkɑˈkɛin]	(2;7.2)
b.	*Tom*				
	kameel	/kaːˈmeːl/	→	[ˈkaːˈkɛj]	(2;0.17)
c.	*Catootje*				
	ballon	/bɑˈlɔn/	→	[ˈpaːˈboːŭn]	(1;11.10)
			→	[ˈpaːˈpɔn]	(2;1.3)

These cases can also not be explained by selecting two syllables from the adult target word. Rather, the child's template expands from monosyllables to disyllables, but the circumscribed domain of the adult target word has not changed. The only way to get an extra syllable is by reduplicating the child's form from the previous stage. The additional syllable is realised to the right of the previous form. These data can be readily explained if we assume that the child's forms from the previous stage are used as input for reduplication, rather than the adult forms.

At the first stage the stressed syllable of the adult target word is taken (stage 1). At the next stage the child realises (i) that the target word contains two syllables, and (ii) that the parts he has selected for production is in final position in the target. Movement of that syllable to the weak branch of the foot leaves the head syllable empty. The empty syllable has to be filled: the onset of the second syllable spreads to the onset of the first (empty syllable). The default vowel, the low vowel /aː/ or /ɑ/, is inserted to fill the nucleus of the first syllable. The reduplication process can be represented as in (27):

(27) *Reduplication*

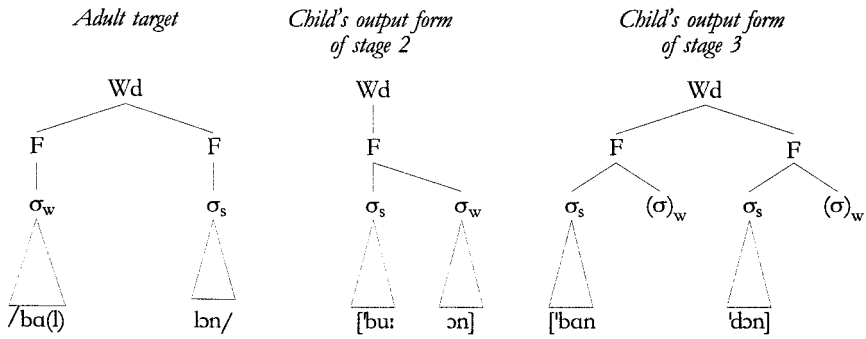


The transition from stage 1 to stage 2 involves moving the segmental content of the output form of stage 1 to the final syllable of the foot and filling the head syllable by reduplication.

6.4.3. Stage 3

At the third stage, the child realises both syllables of the adult target word; however, both syllables receive an equal amount of stress. It seems that the child is learning that the adult word can consist of more than one foot. S/he might therefore hypothesise that it consists of two feet, which results in level stress (28). Thus, the child's template is expanded with one prosodic constituent: an extra foot. Level stress is not an option available in adult language, since the main stress rule provides one foot with more stress.[26] The child is not yet aware of the main stress rule.[27]

(28) STAGE 3



The transition from stage 2 to stage 3 involves the mapping of the segmental content of the child's form at stage 2 onto a two-foot template.

If the child's template is as given above, the prediction is that extra syllables can occur word-medially. There are a few production forms with extra medial syllables attested in the data, as shown in (29). Here again the reason for adding an extra syllable could be to make a complete foot.

(29) *Extra medial syllables*

a.	*Tirza*				
	kasteel	/ˌkɑsˈteːl/	→	[ˈtɑsəˈsøːt]	(1;11.19)
	konijntjes	/koːˈnɛint͡jəs/	→	[ˈkɔnɪˈnɛint͡jəs]	(2;6.12)
b.	*Noortje*				
	konijn	/koːˈnɛin/	→	[ˈtɔtɔˈtɛin]	(2;7.17)
	kameel	/kaːˈmeːl/	→	[ˈkɑnəˈmeːu]	(2;11.0)

[26] The child's language looks very much like a syllable-timed language (Nespor 1990).

[27] In chapter 7 I will discuss the fact that at this stage many stress parameters come into play. The child still has a trochaic foot, but it will be shown that this foot is no longer quantity-insensitive.

c. *Elke*

ballonnen	/bɑ'lɔnə[n]/	→	['bɑulo:'lɔmə]	(2;4.29)

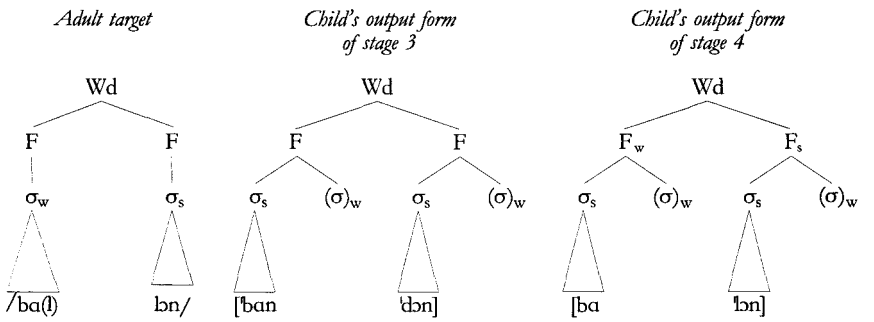
d. *Tom*

kameel	/ka:'me:l/	→	['ki:kɔ'məj]	(1;7.9)

6.4.4. Stage 4

At the final stage, the child knows that these adult words consist of one foot and something more, which might not be a full foot. The child realises main stress on the final foot of disyllabic word. The child might also have learned the destressing rule of Dutch, which destresses the first (incomplete) foot in disyllabic words with final stress. The representation has become adult-like. This is shown in (30):

(30) STAGE 4



The transition from stage 3 to stage 4 involves the acquisition of the main stress rule.

6.4.5. Summary and discussion

1. We have seen that the child's template expands gradually and quite systematically. At the earliest stage the child has only monosyllabic words, which correspond to monosyllabic adult targets (stage 0).

STAGE 1: At stage 1 the child's template consists of minimally one and maximally two syllables, which form one foot: a binary left-headed foot, of which at least the head is filled. The child prosodically circumscribes the rightmost foot of the adult target word and maps the segmental content of that foot onto a trochaic foot template. The remainder of the adult target word is not realised, because it does not fit into the template. If the target foot consists of two syllables, both syllables are realised in the child's output form. If the target foot consists of one syllable, the child's realisation can

be either monosyllabic or disyllabic. In the latter case, a syllable is added to the right of the selected foot to fill both positions in the foot. The child does not copy the foot structure of the adult word, since this extra syllable is not present in the adult target foot.

STAGE 2: At the next stage the child circumscribes a syllable at the left edge[28] of the word, if the child's form consists of one syllable. The segmental content of that syllable is adjoined to the child's previous monosyllabic form. This segmental material is mapped onto a trochaic foot template, resulting is an initial-stressed disyllabic foot. Additional evidence for the fact that the child's previous forms play an important role in the development comes from reduplication and metathesis. These data cannot be explained on the assumption that the only input to the child consist of adult target words. Rather, the child's own previous forms can also serve as input.

STAGE 3: At this stage the child recognises that disyllabic adult target words with final stress do not form one foot. The child now expands his or her template with one foot: the result is a word template that contains two feet. Additional evidence for this comes from data in which an extra medial syllable is realised. Main stress is not yet learned, therefore, both feet receive an equal amount of stress.

STAGE 4: At stage 4 the child learns the main stress rule, which assigns main stress to one of the feet of his or her template. The child's production of disyllabic target words with final stress resembles that of the target word in number of syllables and stress pattern.

2. The data call for a non-linear approach, since they clearly demonstrate that stress and segmental content are largely independent. The child does not copy segmental material of the adult target word with the prosodic structure, but only copies the segmental material of (part of) the adult target which is mapped onto the child's own template. Otherwise the appearance of extra syllables in the child's output forms that are not present in the adult target words cannot be explained. The data representing stage 2 and stage 3 cannot be explained if foot structure has been copied, since stress in the child's output forms is different from stress in the adult target words.

3. The developmental patterns can be described if we make use of the tools of prosodic theory. At stage 1, just the rightmost stressed foot is taken, which may result in deletion of initial (unstressed) syllables. At stage 2, the segmental material of the leftmost syllable is selected for production, which

[28] The leftmost syllable that is selected at stage 2 is also the most prominent one after taking the rightmost stressed syllable. Sometimes it is completely unstressed, but since in these cases it is the only remaining syllable of the word, it is nevertheless the most prominent.

is combined with the material of the child's previous form. The prosodic template of the child does not change. At stage 3 the child's template is expanded with another foot. No reference needs to be made to non-existing prosodic categories, on the assumption that the child's previous forms play an important role.

4. Important in the analysis presented here is that the child's output may serve as its own input. That is, the child's previous form is an important factor for the way his or her system develops. It shows that the child's forms are not fixed, but are constantly in transition towards the adult target forms. The child does not have to 'unlearn' deletion rules like truncation; as the child's template expands in such a way that in can incorporate the whole string of segments of the adult target words, deletion ceases to occur, since the only reason for deletion of syllables is that they are not prosodically licensed.

5. The crucial difference between the analysis of Allen & Hawkins and the analysis presented here is that in the former it is stipulated that stress is on the initial syllable. Initial unstressed syllables are deleted, because they are not stressed. In Allen & Hawkins' analysis, truncation is seen as the result of a deletion process, while in the analysis presented here truncation is the result of mapping of segmental material to a prosodic template. Only the latter provides an explanatory account of the development of disyllabic words with final stress. Although Allen & Hawkins do not exclude the possibility of stress shift as a means of obeying the trochaic constraint, they consider it to be just one of the ways of conforming to the trochaic template. This, however, is no more than a description without explanatory power. There are many ways to get initial stress: by deletion of the first unstressed syllable, by stress shift, or by adding an extra stress (on the unstressed syllable). Only the account presented here explains the *pattern* of development observed.

6. The account given here explains why disyllabic words with initial stress are rarely truncated and do not show stress errors: the child circumscribes the stressed foot and maps this onto a trochaic template. Since the adult word is already a trochaic foot, these forms fit immediately. There is no reason for the child to alter the pattern. This also explains the absence of extra syllables in these words.

So far, I have mainly discussed the developmental patterns found in the acquisition of disyllabic target words. However, the analysis presented here also makes predictions for longer words. Let us turn to these now.

6.5. Predictions for longer words

As we have seen in section 6.2, main stress falls on the window of three syllables from the right edge of the word. In trisyllabic words main stress can in principle be on either one of the last three syllables in adult Dutch. Let us first discuss the predictions for the different stages for the different types of trisyllabic words. I will first discuss the patterns found in Robin's data; then I will show that the same patterns also occur in the data of other children. In general, trisyllabic words are selected by the child later than disyllabic words, probably due to a selection strategy. In section 6.5.4 I will briefly discuss what happens with longer words, which are very infrequent in child language.

6.5.1. Trisyllabic words with final main stress

Stage 1. The prediction for trisyllabic words with main stress on the final syllable (and secondary stress on the initial syllable) is that the child parses out a monosyllabic foot at the right edge, of which the segmental material is mapped onto a trochaic foot template. That this prediction is borne out is evident in Robin's data in (31):

(31) *Robin:* STAGE 1

telefoon	/ˌteːləˈfoːn/	→	[fɔm]	(1;10.7)
krokodil	/ˌkroːkoːˈdɪl/	→	[diːw]	(1;10.7)

Elke and Eva produce only a few trisyllabic target words with final stress, all truncated to the final monosyllabic foot, as shown in (32):

(32) a. *Elke:* STAGE 1

telefoon	/ˌteːləˈfoːn/	→	[pɔm]	(1;10.7)

b. *Eva:* STAGE 1

boerderij	/ˌbuːrdəˈrɛi/	→	[hɛi]	(1;4.26)
microfoon	/ˌmiːkroːˈfoːn/	→	[hʌm]	(1;6.1)
papegaai	/ˌpaːpəˈχaːj/	→	[taːj]	(1;7.22)
krokodil	/ˌkroːkoːˈdɪl/	→	[dɪl]	(1;9.8)

The other children, too, have forms characteristic of stage 1, as shown in (33):

(33) a. *Tirza:* STAGE 1

telefoon	/ˌteːləˈfoːn/	→	[χoːn]	(1;9.11)
paraplu	/ˌpaːraːˈplyː/	→	[pyːt͡ʃ]	(1;10.22)

b.	*Tom:* STAGE 1				
	papegaai	/ˌpaːpəˈχaːj/	→	[ˈpaːjə][29]	(1;5.14)
	pelikaan	/ˌpeːliːˈkaːn/	→	[kɑŋ], [ˈkɑŋɑ]	(1;5.28)
	telefoon	/ˌteːləˈfoːn/	→	[tɔ]	(1;7.9)
c.	*Noortje:* STAGE 1				
	paraplu	/ˌpaːraːˈplyː/	→	[pɔ]	(2;2.7)
	Sinterklaas	/ˌsɪntərˈklaːs/	→	[pɑs]	(2;5.23)
d.	*Catootje:* STAGE 1				
	indiaan	/ˌɪndiːˈjaːn/	→	[ˈhaːnt]	(1;10.11)
			→	[haːn]	(1;10.25)

Stage 2. The prediction is that at the next stage an additional syllable from the adult target from the left edge of the word (or the most prominent remaining one after the rightmost foot is taken out) is circumscribed, the segmental content of that syllable added to the segmental content of the child's previously circumscribed monosyllabic foot, and the result mapped onto a trochaic template. This results in disyllabic words with initial stress. That the prediction is borne out by the data can be seen in (34), which gives examples of Robin's forms typical of stage 2:

(34)

Robin: STAGE 2				
boerderij	/ˌburɪdəˈrɛi/	→	[ˈbuːjɛi]	(1;10.21)
telefoon	/ˌteːləˈfoːn/	→	[ˈtɪfoːm]	(2;0.18)

This shows that the child's template at stage 2 consists of one binary left-headed foot. Data from other children are given in (35):

(35)

a.	*Tirza:* STAGE 2				
	boerderij	/ˌburɪdəˈrɛi/	→	[ˈpɔdɛi]	(1;11.19)
b.	*Tom:* STAGE 2				
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːwɪ]	(1;5.14)
	papegaai	/ˌpaːpəˈχaːj/	→	[ˈpɑpaːŋ]	(1;5.14)
	pelikaan	/ˌpeːliːˈkaːn/	→	[ˈtaːkɑmp]	(1;5.28)
			→	[ˈkiːkɑn]	(1;5.28)
	telefoon	/ˌteːləˈfoːn/	→	[ˈtɛfoː]	(1;8.6)
c.	*Noortje:* STAGE 2				
	paraplu	/ˌpaːraːˈplyː/	→	[ˈpaːpyː]	(2;5.23)
	Sinterklaas	/ˌsɪntərˈklaːs/	→	[ˈtɪntɑ]	(2;7.17)

[29] See section 6.6 for a discussion of segmental changes in the child's output compared to input.

Stage 3. The prediction for stage 3 is that the child now realises two feet with equal stress. However, there are now two possibilities: (i) the child's template expands to include two feet, but the segmental content does not change; this results in disyllabic forms with level stress; or (ii) the child's template expands to include two feet, and now all three syllables of the adult target word can be incorporated into the child's template. Robin has no forms of the first type; he only has trisyllabic productions of these trisyllabic words, as is shown in (36):

(36) *Robin:* STAGE 3

boerderij	/ˌbuːrdəˈrɛi/	→	[ˈbɔjəˈjɛi]	(1;11.7)
speel-o-theek	/ˌspeːloːˈteːk/	→	[ˈpɪləˈtiːk]	(2;0.18)
microfoon	/ˌmiːkroːˈfoːn/	→	[ˈmiːkəˈfoːn]	(2;1.7)
kapitein	/ˌkaːpiːˈtɛin/	→	[ˈpɑpiːˈtɛin]	(2;1.26)
indiaan	/ˌɪndiːˈjaːn/	→	[ˈɪnəˈjaːn]	(2;1.26)
machinist	/ˌmaːʃiːˈnɪst/	→	[ˈmaːçiːˈnɪt͡s]	(2;2.27)
krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːkəˈdɪɔ]	(2;3.22)
speel-o-theek	/ˌspeːloːˈteːk/	→	[ˈspeːloːˈteːk]	(2;4.8)

Disyllabic level stress production forms are found in Tirza and Tom's data, as shown in (37):

(37) a. *Tirza:* STAGE 3′

muzikant	/ˌmyːziːˈkɑnt/	→	[ˈtiːkˈtɪnt]	(1;11.19)
boerderij	/ˌbuːrdəˈrɛi/	→	[ˈpyːˈhaːj]	(2;0.18)
boerderij	/ˌbuːrdəˈrɛi/	→	[ˈbuːˈdɛi]	(2;1.17)

b. *Tom:* STAGE 3′

pelikaan	/ˌpeːliːˈkaːn/	→	[ˈkeːˈkaːm]	(1;7.9)
parachute	/ˌparaːˈʃyːt/	→	[ˈpaːˈplʉt]	(1;10.29)

Since I claimed that truncation is the result of general prosodic constraints on licensing and that there are no deletion rules, the forms in (37) must be based on the child's earlier forms. At this stage the template is extended in such a way that it now can contain two feet. However, if the segmental content of the child's previous form is mapped onto this new template, the result can be a disyllabic word consisting of two feet. Since no main stress rule has yet been learned, both syllables are realised with an equal amount of stress, as in (37). There is no deletion involved, since all segmental content is prosodically licensed. The mapping of the segmental content of the *adult* target words onto the child's two-foot template results in trisyllabic output forms. The prediction is that all words that are produced for the first time at this stage are produced as trisyllabic words, rather than disyllabic ones. They cannot come out as disyllabic output forms without the stipulation of a deletion rule. The trisyllabic output forms outnumber the

disyllabic ones; it might then be the case that stage 3′ precedes stage 3. Tirza and Tom both have forms typical of stage 3, alongside those typical of stage 3′, as is shown in (38):

(38) a. *Tirza*: STAGE 3

krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːkəˈdaːi]	(2;1.17)
papegaai	/ˌpaːpəˈχaːij/	→	[ˈpɑpɑˈχaːij]	(2;2.12)
Amsterdam	/ˌɑmstərˈdɑm/	→	[ˈɑmstəˈdɑmə]	(2;3.27)
boerderij	/ˌbuːrdəˈrɛi/	→	[ˈbuːdɪˈʁɛi]	(2;5.5)
koningin	/ˌkoːnɪˈŋɪn/	→	[ˈkoːnɪŋˈɪŋ]	(2;5.5)
indiaan	/ˌɪndiːˈjaːn/	→	[ˈɪndiːˈjaːnə]	(2;5.5)
telefoon	/ˌteːləˈfoːn/	→	[ˈteːnəˈʃɑ͡ɔ̃nə]	(2;5.21)

b. *Tom*: STAGE 3

papegaai	/ˌpaːpəˈχaːij/	→	[ˈpɑpɑˈpɔj]	(1;5.14)
krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkɛkɛˈkɪw]	(1;7.9)

Other children also have forms characteristic of stage 3, as shown in (39):

(39) a. *Catootje:* STAGE 3

indiaan	/ˌɪndiːˈjaːn/	→	[ˈhiːjəˈhaːn]	(1;10.25)
krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːkɔˈkɪɔ]	(2;0.6)
paraplu	/ˌpaːraːˈplyː/	→	[ˈpaːpəˈpiː]	(2;0.6)
telefoon	/ˌteːləˈfoːn/	→	[ˈhiːnəˈhoːmə]	(2;0.6)

b. *Enzo:* STAGE 3

papegaai	/ˌpaːpəˈχaːij/	→	[ˈpɑpaːˈχaːij]	(1;11.15)
krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkʁuːkəˈdɪɔ]	(2;0.20)
chocola	/ˌʃoːkoːˈlaː/	→	[ˈtɔkəˈlaː]	(2;3.1)
telefoon	/ˌteːləˈfoːn/	→	[ˈtɪlɪˈfoːn]	(2;3.14)

Stage 4. At stage 4 the child is learning that one of the feet of the word has to receive main stress. Children invariably place main stress on the branching foot, although main stress is on the final syllable in the adult target forms.[30] I will come back to this in chapter 7. Some data from Robin are given in (40):

(40) *Robin:* STAGE 4

kapitein	/ˌkaːpiːˈtɛin/	→	[ˈpaːpiːˌtɛin]	(2;1.7)
telefoon	/ˌteːləˈfoːn/	→	[ˈteːləˌfoːm]	(2;1.7)
Amsterdam	/ˌɑmstərˈdɑm/	→	[ˈaːpstəˌdɑm]	(2;4.29)
krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːkəˌdɪw]	(2;4.29)
paraplu	/ˌpaːraːˈplyː/	→	[ˈpɑləˌpyː]	(2;4.29)

[30] No such stress shift are encountered for disyllabic target words. In chapter 7 I will give an explanation for this lack of stress shift in disyllabic words.

That main stress assignment to the first branching foot from the right is not only typical in Robin's data, but is also found in the data of other children, is shown in (41):

(41) a. *Tirza:* STAGE 4

krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːkəlˌtɔ]	(2;1.17)
Amsterdam	/ˌɑmstərˈdɑm/	→	[ˈɛmstəˌdɛm]	(2;3.27)
koningin	/ˌkoːnɪˈŋɪn/	→	[ˈkoːnɪˌŋɪŋ]	(2;5.5)

b. *Tom:* STAGE 4

krokodil	/ˌkroːkoːˈdɪl/	→	[ˈsɔkɔˌtiːw]	(2;2.2)

c. *Noortje:* STAGE 4

Sinterklaas	/ˌsɪntərˈklaːs/	→	[ˈhiːtɑˌtaːs]	(2;8.25)
krokodil	/ˌkroːkoːˈdɪl/	→	[ˈdoːkɛˌdiːw]	(2;9.26)

d. *Enzo:* STAGE 4

krokodil	/ˌkroːkoːˈdɪl/	→	[ˈnɔkɔˌdɪl]	(2;2.14)
boerderij	/ˌbuːdəˈrɛi/	→	[ˈbuːdəˌrɛi]	(2;3.14)
conducteur	/ˌkɔndʉkˈtøːr/	→	[ˈkoːmənˌdøːɪ]	(2;4.25)
saxofoon	/ˌsɑksoːˈfoːn/	→	[ˈsɑʁkɪˌfoːn]	(2;6.11)
chocola	/ˌʃoːkoːˈlaː/	→	[ˈdɔkoːˌlaː]	(2;6.11)

Stage 5. At the next stage (stage 5) these words are produced correctly insofar stress pattern and number of syllables is concerned.[31]

To summarise, the patterns found for trisyllabic words with final stress are largely comparable with those found for disyllabic words with final stress. However, there are a few differences. First, at stage 3 trisyllabic productions with level stress are preferred by most children, although disyllabic productions do occur. The latter type of words reveal the importance of the child's previous form, since if the adult target had been the basis for the mapping procedure, truncation is not expected. A second difference occurs during stage 4: in disyllabic words with final stress, the final (monosyllabic) foot receives main stress, whereas in trisyllabic words with final stress the initial (disyllabic) foot receives main stress. In a sense, the child assigns stress to the optimal foot: a branching foot. I will come back to this in chapter 7. The different stages are all represented in the data of Tom (42) and Tirza (43):

(42) *Tom*

a. STAGE 1

papegaai	/ˌpaːpəˈχaːj/	→	[ˈpaːjə]	(1;5.14)
pelikaan	/ˌpeːliːˈkaːn/	→	[kɑŋ], [ˈkɑŋɑ]	(1;5.28)
telefoon	/ˌteːləˈfoːn/	→	[tɔ]	(1;7.9)

[31] This will also be discussed in more detail in chapter 7.

b.	STAGE 2				
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːwɪ]	(1;5.14)
	papegaai	/ˌpaːpəˈχaːj/	→	[ˈpɑpaːɪŋ]	(1;5.14)
	pelikaan	/ˌpeːliːˈkaːn/	→	[ˈtaːkɑmp]	(1;5.28)
			→	[ˈkiːkɑn]	(1;5.28)
	telefoon	/ˌteːləˈfoːn/	→	[ˈtɛfoː]	(1;8.6)
c.	STAGE 3′				
	pelikaan	/ˌpeːliːˈkaːn/	→	[ˈkeːˈkaːm]	(1;7.9)
	parachute	/ˌparaːˈʃyːt/	→	[ˈpaːˈplʉt]	(1;7.9)
d.	STAGE 3				
	papegaai	/ˌpaːpəˈχaːj/	→	[ˈpɑpɑˈpɔj]	(1;5.14)
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkɛkɛˈkɪw]	(1;7.9)
e.	STAGE 4				
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈsɔkɔˌtiːw]	(2;2.2)

(43) *Tirza*

a.	STAGE 1				
	telefoon	/ˌteːləˈfoːn/	→	[χoːn]	(1;9.11)
	paraplu	/ˌpaːraːˈplyː/	→	[pyːt͡ʃ]	(1;10.22)
b.	STAGE 2				
	boerderij	/ˌbuːrdəˈrɛi/	→	[ˈpɔdɛi]	(1;11.19)
c.	STAGE 3′				
	muzikant	/ˌmyːziːˈkɑnt/	→	[ˈtiːkˈtɪnt]	(1;11.19)
	boerderij	/ˌbuːrdəˈrɛi/	→	[ˈpyːˈhaːj]	(2;0.18)
	boerderij	/ˌbuːrdəˈrɛi/	→	[ˈbuːˈdɛi]	(2;1.17)
d.	STAGE 3				
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːkəˈdaː]	(2;1.17)
	papegaai	/ˌpaːpəˈχaːj/	→	[ˈpɑpɑˈχaːj]	(2;2.12)
	Amsterdam	/ˌɑmstərˈdɑm/	→	[ˈɑmstəˈdɑmə]	(2;3.27)
	boerderij	/ˌbuːrdəˈrɛi/	→	[ˈbuːdɪˈʀɛi]	(2;5.5)
	koningin	/ˌkoːnɪˈŋɪn/	→	[ˈkoːnɪŋˈɪŋ]	(2;5.5)
	indiaan	/ˌɪndiːˈjaːn/	→	[ˈɪndiːˈjaːnə]	(2;5.5)
	telefoon	/ˌteːləˈfoːn/	→	[ˈteːnəˈʃɑ͡ɔnə]	(2;5.21)
e.	STAGE 4				
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːkəlˌtɔ]	(2;1.17)
	Amsterdam	/ˌɑmstərˈdɑm/	→	[ˈɛmstəˌdɛm]	(2;3.27)
	koningin	/ˌkoːnɪˈŋɪn/	→	[ˈkoːnɪˌŋɪŋ]	(2;5.5)

6.5.2. Trisyllabic words with initial main stress

There are two types of trisyllabic words with initial stress: those with and those without secondary stress (on the final syllable). For trisyllabic words with initial main stress and secondary stress on the final syllable exactly the same patterns are found as for trisyllabic words with final main stress and secondary stress on the initial syllable (section 6.5.1). Trisyllabic words with initial stress and no secondary stresses behave somewhat differently. Let us first discuss the former. At the end of this section I will come back to the latter type of words.

Stage 1. For trisyllabic words with initial main stress and final secondary stress the prediction is that at stage 1 the rightmost foot is prosodically circumscribed. This stage is not attested in Robin's data, since he avoids these type of words in the early sessions. However, the prediction is borne out by the data of other children, as shown in (44):

(44)

a.	*Tom:* STAGE 1				
	olifant	/ˈoːliːˌfant/	→	[ham]	(1;2.14)
	kangoeroe	/ˈkaŋguːˌruː/	→	[kau][32]	(1;5.14)
b.	*Jarmo:* STAGE 1				
	olifant	/ˈoːliːˌfant/	→	[faut]	(2;1.22)
c.	*Noortje:* STAGE 1				
	olifant	/ˈoːliːˌfant/	→	[aːnt]	(2;6.5)
d.	*Eva:* STAGE 1				
	kangoeroe	/ˈkaŋguːˌruː/	→	[puː]	(1;6.1)
e.	*Tirza:* STAGE 1				
	olifant	/ˈoːliːˌfant/	→	[ant], [aunt]	(1;11.19)
f.	*Enzo:* STAGE 1				
	allemaal	/ˈaləˌmaːl/	→	[ma]	(1;11.8)

The data in (44) indicate that the child focuses on a foot at the right edge of the word, regardless of whether it has main stress or secondary stress. The child does not circumscribe the foot which has main stress in the adult target word.

Stage 2. At the second stage the segmental content of an additional syllable of the adult target words at the left edge of the word is adjoined to the content of the previously circumscribed monosyllabic foot, resulting in a left-headed binary foot, as predicted by the analysis given in section 6.4. Examples from Robin are given in (45):

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[32] See also section 6.6.

(45) *Robin:* STAGE 2

allemaal	/ˈɑləˌmaːl/	→	[ˈɑmɑu]	(2;1.7)
caravan	/ˈkɛrəˌvɛn/	→	[ˈpɪfɐm]	(2;1.26)
kangoeroe	/ˈkɑŋguːˌruː/	→	[ˈtɑktuː]	(2;1.26)

Data from some of the other children are given in (46):

(46) a. *Catootje:* STAGE 2

olifant	/ˈoːliːˌfɑnt/	→	[ˈoːmaː]	(1;10.11)
		→	[ˈɔŋɑm]	(1;11.10)

b. *Elke:* STAGE 2

olifant	/ˈoːliːˌfɑnt/	→	[ˈoːfɑnt]	(2;3.27)
allemaal	/ˈɑləˌmaːl/	→	[ˈɑmɑm]	(2;3.27)
Portugal	/ˈpɔrtyːˌχɑl/	→	[ˈpɔχɑl]	(2;3.27)

c. *Eva:* STAGE 2

olifant	/ˈoːliːˌfɑnt/	→	[ˈoːʋɑnt]	(1;7.15)

d. *Jarmo:* STAGE 2

olifant	/ˈoːliːˌfɑnt/	→	[ˈhoːtɑ]	(2;2.6)

Stage 3. The prediction for stage 3 is that the child now realises two feet; and since the main stress rule has not yet been learned, both feet receive equal stress. As discussed above, there are now two possibilities: (i) the child's template expands to include two feet, but the segmental content does not change; this results in disyllabic forms with level stress; or (ii) the child's template expands to include two feet, and now all three syllables of the adult target word can be incorporated into the child's template. Both possibilities are attested in Robin's data, as shown in (47a, b):

(47) a. *Robin:* STAGE 3′

caravan	/ˈkɛrəˌvɛn/	→	[ˈkeːˈfɪn]	(2;2.27)

b. *Robin:* STAGE 3

olifant	/ˈoːliːˌfɑnt/	→	[ˈfjoːfiːˈfɑnt]	(2;3.10)
		→	[ˈoːfiːˈfɑnt]	(2;4.8)
allemaal	/ˈɑləˌmaːl/	→	[ˈaːləˈmaːl]	(2;4.8)

It seems that stage 3′ precedes stage 3. The data characteristic of stage 3′ can only be explained on the assumption that the child is building on his or her previous form, since if the adult target word would be taken as base, trisyllabic productions are predicted. If the adult target word is mapped onto the child's template consisting of two feet the trisyllabic forms in (47b) are the result, since it is claimed that deletion of syllables only occurs if those syllables are not licensed by the template. Since a two-foot template can accommodate all three syllables of the adult target word, deletion is not possible. Only when the segmental content of the child's previous form is

mapped onto the new prosodic template can disyllabic forms arise; there is no deletion involved in the production of these forms. (48) gives examples of disyllabic level stress productions of some of the other children.

(48) STAGE 3′

a. *Eva*

olifant	/ˈoːliːˌfɑnt/	→	[ˈoːˈfɑnt]	(1;9.8)

b. *Tom*

kangoeroe	/ˈkɑnguːˌɾuː/	→	[ˈkaːˈkuːŋ]	(1;6.11)
olifant	/ˈoːliːˌfɑnt/	→	[ˈoːˈfɑn]	(1;7.23)

(49) gives examples of trisyllabic productions in other children's data:

(49) a. *Catootje:* STAGE 3

olifant	/ˈoːliːˌfɑnt/	→	[ˈɔnaːˈhɑnt]	(2;0.6)
		→	[ˈoːməˈhaːntə]	(2;1.24)
kangoeroe	/ˈkɑnguːˌɾuː/	→	[ˈkaːməˈʁuː]	(2;1.24)
ooievaar	/ˈoːjəˌvaːr/	→	[ˈoːjəˈvaːɪ]	(2;5.8)

b. *Jarmo:* STAGE 3

olifant	/ˈoːliːˌfɑnt/	→	[ˈoːfɑˈfɑn]	(2;4.1)
		→	[ˈhɔntəˈflɑŋ]	(2;4.1)

c. *Noortje:* STAGE 3

olifant	/ˈoːliːˌfɑnt/	→	[ˈɑuliːˈhɑn͡ts]	(2;8.1)

Stage 4. On the basis of the patterns found for trisyllabic words with final main stress, the prediction is that main stress is assigned to the branching foot, that is, the first foot at this stage. The data indeed point out that it is invariably the branching foot (consisting of two syllables) that receives main stress, which is correct in these words. Some data from Robin are given in (50):

(50) *Robin:* STAGE 4

heleboel	/ˈheːləˌbuːl/	→	[ˈheːləˌbuː]	(2;4.8)
allemaal	/ˈɑləˌmaːl/	→	[ˈaːləˌmaːl]	(2;4.8)
olifant	/ˈoːliːˌfɑnt/	→	[ˈoːviːˌɑnt]	(2;4.8)
		→	[ˈoːΦiːˌfɑnt]	(2;4.8)

In (51) data from some of the other children are given:

(51) a. *Noortje:* STAGE 4

olifant	/ˈoːliːˌfɑnt/	→	[ˈɑuliːˌhɑn͡ts]	(2;8.1)
ananas	/ˈɑnaːˌnɑs/	→	[ˈɑŋəˌŋɑs]	(2;8.1)
allemaal	/ˈɑləˌmaːl/	→	[ˈaːləˌmau]	(2;11.0)

b. *Catootje:* STAGE 4

kangoeroe	/ˈkaŋguːˌɾuː/	→	[ˈkaːhuːˌguː]	(2;2.15)
olifant	/ˈoːliːˌfant/	→	[ˈoːləˌhants͡]	(2;2.15)
ooievaar	/ˈoːjəˌvaːr/	→	[ˈoːjəˌvau]	(2;5.8)
olifant	/ˈoːliːˌfant/	→	[ˈoːləˌɒant]	(2;7.4)

To summarise, there are 4 stages to be distinguished. At the first stage the rightmost foot is prosodically circumscribed, and the segmental content of this foot is mapped onto a trochaic foot template. At the next stage, one additional syllable is prosodically circumscribed and added to the segmental content of the child's previous form. This segmental string is mapped onto the child's trochaic foot template. At the third stage, the child's template consists of two feet. Now there are two possibilities: (i) the child builds on his or her own previous form: the segmental content of the forms of stage 2 is mapped onto a two-foot template, resulting in disyllabic forms; (ii) the child maps the segmental content of the whole adult target word onto his or her own two-foot template, resulting is a trisyllabic (two-foot) production form. Since at stage 3 main stress is not yet learned, the result is that both feet receive an equal amount of stress. At the fourth stage the child assigns main stress to one of the feet of the word; this is invariably the branching (leftmost) foot. These different stages are all present in the data from Tom and Tirza, as shown in (52) and (53):

(52) *Tom*

a. STAGE 1

olifant	/ˈoːliːˌfant/	→	[ham]	(1;2.14)
kangoeroe	/ˈkaŋguːˌɾuː/	→	[kau]	(1;5.14)

b. STAGE 2

kangoeroe	/ˈkaŋguːˌɾuː/	→	[ˈkaːkuː]	(1;5.28)
olifant	/ˈoːliːˌfant/	→	[ˈoːlaː]	(1;5.28)
		→	[ˈoːfan]	(1;6.11)
		→	[ˈoːfan]	(1;7.9)

c. STAGE 3′

kangoeroe	/ˈkaŋguːˌɾuː/	→	[ˈkaːˈkuːŋ]	(1;6.11)
olifant	/ˈoːliːˌfant/	→	[ˈoːˈfan]	(1;7.23)

d. STAGE 3

kangoeroe	/ˈkaŋguːˌɾuː/	→	[ˈkaːkəˈʀuːŋ]	(1;6.11)
		→	[ˈkakuːˈkuː]	(1;7.9)
olifant	/ˈoːliːˌfant/	→	[ˈɔfəˈsan]	(1;7.9)
ooievaar	/ˈoːjəˌvaːr/	→	[ˈɔjəˈfaːɹ]	(1;11.26)

e. STAGE 4

ooievaar	/ˈoːjəˌvaːr/ →	[ˈɔjəˌfaː]	(1;11.26)
kangoeroe	/ˈkɑnguːˌruː/ →	[ˈkɑkuːˌjuː]	(2;1.26)
ananas	/ˈɑnaːˌnɑs/ →	[ˈɑnaːˌnɑs]	(2;2.2)

(53) *Tirza*

a. STAGE 1

olifant	/ˈoːliːˌfɑnt/ →	[ɑnt], [ɑunt]	(1;11.19)

b. STAGE 2

Gideon	/ˈχiːdeːˌjɔn/ →	[ˈχiːjɑ]	(2;0.5)
olifant	/ˈoːliːˌfɑnt/ →	[ˈoːt͡sɑnt]	(2;0.18)
kangoeroe	/ˈkɑŋguːˌruː/ →	[ˈkɑntuː]	(2;1.17)
ooievaar	/ˈoːjəˌvaːr/ →	[ˈoːʃaː]	(2;2.12)

c. STAGE 3′

olifant	/ˈoːliːˌfɑnt/ →	[ˈoːnˈt͡sʌnt]	(2;0.18)

d. STAGE 3

goochelaar	/ˈχoːχəˌlaːr/ →	[ˈsoːχəˈlaːɪ]	(2;2.12)
olifant	/ˈoːliːˌfɑnt/ →	[ˈoːləˈsɑnt]	(2;2.25)

e. STAGE 4

allemaal	/ˈɑləˌmaːl/ →	[ˈɑnəˌsaː]	(2;1.17)
olifant	/ˈoːliːˌfɑnt/ →	[ˈoːləˌlɑmp]	(2;3.12)
allemaal	/ˈɑləˌmaːl/ →	[ˈɑləˌmaːl]	(2;5.5)
goochelaar	/ˈχoːχəˌlaːr/ →	[ˈfoːχəˌlaː]	(2;6.12)
olifant	/ˈoːliːˌfɑnt/ →	[ˈɔliːˌfɑnt]	(2;6.12)
ooievaar	/ˈoːjəˌvaːr/ →	[ˈoːjəˌfaːɪ]	(2;6.12)

The second type of trisyllabic word which have initial stress, but lack secondary stress, are words like *tekenen* /ˈteːkənə[n]/ and *hinkelen* /ˈhɪŋkələ[n]/. These target words are invariable reduced to disyllabic words with initial stress by the child, during all stages. Examples are given in (54):

(54) a. *Jarmo*

tekenen	/ˈteːkənə[n]/ →	[ˈteːtə]	(1;10.9)
	→	[ˈteːkə]	(2;3.9)

b. *Elke*

andere	/ˈɑndərə/ →	[ˈaːnə]	(2;1.16)
tekenen	/ˈteːkənə[n]/ →	[ˈkɛkə], [ˈkɪtt]	(1;8.13)
	→	[ˈkeːkʉ], [ˈteːkə]	(2;2.21)

c. *Robin*

schommelen	/ˈsχɔmələ[n]/ →	[ˈfuːmə]	(1;10.21)
	→	[ˈfɔmə]	(2;1.7)

d.	*Tom*				
	Janneke	/ˈjɑnəkə/	→	[ˈjɑŋə]	(2;2.2)
e.	*Tirza*				
	hinkelen	/ˈhɪŋkələ[n]/	→	[ˈdɪŋkə]	(1;11.19)

At stages 1 and 2 the child has a quantity-insensitive binary left-headed foot template, which can only accommodate two of the three syllables. At stage 3, the child's word template can in principle contain two feet. However, these forms remain realised as disyllables with stress on the initial syllable at this stage. They are, correctly, never realised as two feet by the child. This is predicted by the analysis given above, since at stage 2 the child only selects an additional syllable from the adult target if the previous form contains only one syllable from the adult target.[33] However, in the case of the target words in (54), the previously selected material already contained two syllables. Moreover, at stage 2 it was claimed that the child prosodically circumscribes the additional syllable at the leftmost edge. In the data in (54), the leftmost syllable is already included in the parse at stage 1. Therefore, nothing changes at stage 2 or 3.

6.5.3. Trisyllabic words with medial main stress

Stage 1. The prediction is that at stage 1 the child prosodically circumscribes the final foot of the adult target word, takes out the segmental content and maps this onto a trochaic foot template. For trisyllabic words with medial stress, this means that the final two syllables of the adult words are produced. This prediction is borne out, as is shown by Robin's data in (55):

(55) *Robin:* STAGE 1

oranje	/oːˈʀɑn͡jə/	→	[ˈɦɑnə]	(1;10.21)
vakantie	/vaːˈkɑnsiː/	→	[ˈtɑsiː]	(2;0.18)
kabouter	/kaːˈbɑutər/	→	[ˈbɑutə]	(2;1.7)
Suzuki	/suːˈsuːkiː/	→	[ˈsuːkiː]	(2;1.26)
familie	/faːˈmiːliː/	→	[ˈmiːliː]	(2;2.27)
pyjama	/piːˈjaːmaː/	→	[ˈpjaːmaː]	(2;4.8)[34]
piano	/piːˈjaːnoː/	→	[ˈtjaːmoː]	(2;4.8)

Data from some of the other children representing stage 1 are given in (56):

[33] Additional evidence will be given in the next section.

[34] See also section 6.6.

(56) STAGE 1

a. *Noortje*

pantoffels	/ˌpɑnˈtɔfəls/	→	[ˈtɔfhiːs]	(2;8.29)
Marcella	/ˌmɑrˈsɛlaː/	→	[ˈɛlaː]	(2;8.29)
benzine	/ˌbɛnˈziːnə/	→	[ˈsiːnä]	(2;9.12)

b. *Leon*

piano	/piːˈjaːnoː/	→	[ˈpaːnoː]	(1;10.15)
horloge	/ˌhɔrˈloːʃə/	→	[ˈloːʃə]	(1;10.15)
piano	/piːˈjaːnoː/	→	[ˈpaːnoː]	(1;10.15)
politie	/poːˈliːt͡siː/	→	[ˈplɪksiː]	(2;1.7)
spinazie	/spiːˈnaːziː/	→	[ˈnaːsiː]	(2;3.4)

c. *Elke*

kabouter	/kaːˈbɑutər/	→	[ˈbɑutə]	(2;4.29)
pantoffel	/ˌpɑnˈtɔfəl/	→	[ˈtɑfuː]	(2;4.29)
politie	/poːˈliːt͡siː/	→	[ˈpiːsiː]	(2;4.29)
vakantie	/vaːˈkɑnsiː/	→	[ˈkɑnsiː]	(2;4.29)

d. *Jarmo*

horloge	/ˌhɔrˈloːʃə/	→	[ˈloːʃə], [ˈʃoːʃə]	(2;1.22)
beneden	/bəˈneɪdə[n]/	→	[ˈneːjə]	(2;3.9)

Stage 2. At stage 2 an additional syllable at the left edge is circumscribed in those cases where the previous form contained only one syllable of the adult target. This syllable was adjoined to the segmental material of the previous monosyllabic foot and the resulting string of segments is mapped onto a trochaic template. Since the child's production forms for trisyllabic adult targets with medial stress already are disyllabic, both syllables of the child's template are already filled. Therefore, the child's production forms of trisyllabic target words with medial stress are not changed at this stage: they remain realised as $(\sigma_s\ \sigma_w)$, as before. This illustrates that the child's template can only accommodate two syllables (which together form a foot) in his or her word template. In other words, there is no distinction in the production of those words at stage 1 and 2.[35]

Stage 3. At stage 3 the child's template consists of two feet. The prediction is that at this stage the child realises all syllables of the adult target, possibly with an extra medial syllable; and that the heads of the two feet receive equal stress, since this is typical of stage 3. This prediction is confirmed by the data, as shown by Robin's data in (57):

[35] It should be noted that, contrary to the stages mentioned in chapter 4, the stage numbers in section 6.5 more or less correspond to the stage numbers in the acquisition of disyllabic target words (sections 6.3 and 6.4).

(57) *Robin*: STAGE 3

spaghetti	/spaːˈχɛtiː/	→	[ˈmaːˈkɪtiː]	(2;3.22)
kazerne	/kaːˈzɛrnə/	→	[ˈtɑˈsɛɹnə]	(2;4.8)
parkeren	/ˌpɑrˈkeɪrə[n]/	→	[ˈpɑχˈkeːɹlə]	(2;4.8)

Data from some of the other children are given in (58):

(58) a. *Tirza:* STAGE 3

tracteren	/ˌtrɑkˈteɪrə[n]/	→	[ˈtɑkˈteːʀə]	(2;5.21)
kabouter	/kaːˈbɑutər/	→	[ˈkɑˈbɑutə]	(2;5.21)

b. *Noortje:* STAGE 3

spaghetti	/spaːˈχɛtiː/	→	[ˈpaːˈhɛtɑ]	(2;5.23)

c. *Tom:* STAGE 3

cassette	/cɑˈsɛtə/	→	[ˈkɑχˈsɛtə]	(1;10.8)
komkommer	/ˌkɔmˈkɔmər/	→	[ˈkɔmˈkɔmɑ]	(1;11.26)

The data in (59) show that an extra syllable is indeed sometimes produced to fill the weak branch of the first foot:

(59) *Extra medial syllables*

a. *Enzo*

garage	/χaːˈraːʃə/	→	[ˈχɑndəˈʀaːjə]	(2;3.28)
pantoffels	/ˌpɑnˈtɔfəls/	→	[ˈfɑtɔˈtɔfɔs]	(2;3.28)

b. *Tom*

cassette	/cɑˈsɛtə/	→	[ˈkɑkaːˈsɛtə]	(1;10.8)

c. *Robin*

garage	/χaːˈraːʃə/	→	[ˈχɑnəˈhaːsə]	(2;0.18)
kazerne	/kaːˈzɛrnə/	→	[ˈvaːsɑˈsɛnə]	(2;4.8)

Stage 4. At the next stage the child assigns main stress to one of the feet of the word. We have seen above that in disyllabic words with final stress (which consist of two feet) main stress is assigned to the final foot. We have also seen, however, that, if there is a branching (disyllabic) foot preceding a monosyllabic foot, main stress is assigned to this branching foot, not to the final monosyllabic foot. In the trisyllabic words with medial stress, the final foot is branching and receives stress. Some data are given in (60):

(60) a. *Catootje:* STAGE 4

pantoffels	/ˌpɑnˈtɔfəls/	→	[ˌpɑnˈtɔfɔls]	(2;4.12)
Marijke	/maːˈrɛikə/	→	[ˌmaːˈʀɛikə]	(2;7.4)

b. *Tirza:* STAGE 4

tracteren	/ˌtrɑkˈteɪrə[n]/	→	[ˌtɑkˈteːʀə]	(2;5.21)

To summarise, at stage 1 the child prosodically circumscribes the final foot of the adult target word, selects the segmental material contained in it and

maps this onto a trochaic template. At stage 2 nothing changes: the child's template still equals a trochaic foot. Since at stage 2 the child parses out a disyllabic foot from the adult trisyllabic target word with medial stress, his or her whole template is filled. In this sense, stage 2 in the production of trisyllabic target words with medial stress resembles that of the production of disyllabic words with initial stress. Stage 2 in the production of target words with *final* (main or secondary) stress differs from that of the production of target words with *penultimate* stress in that in the former the child selects an extra syllable from the target word to fill both branches of the foot, while in the latter both branches of the foot are already filled at stage 1. At stage 3 the child discovers that the target word consists of more than one foot: the child realises two feet. However, main stress is only learned at stage 4. Therefore, at stage 3 both feet receive equal stress. At stage 4 main stress is assigned to one of the foot. In general, main stress is assigned to the first branching (disyllabic) foot from the right, resulting in penultimate main stress in the child's production of trisyllabic adult target words with penultimate stress.

6.5.4. Target words with more than three syllables

Finally, the analysis given in section 6.4 and in the sections above also makes predictions for words longer than three syllables. These words are very infrequent in child language; however, they do occur. Let us have a look at them.

Target words with more than three syllables and penultimate stress are predicted to show a pattern similar to the trisyllabic words with medial stress (section 6.5.3). At stage 1 a (disyllabic) foot at the right edge is prosodically circumscribed, the segmental material of this foot is selected, and mapped onto a trochaic foot. At stage 2 nothing changes, since both branches of the child's foot template are already filled. At stage 3 the child's template is expanded by one foot, and can now contain two feet. Since main stress is not yet learned, both feet receive an equal amount of stress. In sections 6.5.1 and 6.5.2 we saw that there are two possibilities for the realisation at stage 3 of trisyllabic target words with final (main or secondary) stress. However, this possibility does not exist for target words consisting of four syllables contained in two feet. Therefore, at stage 3 the child's production form consists of four syllables which are contained in two feet. At stage 4 one of the feet of the word receives main stress. As predicted, the first branching foot from the right edge (the final foot in this case) receives main stress. Examples are given in (61)–(64):

(61) *Enzo*

a. STAGES 1/2

helicopter	/ˌheːliːˈkɔptər/	→	[ˈkɔptɛ]	(2;1.17)

b. STAGE 3

helicopter	/ˌheːliːˈkɔptər/	→	[ˈhɛijəˈkɔptə]	(2;2.14)

c. STAGE 4

helicopter	/ˌheːliːˈkɔptər/	→	[ˌheːləˈkɔptɛ]	(2;3.14)

(62) *Tirza*

a. STAGES 1/2

helicopter	/ˌheːliːˈkɔptər/	→	[ˈkɔpɪs]	(1;11.19)
televisie	/ˌteːləˈviːsiː/	→	[ˈsiːsiː]	(2;0.18)

b. STAGES 3

televisie	/ˌteːləˈviːsiː/	→	[ˈʃɛmə͡ˈtsiːsiː]	(2;1.17)

(63) *Noortje*

a. STAGES 1/2

limonade	/ˌliːmoːˈnaːdə/	→	[ˈmaːmɑu]	(2;3.7)

b. STAGE 3

limonade	/ˌliːmoːˈnaːdə/	→	[ˈmiːmoːˈmaːtə]	(2;8.15)

c. STAGE 4

limonade	/ˌliːmoːˈnaːdə/	→	[ˌmiːmoːˈmaːtɑ]	(2;9.26)

(64) *Robin*

a. STAGES 1/2

televisie	/ˌteːləˈviːsiː/	→	[ˈziːsiː]	(1;5.25)
		→	[ˈfyːΦɪ]	(1;8.24)

b. STAGE 3

televisie	/ˌteːləˈviːsiː/	→	[ˈdɪtəˈfiːsiː]	(2;1.7)
dromedaris	/ˌdrɔməˈdaːrɪs/	→	[ˈdɔməˈdaːləs]	(2;3.22)
limonade	/ˌliːmoːˈnaːdə/	→	[ˈniːləˈmaːlə]	(2;2.27)
macaroni	/ˌmaːkaːˈroːniː/	→	[ˈmaːkɪˈnoːniː]	(2;0.18)

Target words with more than three syllables and final stress are also selected for production by the child. They are treated like the words discussed in section 6.5.1 and section 6.5.2. First, the child circumscribes the final (monosyllabic) foot and maps the segmental content of this foot onto a trochaic template (stage 1). At the next stage an extra syllable at the left edge of the target word is parsed and the segmental content of that syllable is concatenated to the segmental content of the child's previous form; this string is mapped onto the child's trochaic template, resulting in a disyllabic production form with initial stress. At the third stage, the child's template is expanded in such a way that it can contain up to two feet. In principle,

the two options described in section 6.5.1 and section 6.5.2 are possible: however, disyllabic level stress productions are not attested in the data; only trisyllabic level stressed output forms occur. Finally, at stage 4 main stress is assigned. The prediction is that the first branching (disyllabic) foot from the right edge receives main stress, which is confirmed by the data. The data in (65)–(66) give examples of the different stages.[36]

(65) *Noortje*

a.	STAGE 1			
	locomotief	/ˌloːkoːmoːˈtiːf/ →	[tiːf], [piːf]	(2;6.5)
b.	STAGE 2			
	locomotief	/ˌloːkoːmoːˈtiːf/ →	[ˈhoːpiːf]	(2;6.5)
c.	STAGE 3			
	locomotief	/ˌloːkoːmoːˈtiːf/ →	[ˈhɑukɑˈpiːf]	(2;6.5)
d.	STAGE 4			
	locomotief	/ˌloːkoːmoːˈtiːf/ →	[ˈhøːliːˌtiːf]	(2;9.26)

(66) *Tom*

a.	STAGE 1			
	locomotief	/ˌloːkoːmoːˈtiːf/ →	[sliː]	(1;6.25)
b.	STAGE 2			
	locomotief	/ˌloːkoːmoːˈtiːf/ →	[ˈtʉtoːf]	(2;1.14)
c.	STAGE 3			
	locomotief	/ˌloːkoːmoːˈtiːf/ →	[ˈmɑmɑˈt͡siː]	(2;1.14)

6.5.5. Conclusions

The analysis given in section 6.4 makes the correct predictions for the development of longer words. However, the description of the developmental patterns for longer words reveal some more characteristics.

Stage 1. At stage 1 the child selects the rightmost foot and maps the segmental content of that foot onto a quantity-insensitive trochaic foot template. If the adult target word has (main or secondary) stress on the final syllable, only the final (monosyllabic) foot is parsed. The child does not parse the foot with main stress, but the rightmost foot which either has

[36] Unfortunately, there were not many polysyllabic words selected for production. However, the data in (65) are very important because they show a 'regression': initial stress > level stress > initial stress again, even though the target word has final stress. This clearly shows that the child is not just gradually coming closer to the target, but that the process involves the learning of parameter settings. See also chapter 7.

main or secondary stress.[37] Since a quantity-insensitive trochaic template consists of a strong syllable followed by a weak one, an additional syllable is sometimes added to fill both branches of the foot, as for example in some of the data in (33). If the adult target word has penultimate stress the segmental content of the final disyllabic foot is selected and mapped onto the child's trochaic template. No addition of syllables is attested in these cases. Finally, if the target word consists of three syllables with main stress on the initial syllable and with no secondary stresses, one of the unstressed syllables is deleted, since the child's template can only accommodate two syllables (54).

Stage 2. At the second stage, the child's template does not change: it is still a quantity-insensitive trochaic foot. In those cases in which the parsed foot is monosyllabic, the child circumscribes the leftmost syllable of the adult target, concatenates the segmental content of that syllable to the segmental content of the child's previous form and maps this onto a trochaic template. This results in a disyllabic production with initial stress. If the child's form already consists of two syllables, nothing changes: the production of adult target words with penultimate stress remains disyllabic, as at stage 1. This illustrates that the child's template still consists of one foot.

Stage 3. At stage 3 the child's template can contain two feet. For target words with final (main or secondary) stress there are now two possible realisations in child language: (i) the child can take the segmental content of his or her own previous form and map this onto a two-foot template, resulting in a production form consisting of two monosyllabic feet which have equal stress, since main stress has not yet been learned at this stage; (ii) the child maps the segmental content of the whole adult target word onto his or her new template, resulting in trisyllabic production forms. Both possibilities are attested in child language, the latter as a successor to the first.

The disyllabic level stress production forms again provide evidence for the output-as-input model: the forms can only be explained if the child's previous form is underlying; otherwise an independent syllable deletion rule is required, for which there seem to be no motivation. It seems that deletion only occurs if the child's template cannot accommodate all segmental material of the adult target word. Since we also find production forms consisting of three or four syllables at stage 3, it is clear that the child's template can accommodate all material, and deletion is not expected. If the child's disyllabic level stress stage 3 form is based on the previous stage 2 form there is no deletion involved: the child just maps the segmental content of his or her stage 2 form onto the new two-foot template.

[37] This will be discussed further in chapter 7.

For the production of target words with penultimate stress the child is now able to accommodate an additional foot from the adult target form. There are no data attested in which the child's previous stage is mapped onto a two-foot template, resulting in disyllabic level stress productions. Apparently, the child knows that the foot produced at stages 1/2 is also a foot in the adult target, unlike the foot produced at stage 2 for target words with final stress.

Finally, trisyllabic target words with initial stress and no additional stresses in the word remain realised as one foot. Apparently, the existence of two (or more) stresses in the target word guides the child to expand his or her template. Since additional material is selected from the left edge of the word, the analysis correctly predicts that nothing changes in the production of these words, since the leftmost syllable is already included in the child's production form at stage 1.

A prediction made by the analysis is that extra syllables can now appear to fill the empty weak branches of the feet. If the final foot is monosyllabic, additional syllables appear word-finally, as also shown in section 6.3 and section 6.4; if the prefinal foot is monosyllabic, additional syllables appear word-medially, as in (59). Addition of both final and medial syllables is attested.

Stage 4. At this stage main stress is assigned to one of the feet of the word. We saw in section 6.3 that the child assigns main stress to the rightmost foot in disyllabic target words with final stress. We could hypothesise that the child assigns main stress to the final (rightmost) foot. However, this is not always the case, as we have seen in the previous section. Rather, it seems that the child assigns main stress to the first *branching* (i.e. disyllabic) foot from the right edge of the word. This results in antepenultimate stress in the production of adult target words with final main stress and antepenultimate secondary stress and of those with antepenultimate main stress and final secondary stress, since both types of word end in a monosyllabic foot. Adult target words ending in a branching foot receive main stress on the final foot, resulting in penultimate stress. If there is no branching foot, as in the case of disyllabic target words with final stress, main stress is assigned to the final (rightmost) foot. I will come back to this issue in the next chapter.

Stage 5. Finally, the child has to learn that in some of the produced forms main stress is assigned incorrectly, namely in those words that have final main stress in the adult target forms, but antepenultimate stress in the child's production forms at stage 4. How this is learned will be discussed in the next chapter.

6.6. Segmental changes

In this final section I will briefly discuss segmental changes that occur in the child's truncated forms, as in the example given by Allen & Hawkins (1980) in which *Pinocchio* was produced as ['poːkioː]. Smith (1973) provides similar data, as shown in (67):

(67) *Examples from Amahl* (Smith 1973)

a.	belong	→	[bɔŋ], [blɔŋ]
b.	banana	→	['baːnə]
c.	potato	→	['beːduː]

Although segmental changes like the ones in (67) are sometimes mentioned in the literature, the exact nature of the segmental changes that occur in the process of truncation is generally not accounted for. As described in section 6.1.4, Smith argues that truncation of syllables involves deletion of the unstressed vowel, eventually followed by a cluster reduction rule, which either deletes post-consonantal sonorants, or post-consonantal coronal consonants. Although this would describe most of the data, the nature of the first rule and, moreover, the relation between the two processes remain obscure. By deleting an unstressed vowel, the child creates an intermediate form that hardly ever shows up in the child's production forms. Furthermore, since clusters are generally reduced at the early stages of the acquisition of phonology, the unstressed vowel deletion rule creates a structure which is normally repaired by the child, since this structure cannot be accommodated into the child's template (see chapter 4). The second rule, which deletes post-consonantal sonorants or coronal consonants, consists in fact of two rules: the first one is similar to the cluster reduction procedures, as described in chapter 4, and the second rule deletes post-consonantal coronal consonants. This latter rule is needed to account for (67c).

It is clear that such an account is untenable under the analysis of truncation given in this chapter, since it requires that the whole adult target word is selected for the child's production form, which then undergoes several rules, like the ones given above, creating intermediate structures for which no independent motivation exists. Moreover, at a later stage the child must 'undo' the rule(s), or alternatively learn exactly the opposite rule(s), which is an undesirable result from a learnability point of view. Furthermore, the rules given above are not sufficient to account for all data. First, trisyllabic target words with final (main or secondary) stress are reduced to monosyllables in the child's production; however, they show exactly the same segmental changes as disyllabic target words with final stress. To account for these forms the unstressed vowel deletion rule has to apply twice; however, it also has to apply to stressed vowels. For example, in

Tom's realisations of the target word *pelikaan* /ˌpeːliːˈkaːn/ as [ˈpaːjə] or [paːŋ] the vowel deletion rule must have applied twice: to the first stressed vowel, and to the second unstressed vowel. The resulting cluster /plk/ is then reduced to /p/. Second, Tom's examples also point out that the cluster reduction rule(s) are not sufficient. The post-consonantal sonorant /l/ is deleted by the first rule; however, the rules do not determine which one of the two remaining consonants is deleted. In this respect, Macken's (1979) analysis, to which I turn now, is more specific.

Macken (1979) argues that the child's template determines which syllables are truncated (see section 6.1.4). Her Spanish subject, Si, realised words in such a way as to conform to her template, in which the place specification for the consonants in the word is the following: C_{labial} V $C_{coronal}$ V. Macken describes the process of syllable reduction (truncation) as an operation to delete either the initial syllable(s) or the medial one. She argues that if a trisyllabic adult target word starts with a labial the first syllable is selected, and the medial one is deleted. The examples that she gives to illustrate this process are given in (68a). If the labial consonant is in medial position in the adult target word, the preceding syllables are deleted, as shown in (68b):

(68) *Examples from Si* (Macken 1979)

a.	manzana	'apple'	→	['mãn͡na]	(1;9)
	Fernando	*name*	→	['mano]	(1;9)
	pelota	'ball'	→	['pat͡da]	(1;8.7)
b.	Ramón	*name*	→	[mən]	(1;8.7)
	zapato	'shoe'	→	['pwãt͡to]	(1;8.7)
	elefante	'elephant'	→	['batə], ['pãn͡tɪ]	(1;9)
	librito	'little book'	→	['pɪt͡də]	(1;9)

Macken also notes that Si tends to retain the vowel of the stressed syllable (the penultimate syllable in the target words), indicating that the process is more complex than just syllable deletion. Again, this analysis is untenable under the analysis given in this chapter, because in Macken's description of the process the child does not prosodically circumscribe a foot from the adult target, but, rather, focuses on the segmental structure of the adult target word. Under Macken's analysis the selected segmental material from the adult target need not be contained in one prosodic constituent.

In this section I will argue that the segmental structure of the adult target word may play a role, in that certain features are selected for the child's production along with the selected foot. For the Dutch acquisition data we find that, although in most instances of truncated production forms the foot-initial consonant of the adult target form is realised, there are, however, other options, of which 'assimilation' is the most frequent. That is, in addition to prosodic circumscription of a prosodic constituent, the

segmental content of which is used for the mapping procedure by the child, the child sometimes selects additional segmental material from the adult target word. Examples are given in (69) and (70):

(69) *Total assimilation*

a. *Elke*

konijn	/koːˈnɛin/	→	[ˈkɛ]	(1;10.21)
konijn	/koːˈnɛin/	→	[ˈkɛin]	(2;3.27)

b. *Noortje*

konijn	/koːˈnɛin/	→	[ˈkaːi], [ˈkɛin], [ˈkɛi]	(2;3.21)

c. *Jarmo*

konijntjes	/koːˈnɛint͡jəs/	→	[ˈkɛit͡jəs]	(1;10.23)
ballonnen	/bɑˈlɔnə[n]/	→	[ˈpɔmä]	(2;0.28)
kadootje	/kaːˈdoːt͡jə/	→	[ˈkoːχ͡jə], [ˈkoːʃə]	(2;1.8)
meneer	/məˈneːr/	→	[ˈbeːə], [ˈmeːə]	(2;3.9)

d. *Catootje*

ballon	/bɑˈlɔn/	→	[ˈboːmɪ], [ˈboːmiː]	(1;10.11)

e. *Eva*

ballon	/bɑˈlɔn/	→	[ˈbɔ̃n], [ˈbɔ̃m]	(1;6.1)

f. *Robin*

ballon	/bɑˈlɔn/	→	[ˈbɔmə]	(1;7.13)
		→	[ˈpɔnə]	(1;7.27)
banaan	/baːˈnaːn/	→	[ˈpaːn]	(1;10.7)
ballonnen	/bɑˈlɔnə[n]/	→	[ˈbuːmə]	(1;11.7)

(70) *Assimilation of Place of Articulation*

a. *Elke*

banaan	/baːˈnaːn/	→	[ˈmaːŋ]	(1;8.13)
konijn	/koːˈnɛin/	→	[ˈŋɑɲ]	(1;8.31)
fornuis	/ˌfɔrˈnœys/	→	[ˈmœys]	(2;2.6)

b. *Noortje*

banaan	/baːˈnaːn/	→	[ˈmaːm]	(2;2.22)
konijn	/koːˈnɛin/	→	[ˈŋɛiç]	(2;2.22)
meneer	/məˈneːr/	→	[ˈmɪ]	(2;3.7)
bananen	/baːˈnaːnə[n]/	→	[ˈmaːmə], [ˈmaːnə]	(2;7.17)
meneer	/məˈneːr/	→	[ˈmeːə]	(2;8.29)

c. *Jarmo*

kadootje	/kaːˈdoːt͡jə/	→	[ˈkoːχ͡jə], [ˈkoːʃə]	(2;1.8)
gitaar	/χiːˈtaːr/	→	[ˈkaːi]	(2;1.22)
meneer	/məˈneːr/	→	[ˈmeːə]	(2;3.9)

d. *Eva*

banaan	/baːˈnaːn/	→	[ˈmaːn]	(1;7.15)

It looks as if either a place feature (70) or the whole root node (69) of the word-initial consonant spreads to the foot-initial coronal consonant of the final foot. However, I will argue that the changes in Manner of Articulation (MoA) are context-free changes. If so, both (69) and (70) involve changes in Place of Articulation (PoA).

If we look at the children's output forms two observations can be made: (i) Manner of Articulation (MoA) changes invariably go in the unmarked direction; that is foot-initial consonants are realised as either plosives or nasals; (ii) for Place of Articulation (PoA) the generalisation is that segmental changes occur in the following environment: if the final foot of the adult target starts with a coronal consonant, and the word-initial consonant begins with either a labial or dorsal consonant, the children's production form often contains PoA features of the initial consonant of the target word.

With respect to the first observation, we have seen in chapter 4 that onset consonants are preferably realised as plosives at the initial stages. At a later stage, nasals also appear in onset position (see also appendix D). I therefore argue that, although the cases in (69) seem to involve total assimilation, the changes in as far as MoA are concerned are context-free substitutions, governed by the child's template, just as, for instance, word-initial fricatives are often replaced by stops (see chapter 4). This is confirmed by developmental patterns in the realisation of the foot-initial consonant. The forms in which the foot-initial consonant is realised as a stop precede the forms in which the foot-initial consonant is realised by other manners of articulation. The developmental patterns found in the data of Jarmo, Elke and Robin are given in (71), (72) and (73), respectively:

(71) *Jarmo's developmental pattern for the foot-initial consonant*

a.	STAGE A				
	ballon	/bɑˈlɔn/	→	[ˈpɑmɑ]	(2;0.28)
			→	[ˈtɔnə]	(2;1.22)
	kameel	/kaːˈmeːl/	→	[teːuw]	(2;1.22)
	giraf	/ʃɪːˈrɑf/	→	[tɑp]	(2;1.22)
b.	STAGE B				
	ballon	/bɑˈlɔn/	→	[ˈlɔn]	(2;2.27)
	kameel	/kaːˈmeːl/	→	[meːuw]	(2;3.9)
	giraf	/ʃɪːˈrɑf/	→	[ʀɑps]	(2;4.1)

(72) *Elke's developmental pattern for the foot-initial consonant*

a.	STAGE A				
	telefoon	/ˌteːləˈfoːn/	→	[poːm]	(1;10.7)
b.	STAGE B				
	telefoon	/ˌteːləˈfoːn/	→	[føːm]	(2;1.6)

(73) *Robin's developmental pattern for the foot-initial consonant*

a. STAGE A

televisie	/ˌteːləˈviːsiː/ →	[ˈtiːsiː]	(1;5.25)
banaan	/baːˈnaːn/ →	[paːn]	(1;10.7)
macaroni	/ˌmaːkaːˈroːniː/ →	[ˈmaːˈkuːniː]	(2;0.4)

b. STAGE B

televisie	/ˌteːləˈviːsiː/ →	[ˈfiːsiː]	(1;11.21)
macaroni	/ˌmaːkaːˈroːniː/ →	[ˈmaːkˈnoːniː]	(2;0.18)
banaan	/baːˈnaːn/ →	[ˈnaːn]	(2;1.7)

On the basis of these patterns, and the patterns for the realisation of onsets in chapter 4, I argue that the segmental changes that occur with respect to manner of articulation do not involve spreading of manner features or the root node, but are context-free substitutions, governed by the child's onset template.

Let us now turn to the segmental changes involving PoA. The data in both (69) and (70) are representative for the segmental changes found in the children's truncated forms. The input forms in (69) and (70) share two characteristics: (i) the word-initial consonant is either labial or dorsal, and (ii) the final-stressed foot starts with a coronal consonant. If we look at the children's output forms, we see that all forms start with either a labial or a dorsal; that is, the coronal place of articulation of the target foot-initial consonant is replaced by either a labial or a dorsal one. It should be noted that if the target foot-initial consonant is labial or dorsal no substitution takes place.[38] Thus, no substitution is found in the truncated forms in (74):

(74)

kapot	/kaːˈpɔt/ →	*[kɔt], but [pɔt]	
tomaat	/toːˈmaːt/ →	*[taːt], but [maːt] or [baːt]	
kabouter	/kaːˈbɑutər/ →	*[kɑutə], but [ˈbɑutə]	
telefoon	/ˌteːləˈfoːn/ →	*[toːn], but [foːn] or [poːn]	

This leads to the conclusion that coronal consonants are more prone to place assimilation than labial and dorsal consonants. It has been argued that coronal segments are underspecified for PoA. Because the place node is empty, it is vulnerable to assimilation, which has the effect of filling the empty place node. That the feature [coronal] has a special status in child language, in that it behaves as if it is not present underlyingly, is motivated independently in Fikkert & Levelt (1990), Stemberger & Stoel-Gammon

[38] There are, however, a few cases in which a dorsal is replaced by a labial, as in Tom's production of *pelikaan* /ˌpeːliːˈkaːn/ It is argued in Levelt (to appear) that most children acquire the labial place of articulation much earlier than the dorsal one. Therefore, labials sometimes replace dorsals, but the opposite does not occur.

(1991), Fikkert (1992), and Levelt (1993, to appear), who all argue for the underspecified status of coronals. There is also evidence for the underspecified status of the coronal place specification from adult languages (see the papers in Paradis & Prunet 1991), that is, coronal segments behave differently from labial and dorsal segments.

Suppose that the rightmost foot selected by the child at stage 1 starts with a coronal consonant. On the assumption that coronal segments are underspecified, the first consonant of the child's template has no place feature specification. However, since the child tries to incorporate as much information from the adult target word as possible in his or her template, s/he may select a place feature specification from the word-initial consonant if this consonant, unlike the foot-initial consonant, is specified for place. That the material is invariably selected from the word-initial consonant may reveal something about the saliency of this consonant, or about the bias of children to word beginnings, which becomes characteristic at stage 2.

In principle, if the child's goal had been to fill empty place nodes, s/he could, for example, have spread place features from the stressed vowel of the selected foot to the preceding consonant. These CV interactions are typical of the initial stages in child language (see Levelt 1993, to appear). Although some of the data in (69) and (70) could be explained in this way, many of them cannot be accounted for under a CV interaction analysis.

It could also be the case that the child has a template which is also specified for segmental content. Levelt shows that at the initial stage children prefer words which are completely labial; at the next stage coronal words also appear (see the examples given in (104a, b) of chapter 4). If children realise words with two place specifications they prefer the same patterns as Si, namely, C_{labial} V $C_{coronal}$ (...). Moreover, children seem to avoid dorsal consonants in initial position, especially when the following consonant is either labial or coronal. That is, C_{dorsal} V $C_{labial/coronal}$ (...) output forms are produced very late, much later than for example $C_{coronal}$ V C_{dorsal} (...). If changes occur due to the child's preference patterns, we do not expect that a target form like $C_{coronal}$ V $C_{coronal}$(...) would be changed to the output form C_{dorsal} V $C_{coronal}$ (...). However, these cases are frequently attested. Therefore, although preference patterns (often referred to as 'canonical forms' (cf. Ferguson & Farwell 1975, Menn 1978) or 'word recipes' (Velleman 1992)) account for many of the data in (69) and (70), they are not sufficient to explain all the data. The data in which the initial consonant of the final foot has a coronal PoA, but the child's output form starts with a dorsal are particularly unexpected, since on this account, the realisation of the target word *konijn* /koːˈnɛin/ as [tɛin] or [tɛiŋ] is less marked (acquired earlier) than the often attested form [kɛin].

I therefore propose the following assimilation account: if the foot-initial consonant is a coronal it is prone to undergo assimilation. The condition for

the assimilation rule to apply is the following: if the first onset of the word is marked, that is, it is a labial or a dorsal consonant, and the second onset of the word is unmarked, that is coronal, the rule can apply. The rule involves spreading of the features under the place node.

It is not the case that the child selects the word-initial onset which replaces the foot-initial one, because (i) the assimilation process only occurs when the foot-initial consonant is coronal and the word-initial consonant is either labial or dorsal; and (ii) often, only PoA features assimilate, as in the data in (70), on the assumption that the changes in MoA are not due to assimilation of MoA features; rather these changes are context-independent.

With respect to PoA assimilation, there also seems to be a developmental pattern. Although the data are sparse, the following tentative pattern is observed: the forms in which assimilation of PoA has taken place precede those without PoA assimilation. In other words, coronals become less vulnerable to undergo assimilation in the course of development. The data in (75)–(77) exemplify this developmental pattern:

(75) *Elke's developmental patterns with respect to PoA assimilation*

a.	STAGE A				
	banaan	/baːˈnaːn/	→	[ˈmaːŋ]	(1;8.13)
b.	STAGE B				
	banaan	/baːˈnaːn/	→	[ˈnɑn]	(1;9.24)

(76) *Jarmo's developmental patterns with respect to PoA assimilation*

a.	STAGE A				
	konijntje	/koːˈnɛin͡tʃə/	→	[ˈkɛi͡tʃəs]	(1;10.23)
	ballon	/bɑˈlɔn/	→	[ˈpɑmä]	(2;0.28)
	kadootjes	/kaˈdoːt͡ʃəs/	→	[ˈkoːt͡ʃəs]	(2;1.8)
b.	STAGE B				
	ballon	/bɑˈlɔn/	→	[ˈlɔn]	(2;2.27)
	konijntje	/koːˈnɛin͡tʃə/	→	[ˈnɛitjə]	(2;2.6)
	kadootjes	/kaːˈdoːt͡ʃəs/	→	[ˈtoːt͡ʃəs]	(2;3.9)

(77) *Tirza's developmental patterns with respect to PoA assimilation*

a.	STAGE A				
	konijn	/koːˈnɛin/	→	[ˈkɛin]	(1;11.19)
b.	STAGE B				
	konijn	/koːˈnɛin/	→	[ˈnɛin]	(2;1.2)

To summarise, we have seen that there are two types of segmental changes: (i) changes with respect to MoA, which I have argued to be context-independent substitutions, since these changes are not specific to truncated forms – they also occur in word-initial onsets; (ii) changes with respect to PoA, which I have argued to be the result of an assimilation process in

which PoA features from the word-initial onset in the target word spread to the for PoA underspecified coronal onset of the final foot of the target word. Although some of the data could be accounted for by a CV interaction analysis and/or by assuming that children's segmental templates determine what features are selected (Macken 1979, Levelt to appear), not all data can be explained under these accounts. Also, Smith's analysis, in which first deletion of unstressed vowels and then cluster reduction takes place, has been shown to be untenable.

The data have shown several important facts. First, they show that coronals have a special status. Coronals are, especially at early stages, liable to undergo assimilation. They behave as if they were underspecified, which explains why they adopt place features from other consonants so easily. Second, the data showed that the changes with respect to PoA involve spreading of PoA features rather than replacement of onsets. Third, the data show that assimilation not only takes place within the syllable, or between syllables, but that it can also apply between feet. Fourth, the data also show that the child tries to incorporate as much information as can be contained into the child's template. Besides prosodically circumscribing the final foot, the child may also select features from the residue of the target word: the part of the adult target word that is not selected for production.

Finally, the data given by Smith (67) and Macken (68) are also accounted for by the assimilation analysis: in these data it is invariably the coronal that undergoes assimilation; if changes occur in MoA features, plosives (and nasals) are preferred over other manners of articulation.

7 A Parametric Learning Model for Syllable Structure and Stress

IN THE PREVIOUS chapter I gave a description of the developmental stages found in the acquisition of stress. I showed that stress is not learned lexically, since the stress patterns found in child language differ systematically from those of the adult targets. Furthermore, it was shown that the development is very systematic. It therefore seems justified to assume that acquisition takes place in a more principled way. The hypothesis is that it takes place along parametric dimensions. However, I did not show in chapter 6 how the stages can be related to a parametric learning theory. That is the aim of this chapter. It will be shown that the quantity-sensitivity parameter plays a crucial role in explaining the developmental patterns. The results of chapter 5 on the acquisition of rhyme structure will therefore be important, since it is usually assumed that quantity-sensitivity is defined on the structure of rhymes. It will be shown that acquisition of syllable structure and stress occurs simultaneously.

Parametric learning models of stress have been successfully applied to machine learning (Dresher & Kaye 1990, Dresher 1991, 1992, Gillis *et al.*, 1992a, b, Daelemans *et al.* 1992). That is, it has been shown that parametric theories of stress in principle obey the learnability criterion; they are able to solve the logical problem of acquisition, which can be schematised as in (1), repeated from chapter 1:

(1) *The logical problem of language acquisition*

Learning Theory

DATA ⟷ UNIVERSAL GRAMMAR ⟷ GRAMMAR

However, this is not to say that parametric learning models are also good models for child language acquisition; they do not necessarily solve the developmental problem of acquisition (see chapter 1). I will show that there exist two important differences between machine learners and children. First, the machine learner is a batch mode learner, while children learn incrementally, in the sense that they go through several stages in the acquisition process. However, to a certain extent they resemble batch mode learners. I will come back to this issue in section 7.7. Second, the input that children use differs in important ways from the input the machines are supplied with.

This issue will be addressed in sections 7.3 and 7.6. Nevertheless, the basic principles of the cue-based stress-learning model defined by Dresher & Kaye (1990) provide a good starting point for examining acquisition data.

The organisation of this chapter is as follows. I will focus on the four components of (1). First, I discuss a particular version of metrical theory as part of UG. A brief outline of Dresher & Kaye's assumptions with respect to UG (here restricted to metrical theory) is given in section 7.1. In section 7.2 I present an analysis of Dutch in the framework of metrical theory, largely based on Trommelen & Zonneveld (1989, 1990). This is an example of a possible grammar. In section 7.3 I discuss what the input (the data) for the machine learner is and I will point out the main differences between the input to machine learners and the input used by children. In section 7.4 I describe the cue-based learning model underlying the stress learner in the model of Dresher & Kaye. In section 7.5 the structure of Dresher & Kaye's machine learner is described. In section 7.6 I discuss the stages described in the previous chapter from the perspective of the cue-based learning theory proposed by Dresher & Kaye, taking into account the differences between the input used by children and that used by machine learners. In section 7.7 I summarise the results and propose a model for the acquisition of syllable structure and stress in Dutch, based on the results of chapters 4, 5, and 6.

7.1. Metrical theory as part of UG

Dresher & Kaye convincingly show that a parametric theory of stress considerably restricts the set of possible stress systems (see also Hayes 1981, 1991, among others). Moreover, they show that a parametric theory makes non-trivial claims about the number and nature of possible stress systems. For the learner this means that s/he is faced with the problem of searching a finite space of possible grammars, rather than the more difficult problem of inducing a set of rules that lies at an undetermined point in an infinite hypothesis space (Clark 1992, Clark & Roberts 1993). Learning theory must provide an account of how the learner's search through the set of possible combinations of parameter values takes place, and of how certain values are chosen. However, before turning to learning theory, I will first discuss the basic assumptions underlying the metrical theory that Dresher & Kaye assume.

Metrical theory serves as the representation of UG. Although there are various versions of metrical theory debated in the literature, all current versions share a number of properties (Hammond 1990). All versions assume that stress is best represented hierarchically.[1] Dresher & Kaye

[1] Some versions represent stress by metrical trees only (Hayes 1981, Hammond 1984,

(1990) assume a tree-only model. Metrical structures have the form of labelled trees, where, in any group of sister nodes, one node is labelled strong (s) and the others are labelled weak (w). The way in which a metrical tree is constructed is expressed in terms of a set of binary parameters. All versions of metrical theory assume metrical constituents, although they differ in the exact number and nature of the constituents. Dresher & Kaye assume that the prosodic word is the appropriate domain for word stress. Word stress (or main stress) is determined by the word-tree dominance parameter in (2a.i). In addition I assume an obligatory branchingness parameter (2a.ii).[2] Dresher & Kaye further assume several types of feet, which are defined by the foot-shape parameters (see also Kager, to appear), summarised in (2b). Binary or bounded feet contain two positions, while unbounded feet are not subject to any restrictions on size.[3] Feet can furthermore have the head, the strong syllable, at the left or the right edge of the foot. If the strong syllable is at the right edge of a binary foot it is called an IAMB, while if it is at the left edge of a binary foot it is called a TROCHEE. Feet can be quantity-sensitive (QS) or quantity-insensitive (QI); that is, they may or may not be sensitive to whether syllables are heavy. In QI stress systems, syllable weight has no consequences as to the location of stress, while in QS systems, syllable weight plays a crucial role in that heavy syllables are stressed, and unstressed syllables are light.[4] Dresher & Kaye use the Rhyme/Nucleus parameter, 'feet are QS to the [Rhyme/Nucleus]',[5] to determine the weight of syllables. In this chapter I show that the Weight parameter, proposed in chapters 3 and 5, is better fitted to describe both the Dutch acquisition and adult Dutch data than the Rhyme/Nucleus parameter.

All versions of metrical theory assume parameters of directionality, iterativity and extrametricality. These can be subsumed under the parameters

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Giegerich 1985); some represent stress by metrical grids only (Prince 1983, Selkirk 1984b); and some variants use both trees and grids to represent stress (Liberman 1975, Liberman & Prince 1977, Hayes 1984, 1985, Halle & Vergnaud 1987a, b). I will not discuss the various alternatives, and basically assume a tree-only model, to ease the comparison with the Dresher & Kaye model, in which a tree-only model is also assumed.

[2] In section 7.6.4, I will give arguments for the obligatory branchingness parameter, which applies to the foot receiving main stress.

[3] However, recent theoretical considerations have annulled the status of the unbounded foot as a primitive, removing parameter (2b.i). To explain the gap that prosodic templates do not appear to exceed the size of a binary foot, Prince (1986) proposed to reduce unbounded feet to binary feet expanded by stray syllable adjunction. See (Kager, to appear) for a discussion of the considerations.

[4] Light syllables can be stressed if they are in the strong position of the foot. However, unlike heavy syllables they can be unstressed.

[5] Dresher & Kaye assume that [Rhyme] is the default value. However, this is an arbitrary decision — there is no principled reason for it. Moreover, neither value is correct for Dutch. However, the parameter is needed for other languages.

of foot construction, given in (2c). Parsing syllables into feet can be from right to left or from left to right. Feet can be constructed iteratively or non-iteratively. That is, either the string of syllables is fully parsed into feet, or only one foot is parsed at one edge of the domain. Furthermore, a syllable at either the right or the left edge of a word can be extrametrical. The extrametricality parameter (2c.ii) is used for 'early' extrametricality only (as in Dresher & Kaye's model); i.e., the (early) extrametricality parameter determines whether there is a peripheral syllable that does not take part in the foot-building procedures. As we will see below, Dutch does not have early extrametricality, but it has 'late' extrametricality. However, late extrametricality can be captured equally well in terms of an 'obligatory branchingness' parameter which is part of the word-tree dominance parameters, as will be argued in section 7.6.4.

Furthermore, destressing plays a role in all versions of metrical theory. Dresher & Kaye assume the defooting parameter in (2d). The underlined values are the settings relevant for Dutch (see Trommelen & Zonneveld 1989, 1990 and Gillis *et al.* 1992a, b). This will be elaborated on in the next section.

(2)

a. **Word-tree dominance parameters**
   (i) *Main stress parameter*
   The word-tree is strong on the [Left/<u>Right</u>]
   (ii) *Obligatory branchingness parameter (OB parameter)*
   A foot receiving main stress must be branching [<u>Yes</u>/No]

b. **Foot-shape parameters**[6]
   (i) *Binary/Unboundedness parameter (B/U parameter)*
   Feet are [<u>Binary</u>/Unbounded]
   (ii) *Headedness parameter*
   Feet are strong on the [<u>Left</u>/Right]
   (iii) *Quantity-Sensitivity parameter (QS parameter)*
   Feet are quantity-sensitive (QS) [<u>Yes</u>/No]
   (iv) *Weight parameter*
   Closed syllables are heavy [<u>Yes</u>/No]

c. **Parameters of foot construction**
   (i) *Directionality parameter*
   Feet are built from the [<u>Right</u>/Left]
   (ii) *Extrametricality parameter (EM parameter)*
   There is an extrametrical syllable [Yes/<u>No</u>]
   (iii) *Edge of extrametricality parameter (EoE parameter)*
   The extrametrical syllable is on the [Right/Left]
   (iv) *Iterativity parameter*
   Feet are non-iterative [Yes/<u>No</u>]

d. **Defooting parameter**
   A weak foot is defooted in clash [No/<u>Yes</u>]

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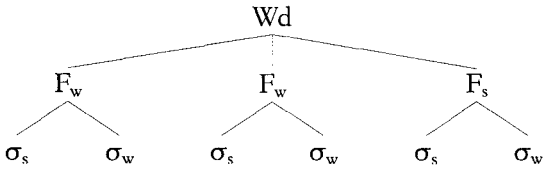
[6] Dresher & Kaye also give the following parameter:
Obligatory branchingness parameter
A strong branch of a foot must itself branch [Yes/<u>No</u>]
This parameter plays a role in languages that have ternary or unbounded feet. However, this parameter has no relevance for Dutch. I assume that the default value is no, and that nothing in the data triggers setting to the marked value. I will not discuss this parameter further.

These are the basic parameters that I assume to be part of the metrical theory.[7] The set of parameters slightly differs from the set proposed in Dresher & Kaye. The stress systems of most languages can be described in terms of a specific configuration of parameters values. I will illustrate the effects of these parameters for Dutch, largely based upon the analysis of Trommelen & Zonneveld (1989, 1990).[8]

7.2. A metrical analysis of Dutch stress

In Dutch, syllables are first (exhaustively) grouped into feet, and then a word-tree in constructed on the feet. Every foot receives a stress; hence languages with feet, such as Dutch, also exhibit secondary stress. This is schematically represented as (3):

(3) *Metrical tree*



where Wd = Word, F = Foot, σ = Syllable, s = Strong, and w = Weak

Main stress in a word is controlled by an unbounded word-tree, in which the rightmost node is labelled Strong in Dutch (Main stress parameter), as shown in (3). (3) also shows that feet are maximally binary (B/U parameter), that feet are strong on the left (Headedness parameter) and that feet are built iteratively (Iterativity parameter). The parameter of directionality stipulates that feet are built from right to left. When the word contains an uneven number of syllables, the remaining (leftmost) syllable constitutes a monosyllabic foot, which is defooted (Defooting parameter), and therefore not labelled; I use the convention of representing a non-labelled foot by a dot in the tree.[9] When a path of s-nodes is followed, main stress is assigned to the correct syllable, the penultimate syllable. Examples are given in (4):

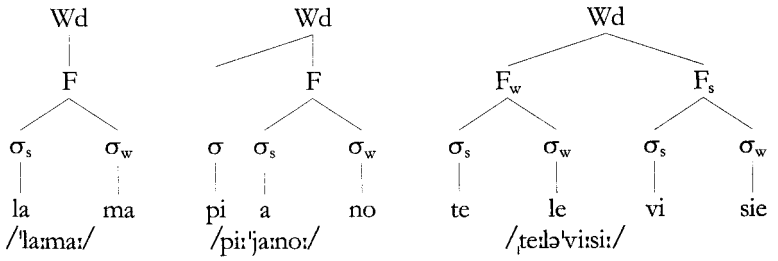
---

[7] Although this set of parameters is not able to characterise all stress systems, many stress systems can be captured.

[8] Gussenhoven (1992) gives a comprehensive overview of the different analyses of Dutch stress. Trommelen & Zonneveld (1989) also give a summary of pre-metrical analyses of Dutch stress.

[9] This foot is adjoined to the following foot by 'stray adjunction'.

(4) *Examples of metrical trees*

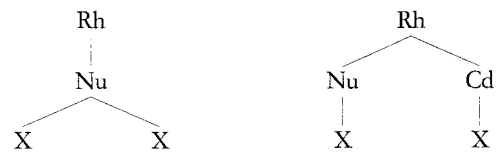


where '.' indicates defooting

According to analyses of the Dutch stress system within the framework of metrical phonology, stress on the penultimate syllable is taken to be the unmarked case. However, final and antepenultimate syllables are also eligible for stress assignment. In order for stress to fall on these syllables the parameters referring to quantity-sensitivity (QS parameter and weight parameter) and extrametricality (EM parameter and EoE parameter) become relevant.

Dutch is a quantity-sensitive language (QS parameter). In quantity-sensitive languages stress assignment is sensitive to the weight of syllables. It is generally assumed that metrical structures are built on the rhyme structures of syllables. Onsets do not play a role in stress assignment. We have already seen that in Dutch the representation of syllable structure cannot reflect both quantity and length by the same means (chapter 3). More specifically, vowel length does not contribute to weight. Therefore, it is assumed that directly branching rhymes count as heavy, but branchingness under the nucleus does not contribute to weight. Although this is not unproblematic for several reasons, let us for the moment assume that Dutch adopts a notion of weight in which syllables containing rhymes that directly branch into a nucleus and a coda count as heavy (Rh/Nu parameter). Given the fact that Dutch has minimally and maximally bipositional rhymes, there are only two basic types of rhymes, as in (5), where (5a) is light and (5b) is heavy:

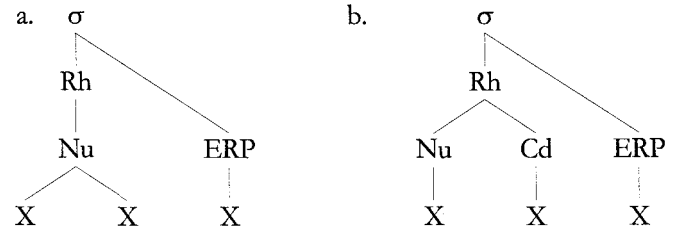
(5) a. *Light syllable* b. *Heavy syllable*



where Rh = Rhyme, Nu = Nucleus, Cd = Coda and X = skeletal position

However, we have seen that word-final syllables can be augmented by an extrasyllabic consonant. This results in what are usually called 'superheavy' syllables. Thus both rhymes in (6) make a syllable superheavy, though (6a) does not have a coda.

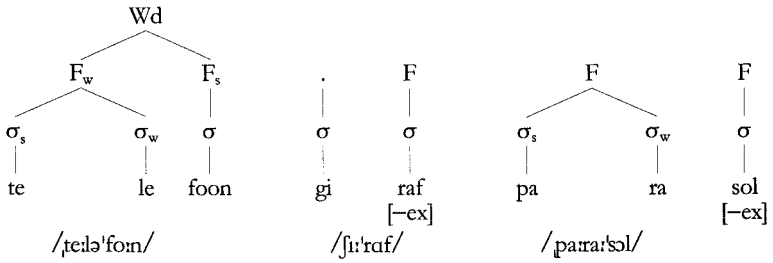
(6) *Superheavy syllables*



where ERP = Extrarhymal Position

(Super)heavy syllables cannot occupy the weak branch of a foot. They occur in the strong branch of a foot, and are thus by definition stressed. The generalisation with respect to quantity-sensitivity in Dutch seems to be that closed syllables count as heavy.[10] Examples are given in (7)[11]:

(7) *Final stress*



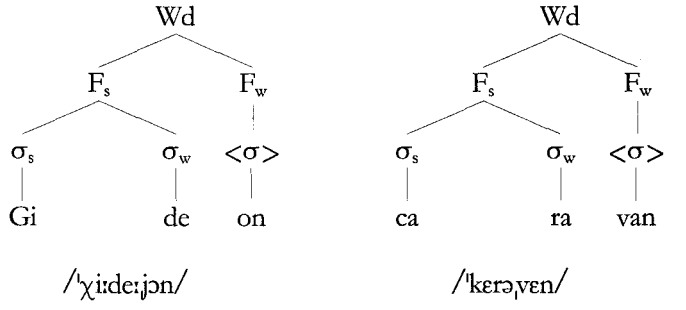
According to Trommelen & Zonneveld (1989, 1990) Dutch requires the setting [Yes] for the EM parameter. They assume that every word-final bipositional rhyme is extrametrical (EoE parameter is set to [Right]). In other words, there is an extrametrical syllable on the right. That is, all final syllables are extrametrical, except the 'superheavy' syllables. Usually, extrametrical syllables do not take part in foot formation. However, Dutch has the idiosyncratic property that final syllables are made extrametrical *after* foot formation. This is referred to as 'late extrametricality' (Lahiri &

[10] Dresher & Kaye assume that languages that are QS on rhymes treat both VV and VC rhymes as heavy; they do not make a distinction between directly branching (in the case of VC) and indirectly branching (in the case of VV) rhymes. Languages that are QS on nuclei treat VV as heavy and VC as light. It is clear, however, that these two distinctions are not able to capture the kind of QS found in Dutch. I will come back to this problem in section 7.6.

[11] I have not drawn a word-tree in the latter two examples. The reasons for not doing so will become clear shortly. The latter two examples are assumed to form exceptions to the regular stress pattern of Dutch in current analyses, rather then form regular cases. Nevertheless, they illustrate the point made in the text.

Koreman 1988, Kager 1989, Trommelen & Zonneveld 1989, 1990).[12] It therefore only affects the location of main stress, which can be placed on the second foot from the right edge of a word, in case the final foot is extrametrical. This results in antepenultimate stress in the examples in (8):

(8) *Antepenultimate stress*



where < > indicates extrametricality

Extrametricality only has an effect on the placement of word stress if the final syllable forms a foot on its own. Whether the final syllable is made extrametrical or not in the examples in (4) does affect the placement of word stress, since the strong syllable of the final foot is not made extrametrical, and thus receives stress.[13]

The parameters discussed so far describe the basic stress pattern of Dutch. However, there are exceptional cases which are not captured by the parameter settings. There are three ways in which lexical variability in stress patterns can be captured: (i) by means of lexical stress on final or prefinal light syllables, marked [+F],[14] and (ii) by lexical markings for the value for the EM parameter, marked [–ex], and (iii) by both lexical stress and extrametricality. The last two examples of (7) are examples of the second type of exception. In these words, the final syllable is marked as an exception to extrametricality. Therefore, stress is on the final syllable in these words.

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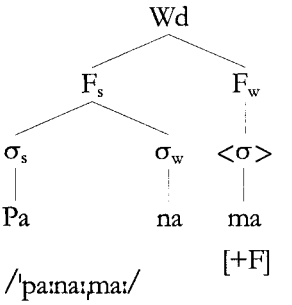
[12] In earlier literature this phenomenon was not captured by (late) extrametricality, but by the Lexical Category Prominence Rule (LCPR): " Label the right/left node strong iff it branches" (Hayes 1981, van der Hulst 1984, among others).

[13] Lahiri & Koreman (1988) adopt a different version of extrametricality: they assume that a final monosyllabic foot is marked extrametrical. That is, it is not the final syllable, but a final monosyllabic foot which is made extrametrical. However, I will argue in section 7.6.4 for an obligatory branchingness parameter instead of a (late) extrametricality parameter.

[14] Nouveau (1992) assumes that lexical stress can only be placed on final light syllables, and that cases in which the prefinal light syllable is apparently stressed have to be reanalysed as having lexically specified consonant extrametricality. Words like *Honduras* /ˌhɔnˈduːˌrɑs/, which are traditionally analysed as having the second syllable marked for [+F], are analysed with a final extrametrical consonant by Nouveau.

Examples of the first type of exception are given in (9):

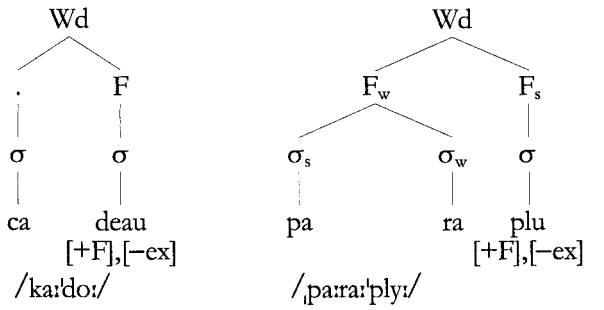
(9) *Lexical marking of stress*



Words like the one in (9) have a lexically marked foot on the final light syllable. This syllable is subject to extrametricality and hence cannot be eligible for word stress. Therefore, word stress is assigned to the strong branch of the second foot from the right, resulting in antepenultimate stress.

Examples of the third type of exception are given in (10):

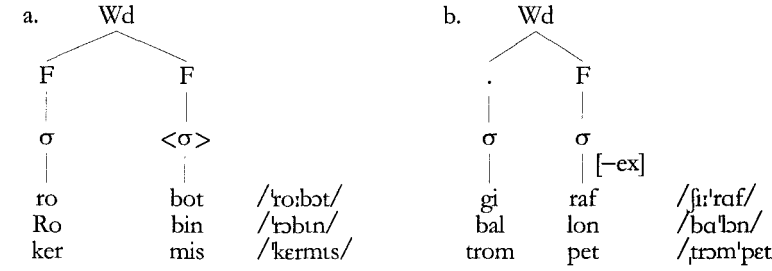
(10) *Lexical marking and exceptional marking for extrametricality*



These words have a lexical foot on the final light syllable, which is also marked as an exception to extrametricality. Therefore, stress is placed on the final syllable.

The analysis presented here has the consequence that disyllabic words with a closed final syllable are analysed with an extrametrical final syllable, and therefore stress is on the penultimate syllable. Disyllabic words with final stress are exceptional in that they do not have a final extrametrical syllable. Thus, the words in (11a) are considered regular, and those in (11b) exceptional. This will be important in the discussion of the patterns found in child language.

(11)



Late extrametricality has to apply before destressing takes place. Otherwise, the first syllable of the words in (11a) would be defooted, resulting in final stress. The first syllables in (11b) undergo defooting, as shown in the representation.[15]

7.3. The input to the learner

In the previous section I described the parameters that are assumed to be part of UG (section 7.1) and I gave an example of a possible grammar, Dutch, in section 7.2. These form two of the four components of the schematised representation of the logical problem of language acquisition. The third component is formed by the data, or the input to the learner. I first describe the form of the input to the machine learner and discuss the differences between the form of the input machine learners are supplied with and the form of the input children use (section 7.3.1). Subsequently, I focus on the manner in which the machine learner uses the input and compare this to the manner in which children use the input (section 7.3.2).

7.3.1. The form of the input

Above we saw that metrical structure is built upon syllable structure. For quantity-sensitive stress systems, syllable structure contains crucial information for foot-building procedures. Therefore, Dresher & Kaye assume that the data go through several stages of pre-processing before they become the input to the stress-learning system. They assume that the data are segmented and syllabified. Moreover, they assume that the degree of stress is indicated

[15] A different analysis of the forms in (11a) is possible on the assumption that there is a minimal word constraint in Dutch. The result of extrametricality in disyllabic words is a monosyllabic foot. As long as this is a heavy foot it still constitutes a minimal word. However, in the case that the resulting foot consists of a light syllable, the minimal word constraint is violated. This problem can be solved by marking just the final consonant of the word as extrametrical. The result is then a bisyllabic foot with two light syllables (see footnote 14).

in the data. The data relevant to learning word stress consist of words with vowels marked as bearing main stress (2), secondary stress (1) or no stress (0). Some sample forms are given in (12):

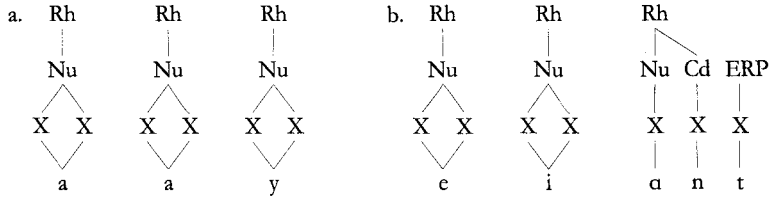
(12) *Sample input data*

a. pa1raoplu2 /ˌpa:raˈply:/

b. le1dioka2nt /ˌle:diːˈkant/

However, these forms do not yet represent the input to the stress learner. The first step in the analysis of the input data in (12) involves the parsing of the word into syllables by the syllable parser. The parser analyses the syllable as containing an onset and a rhyme. Since onsets do not contribute to weight, the input relevant to stress consists of rhyme structures only. Thus, the words in (12) will receive the following structure:

(13) *Rhyme projections*[16]



The structures in (13) also constitute the input to the machine stress learner. The question is whether the same kind of structure constitutes the input to the child who is learning the stress system of the language of his or her environment.

From the discussion of the development of onsets (chapter 4) and rhymes (chapter 5), we may conclude that children do not necessarily have a complete representation of the adult words in terms of syllable structure. One could entertain the hypothesis that stress parameters cannot be fixed before syllable parameters are fixed. If this hypothesis is confirmed by the data, than the data that serve as input to the child could in principle have a structure similar to the input to the machine learner. It is more likely, however, that the acquisition of syllable structure and stress takes place simultaneously, in which case the input may be subject to change, dependent on the setting of syllable parameters.

Another difference, as we saw in chapter 6, is that children at the initial stages of acquisition have not fully parsed the input. They parse out part of the adult structure if the whole word is 'too long' to fit into the children's template. The parsed part of the target is mapped onto their word template.

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[16] I will argue that the syllable minus the onset constituent forms the input, rather than the rhyme structures. In this way the extrarhymal position also plays a role. It will be shown that children regard closed syllables as heavy (see section 7.6.3).

The machine learner lacks this kind of creativity; the whole input string is parsed, and mapping does not play a role. Moreover, we have seen that the input is not fixed: children's own forms may serve as input (the 'output-as-input' model); these forms are subject to change, hence the input to children is not completely fixed.

Finally, it is unclear whether children encode the acoustic representation of stress into three degrees of stress. It might be the case that children initially only distinguish stressed from unstressed syllables. They certainly do not reduce syllables or vowels to schwa (see chapter 5). We have also seen that at stage 3 in the acquisition of disyllabic final-stressed words children realise both syllables with equal stress: they do not seem to represent main stress differently from secondary stress in such words, nor have they fixed the destressing parameter.

7.3.2. Incremental versus batch mode learning

Another point regarding the information that is available to the learner is the following. The learner could be an INCREMENTAL learner: data are processed by the learner one at a time. That is, the learner has only access to the 'current' word and to knowledge of the parameters set so far. Such a learner cannot make use of indirect negative evidence, since s/he will never know whether s/he has encountered all relevant data. On the other hand, the learner could also be a BATCH MODE learner: such a learner gathers input forms for some fixed interval, in which all forms are processed at once. This learner has access to previous encountered forms. S/he is able to notice that two words have the same number of syllables, but different stress patterns. Such information is not available to a strict incremental learner. A batch mode learner can in principle make use of negative evidence; on the assumption that s/he has encountered all relevant data, the lack of a cue in the data can be used for setting parameters. An incremental learner does not have this possibility, but can only make use of positive evidence. A batch mode learner incorporates the idealisation of instantaneous acquisition (Chomsky & Halle 1968). For the child this means that there is a latency period in which s/he stores input data without analysing them.

Incremental learning is more constrained than batch mode learning, since any cue available to the former is also available to the latter, but not vice versa. Dresher & Kaye, however, assume a batch mode learner, because some of the cues associated with the parameters are defined in such a way that the learner must be able to make cross-word comparisons. Another difference is that their batch mode learner has received all relevant information and is thus able to fix all parameters at once. I will show that to a certain extent the child is a batch mode learner. The child does not

seem to be a strict incremental learner, in the sense that s/he only has access to the current word. It will further be shown that children do not use all information available in the data from the start, but wait with using certain information until s/he is 'ready' for it. This means that not all parameters have to be fixed at once.

That the child is able to make cross-word comparisons at an abstract level is evident from the way in which children organise their early lexicon. All words produced by the child at the initial stages of acquisition show certain 'preferred' or 'canonical' segmental and prosodic patterns (Waterson 1971, Ingram 1974, Menn 1978, Macken 1979). Levelt (1993, to appear), for example, shows that Dutch children have a tendency either to select only words that have a certain structure, or to alter adult target forms in such a way that they conform to a certain structure. She shows that at initial stages of acquisition children only have forms that have a labial pattern, that is, consist of labial consonants and round vowels. At the following stage words with coronal patterns are also produced: these words have coronal consonants and front vowels (see chapter 4 (104) for some examples; also Fudge (1969) and Stoel-Gammon (1983) for similar observations). Children are thus able to select certain words and to place words into certain categories.

A strictly incremental learner can only make reference to the 'current' word, and does not have information about previous words. However, we have seen in chapter 6 that children may use their own output forms as input. This implies that the child has access to more information than just the 'current' word, and thus that learning is not strictly incremental, but involves at least some kind of batch mode learning as well. It also shows that children learn not only when they are actually using language (on-line processing), but also when they are not confronted with new data (off-line processing) (Bowerman 1982, 1987, Elbers 1991, 1993). If children make use of off-line processing they may (unconsciously) compare forms so that regularities are extracted even when not confronted with new data. This is implicit in the 'output-as-input' model. However, unlike what is often assumed for a machine learner, the child's memory is far from perfect. Examples to illustrate this are common in the literature. For example, it is often mentioned that children may imitate words almost correctly. These initially correctly imitated forms may also be produced correctly in spontaneous speech for some time (stored representation). However, at a later stage these words are often produced far less correctly, since these forms are now produced according to the child's grammar at that point in the development (Priestly 1977). If memory were perfect, this is unexpected. Rather, children seem to have an imperfect or selective memory in the sense that they only keep the generalisation they have made, e.g., the generalisation that a word has a labial pattern.

After this sketch of the data, grammar and UG, let us now turn to the principles underlying a cue-based learning theory.

7.4. A cue-based learning theory

A learning theory has to provide an answer to the question of how the learner is able to fix the parameter values of the language L_i being learned (a particular grammar G_i), given UG (the metrical component) and the data of language L_i (the input). Dresher & Kaye assume that in the initial state S_0 all parameters have the default (unmarked) value. Parameters can be set to the marked value in the course of development on the basis of evidence in the data. Dresher & Kaye assume a deterministic learner, rather than a non-deterministic one (see section 7.4.1).

If all parameters have the default value at stage S_0, this poses the following question. What is the default value of each parameter? If parameter setting takes place on the basis of evidence in the data the question of what constitutes the evidence must be answered. In other words, which aspects of the data (or which cues) are relevant to which parameters? Both questions are addressed in section 7.4.2.

7.4.1. Deterministic versus non-deterministic learners

In terms of learning strategies, learners can be divided into two classes: DETERMINISTIC and NON-DETERMINISTIC learners. The assumption underlying the cue-based model is that learning is deterministic. This means that there is no backtracking and no structure destroying. Suppose the learner has already fixed some of the parameter values and that this learner encounters data that do not fit in with these fixed parameter values. If the learner were non-deterministic, s/he could backtrack to the lowest decision point and start parsing from that point on to find another possible configuration of the parameter settings which is compatible with the new data (as well as the previous data). The learner would then be able to erase previous settings and start all over again. This strategy is not available to a deterministic learner.[17] Once a parameter is fixed it cannot be changed. Moreover, the learner is unable to go back to the point at which these new data are incompatible with the fixed parameter values, since this would involve undoing parameter settings. The learner now has to try to find a cue in these new data which triggers the setting of parameters which are not yet fixed and which are compatible with the new data. Alternatively, these forms would have to be marked as exceptions. Below I will illustrate how this might work in language acquisition. It will be shown that this might

[17] In their framework Dresher & Kaye have to suspend the constraint against retreating from a marked value in the case where the default value of a parameter depends on the setting of another parameter. This will be illustrated below.

create errors in previously correctly produced forms.[18] A deterministic learner of this type is error-driven in the sense that the learner changes a hypothesis just in the case there is evidence that the hypothesis is incorrect. This will occur when the output created by the learner does not match the input. A deterministic learner is data-driven to the extent that changes (at its initial stage) are triggered by data from the input. The hypothesis is that errors made by a deterministic learner can only be the result of parameters which are not yet fixed, assuming that at the final stage S_s (steady state) all parameters are correctly fixed. A non-deterministic learner is driven by 'knowledge' or by a fixed agenda rather than by data. That is, s/he computes all possible configurations of parameter settings and selects the one that accounts for all data. The data are only relevant to the extent that they indicate failure or success. Such a learner can always retreat from 'wrong' settings of parameters, since s/he can always select another configuration of parameter settings and banning the previous configuration. Such non-deterministic models have been proposed (Gillis *et al.* 1992a, b). However, it is not easy to formulate a testable hypothesis for the acquisition process.

The possible learning paths are thus highly restricted for a deterministic learner, since, once a parameter is fixed, it may not be changed. However, the choice of the initial unmarked parameter values is crucial; furthermore, it is important to ensure that parameters are fixed correctly from the start, since fixing a parameter in the wrong setting is fatal. Therefore, the learner should be prevented from, for example, fixing a parameter on the basis of exceptional data. S/he should also be prevented from fixing parameters that are dependent on other parameter values prior to the parameters on which they are dependent. Cross-parameter dependencies are especially tricky for an incremental mode learner: since the evidence for the marked value of a parameter P_j, which is dependent on the value of another parameter P_j, may be presented first in the data, the fixing of parameter P_i can occur before the fixing of parameter P_j. This, however, may lead to crucial errors from which the learner cannot retreat. To prevent the learner from resetting parameters, s/he must, in some sense, be aware of the potential effects of parameter settings. Clark (1992) argues that to supply the learner with this kind of awareness is too costly, since the hypothesis space is increased drastically when cross-parameter dependencies are taken into account. One way to overcome this problem is to assume that parameters are fixed in a specific order, and that 'early' parameters have to be fixed before 'later' parameters can be fixed. By ordering the parameters, UG is assumed to have more information, since it not only contains a set of principles and parameters, but also contains statements about the order in which

[18] This illustrates the imperfect memory of children.

parameters have to be fixed. This solution is adopted in the model proposed by Dresher & Kaye. Alternatively, one could relax the constraint against retreating from marked parameter values by assuming that any time a parameter value changes, all parameters which depend on it are set into their default values. We will see below that parameters seem to be fixed in a specific order in both child language acquisition and in machine learning.

Dresher & Kaye mention three reasons for considering deterministic systems to be more interesting models of phonological acquisition than non-deterministic ones. First, deterministic models may reveal how stress systems are organised, whereas non-deterministic systems do not reveal such information, since the organisation of stress systems is irrelevant to these systems: they simply search through all possible stress systems. Second, deterministic learners may trace idiosyncratic properties of stress systems that may not be foreseen in the parameter settings. Failure may guide the learner in further efforts to acquire the stress system. Non-deterministic learners would simply fail when they encounter idiosyncratic properties. I will show below that children are indeed able to trace idiosyncratic properties and to deal with them in a systematic way, namely as exceptions to the stress system. Third, we will see in the next section that each parameter can be associated with a cue. The existence of appropriate cues in the data would be accidental in non-deterministic systems; moreover, non-deterministic systems do not make use of these cues at all, while deterministic systems can only operate on the basis of appropriate and robust cues in the data. Let us now discuss the properties and nature of these cues.

7.4.2. The cues

Ideally, the observed stress patterns of the language are exactly those that follow from the parameter settings of its stress system. However, languages often have idiosyncratic properties. To ensure that parameters are not set on the basis of exceptional data, Dresher & Kaye assume a principle of ROBUSTNESS, which is given in (14):

(14) *Principle of robustness*
Core parameters must be learnable despite disturbances to the basic patterns caused by opacity, language-specific rules, exceptions, etc.

The learner has to be protected from conflicting information in the data. Dresher & Kaye implement two ways of filtering the input from conflicting data. One is by proposing a buffer which filters infrequent exceptional forms; the other is by stipulating that exceptions invariably go in the

unmarked direction. Both ways of filtering the data are discussed below.

Dresher & Kaye propose a model in which each parameter has an accompanying counter associated with it (the classifier, see below). When the learner encounters a cue for the marked value of a certain parameter, this does not trigger a permanent change in the parameter setting; rather the counter associated with the parameter is incremented (activated) until a certain saturation point is reached. At this point the parameter associated with the counter is set. As long as exceptions are infrequent they do not affect the setting of parameters.[19]

Dresher & Kaye entertain the hypothesis that exceptions invariably go in the unmarked direction. That a deterministic (incremental) learner requires that unexceptional data must drive him or her to the marked value for some parameter can be seen as follows. The learner may encounter the unexceptional forms first, and set the parameter to its marked value. When the learner now encounters an exception, the parameter has already been fixed, and these exceptions are thus detectable, since they are incompatible with the current setting. In the case where the unexceptional data require the unmarked setting, exceptions could trigger the setting of the parameter to the marked setting. This would require the learner to retreat from this parameter value to arrive at the final stage, which requires the unmarked setting. This is problematic on the assumption that learning is deterministic. The learner could also encounter exceptions before the regular cases. On the assumption that exceptions go in the unmarked direction no parameter will be set to the marked value. When the learner subsequently encounters the regular data, s/he receives evidence for the marked setting. Exceptions are now incompatible with the current parameter settings and therefore the learner is able to mark them as exceptions. If the exceptions had required the marked setting, the learner would have to mark the regular cases which require the unmarked setting as exceptions.[20] I will show that the child language data provide some support for the hypothesis that exceptions go in the unmarked direction (section 7.6.4).

To formalise a deterministic learning system each parameter must come with a description of a trigger (the cue for which the learner is looking). Let

[19] Dresher & Kaye assume that short words (monosyllabic or disyllabic words) do not affect the configuration of parameter values, since all stress systems converge at monosyllabic forms, and any disyllabic stress pattern is derivable from an impressive number of configurations of parameter settings. Given a choice, these systems will assume the least marked counter compatible with the form in question. However, I will show that children *do* fix parameters on the basis of short words; they simply have no access to many long words, and they certainly do not produce long words at the initial stages of acquisition.

[20] Exceptions are often stated as exceptions to certain parameters. When exceptions are marked by the learner as such, the learner may try to detect which parameter determines the exceptionality. That is, these forms are again input to the stress learning component.

us now return to the question of what the cues in the data are that can serve as positive evidence to the learner, on the basis of which parameters can be set to a particular value. Each parameter must be associated with a specific cue or set of cues. The presence of some cue in the data serves as a trigger for setting its associated parameter. Dresher & Kaye assume the APPROPRIATENESS principle, which requires that there exist principled relations between the parameters of UG and their cues. This principle is stated as follows:

(15) *Principle of appropriateness*
Cues must be appropriate to their parameters with regard to their scope and operation.

Although the exact status of this principle is not fully understood, it aims to ensure that the cues are defined in the same terms as their corresponding parameters. That is, they can refer to constituents, to directionality, etc., but not to 'the last four syllables' or 'the third syllable from the right'. Assuming the principle of appropriateness ensures that the learner does not have to make computations; parameter values can in principle be fixed by simple cues in the data which do not require computation. It also ensures that the learner does not have to have a complete analysis of the data; instead the learner only has to search for the relevant cues for each parameter.

As mentioned above, it is assumed that at the initial state S_0 all parameter values are in the unmarked or default setting. How do we determine what the default setting of a parameter is? We will see below that acquisition data may help to determine this matter. In fact, we have already illustrated this in chapters 4 and 5. However, not only acquisition data determine the unmarked values, since these were also defined to describe 'implicational universals' or the subset relations, as was also illustrated in chapters 4 and 5. Since Dresher & Kaye do not have access to acquisition data, they determine the default values on the basis of the subset principle. It is assumed that the default value is that value for which no positive evidence is available. The marked value can be determined on the basis of positive cues in the data. This is exactly the underlying idea of the 'subset principle', repeated here as (16):

(16) *Subset principle*
If a parameter has two values + and –, and the value – generates a proper subset of the grammatical sentences generated with the choice of value +, then – is the 'unmarked value' selected in the absence of evidence (Chomsky 1986:146).

This principle has shown its usefulness in the acquisition of syntax (Berwick 1985, Wexler & Manzini 1987). Children seem to start with the most constrained system (the subset). In phonology, however, it is a more complex

matter to determine subset relations, since, as Dresher & Kaye point out, the types of stress systems simply do not form subset relations in the same way as syntactic systems do. For any two stress systems A and B, there exists some stress pattern in A that may not occur in B, and vice versa. Thus, subsets cannot be defined on the output in phonology, but have to be defined on the level of the cues associated with the parameters. Below I present the cues associated with the parameters given in section 7.1. I already mentioned above that cross-parameter dependencies require that cues are searched for in a particular order, assuming a deterministic learner. The order in which parameters are set by Dresher & Kaye's machine learner is given in (17).

(17) *Order in which parameters are set by the machine learner*

1.	(a) *QS parameter*	
	Feet are quantity-sensitive (QS)	[Yes/No]
	(b) *Rhyme/Nucleus parameter (Rh/Nu parameter)*	
	Feet are QS to the	[Rhyme/Nucleus]
2.	*Iterativity parameter*	
	Feet are non-iterative	[Yes/No]
3.	(a) *Extrametricality parameter (EM parameter)*	
	There is an extrametrical syllable	[Yes/No]
	(b) *Edge of extrametricality parameter (EoE parameter)*	
	The extrametrical syllable is on the	[Right/Left]
4.	*Binary/Unboundedness parameter (B/U parameter)*	
	Feet are	[Binary/Unbounded]
5.	*Main stress parameter*	
	The word-tree is strong on the	[Left/Right]
6.[21]	*Directionality parameter*	
	Feet are built from the	[Right/Left]
7.	*Headedness parameter*	
	Feet are strong on the	[Left/Right]
8.	*Defooting parameter*	
	A weak foot is defooted in clash	[No/Yes][22]

[21] Dresher & Kaye's next parameter is the one given in footnote 6, for which the default value is assumed to be that a strong branch of a foot must itself branch [Yes]. There exists a positive cue to decide that strong branches of feet do not necessarily branch, namely the existence of stress on a light syllable (not due to main stress). Therefore, the default value is that strong branches of feet must be branching. If the obligatory branchingness parameter is part of the set of word-tree dominance parameters, i.e., feet receiving main stress must be branching, the default value seems to be [No] (see section 7.6.4).

[22] The defooting parameter is not part of the actual stress learning component. It plays a role in the destressing component to which data are sent after they have passed the stress learning component.

The underlined values are considered to be the default values of the parameters by Dresher & Kaye. Dresher & Kaye were not able to determine the default values for directionality and headedness parameters. However, I will hypothesise that the default value for the directionality parameter is [Right-to-left] (section 7.6.1). This default setting will be argued to determine the default value of the headedness parameter, which I hypothesise is [Left]. I further hypothesise that the default value for the main stress parameter is also dependent on the value for the directionality parameter: main stress is assigned to the foot at the edge at which foot-building starts, i.e., the right edge (section 7.6.4). Evidence for the marked values of parameters comes from the following cues in the data.

QS Parameter. Evidence for QS comes from the existence of at least two words with the same number of syllables, but with a different stress pattern. As long as no such words are found, the learner assumes that the language is QI. The learner can thus never receive positive evidence for QI, and this is therefore the default value.

There is another argument in favour of the QI default value not mentioned by Dresher & Kaye: QS systems have to take both the number of syllables and rhyme structures of syllables into account. They therefore assume more knowledge on the part of the learner. In the model sketched above, the learner has access to such knowledge, but children might not have. In a QI system only syllables are relevant for stress assignment; no knowledge about the structure of these syllables is required. This is more in line with the results of chapters 4 and 5, which showed that syllable structure is mastered gradually along parametric dimensions.[23]

Rh/Nu parameter. If the learner has decided that the language s/he is learning is QS, then s/he must also determine a value for the Rh/Nu parameter: is the language QS on rhymes or on nuclei? In the former case both VV and VC rhymes are treated alike, while in the latter case VV is heavy, and VC is light. I have shown that this binary distinction is not sufficient to capture the Dutch stress facts. Moreover, I will show that when children become aware of QS they only distinguish between closed (heavy) and open (light) syllables. It was also shown in chapter 5 that children acquire branching rhymes before branching nuclei. I postpone the details of the acquisition of quantity-sensitivity until section 7.6.3

The learner in the Dresher & Kaye model first tries the hypothesis that languages are QS on rhymes. If this hypothesis has been proved to be

[23] It is possible to define a cue in such a way that QS is assumed to be the unmarked value. For a discussion the reader is referred to Dresher & Kaye (1990).

incorrect, the learner tries the second option: QS on nuclei.[24] This seems to suggest that QS on rhymes is the unmarked setting for the Rh/Nu parameter. However, there is no principled reason for this ordering: it could as easily have been the other way.

Iterativity parameter. The absence of secondary stresses is the cue associated with the iterativity parameter: in that case the learner knows that feet are non-iterative. The default value is therefore that feet are iterative. However, this cue is only reliable for a batch mode learner, since only this learner can make use of negative evidence, such as the absence of secondary stresses. One could also argue that the presence of secondary stresses is a cue for the fact that feet are built iteratively. Assuming this positive cue implies that the default value is that feet are non-iterative. I will show that this is in line with the acquisition data.

Extrametricality parameter. The extrametricality test is a tricky one: it can rule out extrametricality at an edge in the case that there is stress at that edge, but it is impossible to define a cue for detecting extrametricality: even when final syllables are always stressless, this need not be caused by extrametricality. Dresher & Kaye nevertheless assume that no extrametricality is the unmarked case, although no positive cue for detecting extrametricality can be defined. For Dutch it is often assumed that there is a late extrametricality rule, applying after foot formation, and affecting the location of main stress. Since main stress must always be on a peripheral foot (modulo extrametricality), a foot without main stress on each side of the word is a cue that there is foot extrametricality. However, words consisting of four feet are needed to decide at what edge the extrametrical foot is. I will come back to the issue of how this kind of extrametricality in Dutch can be acquired in section 7.6.4, where I will argue for an obligatory branchingness parameter instead of a (late) extrametricality parameter.

B/U parameter. It was assumed above that the default value for the QS parameter is [QI]. Quantity-insensitive systems allow only binary feet; this means that when the language is quantity-insensitive, the B/U parameter, 'feet are [Binary/Unbounded]', has to be set to [Binary]. However, for the

[24] In fact, this assumes that the learner can destroy previously assigned structure. If the hypothesis that the language being learned is QS on rhymes has turned out to be wrong, the learner has to undo the syllables from their 'heavy' or 'light' marking. Certain syllables that were analysed as being 'heavy', namely those containing VC rhymes, do not have to be reanalysed as being 'light'.

It should also be noted that it is impossible to define a robust subset relationship between the 'unmarked' and the 'marked' setting. If things were reversed, that is, if the learner starts with assuming that QS is defined on nuclei, he or she is also able to receive positive evidence for the contrary.

B/U parameter, Dresher & Kaye assume that the default value is [Unbounded], given a quantity-sensitive system, because a positive cue exists for detecting the presence of binary feet, but not unbounded feet. A light stressed non-peripheral syllable in a word or stress on both the rightmost and leftmost light syllable is the positive cue for setting the parameter to [Binary], since this requires that feet are bounded, and thus binary.[25] Since the value for the B/U parameter is dependent on the value for the QS parameter, Dresher & Kaye have to assume that the B/U parameter may follow a path from [Binary] to [Unbounded] and back to [Binary]. I will show below that this problem of retreating from unmarked values simply does not arise in Dutch child language, giving support to the claim that unbounded feet do not exist (Prince 1986, 1990, Prince & Smolensky 1993).

Main stress parameter. The cue associated with the main stress parameter utilises the notion of a foot-sized window at the edge of a word, since main stress is always placed on a peripheral foot.[26] To be able to do the 'main stress test' the learner has to know what a foot is in the language; in other words, the learner has to know what the parameter values for some of the foot-shape parameters in (2) are; that is, the learner has at least to know the values for the B/U parameter, the QS parameter and the Rh/Nu (or weight) parameter. The learner also has to know whether there is an extrametrical syllable (or foot), and if so at what edge, since this can obscure the pattern for main stress. Dresher & Kaye do not determine the default or unmarked edge to which main stress is assigned. The learner just has to check a foot-sized window at each edge. However, I will hypothesise that the default location of main stress is determined by the value of the directionality parameter. If feet are built from right to left, main stress is located at the right edge.

Directionality and headedness parameters. The directionality parameter and the headedness parameter have to be tested simultaneously. The two parameters generate four configurations (feet can be built from right to left or from left to right, and feet can be left-headed or right-headed), each with a characteristic pattern of alternating stresses. Dresher & Kaye make no decision as to default values of these parameters. Therefore, the learner has to check all four possibilities until he finds a consistent fit: that is, a stressed syllable in what should have been an unstressed position is inconsistent with the parameter settings. An unstressed syllable in what should have been a stressed position is not a reliable cue, since it may be due to destressing. My hypothesis, however, is that the default value for the directionality parameter

[25] I am neglecting the possibility of ternary feet here, because it is irrelevant for the Dutch.
[26] Although this is not completely true for Dutch: rather, the rightmost branching foot will receive main stress.

is [Right-to-left]. This also determines the default value for the headedness parameter as [Left], as will be shown in section 7.6.1.

The cues for the directionality and headedness parameters are defined in such a way that no information about destressing is needed for the learner to succeed. The machine learner is able to set the parameters of the language it is learning without access to information about destressing. Dresher & Kaye assume that the destressing parameter is set after stress assignment. Therefore, destressing should not have an effect on the acquisition of stress. Since destressing is usually defined as an operation that applies to the output of the stress rules, it is a welcome result that destressing parameters are only set once the stress parameters are fixed.

Now that all relevant components of the schematic representation of the logical problem, as given in (1), have been discussed, let us turn to a description of the structure of Dresher & Kaye's machine learner.

7.5. The structure of Dresher & Kaye's machine learner

Dresher & Kaye (1990) develop a parametric learning model for stress. They adopt the 'principles and parameters' approach (Chomsky 1981a, b); they assume that all principles and parameters are innate, and that the learning process consists of correctly fixing the values of the stress parameters for the grammar the learner is acquiring on the basis of robust and appropriate cues in the data. Dresher & Kaye's machine learner, called YOUPIE, (for Universal Phonology), which is equipped with the principles, parameters and their associated cues, appears to do quite well in setting its parameters as long as it is supplied with data that is not lacking crucial cues. It does not need enormous amounts of data, although it requires words of a certain length (at least more than two syllables, see footnote 19). For example, the learner does quite well in determining whether a language is QI or QS. It does less well in further discriminating between systems that are QS on rhymes and those that are QS on nuclei. This problem will be discussed in section 7.6.3, since Dutch is not entirely unproblematic in this respect. Furthermore, the learner has problems with extrametricality. This will also be dealt with in the next section, when discussing how the idiosyncratic extrametricality in Dutch might be learned.

The structure of the stress-learning program YOUPIE contains several components: the syllable parser, the classifier, the learner, the applier and the cranker. These are described below.

Syllable parser. The syllable parser parses input words into strings of segments; the vowels are marked with their stress levels, as indicated in (12). The words are then parsed into syllables. From this syllable parse two

representations are derived for each word. The first is a rhyme projection with stress marks which forms the input to the learner.[27] The second representation is derived by removing the stress level indicators from the rhyme projection, as sketched in (13). These representations are used later by the applier in building metrical structures.

Classifier. Before the input forms (the rhyme projections with stress indicators) are sent to the learner, they first have to pass the classifier. The classifier's task is to test the transparency of the system. If there are obvious conflicts, for example two words with exactly the same syllable structure but different stress patterns, the learner is alerted, since it will be unable to arrive at a successful setting of the parameters.

Learner. The input forms are then sent to the learner. The learner is equipped with the set of parameters and their associated cues described above. The learner fixes the parameter values on the basis of cues in the data. The output, the set of parameter values, is the learner's hypothesis about the grammar of the language.

Applier. The applier receives the set of parameter values from the learner to build metrical structures on the rhyme projections without stress indicators. These metrical structures are used to assign stress. The derived stress pattern is then checked against the input data (the rhyme projections with stress indicators). If the parameter settings received from the learner are correct, then there is a complete match between the derived forms and the input forms. The learner has been successful. However, the learner has abstracted from destressing. Therefore, it is possible that the applier generates stresses that do not appear in the input (but not the reverse). This is still counted as a match, but the model now marks the extra stresses. Forms marked as such can serve as the input for a destressing component. It might also be the case that the learner has not yet fixed all parameters; some parameters may still have their default value. This also can cause mismatches between the stress patterns created by the applier and the input stress patterns.[28] I will show that such mismatches help the learner in fixing parameters that are not yet set. The second function of the applier is to assign stress patterns to new words that are not part of the input. If the applier is provided with the correct parameter values it will be able to correctly predict stress pattern of new words.

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[27] I assume that the syllables minus the onset constituent form the input (cf. footnote 16).

[28] Since Dresher & Kaye's learner is a strict batch mode learner, this possibility does not arise. However, since children are neither strict batch mode learners nor strict incremental learners, this possibility does occur in the children's developmental patterns, as will be shown in section 7.6.

Cranker. The model is further supplied with a cranker. If the learner is not able to fix a parameter, and therefore assumes the default value, mismatches can occur between the stress patterns generated by the applier and stress patterns of the input. For example, the only positive cue for extrametricality is one that excludes extrametricality. If no such cue is available in the data, the learner cannot be sure about the correct setting of the EM parameter. It will therefore assume no extrametricality as a conservative strategy. When this turns out to be wrong, Dresher & Kaye assume that the forms are then send to the cranker, which simply looks for all other legal settings of the parameters until it finds the set of parameters in accordance with the input data. The number of possible parameter combinations might, however, be reduced drastically, since many parameter values have been excluded by the learner. The cranker is a non-deterministic learner in the sense described in section 7.4.1. It is clear that ideally the model would not have to make use of a cranker.

The mere existence of a working model for the acquisition of stress by machines does not necessarily mean that the model is also suitable to describe the stages in the acquisition of stress by children. However, the existence of a working model is promising. Ideally, a model of stress acquisition should not only reach the correct final state of the grammar being learned, but should also simulate the developmental progression found in child language acquisition. The learner in the model described above is a batch mode learner: it has access to all data, and must therefore be able to fix all parameters. This batch mode learner idealises the acquisition process as instantaneous. Language development researchers have criticised instantaneous learning because it is not realistic. Rather, they assume that learning is incremental. Children are incremental learners because they do not learn 'all at once', but instead go through several developmental stages before reaching the final steady state S_s. However, although children can be argued to be incremental learners, they are also batch mode learners to a certain extent. They do not process data one by one, but rather absorb data until they have encountered enough evidence for setting a parameter to the marked value. This means that not all relevant data can be assumed to be present at the stage at which the child starts setting the stress parameters. With this difference between machine learners and children in mind, let us now return to the acquisition data. The aim of the next section is to apply the model of stress acquisition sketched above to the developmental stages found in chapter 6.

7.6. The Dutch acquisition data again

The hypothesis underlying the model described above is that, if child language acquisition is guided by cues in the data, then we expect to find errors based on parameter values not yet fixed (crucially, not *wrongly* fixed parameter values). Dresher & Kaye hypothesise that, by virtue of their default settings, children start out assuming quantity-insensitive binary feet in all cases. Children acquiring English (or Dutch for that matter) would then move to quantity-sensitive unbounded feet, before arriving at the correct parameter setting of quantity-sensitive binary feet. It will be shown that children indeed start with quantity-insensitive binary feet, but that the intermediate step of unbounded feet is not necessary, since it is simply irrelevant to the children's output. It will also be shown that a point can indeed be detected when children become aware that stress is sensitive to quantity. It will furthermore be shown that destressing is learned relatively late. Since in the model presented above the setting of destressing parameters follows that of stress assignment, this is an encouraging result. In the following sections I will concentrate on what might cause the transitions from one stage to the next. The first transition, from stage 0 to stage 1, is indicated by the appearance of disyllabic words in the child's production forms, although not all adult target disyllabic forms are produced as disyllables by the child. At stage 1 disyllabic target words with final stress are produced as monosyllables. At stage 2 these target forms are produced as disyllables, where stress invariably is on the first syllable. At stage 3 disyllabic target forms with final stress are produced with an equal amount of stress on both syllables in the child's output forms. Finally, at stage 4 disyllabic target forms with both final and initial stress are produced correctly.

7.6.1. The transition from stage 0 to stage 1

At the initial stage all parameters have the default value. At this stage children only produce monosyllabic words, and the target forms (the input) also consist almost exclusively of monosyllabic words (stage 0). This is certainly true for those children recorded from the onset of speech. At this stage the child may solely focus on segmental and syllable structure, since stress parameters are simply not relevant. All words and feet are monosyllabic, and therefore none of the foot-shape parameters or parameters of foot construction (2b, c) needs to be set. Only when disyllabic words enter the child's system do stress parameters become relevant (stage 1). At this stage the child must set at least some of the stress parameters: namely, those for which no default value exists. The two parameters for which Dresher & Kaye could not determine the default value are the directionality and the

headedness parameters. In this section I will focus on those two parameters, and I will hypothesise that there is a default value for these parameters.

The model sketched above predicts that children start with quantity-insensitive binary feet, which can in principle be either left or right-headed. The model does not make predictions in this respect.

In chapter 6 it was shown, however, that the first disyllabic words children produce are initial-stressed. These words typically correspond to disyllabic initial-stressed target words (the input). Furthermore, when disyllabic words with final stress enter the child's system, which typically occurs later, they are usually truncated to the final-stressed syllable (stage 1). At a later stage they are produced as disyllabic words with initial stress (stage 2). Moreover, we have also seen that disyllabic target forms with initial stress are hardly ever reduced, and are seldom prone to stress errors. On the basis of these observations we might conclude that the child entertains the hypothesis that the language has binary left-headed QI feet: $(\sigma_s\ \sigma_w)_F$, in which the second syllable is optional.[29] What has led the child to this hypothesis?

That disyllabic adult target words with final stress enter the child's system much later might be due to a selection strategy; that is, children seem to prefer disyllabic words with initial stress and only select target words of this form for their own production. It might also be a reflection of the frequency of these words compared with initial-stressed disyllables. It could also be the case that left-headed feet are the unmarked QI feet; this implies that the child has not learned any stress parameter, but has only 'learned' that the language has feet; that is, words can consist of more than one syllable. The question that remains to be answered, unless we assume an asymmetric foot inventory which lacks QI iambs (see footnote 29), is why left-headed feet are the default, and not right-headed feet. Or put differently, why are disyllabic words with initial stress produced correctly, but disyllabic words with final stress truncated?

On the hypothesis that the child expands his or her system in a systematic way by making use of the basic prosodic constituents, the prediction is that when the child adds a syllable to the monosyllabic template, s/he could either add a syllable to the right or to the left of this syllable, thus creating

[29] Assuming the asymmetric foot typology of Hayes (1985, 1987, 1991), independently motivated by McCarthy & Prince (1986) and Prince (1990), the only quantity-insensitive foot is the syllabic trochee, which is by definition left-headed. Motivation for an asymmetric inventory of foot templates comes from the typology of iterative bound systems, in which the QI iamb $(\sigma_w\ \sigma_s)$ is missing, processes that change syllable quantity in foot-governed contexts, and prosodic morphology. Iterative iambic systems display QS almost without exception, and use feet whose members are of uneven duration. In contrast, iterative trochaic systems strongly tend towards durational evenness of the members of feet. This is called the iambic-trochaic rhythmic law.

a disyllabic foot, which is either left-headed or right-headed. If the adult target word contains more than one foot, only one foot is selected for production by the child; the remaining part of the word is not realised, simply because it does not fit into a word template that at most contains one foot. When the input contains both $(\sigma_s\ \sigma_w)_{Wd}$ and $(\sigma_w\ \sigma_s)_{Wd}$ words, the child knows that one of these forms contains more than one foot. Now, s/he has to make a decision about headedness and direction of parsing. If the child parses out just one foot from the adult target, the different settings for the directionality and headedness parameter predict different results, as is illustrated in (18):

(18) *Parsing out one foot given different settings for the directionality and headedness parameters*

	Target words:	$(\sigma_s\ \sigma_w)_{Wd}$	$(\sigma_w\ \sigma_s)_{Wd}$
a.	D:LR, H:L	$(\sigma_s\ \sigma_w)$	(σ_w)
b.	D:RL, H:L	$(\sigma_s\ \sigma_w)$	(σ_s)
c.	D:RL, H:R	(σ_w)	$(\sigma_w\ \sigma_s)$
d.	D:LR, H:R	(σ_s)	$(\sigma_w\ \sigma_s)$

Where D = Directionality, and H = Headedness, L = Left, R = Right

Only the settings of (18b) explain the observed pattern characterising stage 1 in child language. The child seems to have left-headed feet parsed from the right, or the word ending. It often noted in the literature that children pay attention to word endings. The word endings are usually more salient than word beginnings for various reasons (see Slobin 1973). Let us therefore hypothesise that there is a default value for the directionality parameter: the default direction of parsing is [Right-to-left]. Can we also find reasons for assuming that the unmarked value for the headedness parameter is [Left-headed]? What does the child know, given UG, about the constituent 'foot'? Besides a bias to attend to the word ending the literature often mentions that children pay attention to stress in the adult target (Echols 1987, 1988, among others). Moreover, it has been shown that stress in the adult target guides the child in the acquisition process. The child seems to know that stress in the adult target word indicates the boundary (the strong branch) of a foot.[30] Other cues for foot boundaries are other stressed syllables in the word, or word boundaries. Unstressed syllables can only be used if the child already knows that the system has binary feet. However, even in a system with unbounded feet the stressed syllable still indicates an edge of the foot. Therefore, stressed syllables seem to be a more robust cue than

[30] Here it is assumed that the prosodic hierarchy and the principles of prosodic phonology play a role from the start of acquisition. Children only use prosodic constituents, and no others. Evidence for this position has been given in chapter 6.

unstressed syllables.[31] However, word boundaries seem to be more robust cues than other stresses in the word for the following reasons. First, all words have word boundaries, but not all words have more than one stressed syllable; at the early stages, especially, children have very few long words.[32] Second, even if the child focuses on two stresses in the word, s/he still does not know the exact boundaries of the feet contained in the word, since the language could employ left-headed (19a) or right-headed (19b) feet, resulting in different foot boundaries, as schematised in (19):

(19) a. H:L $(\sigma_s\ \sigma_w)\ (\sigma_s\ \sigma_w)$ $(\sigma_w)\ (\sigma_s\ \sigma_w)\ (\sigma_s)$
b. H:R $(\sigma_s)\ (\sigma_w\ \sigma_s)\ (\sigma_w)$ $(\sigma_w\ \sigma_s)\ (\sigma_w\ \sigma_s)$

There are other arguments in favour of the word edge as the cue for deciding upon one of the boundaries of the foot constituent. The cue based on two stressed syllables is not appropriate according to the definition in (15), since the cue refers to two stressed syllables, while the parsed constituent only contains one stressed syllable. Moreover, it makes the wrong predictions. If children start parsing from the first stressed syllable from the edge until they encounter the next stressed syllable (which is nevertheless not included in the parse; that is, the boundary is placed before the second stress), we expect the patterns in (20a) for both left-to-right and right-to-left parsing.

(20) a. *Parse from first stress until another stress is found*
D:LR $(\sigma_s\ \sigma_w)\ \sigma_s\ \sigma_w$ D:RL $\sigma_s\ (\sigma_w\ \sigma_s)\ s_w$
D:LR $\sigma_w\ (\sigma_s\ \sigma_w)\ \sigma_s$ D:RL $\sigma_w\ \sigma_s\ (\sigma_w\ \sigma_s)$
b. *Parse from edge until the second stressed syllable*
D:LR $(\sigma_s\ \sigma_w)\ \sigma_s\ \sigma_w$ D:RL $\sigma_s\ (\sigma_w\ \sigma_s\ \sigma_w)$
D:LR $(\sigma_w\ \sigma_s\ \sigma_w)\ \sigma_s$ D:RL $\sigma_w\ s_s\ (\sigma_w\ \sigma_s)$
c. *Parse from word edge until a stressed syllable is included in the parse*
D:LR $(\sigma_s)\ \sigma_w\ \sigma_s\ \sigma_w$ D:RL $\sigma_s\ \sigma_w\ (\sigma_s\ \sigma_w)$
D:LR $(\sigma_w\ \sigma_s)\ \sigma_w\ \sigma_s$ D:RL $\sigma_w\ s_s\ \sigma_w\ (\sigma_s)$

There are two problems with the parsing in (20a): (i) it does not make the right predictions, and (ii) it involves 'skipping' a syllable (at the edge), which

[31] The fact that the default value for the B/U parameter is [Binary] does not mean that the child knows that feet are binary. On the assumption that default values cannot be used to determine the values of other parameters, the child cannot use the presence of unstressed syllables as indicators of word-boundaries.

[32] It should be recalled that YOUPIE can only fix the stress parameters if it receives data which contain the relevant cues. The relevant cue for the directionality and headedness parameters consists crucially of quite long words. However, children seem to be able to decide on the values of these parameters on the basis of short words only.

generally seems to be avoided in linguistic processes; 'no skipping' is assumed to be a principle of prosodic phonology (McCarthy & Prince 1986). The parse in (20b) is defined in such a way as to solve the 'skipping' problem of (20a). However, the result of (20b) is even worse, since the parsed part is no longer a legitimate prosodic constituent, violating the principles of prosodic theory, which state that reference can only be made to prosodic constituents. (20c) shows the results on the assumption that the first stressed syllable of a word and a word edge form the properties on the basis of which the cue for the directionality parameter has to be defined. Not only does it make the right predictions, this analysis does not need to make reference to 'skipping' or illegitimate feet. Moreover, the direction of parsing can be determined on the basis of disyllabic words. This is a particularly important result, since children seem to learn stress on the basis of short words, unlike YOUPIE.

Another interesting result of (20c) is the following: $(\sigma_w\ \sigma_s)_F$ feet can never be parsed from right to left; they can only occur if the direction of parsing is from left to right. If children indeed have a bias towards the end of words and a bias to stress, only disyllabic $(\sigma_s\ \sigma_w)_F$ and monosyllabic feet are generated, without even having to decide on the value of the headedness parameter. Let us therefore assume that the default value for the directionality parameter is [Right-to-Left]; it follows from this direction that the default value for the headedness parameter is that feet are [Left-headed].

However, in principle it is still possible that children hypothesise that the language may require the marked value for directionality, and that they start parsing at the left edge of a word, since the literature also mentions a bias towards beginnings of words (Peters 1977, 1983). The only data that possibly provide support for this are those from the early recording sessions of Elke.

During the first recording session, Elke realises only monosyllabic forms which correspond to monosyllabic target forms (input) (stage 0). At the second recording session a few disyllabic words are produced, all with initial stress, as in the corresponding adult target forms. However, as opposed to other children she also selects adult target disyllabic words with final stress very early, although they are less frequent than initial-stressed disyllabic words. The cue for the quantity-sensitivity parameter, the first parameter set by YOUPIE, is present very early. Nevertheless, she first seems to focus on the directionality parameter: are the feet of the language built from the left or from the right? Although her initial disyllabic forms are all produced with initial stress (like the corresponding adult targets), as soon as disyllabic target words with final stress come in, this leads to confusion. For a brief period at the early stages the following forms are attested:

(21) *Elke*

a.	appel	/ˈɑpəl/	→	[ˈɑpɔ]	(1;7.8)
	auto	/ˈoːtoː/	→	[ˈɑtuː], [ˈɑtoː]	(1;7.22)
	baby	/ˈbeːbiː/	→	[ˈpeːpɯ]	(1;7.22)
b.	banaan	/baːˈnaːn/	→	[naːn]	(1;7.22)
	konijn	/koːˈnɛin/	→	[ŋɑ], [nɑn], [nɛiŋ]	(1;8.13)
	WC	/veːˈseː/	→	[siːs]	(1;8.13)
c.	Dicky	/ˈdɪkiː/	→	[dɪ]	(1;7.8)
	baby	/ˈbeːbiː/	→	[beː]	(1;7.22)
d.	appel	/ˈɑpəl/	→	[ɑˈpɔ], [ɑˈpuː]	(1;7.22)
	auto	/ˈoːtoː/	→	[ɑˈtuː]	(1;7.22)
e.	banaan	/baːˈnaːn/	→	[ɑˈnaː]	(1;7.8)

The forms in (21a, b) indicate that Elke is parsing the adult target words from right to left. The forms in (21c, e), on the other hand, indicate that she is parsing the words from left to right. The forms in (21d) are remarkable in that stress is on a different syllable in her production forms than in the adult target form. However, if both syllables of the words in (21d) are parsed from left to right, she assigns main stress to the final syllable. She is clearly testing the marked value for the directionality parameter. However, this confusion does not persist long: only at 1;7.22 are all three possibilities for realising initial-stressed disyllables attested; from 1;8.13 disyllabic words with initial stress are produced correctly. They are no longer reduced to monosyllables, and neither are they produced with the wrong stress pattern. Disyllabic words with final stress, on the other hand, are invariably reduced to the stressed syllable from 1;8.13, as in (21b). This remains largely the case throughout all recording sessions. This indicates that stress in the adult words plays a crucial role in selecting material from the target form, as do word boundaries. Directionality of parsing determines the output: parsing from right to left results in $(\sigma_s\ \sigma_w)_F$ and $(\sigma_s)_F$ feet; while parsing from left to right results in $(\sigma_w\ \sigma_s)_F$ and $(\sigma_s)_F$ feet. From 1;8.13 Elke seems to have decided that feet are built from right to left, with the result that only feet (and words) of the following types are produced: $(\sigma_s\ \sigma_w)_F$ and $(\sigma_s)_F$. In other words, she now seems to have a disyllabic left-headed foot template, of which the second syllable need not be filled. Before this parameter setting was fixed, she tested both possibilities for directionality, and decided, probably on the basis of the much higher frequencies, that feet in Dutch are built from right to left, and therefore, left-headed; the infrequent $(\sigma_w\ \sigma_s)_{Wd}$ words are probably filtered out by the buffer (classifier), as described above.

The fact that the child has picked out a foot from the adult target form does not mean that the child has a stress pattern similar to that of the adult.

If the default value of the directionality parameter is that feet are parsed from right to left, the child has only extended his or her word template with one syllable; now s/he has a binary foot template. The headedness parameter is directly dependent on the directionality parameter. Parsing feet from right to left results in left-headed feet, as was also shown above. This implies that the child has not fixed any parameters. This result fits together with the claim that a trochee is favoured for QI systems. Independent evidence for the default value [Left-headed] for the headedness parameter is provided by Prince (1986) and Hayes (1987), who argue that the only QI foot is a syllabic trochee: a left-headed foot consisting of two syllables (see also footnote 29). Parsing from the left would result in iambs, which are not favoured for QI systems.[33]

Although the existence of $(\sigma_s\ \sigma_w)_{Wd}$ and $(\sigma_w\ \sigma_s)_{Wd}$ words is the relevant cue for the quantity-sensitivity parameter in the model described above, it has been shown that it is also the relevant cue for deciding on the foot boundaries, on the assumption that feet are built from right to left. Quantity does not seem to play a role: both syllables in the words in (21a, d) are light, and both can be stressed. Moreover, if the second syllable of *konijn* in (21b) is a light syllable in the child's production form, this does not lead to a disyllabic production with either initial or final stress; that is we do not find *['koːŋɑ] or *[koː'ŋɑ], which would be expected if the child has discovered quantity-sensitivity; the child produces [ŋɑ] instead. The crucial piece of data, a heavy syllable in unstressed position, is lacking; however, it will be shown below that feet at the initial stages are indeed quantity-insensitive. Furthermore, it has been shown that Elke has not yet mastered rhyme structures (see appendix G–1); it is therefore unlikely that quantity plays a role at this early stage. This clearly illustrates that the child is an incremental mode learner: although the relevant cues are available quite early, the cues are only used to determine parameter values when the child is 'ready' to use the cues. Just as children may focus on the labial properties of words and neglect the rest, they may similarly focus on the final-stressed foot, neglecting the rest of the word for the moment; that is, the cue for QS is neglected. This also provides evidence in favour of the prosodic hierarchy and the principles of prosodic phonology, since it shows the importance of the basic prosodic constituents: the child's template is extended in such a way that it contains a larger prosodic constituent. First, the template contained only one syllable (stage 0); at the second stage it can contain two syllables, as long as these syllables are contained in one foot (stage 1).[34]

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[33] This makes the prediction that, if a language has trochees, right-to-left parsing is preferred to left-to-right parsing.

[34] Further evidence was given in chapter 6.

Elke's data indicate that children can use the input to decide whether feet in the language are built from right to left or from left to right. However, none of the other children produced data which show that the directionality hypothesis is tested. They seem to have the [Right-to-left] value for the directionality parameter from the start. However, since in Dutch feet are parsed from right to left, crucial evidence for the default value of the directionality parameter would come from acquisition data from languages in which feet are built from left to right. If the default direction is parsing from right to left, children acquiring such languages must somehow discover that the language employs the marked value. However, I know of no such data in the literature. It would also be interesting to know what the first disyllabic words of children acquiring a language with iambic (σ_w σ_s) feet are. The prediction is that, if the default direction of building feet is from right to left, these children produce left-headed feet as well, which then would be invariably monosyllabic. Further research into such languages may reveal important properties of the stress system. It might, for example, turn out to be the case that there is a conspiracy between headedness of the feet of the language and directionality of foot-building procedures, in such a way that if the language has left-headed feet, parsing is from right to left, whereas a language with right-headed feet may parse feet from left to right. Whether this hypothesis will be confirmed by the acquisition data is, however, an empirical question. In any event, the data from Dutch are in line with this hypothesis.

Thus, once Elke has decided on the directionality parameter, she also knows that feet can be either monosyllabic or disyllabic, in which case stress is on the leftmost syllable. Independent evidence comes from monosyllabic target words which are occasionally augmented by Elke from (1;8.31) onwards, although this process is not very frequent. Examples are given in (22):

(22)

Elke				
jeep	/d͡ʒiːp/	→	['diːziː]	(1;8.31)
koek	/kuːk/	→	['puːkə]	(1;8.31)
paard	/paːrt/	→	['paːtiː]	(1;9.10)
pop	/pɔp/	→	['puːpə]	(1;9.24)
melk	/mɛlk/	→	['mɛkɑ]	(1;10.21)

These forms indicate that the child has a disyllabic foot template which is left-headed. If the direction of building feet indeed is from right to left (either by default, or by actively setting the parameter), then it follows from this that feet are left-headed. The data in (22) also show that the foot template of children is not identical to that of the adult: the child's foot template consists of at most two syllables of which the leftmost is stressed, and the rightmost is not obligatorily, but optionally, filled, as shown in chapter 6.

At an early stage Elke has a few trisyllabic target forms with initial stress, which are invariably reduced to disyllabic forms with initial stress (23):

(23) *Elke*

tekenen	/ˈteːkənə[n]/	→	[ˈkaːkə]	(1;8.13)
		→	[ˈkɛkiː], [ˈkɑkaːi]	(1;8.31)
		→	[ˈkɛikɛi]	(1;9.24)
andere	/ˈɑndərə/	→	[ˈaːnə]	(2;0.25)

The data in (23) show that at the initial stages feet are at most binary; that is they are not unbounded, since then we would have expected that she would produce all three syllables of the target word. This conforms to the prediction made by the model. It might either be the case that one of the syllables in the words in (23) is deleted, because of the default value for the B/U parameter. Alternatively, it might also be the case that the child's template maximally contains two syllables, because the template is expanded by one prosodic constituent: one extra syllable, as long as the resulting two syllables are contained in one foot. That is, the child seems to expands the system minimally. Therefore, all three syllables of the target words cannot be contained in the child's template. On this assumption the default value of the B/U parameter is [Binary] only because the child's system expands minimally; in fact, it is only at a later stage, a stage at which the child's template either contains three syllables or two feet that s/he has to decide on the value of the B/U parameter. However, at that stage, the child has to decide on many other parameters as well.[35] On the assumption that [Unbounded] is the default, stress must always be on one edge of the word. This is in line with the data, in which stress is always at the left; however, there are different ways to arrive at initial-stressed forms: (i) by deletion of the unstressed syllable (stage 1); (ii) by stress 'errors' (as at stage 2); (iii) by placing an extra stress (resulting in level stress at stage 3). The developmental pattern is not explained. Furthermore, if [Unbounded] had been the default value, the non-existence of, for example, trisyllabic forms with initial stress is purely accidental. Since words like the ones in (23) are invariably reduced to disyllables, I conclude that [Binary] is indeed the default value for the B/U parameter.[36]

That the child selects a foot at the right edge of the target word is also confirmed by the production forms of longer adult target words. From

[35] For example, if at the hypothesised stage the child has one foot containing three syllables, the child must already have decided that feet are QS. On the other hand, if the child has expanded his or her template in such a way that it may contain more than one foot, the child must have decided on the setting of the iterativity parameter, for example.

[36] Independent evidence comes from Prince (1986) and Prince & Smolensky (1993), who argue that there are no unbounded feet.

1;9.24 Elke occasionally selects trisyllabic forms with final stress for her production (24a), which are reduced to the final-stressed syllable, as predicted. At 1;10.21 a target word consisting of four syllables with penultimate stress is produced; the final foot of the adult target is realised, as shown in (24b):

(24) *Elke*

a.	telefoon	/ˌteːləˈfoːn/	→	[poːm]	(1;9.24)
			→	[føːm]	(2;1.16)
b.	televisie	/ˌteːləˈviːsiː/	→	[ˈʃiːʃɑ]	(1;10.21)
			→	[ˈʃʃə]	(1;11.7)

What these data indicate is that a stressed foot at the right edge is selected from the target word for the production form. The child scans the adult word from right to left, and stops after the parse includes a stressed syllable. As was shown in chapter 6, whether the final foot of the adult target has main stress or secondary stress is irrelevant. In both cases the final foot in parsed, as long as it contains a stressed syllable.

Since children seem to have a QI binary left-headed foot template quite early, we might now reconsider the disyllabic target forms with final stress in the light of the model sketched above. It is clear that these $(\sigma_w\ \sigma_s)_{Wd}$ target forms do not fit into the QI binary left-headed foot template. Suppose that the child, like the applier, is able to use the rhyme projections without stress indications of these words for the construction of metrical trees, on the basis of which stress is assigned. If the child acts like YOUPIE we expect that disyllabic target words with final stress will be realised as disyllabic words with initial stress, given that all other parameters are still in the default setting. Although there is a stage at which this prediction is borne out, this is not the first stage in the development. Rather, the first stage is the stage at which these words are typically reduced to the stressed (monosyllabic) foot of the adult target, possibly augmented with an extra syllable to the right, but crucially not to the left, of this stressed monosyllabic foot. Only when the applier does not built metrical trees on the whole string of segments and syllables of the adult targets with final stress, but only the final foot of the adult word, do we expect the forms typical of stage 1. In other words, the input to the child is not similar to the input to YOUPIE: children do not necessarily use the whole target word, but part of it, the foot at the right edge of the word. These prosodically circumscribed forms are sent to the learner. Since the data are compatible with the default values for the parameters, no change in the setting of parameters will be hypothesised, since there is no evidence for the marked settings.

(25) **Relevant parameters still in the default value at stage 1**

Directionality parameter	Feet are built from the	[Right]
Headedness parameter	Feet are strong on the	[Left]
QS parameter	Feet are QS	[No]
EM parameter	There is an extrametrical syllable	[No]
B/U parameter	Feet are	[Binary]

I have not included all parameters, since many of them are simply irrelevant at this stage. As long as the input forms to the learner consist of maximally one foot and maximally two syllables, the iterativity parameter is not relevant. The main stress parameter, too, only becomes relevant when the input forms which are used by the learner contain at least two feet. The same is true for the defooting parameter: as long as there is only one foot, stress clashes simply do not arise. Since the default option for the QS parameter is QI, the weight parameter, 'closed syllables are heavy' is simply irrelevant, since QI implies that rhyme or syllable structures do not matter. Since the default value for the EM parameter is that there is no extrametrical syllable, the EoE parameter, which marks the edge of extrametricality, is not relevant. Thus, given the prosodically circumscribed input forms, the applier assigns stress correctly. When these output forms are compared with the input forms (the adult target words), no stress errors are detected by the applier.[37]

To sum up, the transition from stage 0 (only monosyllabic forms) to stage 1 (one foot, with maximally two syllables) is triggered by the existence of disyllabic words in the input. On the assumption that the child's template expands gradually and conforms to the principles of prosodic phonology, a child producing disyllabic words (which form one foot) either has to figure out what the correct value for the directionality parameter (and therefore the headedness parameter) is, or assumes that these parameters also have a default setting: [Right-to-left] and [Left-headed], respectively. I argued for the latter, since otherwise the input to the child's learning system must be equal to the input data s/he receives from the environment. However, if this were the case, truncated forms are not expected. I therefore argued that the input to the child's learning system is different from the input the child receives from the environment. Additional evidence for this claim was given in chapter 6.

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[37] If the child's template extends from one syllable to two syllables, without the restriction that both syllables have to be contained in one foot, we would not have expected truncation. Rather, we would have expected that either (σ_s σ_w) or (σ_w σ_s) target words were produced by the child as disyllabic words with incorrect stress as compared with the adult target forms. In other words, if the child's focus had been on the number of syllables, rather than on stress (or feet), truncation would not be expected. Therefore, it must be concluded that children focus on stress, rather than on the number of syllables in the adult target forms.

None of the other parameters needs to be set at this stage, since the applier does not detect stress errors, based on the prosodically circumscribed input to the learning component (which differs from the input the child receives from the environment).

7.6.2. The transition from stage 1 to stage 2

Although the applier does not detect any stress errors at stage 1, as shown above, it may, however, discover at some point that, although stress is correct, the output forms and the input (the adult target) forms do not match in the number of syllables. To solve this mismatch between input and output, the next step in the development is to produce an extra syllable in words that have one syllable in the output form, and two (or more) in the adult target form (stage 2). These disyllabic output forms are sent to the applier, which builds a QI binary left-headed foot on the syllables from right to left and therefore assigns initial stress. In fact, the applier can be viewed as a template mapping procedure: the input (that is, the input to the learning component) is mapped onto the child's template, which is defined by the principles and parameters of UG. So far there has been no evidence that the stress parameters are inappropriately set: the applier has only discovered a mismatch in the number of syllables between input and output, not in the stress pattern. Therefore, the parameter values are the same as in (25). None of the stress parameters is set to the marked value. The child's foot template is still a binary left-headed QI foot. Examples are given in (26):

(26) STAGE 2: *(super)heavy unstressed syllables*

a.	*Noortje*				
	ballon	/bɑˈlɔn/	→	[ˈpɑpɔm]	(2;5.23)
	konijn	/koːˈneɪn/	→	[ˈpɔtɛin]	(2;5.23)
b.	*Tirza*				
	courgette	/ˌkuːrˈʃɛt/	→	[ˈkoːʃɛt]	(1;11.19)
	konijn	/koːˈneɪn/	→	[ˈsɔkɛin]	(1;11.19)
c.	*Robin*				
	ballon	/bɑˈlɔn/	→	[ˈbuːɔn]	(2;1.7)
	giraf	/ʃiːˈrɑf/	→	[ʃiːɑf]	(2;1.26)
d.	*Leonie*				
	banaan	/baːˈnaːn/	→	[ˈpaːlɑn]	(1;9.21)
	kapot	/kaːˈpɔt/	→	[ˈpɑpɔk]	(1;9.21)

The examples in (26) illustrate clearly that the child assumes QI feet: the data contain (super)heavy unstressed syllables, which would not have arisen if the child had assumed that feet were QS. Thus the default value QS is

problematic since the data at stage 2 clearly show that the child has the value QI. On the assumption that the default value is QS, the child has now somehow set the parameter to the marked value. However, on the assumption that learning is deterministic, this learner cannot arrive at the setting QS required by the language. Therefore, the hypothesis that QS is the default value is both theoretically and empirically false.[38]

For trisyllabic words with final stress (either main or secondary), which were reduced to monosyllables at stage 1, the applier may also discover that the number of syllables in the target words exceeds the number of syllables in the output forms. We saw in chapter 6 that these forms are also now produced as disyllabic words: they are also augmented with one syllable at stage 2. The child now selects a stressed syllable from the word beginning. The applier builds a left-headed QI binary foot on the resulting disyllabic words, which therefore receive initial stress. Examples are repeated under (27):

(27) *Target trisyllables with final (main or secondary) stress produced as* $(\sigma_s\ \sigma_w)$

a.	*Robin*				
	boerderij	/ˌbuːrdəˈrɛi/	→	[ˈbuːjɛi]	(1;10.21)
	telefoon	/ˌteːləˈfoːn/	→	[ˈpɪfoːm]	(2;0.18)
	allemaal	/ˈɑləˌmaːl/	→	[ˈɑmɑu]	(2;1.7)
	caravan	/ˈkɛrəˌvɛn/	→	[ˈpɪfɐm]	(2;1.26)
b.	*Elke*				
	olifant	/ˈoːliːˌfɑnt/	→	[ˈoːfɑnt]	(2;3.27)
c.	*Tom*				
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːwɪ]	(1;5.14)
	kangoeroe	/ˈkɑŋguːˌruː/	→	[ˈkaːkuː]	(1;5.28)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈoːfɐn]	(1;6.11)
	pelikaan	/ˌpeːliːˈkaːn/	→	[ˈkeːkaːm]	(1;7.9)

This shows that the child's template at stage 2 consists of one binary QI left-headed foot. Trisyllabic words with medial stress undergo no change from stage 1 to stage 2: they remain realised as $(\sigma_s\ \sigma_w)$, again illustrating that the child's template can only accommodate two syllables (which together form a foot) in his or her word template. Examples are given in (28):

(28) *Target trisyllables with medial stress produced as* $(\sigma_s\ \sigma_w)$

a.	*Noortje*				
	Marcella	/ˌmɑrˈsɛlaː/	→	[ˈɛlaː]	(2;8.29)
	benzine	/ˌbɛnˈziːnə/	→	[ˈsiːnaː]	(2;9.12)

[38] Another argument for the default value QI is that the cue for detecting QS is much more robust then the one for detecting QI. For discussion see Dresher & Kaye (1990).

b.	*Tirza*				
	koala	/koːˈaːlaː/	→	[ˈlaːliː]	(2;0.5)
	pyjama	/piːˈjaːmaː/	→	[ˈpaːmaː]	(1;11.8)
	asperge	/ˌɑsˈpɛrʃə/	→	[ˈpɛʃɛ]	(2;1.17)
c.	*Leon*				
	horloge	/ˌhɔrˈloːʃə/	→	[ˈloːʃə]	(1;10.15)
	piano	/piːˈjaːnoː/	→	[ˈpaːnoː]	(1;10.15)
	spinazie	/spiːˈnaːziː/	→	[ˈnaːsiː]	(2;3.4)

To summarise, the transition from stage 1 to stage 2 involves resolving the mismatch that exists between the output and the input (adult target forms; not the input to the learner at stage 1) in the number of syllables. The child, who still has a QI binary left-headed foot, selects one additional syllable from the adult target (from the left edge of the word). The result is an output form consisting of two syllables. Since no stress parameters are involved in resolving this mismatch, no parameters are set or changed. The applier builds binary QI left-headed feet from right to left, which results in initial-stressed disyllabic productions of target final-stressed disyllabic and trisyllabic words.

7.6.3. The transition from stage 2 to stage 3

When the disyllabic initial-stressed output forms, as created by the applier in the previous section, are compared with the input forms (final-stressed disyllabic adult target forms) the applier will first check the number of syllables, since this is what has been changed at the previous stage. It concludes that the number of syllables is correct;[39] however, it now discovers that the stress patterns do not match. Therefore, these forms are sent back to the learner, which now has to look for the relevant cues in the data on the basis of which other parameters have to be set in order to create the desired output. Until stage 3 all stress parameters are in the default setting. At stage 3 some of the stress parameters become relevant: the QS parameter, the Weight parameter, the iterativity parameter, the B/U parameter.

If the output forms of stage 2 are compared with the input forms, a conflict in the stress patterns between the input and output forms is discovered. The child now has access to the cue for quantity-sensitivity: s/he has encountered words with an equal number of syllables (two) but a different stress pattern $(\sigma_s\ \sigma_w)_{Wd}$ and $(\sigma_w\ \sigma_s)_{Wd}$. The crucial difference from stage 1 is that although the child's input (the adult forms) contains both

[39] This is not correct for trisyllabic forms, which I will discuss below.

types of words at stage 1, only one type of disyllabic word is selected by the child. The other type is reduced to monosyllables in the child's output. However, these output forms also function as input forms to the learner ('output-as-input'). At stage 2 the child has disyllabic productions, which, however, are still of one form: initial-stressed. At stage 3 the child has discovered for the first time that there are two types of *disyllabic* words: those with initial stress and those with final stress. Therefore, the child now is able to set the QS parameter to the marked setting [QS] on the basis of the cue in the data: two words with an equal number of syllables but with a different stress pattern. Before turning to QS, let us first discuss the other parameters that now become relevant.

Besides setting the QS parameter to the marked value the child also has to make decisions about the value of the iterativity parameter, since s/he now knows that some target words consist of one foot and something more, probably another foot.[40] Moreover, the produced forms at stage 3 consist of two feet. Until stage 3 the child's production forms all consist of one foot. At stage 3, this is no longer the case: the child also produces words consisting of two feet. I have, however, taken the fact that all output forms consist of one foot at the initial stages in the acquisition process as evidence for the unmarked value [Non-iterative]. Moreover, only positive evidence can be gained for the value [Iterative], on the assumption that the child is an incremental learner. The cue for [Non-iterative] was based on the absence of secondary stresses. This kind of evidence is not available to the incremental learner, who cannot assume that s/he has encountered all relevant data. This is an additional argument for the default value [Non-iterative]. The child could have started out assuming that feet are built iteratively. In principle, this results in output forms containing more than one foot. However, if the child's template is constrained by the basic prosodic categories, only one foot is realised (stages 1/2). The data from stages 1/2 are thus in principle in accordance with either value for the iterativity parameter.

If the child assumes that only one foot is built, and that stress assignment is non-iterative, s/he could not decide that the marked value is required on the basis of disyllabic words with final stress, in which the initial monosyllabic feet are defooted, and thus stressless. Nevertheless, the child produces two feet in the realisation of these words, for which there is no evidence. This would be an argument in favour of the default value [Iterative]. However, it could be the case that the child has determined on

[40] On the basis of the exhaustivity principle, which dictates that all prosodic constituents are fully incorporated in the prosodic structure, and on the basis of the fact that the child now clearly has feet, the child hypothesises that the remaining part of the word also constitutes a foot (which may be monosyllabic, as the data show).

the basis of trisyllabic words of the type *olifant*, *pelikaan*, etc. that words can contain more than one stress, and that stress is therefore assigned iteratively. In that case, the child has received evidence for the setting [Iterative]: namely, words with more than one stress. This suggests that [Non-iterative] is the default value.

On the other hand, on the assumption that [Iterative] is the default value, the child may conclude from the absence of secondary stresses in disyllabic words with final stress, that the language requires the marked setting [Non-iterative], since the absence of secondary stress, where it is predicted on the assumption that stress is by default assigned iteratively, is the relevant cue for this parameter. If the child does not have access to longer words or does not yet 'use' longer words for learning, this may lead the learner to the wrong setting, since stress assignment in Dutch is clearly iterative. By assuming the default value [Non-iterative], no such traps exist. This is another argument for the default value [Non-iterative].

Since stress in Dutch is assigned iteratively, we cannot draw conclusions about the default value with certainty. I assume that [Non-iterative] is the default value, because there exists a more robust positive cue for detecting that the language assigns stress iteratively; and moreover, the learner is protected from potential traps which could lead to setting a parameter wrongly if [Iterative] is the default value. However, acquisition data from languages in which stress is assigned non-iteratively have to be studied to determine this issue. I know of no such data in the literature, however. If the default value for the iterativity parameter indeed is [Non-iterative], then it can be concluded that the parameter is set to its marked value [Iterative] at stage 3, since the child's output forms may contain more than one foot.

Dresher & Kaye predict that once children have decided that the language they are learning is QS, the unmarked value for the B/U parameter, 'feet are [Binary/Unbounded]' is set to [Unbounded], the default value, given a QS system. However, the data do not give evidence for a stage at which the child assumes that the language has unbounded QS feet. Rather, it seems that children still have maximally binary feet. Since Dutch has binary, rather than unbounded feet, it might be the case that the child has already received evidence for binary feet. The cue for detecting that the language has binary feet is either the existence of a light stressed, non-peripheral syllable or the existence of a stress on both the rightmost and the leftmost light syllable (not necessarily in the same word); if a language has unbounded feet, only one peripheral light syllable in a word is eligible to receive stress. Thus, words like *televisie* /ˌteːləˈviːsiː/ and *piano* /piːˈjaːnoː/ contain the cue associated with the B/U parameter on the basis of which the child can set the parameter to the marked value [Binary]: these words contain non-peripheral light syllables which are stressed. A word like *paraplu* /ˌpaːraːˈplyː/

would also provide such a cue, as well as words like *auto* /ˈo:to:/ and *cadeau* /kaːˈdo:/. Although these words are present in the input to the child, it is more likely that they will be filtered out as exceptions by the 'classifier', since these are typical 'conflicting' data. It is therefore unlikely that they serve as cue for detecting that the language has binary feet. However, the polysyllabic words with penultimate stress (the unexceptional stress pattern in Dutch) of the type mentioned above contain robust cues for detecting the marked value [Binary].

The main stress parameter is still not set. The fact that the child produces disyllabic forms in which both syllables receive equal stress indicates that there is no default setting. The parameter is simply not relevant, since no word stress is assigned. The data from stage 3 also show that the destressing parameter is not yet set: it still has the default value [No]. Stress clashes are not resolved at this stage.[41]

The first parameter to be set at stage 3 is the QS parameter. However, the child also now has to determine what counts as a heavy syllable. Is the language QS on rhymes or on nuclei? Here the results of chapter 5 are important. Dresher & Kaye stipulate that the learner first attempts an analysis assuming QS on rhymes. If this analysis is unsuccessful, the learner then proceeds on the assumption that the language is QS on nuclei. However, as noted above, Dresher & Kaye do not make a difference between directly branching rhymes and indirectly branching rhymes: in a language which is QS on rhymes they assume that both VC and VV are equally heavy, and contrast with V, which is light. However, children acquire directly branching rhymes (VC_{obstr}) before indirectly branching rhymes (VV and VC_{son}). We might, therefore, hypothesise that children first try to establish whether the language is QS on directly branching rhymes, since these are acquired first. The implication of this hypothesis is that rhymes consisting of a short vowel plus a sonorant consonant do not count as heavy, and that rhymes consisting of a vowel followed by an obstruent are heavy. An examination of the data in (29) reveals that this is not the case: children seem to regard any closed syllable as heavy, independently of the length of the vowel and independently of the nature of the final consonant, since all closed syllables are now stressed in the child's output forms:

[41] Hayes (1991:76) proposes a degenerate foot parameter which he defines as follows: foot parsing may form degenerate feet under the following conditions: (a) strong prohibition (degenerate feet are absolutely disallowed), or (b) weak prohibition (degenerate feet are allowed only in strong position). It is clear that the strong prohibition is too strong to handle the child language data: children do produce degenerate feet at stage 3. I therefore assume that the whole string is exhaustively parsed into feet, which are eventually subject to destressing or defooting.

(29)						
	a.	*Noortje*				
		konijn	/koːˈnɛin/	→	[ˈtɑˈtɛin][42]	(2;7.2)
		fazant	/faːˈzɑnt/	→	[ˈhɑˈhaːŋ]	(2;7.17)
		giraf	/ʃiːˈrɑf/	→	[ˈhiːˈhɑf]	(2;8.1)
		ballon	/bɑˈlɔn/	→	[ˈpɑŋˈtɔm]	(2;8.1)
	b.	*Catootje*				
		ballon	/bɑˈlɔn/	→	[ˈboːˈnaːm]	(1;10.25)
		konijn	/koːˈnɛin/	→	[ˈkoːˈnɛn]	(1;10.25)
		paleis	/paːˈlɛis/	→	[ˈjaːpˈpɛis]	(1;10.25)
		giraf	/ʃiːˈrɑf/	→	[ˈeːˈɑχ]	(1;11.10)
		ballon	/ˌbɑˈlɔn/	→	[ˈbɑmˈbɔn]	(2;0.6)
	c.	*Robin*				
		ballon	/bɑˈlɔn/	→	[ˈbɑnˈdɔn]	(2;1.26)
		kasteel	/ˌkɑsˈteːl/	→	[ˈtɑsˈteːw]	(2;1.26)
		banaan	/baːˈnaːn/	→	[ˈmaːˈnaːn]	(2;2.27)
		misschien	/ˌmɪs͡ˈχiːn/	→	[ˈpɪˈziːn]	(2;3.10)
		giraf	/ʃiːˈrɑf/	→	[ˈʃiːˈɑf]	(2;3.22)
	d.	*Tom*				
		konijn	/koːˈnɛin/	→	[ˈkɔˈnɛin]	(1;7.23)
		trompet	/ˌtrɔmˈpɛt/	→	[ˈdoːˈlɛp]	(1;8.6)

From these data we have to conclude that closed syllables are heavy. In principle, children could have started out by assuming that superheavy syllables are heavy and all others light, since superheavy syllables are generally stressed in adult Dutch, whereas stressed closed final syllables (but not superheavy syllables) can only occur in exceptional cases, namely, if they are marked as exceptions to the extrametricality rule. This, however, does not seem to be the case: all closed syllables, whether heavy or superheavy, are treated alike with regard to stress.

If children have discovered that the language is QS, and that closed syllables count as heavy, that is the QS parameter has the value [QS] and the weight parameter 'closed syllables are heavy' has the value [Yes], the applier assigns stress correctly to the target words of (29). However, it may now produce the wrong patterns for disyllabic words with initial stress which have a final closed syllable, on the assumption that nothing has

[42] As in chapter 6 I marked stress in both syllables of these words with the main stress symbol, although it would be more appropriate to use the secondary stress symbol, since main stress is not yet assigned. However, the presence of secondary stresses implies the presence of main stress. Therefore, I decided to use the main stress symbol to indicate that it is the only kind of stress present in the children's data.

triggered the setting of the EM parameter to the marked value.[43] Robin's data show this nicely. (30a) illustrates that these target words were produced correctly by the child during the previous stages. However, at stage 3, when the QS parameter is set to [QS], these words are produced with level stress, as shown in (30b).

(30) a. *Robin:* STAGES 1/2

Robin	/ˈrɔbɪn/	→	[ˈɔpɪn], [ˈnɔmɪ]	(1;10.7)

b. *Robin:* STAGE 3

Robin	/ˈrɔbɪn/	→	[ˈhɔˈpɪn]	(2;1.26)
David	/ˈdaːvɪt/	→	[ˈtɑˈfuːn]	(2;1.26)
tractor	/ˈtrɛktɔr/	→	[ˈtɑkˈtɔɹ]	(2;2.27)
pinguin	/ˈpɪŋʊɪn/	→	[ˈpɪˈwɪŋ]	(2;3.10)

c. *Robin:* STAGE 4

botsing	/ˈbɔtsɪŋ/	→	[ˈbɔχɪŋ]	(2;4.29)
circus	/ˈsɪɾkʉs/	→	[ˈsɪɹkʉs]	(2;4.29)
robot	/ˈroːbɔt/	→	[ˈhoːpɔs]	(2;4.29)

The data in (30c) show that the child eventually learns to produce them correctly. This will be discussed in the next section, because it involves the transition from stage 3 to stage 4.

Another prediction made on the basis of the values for the QS parameter and the Weight parameter is that words like *cadeau* /kaːˈdoː/ are produced as disyllables with initial stress, as at stage 2, because they do not have a final closed syllable. The database did not contain these words during stage 3.[44] However, the prediction is that if the child had produced a word like *cadeau* it would have been produced as [ˈkaːdoː].

Main stress is not yet relevant at stage 3. This will become particularly clear after a discussion of the child's production of target trisyllabic words, to which I now turn.

We saw that at stage 2 all trisyllabic forms were produced as disyllabic forms with initial stress. When these output forms are checked against the input forms the applier may detect two things: (i) trisyllabic targets with final (main or secondary) stress are produced with the wrong stress pattern at stage 2, while trisyllabic target forms with medial stress have the right stress pattern; or (ii) the number of syllables is lower in the output forms than in the target forms. If the child focuses on the second aspect first, the prediction is that all trisyllabic forms are then produced as trisyllabic forms, with the stress pattern $(\sigma_s)_F(\sigma_s\ \sigma_w)_F$. However, this is not the case. For

[43] In these words the final syllable is extrametrical, and therefore stress is on the first syllable, according to the standard analyses.

[44] All the attested forms were produced as diminutives: [ˈdoːt͡ʃə].

example, trisyllabic target words with medial stress are still produced as disyllabic forms with initial stress. Moreover, we saw in sections 7.6.1 and 7.6.2 that children first focus on feet, and only later on the number of syllables. This is not different at this stage. Since trisyllabic target words with medial stress are not changed, let us focus on the other two types of trisyllabic words. We saw in chapter 6 that two patterns arise, both with level stress. Examples are repeated under (31) and (32):

(31) *The production of trisyllabic target forms at stage 3 as disyllables*

a.	*Robin*				
	caravan	/ˈkɛrəˌvɛn/	→	[ˈkeɪɹˈfɪn]	(2;2.27)
b.	*Tom*				
	kangoeroe	/ˈkɑnguːˌruː/	→	[ˈkaːˈkuːŋ]	(1;6.11)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈoːˈfɑn]	(1;7.23)
	parachute	/ˌpaːraːˈʃyːt/	→	[ˈpaːˈplʉt]	(1;10.29)
c.	*Tirza*				
	muzikant	/ˌmyːziːˈkɑnt/	→	[ˈtiːkˈtɪnt]	(1;11.19)
	boerderij	/ˌbuːrdəˈrɛi/	→	[ˈpyːˈhaːj]	(2;0.18)

(32)

a.	*Robin*				
	kapitein	/ˌkaːpiːˈtɛin/	→	[ˈpɑpiːˈtɛin]	(2;1.26)
	indiaan	/ˌɪndiːˈjaːn/	→	[ˈɪnəˈjaːn]	(2;1.26)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈfjoːfiːˈfɑnt]	(2;3.10)
b.	*Tom*				
	kangoeroe	/ˈkɑnguːˌruː/	→	[ˈkaːkəˈʁuːŋ]	(1;6.11)
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkɛkɛˈkɪw]	(1;6.25)
	ooievaar	/ˈoːjəˌvaːr/	→	[ˈɔjəˈfaːɹ]	(1;11.26)
c.	*Tirza*				
	microfoon	/ˌmiːkroːˈfoːn/	→	[ˈmiːkəˈsoːn]	(2;0.5)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈoːləˈsɑnt]	(2;2.25)
d.	*Catootje*				
	indiaan	/ˌɪndiːˈjaːn/	→	[ˈhiːjəˈhaːn]	(1;10.25)
	telefoon	/ˌteːləˈfoːn/	→	[ˈhɪnəˈhɔm]	(2;0.6)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈoːnaːˈhɑnt]	(2;1.24)

Presumably the forms in (31) precede the ones in (32). Again, the parameters described in this section are applied to these cases: thus, the language is QS, where closed syllables count as heavy; feet are binary and built iteratively. This results in the forms in (31) and (32). The child realises two feet. The final syllable of these words must form a foot on its own because it is heavy; feet are left-headed, and a heavy syllable cannot form the weak branch of a foot. The remaining syllable forms a foot on its own in (31).

However, the child already knows that feet can be disyllabic, as long as the weak branch of a foot does not contain a heavy syllable. We saw in chapter 6 that at stage 3 an extra medial syllable is sometimes produced, since the template in principle allows another syllable. That trisyllabic forms are now produced as such can no longer surprise us, especially since the target words have an extra syllable in these words. In fact, the cases in (31) are more remarkable, since they show that the child's previous forms are important for the further development of the system. If the child's previous forms did not matter, the forms in (31) are not expected. Rather, we would have expected the forms in (32) if the child uses only the adult target forms.

To summarise, the child has set the parameters in (33a) at stage 3, where the marked (underlined) values (the actual settings) are given. All other parameters are in the default setting, and there has been no evidence to set them to the marked value. Stages 1 and 2 did not involve the setting of any stress parameters to the marked value. The parameters given in (33b) are not set to the marked value. However, I hypothesise that when the QS parameters are set, the values for these parameters are now fixed in the default values. They are no longer subject to change. The parameters in (33c) are still irrelevant.[45] Thus, all foot-shape parameters and all parameters of foot construction have now been set. The child has so far not set the word-tree dominance parameters.

(33)

a.	**Parameters set at stage 3**		
	QS parameter:	Feet are QS	[Yes]
	Weight parameter:	Closed syllables are heavy	[Yes]
	Iterativity parameter:	Feet are iterative	[Yes]
	B/U parameter:	Feet are	[Binary]
b.	**Parameters that have the default value**		
	Directionality parameter:	Feet are built from the	[Right]
	Headedness parameter:	Feet are strong on the	[Left]
	EM parameter:	There is an extrametrical syllable	[No]
c.	**Parameters that are still irrelevant**		
	EoE parameter:[46]	The extrametrical syllable is on the	[Right/left]
	Main stress parameter:	The word-tree is strong on the	[Right]
	OB parameter:	The main stress foot must branch	[No][47]
	Defooting parameter:	A weak foot is defooted in clash	[No]

[45] It should be noted that the order of the parameters within a stage does not necessarily reflect the order in which parameters are set at that stage. It could, however, be the case that the parameters within a stage are ordered, and that, in fact, more stages can be distinguished. However, my data did not provide evidence for this. I suggest that further research focus on this question.

[46] If the EM parameter is fixed in the value [No], this parameter will not become relevant at all.

[47] See section 7.6.4 for a discussion of this parameter and its default value.

7.6.4. The transition from stage 3 to stage 4

At stage 4 there are still three possible parameters to be set, the ones given in (33c) minus the (early) EoE parameter. The prediction made by the Dresher & Kaye model is that the main stress parameter is set before the defooting parameter. They assume that defooting (destressing) takes place in the destressing component. I leave this parameter out of consideration. The obligatory branchingness parameter has to be set before main stress is assigned, since it has an effect on the location of main stress. This section focuses on the word-tree dominance parameters.

When the level stress forms of stage 3 are compared with the input forms, the child may discover that there is a difference between main stress and secondary stress in the adult forms; therefore s/he may focus on the location of main stress. Since the child has trisyllabic forms which have the same foot structure, but different stress patterns, s/he knows that some forms must be regular, and others must be marked as exceptions to the word-tree dominance parameters.

Since the disyllabic target words with final stress are now produced correctly, we can decide that children have learned that main stress is assigned to the rightmost foot. However, we would expect to find main stress on the rightmost foot in longer words too. This prediction is not borne out by the data. When Tirza, for example, makes a distinction between main and secondary stressed syllables, she produces all trisyllabic target words with main stress on the leftmost foot, as shown in (34), although she often sticks to level stress, as shown in (32c). The target words in (34a) have main stress on the final syllable; those in (34b) have main stress on the first syllable. However, Tirza does not treat these words differently. The target words in (34b) are usually analysed as being exceptions to the Dutch stress system, since they all end in a superheavy syllable, which would normally be stressed. In other words, the final syllables of the words in (34b) are marked as exceptions to (late) extrametricality in adult Dutch or as exceptions to the obligatory branchingness parameter.

(34) *Tirza*

a.	microfoon	/ˌmiːkroːˈfoːn/	→	[ˈmiːkəˌsoːn]	(2;0.5)
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːkəlˌtɔj]	(2;1.17)
	Amsterdam	/ˌɑmstərˈdɑm/	→	[ˈɛmstəˌdɛm]	(2;3.27)
	koningin	/ˌkoːnɪˈŋɪn/	→	[ˈkoːnɪˌŋɪŋ]	(2;5.5)
b.	allemaal	/ˈɑləˌmaːl/	→	[ˈɑnəˌsaːi]	(2;1.17)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈoləˌlɑmp]	(2;3.12)
	allemaal	/ˈɑləˌmaːl/	→	[ˈɑləˌmaːl]	(2;5.5)
	goochelaar	/ˈχoːχəˌlaːr/	→	[ˈfoːχəˌlaːi]	(2;6.12)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈɔliːˌfɑnt]	(2;6.12)
	ooievaar	/ˈoːjəˌvaːr/	→	[ˈoːjəˌfaːɹ]	(2;6.12)

Robin shows exactly the same pattern; some data are given in (35):

(35) *Robin*

a.	kapitein	/ˌkaːpiːˈtɛin/	→	[ˈpaːpiːˌtɛin]	(2;1.7)
	telefoon	/ˌteːləˈfoːn/	→	[ˈteːləˌfoːm]	(2;1.7)
	Amsterdam	/ˌɑmstərˈdɑm/	→	[ˈaːpstəˌdɑm]	(2;4.29)
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkoːkəˌdɪw]	(2;4.29)
	paraplu	/ˌpaːraːˈplyː/	→	[ˈpɑləˌpyː]	(2;4.29)
b.	heleboel	/ˈheːləˌbuːl/	→	[ˈheːləˌbuː]	(2;3.22)
	allemaal	/ˈɑləˌmaːl/	→	[ˈaːləˌmaːl]	(2;4.8)
	olifant	/ˈoːliːˌfɑnt/	→	[ˈoːviːˌɑnt]	(2;4.8)
			→	[ˈoːΦiːˌfɑnt]	(2;4.8)

Noortje also assigns main stress to the leftmost foot, when she starts making a distinction between main stress and secondary stress, as shown in (36a, b):

(36) *Noortje*

a.	Sinterklaas	/ˌsɪntərˈklaːs/	→	[ˈhiːtɑˌtaːs]	(2;8.25)
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈdoːkɛˌdiːw]	(2;9.26)
b.	olifant	/ˈoːliːˌfɑnt/	→	[ˈɑuliːˌhɑn͡ts]	(2;8.1)
	ananas	/ˈɑnaːˌnɑs/	→	[ˈɑŋəˌnɑs]	(2;8.1)
	allemaal	/ˈɑləˌmaːl/	→	[ˈaːləˌmau]	(2;11.0)

It looks as if these children have discovered that the first *branching* foot from the right receives main stress. In principle, the children could also have assigned main stress to the leftmost foot. However, if this is the case, we would have expected that the disyllabic forms with final stress would also be stressed on the first foot, which is never the case.[48] One explanation could be that the first syllables of these words do not form a 'complete' foot:[49] they are 'degenerate', since most of them consist of a single light syllable. In other words, these children could still have discovered that the rightmost branching foot receives main stress; if there is no branching foot, the rightmost foot receives stress. Main stress is then assigned to the first branching foot on the right.

Crucial evidence against the hypothesis that main stress is assigned to the leftmost foot has to come from longer words, which contain two complete feet, or from trisyllabic productions of target trisyllabic words with medial stress, and a heavy first syllable, since this syllable forms a foot on its own. These data are scarce, although a few are found. They are given in (37):

[48] That is, if the child realises two feet, it is never the case that the first foot receives main stress, and the second foot secondary stress.

[49] If the 'minimal word' plays such a crucial role, it follows that the child only marks the final consonants in words like *Robin* and *robot* as extrametrical, since if the final foot is made extrametrical, the remaining part is not a complete foot.

(37) a. *Robin*
macaroni /ˌmaːkaːˈroːniː/ → [ˌmaːkiːˈoːniː] (2;3.22)
b. *Noortje*
limonade /ˌliːmoːˈnaːdə/ → [ˌmiːmoːˈmaːtə] (2;8.1)
c. *Tirza*
tracteren /ˌtrɑkˈteːrə[n]/ → [ˌtɑkˈteːʀə] (2;5.21)
d. *Leon*
televisie /ˌteːləˈviːsiː/ → [ˌteːləˈfiːsiː] (2;1.7)

Although more data are certainly required to make absolute statements, these data nevertheless seem to point out that main stress is assigned to the first branching foot from the right. The question that remains to be answered is what has triggered the setting of the OB parameter.[50]

One hypothesis is that the default value for the main stress parameter is that main stress is assigned at the same edge as where the foot-building procedures start. Since the default value for the directionality parameter is [Right-to-left], it follows that the default value for the main stress parameter is that main stress is assigned to the rightmost foot. If this hypothesis is correct, the trigger for setting the OB parameter is the presence of main stress on an antepenultimate syllable. This cue is present in the data (34b), (35b) and (36b). However, on the assumption that [No] is the default value for the OB parameter, i.e., the main stress foot does not have to branch, we would expect that the production forms in (34), (35) and (36) are preceded by a stage at which the final foot receives stress. When the child encounters the target forms in (34a), (35a) and (36a), nothing would change, since these data do not result in conflicts in the configuration of parameter values. On the other hand, the target forms in (34b), (35b) and (36b) would trigger the setting of the OB parameter to the marked value. This would then result in the production forms in (34), (35) and (36). However, no such intermediate stage is attested for these children. It could be the case that these children simply do not decide about main stress until they are sure about the value for the OB parameter (that is, until the cue 'antepenultimate syllable with main stress' is found). Only when the OB parameter is set do they stop producing these words with level stress. The prediction is that at a later stage the forms in the (a)-examples of (34), (35) and (36) will be detected as exceptions to the OB parameter. Leon's data illustrate this. Moreover, his data seem to show the intermediate stage where main stress is assigned to the rightmost foot in all cases. The trisyllabic target forms are invariably first produced with final stress (38a). Subsequently, target words with main stress

[50] The OB parameter corresponds to the Lexical Category Prominence Rule (LCPR) (Hayes 1981, van der Hulst 1984). If a word does not contain a branching (disyllabic) foot, the final foot receives main stress (assuming that main stress is on the rightmost foot), as in the case of disyllabic words with final stress.

on the first (antepenultimate) syllable are produced correctly (38b). This is followed by a stage at which trisyllabic words with main stress on the final syllable are also produced with initial stress (38c). Still later, the child recovers from the incorrect main stress assignment on these forms, probably by marking them as exceptions to the OB parameter (38d):

(38) *Leon*

a.	ooievaar	/ˈoːjəˌvaːr/	→	[ˌoːfaːˈfaː]	(1;10.1)
	olifant	/ˈoːliːˌfɑnt/	→	[ˌɔnəˈfɑnt]	(1;10.15)
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˌtiːtyːˈtyːl]	(1;10.15)
	pelikaan	/ˌpeːliːˈkaːn/	→	[ˌmeːkaːˈkaːn]	(1;10.15)
	indiaan	/ˌɪndiːˈjaːn/	→	[ˌɪndiːˈjaːn]	(1;10.29)
b.	olifant	/ˈoːliːˌfɑnt/	→	[ˈoːnəˌfɑnt]	(1;11.12)
	ooievaar	/ˈoːjəˌvaːr/	→	[ˈoːfiːˌfaː]	(1;11.12)
	kangoeroe	/ˈkɑŋguːˌruː/	→	[ˈkɑŋgəˌʀuː]	(2;1.21)
c.	krokodil	/ˌkroːkoːˈdɪl/	→	[ˈkʀoːkuːˌdɪl]	(2;2.4)
			→	[ˈkoːkɔˌdɪl]	(2;2.4)
	Amsterdam	/ˌɑmstərˈdɑm/	→	[ˈɑmstəˌdɑm]	(2;3.18)
d.	krokodil	/ˌkroːkoːˈdɪl/	→	[ˌkʀoːʀoːˈdɪʋ]	(2;4.15)
	papegaai	/ˌpaːpəˈχaːj/	→	[ˌpɑpəˈχɛij]	(2;4.15)
	apparaat	/ˌɑpaːˈraːt/	→	[ˌɑpɑˈʀaːt]	(2;8.5)

Leon's data in (38a) seem to indicate that the default value for the OB parameter is [No], i.e., the foot receiving main stress does not have to branch, and main stress is therefore assigned on the final foot of the word. When he discovers the cue for the marked value of this parameter, the existence of main stress on the antepenultimate syllable, all forms are subject to change. However, the words in (38c) are now incorrectly produced with antepenultimate stress. When these forms are checked against the input data, a mismatch is discovered. However, since the parameter is already set to the marked value, there is no other way to resolve this mismatch. Therefore, the forms in (38c) are marked as exceptions to the OB parameter.[51]

Leon's data show that the default value for the OB parameter is [No].

[51] It should be noted that descriptively the late extrametricality parameter and the obligatory branchingness parameter are equivalent. I prefer to use the latter, though, since it directly expresses the relation with main stress location. The late extrametricality parameter which marks a syllable extrametrical after foot formation does not seem to be appropriate, since it does not directly express the relationship between late extrametricality and the location of main stress. It would be better to mark a monosyllabic foot as extrametrical (see Lahiri & Koreman 1988). However, the obligatory branchingness parameter is more general. Furthermore, the location of main stress on the final syllable of disyllabic words consisting of two feet follows without further stipulations. Moreover, the EoE parameter is no longer necessary.

The other children have presumably already set this parameter to the marked value [Yes].

If a word does not contain a branching foot, main stress is assigned to the rightmost foot (as in disyllabic words with final stress). Alternatively, the two syllables are parsed into one foot, as seems to be the case in the data in (30c). After the stage (stage 3, (30b)) at which disyllabic words with a final closed syllable but initial stress are produced with level stress (*Robin* /ˈrɔbɪn/ is produced as [ˈhɔˈpɪn]), Robin produces these words correctly with initial stress at stage 4 (*robot* /ˈroːbɔt/ is produced as [ˈhoːpɔs] (30c)). How does Robin get rid of these 'errors' produced at stage 3? When the forms produced in (29), the disyllabic target forms with final stress produced as disyllabic words with level stress, i.e., *konijn* /koːˈnɛin/ produced as [ˈkoːˈnɛn], are sent to the applier to check whether the configuration of parameter settings at stage 3 (33) are sufficient to assign stress correctly, the applier produces stress correctly.[52] When forms like the ones in (30b) are now produced the applier discovers a mismatch between the stress pattern of the output forms and that of the input forms. However, the QS parameter is already set. On the assumption that learning is deterministic, the child cannot retreat from this setting. Therefore, the forms in (30b) are marked as exceptions to the current parameter settings. The child may now subject these forms to reanalysis. S/he may conclude that these forms are exceptional in that the final syllable does not receive stress, although it normally would have had final stress. Apparently the final syllable is exempted from the parse, and is marked as extrametrical.[53]

It should be noted, however, that this analysis predicts that disyllabic words with final closed syllables have final stress. In other words, forms like *giraf* and *ballon* are treated as the regular cases, whereas words like *pinguin* and *robot* are treated as exceptions, because they have an extrametrical element.

Another prediction made on the basis of the marked values for the QS parameter and the Weight parameter is that words like *cadeau* /kaːˈdoː/ are produced as disyllables with initial stress, as at stage 2, because they do not have a final closed syllable. The database did not contain these words during stage 3.[54] However, if the child had produced [ˈkaːdoː], the applier would ultimately have discovered that this form does not match the input form. Since the QS and Weight parameters have, again, already been fixed, the applier has to mark this form as exceptional: these forms have to be marked

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[52] Although there is one stress too many, this still counts as a match (see section 7.5). These forms are now possibly marked for the destressing component. Alternatively, these forms are sent back because main stress has not been assigned.

[53] Alternatively, the child may conclude that the final syllables of the words in (30b) are not heavy and thus may mark the final consonant as extrametrical. In any event, both syllables of the words are parsed into a single foot, which receives main stress. See also footnote 52.

[54] All the attested forms were produced as diminutives: [ˈdoːt͡ʃə].

for lexical stress on a final light syllable. This model of acquisition shows that the child is able to detect exceptions, which then can be subjected to a different analysis. They do not disturb the regular pattern.

To summarise, we have seen that the transition from stage 3 to stage 4 is triggered by cues for both obligatory branchingness and main stress. The presence of trisyllabic forms with antepenultimate stress, as well as the presence of trisyllabic target forms with final stress, has alerted the child: one of these forms must be exceptional. On the hypothesis that main stress is assigned from the same edge as secondary stress, the trisyllabic target forms with antepenultimate stress contain the relevant cue to detect that feet receiving main stress must be branching. Leon's data showed that the unmarked value is that the foot receiving main stress does not have to branch: it has the default value [No]. When the OB parameter is set to the marked value, these forms are subject to change: they are now produced with antepenultimate stress. The child now has to start marking the target forms with final stress as exceptions to the OB parameter.

If the default value for the OB parameter had been [Yes], the disyllabic words with final stress could lead the child to set the parameter to the marked value [No]. However, s/he could not go back to the required marking [Yes], on the assumption that learning is deterministic.[55]

A final remark needs to be made on the disyllabic forms with final stress. These are either exempted from extrametricality, because the remaining part of the word is not a proper foot (it is 'degenerate'); or they are exceptions to the marked value of the OB parameter, because there simply is no branching foot in these words. Main stress is therefore assigned to the final foot.

However, it should also be noted that the initial syllable is often produced without stress. At stage 3 these words were produced with equal stress on both syllables. At stage 4 the child may have detected a stress clash for the first time; s/he now has found the cue to set the defooting parameter to the marked value [Yes]. Thus, at stage 4 the remaining parameters are set. In other words, the child has mastered the stress pattern of the language, since all parameters now have the value as indicated in section 7.1.1. They are set in the order given in (39).

I have hypothesised that, once the child knows the direction in which feet are built, this same direction is used for assigning main stress, as a default strategy. In this way, the patterns of main stress assignment could be explained. Moreover, it confirms the hypothesis of Dresher & Kaye that exceptions always go in the unmarked direction. The default value for the

[55] However, it is not easy to define a positive cue for the marked value [Yes] for the OB parameter. A positive cue exists for the value [No]: the existence of main stress on a non-branching foot in the presence of a branching one is a positive cue to detect the marked value [No]. It should be noted, however, that the same problem arises with the late extrametricality parameter.

(39) **Order in which the parameters become relevant/are set by the child**

a. STAGE 1 *(by default, but never changed to the marked value)*

Directionality parameter.	Feet are built from the	[Right]
Headedness parameter.	Feet are strong on the	[Left]
EM parameter.	There is an extrametrical syllable	[No]
QS parameter.	Feet are QS	[No]
Iterativity parameter.	Feet are iterative	[No]
B/U parameter.	Feet are	[Binary]

b. STAGE 2

No additional parameters become relevant, nor does parameter setting take place.

c. STAGE 3

Directionality parameter.	Feet are built from the	[Right]
Headedness parameter.	Feet are strong on the	[Left]
EM parameter.	There is an extrametrical syllable	[No]
QS parameter.	Feet are QS	[Yes]
Weight parameter.	Closed syllables are heavy	[Yes]
Iterativity parameter.	Feet are iterative	[Yes]
B/U parameter.	Feet are	[Binary]
Defooting parameter.	A weak foot is defooted in clash	[No]

d. STAGE 4

Directionality parameter.	Feet are built from the	[Right]
Headedness parameter.	Feet are strong on the	[Left]
EM parameter.	There is an extrametrical syllable	[No]
QS parameter.	Feet are QS	[Yes]
Weight parameter.	Closed syllables are heavy	[Yes]
Iterativity parameter.	Feet are iterative	[Yes]
B/U parameter.	Feet are	[Binary]
Main stress parameter.	The word-tree is strong on the	[Right]
Obligatory branchingness parameter (OB parameter)	A foot receiving main stress must be branching	[Yes]
Defooting parameter.	A weak foot is defooted in clash	[Yes]

[ ] = by default; [__] = marked setting, [.....] = not known whether it is default or marked value

OB parameter is [No], and we have seen that the forms that were marked by the children as exceptions are the ones which are exceptions to the marked value of the OB parameter; that is, exceptions go in the unmarked direction. Whether there is more and independent evidence for this hypothesis has to be answered by future research.

The main difference in the order in which parameters are fixed by the child and by YOUPIE is that the child fixes the directionality and headedness parameters very early, while YOUPIE first sets the quantity-sensitivity and Rh/Nu (or weight) parameters. However, like YOUPIE children are able to fix all the stress parameters correctly, and they do so before the age of 3.

7.7. Summary and conclusions

1. It has been shown that the model proposed by Dresher & Kaye is not only successful as a model for machine learning; it also sheds more light on child language acquisition. On the assumption that learning is deterministic, and that UG contains, besides a set of principles and parameters, a set of cues associated with the parameters, the child is able to set the parameters to the values required by the language s/he is learning on the basis of simple data. It has furthermore been shown that acquisition of stress takes place along parametric dimensions, just like the acquisition of syllable structure (as described in chapters 4 and 5). The transitions from one stage to the next often involve either the extension of the child's template or a change in one or more parameter values. The transitions can be summarised as follows.

Transition from stage 0 to stage 1
At stage 0 the child only has monosyllabic words. The transition from stage 0 to stage 1, in which the child realises disyllabic words, is triggered by the existence of disyllabic words in the input. At stage 1 the notion of foot becomes relevant. The child has to decide what kind of feet the language has. S/he has to figure out what the required settings for the directionality and headedness parameters are. On the assumption that the default value for the directionality parameter is [Right-to-left], I argued that the default value for the headedness parameter in [Left-headed]. This explains why disyllabic target words with initial stress are produced correctly, while disyllabic words with final stress are truncated. The data further provide evidence for the default value [QI] for the QS parameter, and [Binary] for the B/U parameter. Other parameters are simply not relevant at this stage.

Transition from stage 1 to stage 2
When the child compares his or her monosyllabic productions of disyllabic target words with final stress with the target forms, s/he concludes that there are no mismatches concerning the location of stress. However, there is a mismatch in the number of syllables. Therefore, the child produces an extra syllable, but has not found a trigger to change stress parameters. The string of segments is mapped onto the child's QI trochaic template, resulting in initial-stressed disyllabic productions of target disyllabic words with final stress.

Transition from stage 2 to stage 3
When these initial-stressed disyllabic productions are compared with the target words, the child discovers a mismatch concerning the location of stress. The existence of $[\sigma_s\ \sigma_w]_{Wd}$ and $[\sigma_w\ \sigma_s]_{Wd}$ adult words in the input triggers the setting of the QS parameter: this parameter is set to the marked

value [QS]. At this stage the child must also find out what determines QS in the language. I showed that the child regards all closed syllables as heavy. Heavy syllables receive stress.

Not only the QS and the Weight parameters need to be set at this stage, also the iterativity parameter becomes relevant, since either $[\sigma_s\ \sigma_w]_{Wd}$ or $[\sigma_w\ \sigma_s]_{Wd}$ targets must contain more than one foot. The child sets the iterativity parameter to [Yes]. Furthermore, the child assigns stress to each foot in the word, resulting in level stress. So far, there has not been evidence to set the main stress parameter. All feet receive an equal amount of stress, resulting in forms with level stress. It has also been shown that the child has set the B/U parameter as well at this stage.

Transition from stage 3 to stage 4

If the level stressed output forms are compared with the input forms, the child receives evidence for setting the main stress parameter, since in the target words one foot receives more stress than the other(s). It has been argued that the default value for main stress assignment is related to the value for the directionality parameter. If the directionality parameter has the value [Right-to-left], main stress is assigned to the rightmost foot.

The existence of target words with antepenultimate stress triggers the setting of the OB parameter to the marked value [Yes]. The result of this parameter setting is that main stress is assigned to the rightmost branching foot. If there is no branching foot, main stress is on the rightmost foot of the word.

2. It has been shown that there are important differences between YOUPIE and child learners. First, while YOUPIE is a batch mode learner, which collects all data and then fixes all parameter values, children are incremental learners, although they are batch mode learners to some extent. That is, they do not set parameters based on single words, but collect data for some period before fixing a parameter. During this period the child checks the input for inconsistencies in the data. Only when a certain cue is found in a certain number of cases does the child actually set the associated parameter. This ensures that parameters are not set on the basis of exceptions or infrequent patterns in the data (principle of robustness) and explains the gradualness of transitions. Furthermore, children do not focus on parameters until they are 'ready': not all parameters play a role from the start.

Second, since incremental learners cannot make use of negative evidence in the input data, it follows that children can only fix parameters on the basis of positive evidence. This has some consequences for the unmarked values of parameters. For example, the cue used by YOUPIE to set the iterativity parameter is based on negative evidence: the absence of secondary stress in words was used to determine the marked value [Non-iterative]. I have shown that, since children only make use of positive cues, the default

value must be assumed to be [Non-iterative], since the presence of secondary stress is positive evidence for the marked value [Iterative]. I have furthermore illustrated that the data seem to confirm this.

I have not found evidence for a stage at which the B/U parameter requires the value [Unbounded]. This can be seen as an argument for the claim that unbounded feet do not exist (Prince 1983, 1990, Hayes 1991). As a consequence, the problem of switching from the default value [Binary] if the QS parameter is [QI] to the default value [Unbounded] if the QS parameter is set to the marked value [QS], does not arise in child language.[56]

Third, I showed that the 'cranker' in the Dresher & Kaye model is not needed, if the model is set up in such a way that it can run through the learning procedure several times. This is a desirable result, since the cranker is an unintelligent brute force learner which simple checks all possible combinations of parameter values. Moreover, such a learner is computationally very costly.

Fourth, there are important differences between the input to the machine learning system and that to the child's learning system. We have seen that children may use a 'selection strategy', in that they only select certain input forms. For example, disyllabic target words with final stress seem to be avoided by many children at the initial stages of acquisition. We have seen similar 'selection' strategies in the acquisition of syllable structure (chapters 4 and 5). Moreover, the whole adult target word is not necessarily used as input to the child's learning system. The child may pay attention to part of the adult target word, neglecting the rest. We have seen that this was the case at stage 1, where only one foot was selected. At the following stage the selected part is possibly augmented by one other syllable from the adult target, which is adjoined to the previous one. Thus, at stage 2 the input to the learning system invariably consists of two syllables, which need not form a foot in the adult target. They do, however, form a foot in the child's output form. This means that the input to the child's learning system (as distinguished from the input the child receives from his or her environment) is not fixed, but is subject to change in the course of development. The input to YOUPIE's learning system is fixed; in this sense it is comparable to the adult input that children receive. Furthermore, the input to YOUPIE is fully segmented, syllabified and coded for stress levels. This is not necessarily the case of the input to the child's learning system: it may not be fully segmentalised and syllabified, dependent on the syllable parameters at the point in the development. Moreover, there is no evidence that children at the initial stages make a distinction between main and secondary

[56] Languages which have been analysed as having unbounded feet have to be reanalysed. Further research has to show how a child distinguishes between, for example, Dutch and Eastern Cheremis.

stress. Thus, the input to the child's learning system is already influenced by the child's linguistic knowledge. Also, the child's own production forms (the output forms) are important to the learning system. Finally, another important difference between the input to the child's learning system and that to YOUPIE is that children, unlike YOUPIE, are able to fix many of the parameters on the basis of fairly short words.

3. The analysis presented here differs in some respects from the standard analyses of Dutch stress. First, I propose a different parameter for deciding on what makes a syllable heavy, since children seem to regard any closed syllable as heavy. To capture the fact that superheavy syllables of the form [VVC] are considered as closed syllables I assumed that the relevant input consists of syllables minus their onsets, to include extrarhymal consonants.

Second, I argued that late extrametricality can best be represented by assuming that the set of word-tree dominance parameters contains an obligatory branching (OB) parameter, i.e., 'feet receiving main stress must be branching', whose default value is [No].

Third, I showed that final-stressed disyllabic words ending in a final closed syllable are regular, rather than irregular, as assumed in the standard analyses of Dutch stress, according to which final closed syllables are extrametrical. However, by assuming the OB parameter rather than a late extrametricality parameter this follows: if a word does not contain a branching foot, the rightmost foot receives main stress.

4. I proposed default values for the parameters for which Dresher & Kaye did not determine default values. I hypothesised that the default value for the directionality parameter is [Right-to-left]. The default value for the headedness parameter is directly dependent on the value for the directionality parameter, as shown in section 7.6.1, and is [Left-headed] given [Right-to-Left] parsing of feet. I assumed that the default value for the main stress parameter also depends on the value for the directionality parameter: main stress is assigned at the edge at which foot parsing starts; in this case, the right edge.

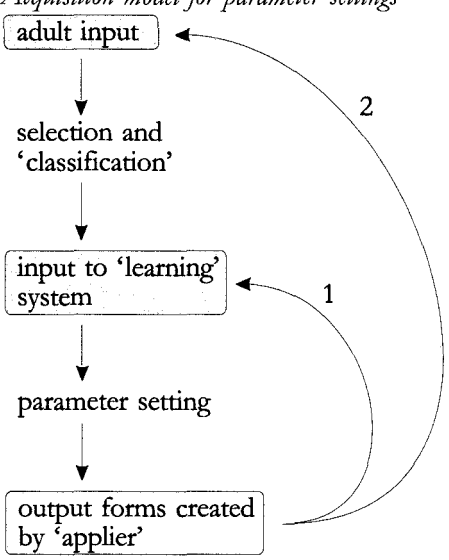
5. It has been argued that, at each stage of the development, the child's template is determined by the current configuration of parameter values. These parameter values (and thus the child's template) also determine the nature of the relationship between input (adult target) forms and output (the child's produced) forms. Input words are mapped onto the child's template to create an output. Mismatches between input and output occur when the child's template is not able to accommodate all elements of the input word. If the child's template, for example, is exactly one foot, target words consisting of more than one foot are either reduced to a single foot (as at stage 1), or the melodic material of the adult target is mapped onto the child's template (as at stage 2). Thus, mismatches between the adult target

words and a child's output forms can result if the child's template is not large enough to represent the whole word, or if the child's template is different from that of the adult, for example consisting of a different foot type. This is not only true for stress, but also for syllable structure, as was shown in chapters 4 and 5. The part of the target word that cannot be mapped onto the template is deleted by stray erasure. That is, it is not licensed by the child's template and it will therefore not be realised. In other words, the representations are governed by a universal prosodic licensing principle (see chapter 1, and Itô 1989). There are no deletion rules. Errors with respect to stress in the child's language are not the result of wrongly fixed parameters (or rules), but are the result of parameters not yet fixed: they still have the default value. The acquisition of prosodic phonology does not involve the learning of rules, but involves the setting of parameters.

A mismatch between input and output forms leads the child to reconsider the input data, and to seek for other cues, which will eventually result in the setting of parameters which have not yet been set (and still have the default value); alternatively, the child may use mismatches to detect exceptions, in which case the input is also reconsidered to discover to which parameter the input forms are exceptions. In other words, the input data are run through the learning system until a complete match is reached.

To conclude, the child acquisition model for prosodic structure can be schematised as follows:

(40) *Acquisition model for parameter settings*



1. The output is first checked against the input to the 'learning system'.
2. Then the output is checked against the adult input. If there are mismatches, the adult input forms go through the system again.

The adult input is first subject to selection and 'classification'. Children may only select certain target words that match with their own template. This has been referred to as the 'selection strategy'. The adult input is further checked for inconsistencies before it enters the child's 'learning' system. I assume that the input is syllabified according to the syllable parameters of the child at that time; and further, that syllables are marked as either stressed or unstressed at the initial stages. Only later does the child make a distinction between main and secondary stress. The 'learning' system tries to find cues for parameter values on the basis of this modified input. The parameter values that are detected play a crucial role in producing the output. The child's output is first checked against the input to the learner: mismatches between these input forms and the output forms should not occur if parameter setting has been successful, but if they do, the input forms are once more sent to the learning system until there is a complete match. The child's output forms are also checked against the adult input, since the child has to learn the language of his or her environment. This can result in modifications to the input to the learning system. These new input forms go through the learning system, etc. At the final state, which will eventually be reached after many cycles, the child has mastered the adult's grammatical system.

8 Summary and Conclusions

THIS THESIS DEALS with the acquisition of prosodic structure below the word level: i.e., the acquisition of syllable structure and stress. Its focus is on both the *logical* and the *developmental* problem of acquisition. The first addresses the question of how a grammatical system can be learned on the basis of the data and on the assumption that UG, the set of universal principles and parameters, is innate. The second focuses on the stages that can be identified in the course of development and seeks to find an explanation for the transition from one stage to the next. Although these two problems have often been separately addressed, they should ideally be combined. This is accomplished in this dissertation: I have shown at various places that the transition from one stage to the next often means a change in one or more parameter values.

The basic assumptions and preliminaries are given in CHAPTER 1. I have assumed a *'principles and parameters'* approach. Universal principles are innate and need not be learned. Although the set of parameters is claimed to be universal, the values for the parameters vary from language to language: they determine the variation between languages. It is the child's task to determine the parameter values of the language s/he is learning on the basis of the input data. The language of the environment forms one form of input (*positive evidence*). I have shown in this thesis that there are two other important sources of input: (i) the *child's output may function as input*, and (ii) *indirect negative evidence*, i.e., the systematic lack of certain data. I put forward the hypothesis that the core grammar (the set of parameter values) of a language is learned on the basis of positive evidence only. Language-specific properties, which lie outside the core grammar, are learned on the basis of indirect negative evidence. On the assumption that children are conservative learners, i.e., they only change their grammatical system if they have received 'enough' evidence, it follows that language-particular properties, learned on the basis of indirect negative evidence, are learned late. This thesis provides evidence for this hypothesis at several places (chapters 4, 5, and 7).

An important property of UG is that its parameters have a default value. In this sense markedness is part of UG: the default value is the unmarked value. Or stated differently, the value for which positive evidence is most

available is the marked value (*subset principle*). A parameter can be set to the marked value if there is positive evidence for the marked value. I provided evidence for a cue-based model (proposed by Dresher & Kaye 1990): each parameter is associated with an appropriate and robust cue for which the learner is looking. If a cue is found, the associated parameter is set to the marked value.

The child's word template at the earliest stages is determined by the default values of the parameters. If one or more parameters are set to the marked value, the child's template changes in the direction of that of the adult. At the early stages the child's template is very simple, and cannot accommodate all segmental material of the target words. Material that cannot be mapped onto the template is not licensed, and therefore subject to stray erasure. It is *not* subject to a deletion rule. In general, the child tries to incorporate as many properties of the target word as can be accommodated into his or her template. If there is excessive material it is subject to stray erasure; if the target does not provide enough material, the child's template is filled otherwise. Both are instances of a '*repair strategy*'. Another strategy often found is that of *selection*: the child exclusively selects adult words of which the properties fit into the child's template.

The research reported on in this dissertation is based on spontaneous data from twelve children acquiring Dutch as their first language. The children, aged between 1;0 and 1;11 at the start of a one-year period of data-collection, were recorded every other week. The data were phonetically transcribed and entered into a computerised database. CHAPTER 2 gives a detailed description of the methods and materials.

CHAPTER 3 provides the background for chapters 4 and 5. It describes the two most commonly held views on the structure of the syllable: the 'onset–rhyme' and the 'moraic' syllable. The main difference between the two views is that the latter does not recognise onsets, rhymes, nuclei and codas as subsyllabic constituents, but claims that (i) reference to onset constituents is never needed, and (ii) moras are the only subsyllabic constituents.

In the second part of chapter 3 an overview of syllable structure in Dutch is given. Two other properties of Dutch are discussed: (i) the relation between length and weight; and (ii) the apparent lack of the CV core syllable.

The remaining chapters deal almost exclusively with Dutch acquisition data.

CHAPTER 4 deals with the acquisition of onsets. Five general stages can be distinguished. (i) At the first stage onsets are obligatory. The child realises all onsets as plosives. The child seems to strive for a maximal contrast in sonority between the onset (plosive) and nucleus (low vowel) (Jakobson

1941/68). At this stage all parameters are in the default value, resulting in the universal core syllable CV. (ii) At the second stage, onsets become optional. The minimal onset parameter is set to the marked value. (iii) At the third stage different types of segments occur in onset position: first, nasals appear, and later also fricatives, glides, and liquids. (iv) For most children the next stage is one at which obstruent-sonorant clusters appear: the maximal onset parameter is set to the marked value. (v) At the next stage /s/-obstruent clusters are produced, which indicates that the extrasyllabicity parameter is set to the marked value. However, some children have /s/-obstruent clusters earlier than obstruent-sonorant clusters, showing that the maximal onset parameter and the extrasyllabicity parameter are independent.

The acquisition of obstruent–sonorant clusters takes place in three steps: (1) reduction to the obstruent; (2) reduction to the sonorant; (3) production of an obstruent–sonorant (plosive–liquid/glide) cluster. The second step is optional: it is not attested for all children. A similar pattern is found for /s/–obstruent clusters: (1) reduction to the obstruent; (2) reduction to /s/ (optional stage); (3) production of /s/–obstruent cluster.

I assumed that the Sonority Sequencing Principle (SSP) is universal, and that segments that do not obey the SSP lie outside the scope of the syllable. If a child allows complex onsets, /sl/ and /kn/ clusters are analysed as complex onsets, rather than an onset preceded by an extrasyllabic segment (the standard analysis of Dutch). Since both segments obey the SSP and can be mapped onto the child's bipositional onset template, there is no evidence for the child that forces him or her to assume a different analysis.

Although the child does not receive positive evidence for /tl/ and /pv/ clusters, s/he frequently produces them. These clusters are disallowed in Dutch: consonants in the onset may not share place of articulation (PoA) features. However, since children prefer words in which all segments have the same PoA features, these forms are frequently attested. The child has to learn from the absence of matches between the output forms and the input forms (i.e., indirect negative evidence) that Dutch has a constraint disallowing homorganic onset clusters.

CHAPTER 5 describes and explains the patterns found in the acquisition of rhymes. Five stages have been distinguished. (1) The child only allows open syllables consisting of a consonant and any vowel (either long or short): the core syllable. No parameters have been set. Vowel length is non-distinctive.

(2) At the next stage the child sets the branching rhyme parameter to the marked value, allowing codas. However, only obstruents (first fricatives and later also plosives) are allowed. Sonorants are deleted.

(3) The branching nucleus parameter is set to the marked value, allowing two-positional nuclei. However, since there is a universal principle stating that rhymes are maximally binary (maximal rhyme constraint), vowel length

cannot be represented if a final consonant is realised. The fact that the child's output forms strictly obey the maximal rhyme constraint, despite many counterexamples in the input, is further evidence for the claim that this constraint is universal. At this stage sonorants are sometimes realised: they are realised if preceded by a short vowel, but deleted if preceded by a long one. Furthermore, they are sometimes deleted under triggering of vowel lengthening (compensatory lengthening). Obstruents do not have such a relationship with the preceding vowel. I therefore argued that obstruents and sonorants are in different positions: obstruents are in the coda, while sonorants are part of the nucleus. Compensatory lengthening occurs within a constituent (the nucleus), not between constituents. These data give clear support for the notions rhyme, nucleus and coda.

(4) At the next stage vowel length is represented before obstruents and sonorants. On the assumption that rhymes are maximally bipositional the child must have set the extrarhymal parameter to the marked setting, allowing an extra final consonant in addition to the bipositional rhyme. This consonant obeys the SSP, and is therefore not extrasyllabic. The prediction is that at this stage final clusters consisting of a sonorant and an obstruent appear. This prediction is borne out by the data.

(5) Final clusters consisting of two obstruents are produced very late. They require the marked setting for the extrasyllabicity parameter.

Despite the clear general pattern, there are individual differences between the children. Some children set the extrarhymal parameter earlier than the branching nucleus parameter, indicating that these parameters are independent. Some children also allow a different subset of consonants in the coda than others: while most children make a distinction between obstruents and sonorants, others have obstruents and nasals in the coda, and other sonorants in the nucleus. Further research is required, to determine the exact nature and manner of variation.

In CHAPTER 6 I investigated the relation between truncation and stress. Disyllabic words with final stress (i) are far more prone to truncation, and (ii) show more stress errors. If truncation is just the deletion of unstressed syllables this difference is not expected. Furthermore, while various stages can be determined in the acquisition of disyllabic words with final stress, disyllabic words with initial stress do generally not undergo changes.

Four stages can be distinguished in the acquisition of disyllabic words with final stress. (1) The segmental material of the (main or secondary) stressed foot at the right edge of the target is realised and mapped onto the child's trochaic template. Evidence comes from the addition of final syllables in those cases where the foot contains just one syllable.

(2) The segmental material of the leftmost (most prominent remaining) syllable is taken, adjoined to the child's previous form and mapped onto a

trochaic template. Additional evidence comes from metathesis and reduplication data, which clearly show that the child is building on his or her previous form, supporting the 'output-as-input' hypothesis.

(3) The segmental material from stage 2 is now mapped onto a two-foot template. Both feet receive equal stress.

(4) One of the feet (the rightmost branching) receives main stress. The output form resembles the adult input form.

The development can be described using the tools of prosodic theory: only reference to prosodic units has to be made. Even in cases where on the surface the 'no skipping' condition is violated, are only apparent violations. The analysis of stage 1 and 2 resembles that of prosodic circumscription: not the whole target is selected, but only part of it. The analysis furthermore explains the lack of truncation and stress errors in disyllabic words with initial stress and makes the right predictions for longer words.

The pattern of development clearly shows that the child is not just approaching the adult target, but is really learning 'rules' or rather parameter values.

Finally, I have shown that truncation of disyllabic words with final stress sometimes triggers segmental changes. There are segmental changes of two types: (a) changes in manner of articulation (MoA); and (b) changes in place of articulation (PoA). I argued that the former are context-free: similar changes occur in word-initial position. However, the changes in PoA are restricted to certain environments: if the onset of the final-stressed foot has a coronal PoA, and the onset of the first foot either a labial or dorsal one, an assimilation rule can apply which spreads the PoA features of the specified initial consonant to the (underspecified) coronal consonant.

In CHAPTER 7 the results of chapter 6 are incorporated in a parametric learning theory. In chapter 6 the focus was on prosodic constituents; in this chapter, I focus on the acquisition of the values for the stress parameters. I described the deterministic cue-based learning model proposed by Dresher & Kaye (1990), and investigated whether this model, which is successfully applied to machine learners, can also be applied to child language acquisition.

In the proposed model the learner builds prosodic representations on strings of segments on the basis of the parameter values of his or her grammar. The created output is compared with the input. In the case of a mismatch between input and output forms, the learner looks for a cue to change the system. It turns out that many transitions are the result of the setting of one or more parameters to the marked value.

I have shown that this model when applied to child language is able to explain the stages described in chapter 6 and the transitions from one stage to the next. The transition from stage 0, where the child only produces CV syllables, to stage 1 in which two-syllable words appear is triggered by the existence of disyllabic words. At this stage the notion 'foot' becomes

relevant: all output forms form one foot in the child's system. It has been argued that by default the child assumes that the language s/he is learning is quantity-insensitive. I put forward the hypothesis that the default value for the directionality parameter is 'right-to-left' parsing, resulting in quantity-insensitive trochaic feet. Parsing a QI trochaic foot from right to left explains the patterns found at stage 1. In other words, the child has not yet set any stress parameters. Comparison of output and input forms does not show a mismatch concerning the nature or location of stress, but a mismatch in the number of syllables. The next step is the addition of an extra syllable (stage 2). It does not involve the setting of stress parameters: therefore, all output words are still trochaic. If the input and output are compared, the child discovers a mismatch concerning the location of stress. The presence of both disyllabic initial-stressed and final-stressed words in the input is a reliable cue for detecting that the language is QS; that is, the QS parameter is set to the marked value. It has been shown that closed syllables are regarded as heavy, and therefore receive stress. The remaining syllable forms a foot on its own, and will also receive stress. Since closed syllables can have different syllable representations, as shown in chapter 5, syllable structure cannot directly express weight. I therefore proposed an interpretative weight parameter to determine syllable weight.

An interesting consequence of the setting of the QS and weight parameters is that disyllabic target words with initial stress and a final closed syllable are now produced incorrectly: the closed syllable receives stress. I therefore assume that the these words are exceptions to the Dutch stress system, contrary to the standard analyses of Dutch, which assume that final-stressed disyllabic words ending in a closed syllable (VC) are exceptional.

When these level stress forms of stage 3 are compared with the input, the child discovers that one foot is more prominent in the input forms. In other words, when his or her template can contain two feet the main stress parameter becomes relevant. I hypothesised that the default location of main stress is at the same edge as where foot-building procedures start: the right edge. This results in main stress on the rightmost foot (stage 4). Longer words, however, show that the child assigns main stress to the first *branching* foot from the right. If the word does not contain a branching foot, stress is on the rightmost foot. Words like *ananas* and *Portugal* are the normal case; words like *krokodil* and *parasol* are exceptional in that main stress in on the rightmost foot, rather than the rightmost branching foot, as in the standard analysis of Dutch stress.

I conclude that the model is successful as an learning model for the acquisition of prosodic structure.

There are, however, important differences between children and machine learners.

(1) The input to children differs in important ways from the input to machine learners. (a) The input data to machine learners are fully parsed, while children do not necessarily parse the whole input word: rather, it has been shown that often only part of the input form is parsed, which is then mapped onto the children's own template. Mapping plays no role for machine learning. (b) The input data to machine learners is fully segmentalised and syllabified, while children learn syllabification and stress simultaneously. (c) The input to the machine learner is fixed, while the input to child is not: the child's own output is an important form of input, and is in constant development. (d) The input data to the machine learner are coded for different stress levels (main, secondary and no stress), the child initially makes no distinction between different stress levels.

(2) A very important difference between machine learners and children is that children, unlike machine learners, set parameters on the basis of simple and short words.

(3) The machine learner is a batch mode learner; i.e., it collects all data and then sets all parameters at once. Children are typically not instantaneous learners, but are incremental learners: they go through several stages before reaching the adult grammar. Furthermore, they only look for cues when the associated parameter becomes relevant. However, it has been shown that not all parameters are relevant at the beginning. Moreover, children appear to be conservative learners: only when 'enough' evidence is gained for the marked setting of a parameter is this setting fixed. This explains the observed gradualness of the transitions.

Chomsky & Halle recognise that instantaneous learning is an idealisation and that "a more realistic model of language acquisition would consider the order in which primary linguistic data are used by the child and the effects of preliminary 'hypotheses' developed at the earlier stages of learning on the interpretation of new, often more complex, data" (1968:331). However, they assumed that "this more realistic study is much too complex to be undertaken in any meaningful way today and that it will be far more fruitful to investigate in detail, as a first approximation, the idealised model (...) leaving refinements to a time when this idealisation is better understood". I have shown in this dissertation that, 25 years later, this time has come. Despite all kinds of variation, variation between children and within children, variation in linguistic analyses, etc., detailed study of acquisition data also shows clear patterns of development.

Appendix A The International Phonetic Alphabet

revised to 1989

Consonants

	bilabial	labiodental	dental	alveolar	postalveolar	retroflex	palatal	velar	uvular	glottal
plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ	ʔ
nasal	m	ɱ		n		ɳ	ɲ	ŋ		
trill	ʙ			r					ʀ	
tap or flap				ɾ						
fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	h ɦ
lateral fricative				ɬ ɮ						
approximant	w	ʋ		ɹ		ɻ	j	ɰ		
lateral approximant				l		ɭ	ʎ	ʟ		

Where symbols appear in pairs, the one to the right represents a voiced consonant.

Vowels

	Front	*Central*	*Back*	*Front*	*Central*	*Back*
Close	i	ɨ	ɯ	y	ʉ	u
	ɪ			ʏ	ʊ	
Close-mid	e		ɤ	ø		o
		ə			ɵ	
Open-mid	ɛ		ʌ	œ		ɔ
	æ	ɐ				
Open	a		ɑ	ɶ		ɒ

Unrounded *Rounded*

Diacritics

ʰ	p^h	aspirated
◌̤	b̤	breathy voice
◌̪	t̪	dental
◌̺	t̺	laminal
◌̜	ɻ̜	less rounded
◌̹	ɻ̹	more rounded
◌̟	u̟	advanced
◌̠	i̠	retracted
◌̈	ë	centralised
◌̼	t̼	labialised
◌͡ʲ	t͡ʃ	palatalized by diminutive suffix
	t͡s	or affricates and double articulations
ʲ	tʲ	palatalized
◌̃	ẽ	nasalised
◌̚	t̚	no audible release
◌̞	e̞	lowered
◌̝	e̝	raised

Suprasegmentals

ˈ	primary stress
ˌ	secondary stress
ˑ	half-long
˘	extra short
.	syllable break
‿	linking (absence of a break)
/	reiterated articulation or pause
ː	long

Appendix B Glossary

(d) = dimunitive form

Aa

aai	'stroke'
aalmoes	'alms'
aan	'on'
aap	'monkey'
aardappel	'potato'
aardbei	'strawberry'
aarde	'earth'
accordeon	'accordion'
acht	'eight'
acne	'acne'
al	'already'
allemaal	'all'
almanak	'almanac'
Amsterdam	'Amsterdam'
ananas	'pineapple'
andere	'other'
andijvie	'endive'
Ank	*name*
apie	'monkey' (d)
apparaat	'machine'
appel	'apple'
Appo	*name*
aquarium	'aquarium'
asperge	'asparagus'
Australië	'Australia'
auto	'car'

Bb

baan	'path'
baby	'baby'
bal	'ball'
ballon	'balloon'
ballonnen	'balloons'
bam	'dong'
bamboe	'bamboo'
banaan	'banana'
bananen	'bananas'
barbecuen	'to barbecue'
bed	'bed'
beer	'bear'
beest	'beast'
Belg	'Belgian'
beneden	'down'
benzine	'patrol'
Bert	*name*
bij	'bee'
bijten	'to bite'
bim	'ding'
blaadjes	'leaves' (d)
blauw	'blue'
blazen	'to blow'
bloem	'flower'
bloemen	'flowers'
blok	'block'
blokjes	'blocks' (d)
blokken	'blocks'
boek	'book'
boerderij	'farm'
bof	'wham'
bom	'boom'
boom	'tree'
boot	'boat'
bord	'plate'
bos	'woods'
boterham	'slice of bread'
botsing	'collision'
brand	'fire'
bril	'glasses'
broek	'trousers'
broem	'boom'
brood	'bread'
broodje	'(bread) roll'
buik	'belly'
bus	'bus'

Cc

cadeau	'present'
cadeautje	'present' (d)
cadeautjes	'presents' (d)
caravan	'caravan'
cassette	'cassette'
catalogus	'catalogue'
Cato	*name*
chocola(de)	'chocolate'
circus	'circus'
Claartje	*name*
clown	'clown'
clowntje	'clown' (d)
conducteur	'conductor'
confetti	'confetti'
courgette	'courgette'
cyclus	'cycle'

Dd

daag	'bye bye'
daar	'there'
dak	'roof'
dansen	'to dance'
dat	'that'
David	*name*
denk	'think'
deur	'door'
deze	'these'
dicht	'closed'
Dick	*name*
Dicky	*name*
dier	'animal'
dik	'thick'
dit	'this'
doen	'to do'

dokter 'doctor'
door 'by'
dorst 'thirst'
draaien 'to turn'
draak 'dragon'
Dribbel *name*
drie 'three'
drinken 'to drink'
drinkt 'drinks'
dromedaris 'dromedary'
druif 'grape'

Ee

echt 'really'
eend 'duck'
eenden 'ducks'
ei 'egg'
Elke *name*
emmer 'bucket'
experiment 'experiment'
extra 'extra'

Ff

familie 'family'
fazant 'pheasant'
feest 'party'
fiets 'bicycle'
fietsen 'to bicycle'
flamingo 'flamingo'
fles 'bottle'
flesje 'bottle' (d)
Florien *name*
fluit 'flute'
fornuis 'cooker'
framboos 'raspberry'

Gg

ganzen 'geese'
garage 'garage'
geit 'goat'
gemaakt 'made'
geplakt 'stuck'
Gert *name*
gevallen 'fallen'
geweest 'been'
gezien 'seen'
gezwaaid 'waved'
Gideon *name*
giraf 'giraffe'
gitaar 'guitar'
glij 'slide'
glijbaan 'slide'
glijden 'to slide'
goochelaar 'conjurer'
gordijn 'curtain'
graaf 'dig'
grammatica 'grammar'
grapje 'joke' (d)
groen 'green'
groente 'vegetable'
grond 'ground'
groot 'big'
Groover *name*
grote 'big'

Hh

haan 'cock'
hand 'hand'
handschoentje 'glove'(d)
heleboel 'a lot'
helikopter 'helicopter'
herfst 'autumn'
hinkelen 'to hop'
hoed 'hat'
hond 'dog'
Honduras 'Honduras'
honkballen 'to play baseball'
hoofd 'head'
horloge 'watch'
huilt 'cries'
huis 'house'

Ii

ik 'I'
in 'in'
Indiaan 'Indian'
ingestopt 'put in'
inschenken 'to poured in'
insekt 'insect'
is dat 'is that'
islam 'Islam'

Jj

Janneke *name*
Jarmo *name*
jas 'coat'
jasmijn 'jasmine'
jeep 'jeep'

Kk

kaars 'candle'
kaas 'cheese'
kabouter 'gnome'
kado 'present'
kadootje 'present' (d)
kadootjes 'presents' (d)
kalkoen 'turkey'
kameel 'camel'
kangoeroe 'kangaroo'
kapitein 'captain'
kapot 'broken'
karwei 'job'
kast 'cupboard'
kasteel 'castle'
kazerne 'barrack(s)'
kermis 'fair'
kijk 'look'
kikker 'frog'
kind 'child'
kip 'chicken'
klaar 'ready'
klap 'bang'
kleien 'to work clay'
klein 'small'
kleur 'colour'
kleuren 'to colour'
klimt 'climbs'
klok 'clock'
knap 'clever'
knietje 'knee' (d)
knikkeren 'to play marbles'
knikkers 'marbles'
knip 'cut'
knippen 'to cut'
knoeien 'to make a mess'
knoop 'button'
knoopje 'button' (d)
knoopjes 'buttons' (d)
knopen 'buttons'
knopje 'button' (d)
knot 'knot'
knuf(fel) 'cuddle'
knuppel 'club'
koala 'koala'
koe 'cow'
koek 'biscuit'
koffie 'coffee'
komkommer'cucumber'
konijn 'rabbit'
konijntje 'rabbit' (d)

konijntjes 'rabbits' (d)
koningin 'queen'
kous 'stocking'
kraan 'tap'
krant 'newspaper'
krijtje 'chalk'
krokodil 'crocodile'
kroon 'crown'
krullen 'curls'
kwaak 'croak'
kwak 'quack'
kwartet 'quartet'
kwijt 'lost'

Ll

lama 'llama'
land 'land'
last 'load'
ledikant 'bed'
leeuw 'lion'
lekker 'nice'
leuk 'funny'
limonade 'lemonade'
literatuur 'literature'
locomotief 'locomotive'
loopt 'walks'

Mm

maan 'moon'
macaroni 'macaroni'
machinist 'engine-driver'
mais 'maize'
mam 'mom'
man 'man'
Marcella *name*
Marijke *name*
matras 'mattress'
matroos 'sailor'
meer 'more'
meisje 'girl'
melk 'milk'
meneer 'gentleman'
mensen 'people'
mevrouw 'lady'
microfoon 'microphone'
mier 'ant'
mij 'me'
misschien 'perhaps'
Monkey *name*
motor 'motor'
muesli 'muesli'
muis 'mouse'
muts 'hat'
muziek 'music'
muzikant 'musician'

Nn

Napoleon *name*
nat 'wet'
neus 'nose'
niet 'not'
nieuwe 'new'
nu 'now'

Oo

olifant 'elephant'
oog 'eye'
ooievaar 'stork'
oor 'ear'
oranje 'orange'
Oslo 'Oslo'

Pp

paard 'horse'
pad 'toad'
pakken 'to fetch'
paleis 'palace'
pan 'pan'
Panama 'Panama'
panda 'panda'
pantoffel 'slipper'
pantoffels 'slippers'
papegaai 'parrot'
papier 'paper'
parachute 'parachute'
paraplu 'umbrella'
parasol 'sunshade'
parkeren 'to park'
partij 'party'
pasta 'pasta'
pelikaan 'pelican'
pet 'hat'
piano 'piano'
pijn 'pain'
pinda 'peanut'
pinguin 'penguin'
plant 'plant'
plas 'puddle'
plassen 'to pee'
plons 'splash'
poes 'puss'
poetsen 'clean'
politie 'police'
pop 'doll'
Portugal 'Portugal'
praten 'to talk'
priester 'priest'
promptst 'most prompt'
pyjama 'pyjamas'

Rr

raaf 'raven'
raam 'window'
raap 'pick up'
race 'race'
ram 'ram'
ramp 'disaster'
regen 'rain'
regent 'rains'
rijden 'to drive'
rijst 'rice'
Robin *name*
robot 'robot'
rol 'roll'
rozemarijn 'rosemary'

Ss

saxofoon 'saxophone'
schaap 'sheep'
schaar 'scissors'
schapen 'sheep'
schelp 'shell'
schep 'scoop'
schildpad 'tortoise'
schoen 'shoe'
schoenen 'shoes'
schommel 'swing'
schommelen 'to swing'
school 'school'
schop 'kick'
schoppen 'to kick'
schuur 'shed'
Selma *name*
Sinterklaas 'Santa Claus'
skate-boarden 'to skateboard'
slaap 'sleep'
slak 'snail'
slapen 'to sleep'
sleutel 'key'
slof 'slipper'
sloffen 'slippers'
sloot 'ditch'
smeerkaas 'cheese spread'

smeren 'to smear'
snaren 'strings'
snavel 'bill'
sneeuw 'snow'
sneeuwen 'to snow'
snoep 'sweets'
snoepje 'sweet'
snoepjes 'sweets'
Snoopy *name*
snor 'moustache'
snorhaar 'whisker'
snotneus 'snivelling'
snottebel 'snot'
snuit 'snout'
sok 'sock'
sop 'suds'
spaghetti 'spaghetti'
speel 'play'
speel-o-theek 'playground'
speeltuin 'playground'
speen 'dummy'
spelen 'to play'
spijker 'nail'
spin 'spider'
spinazie 'spinach'
spoken 'ghosts'
spons 'sponge'
spreken 'to speak'
springen 'to jump'
spuit 'squirt'
staan 'to stand'
staart 'tail'
step 'scooter'
sterretje 'star' (d)
stoel 'chair'
stok 'stick'
stout 'naughty'
straat 'street'
strakjes 'soon'
straks 'later'
strand 'beach'
strooien 'to scatter'
stroop 'syrup'
struisvogel 'ostrich'
stuk 'piece'
stukken 'pieces'
sturen 'to steer'
stuur 'steering wheel'
Suzuki *name*

Tt

taart 'cake'
tanden 'teeth'
tas 'bag'
tekenen 'to draw'
tel 'moment'
telefoon 'telephone'
televisie 'television'
tempo 'tempo'
tent 'tent'
thee 'tea'
thuis 'at home'
tij 'tide'
toendra 'tundra'
tok 'cluck'
tomaat 'tomato'
tractor 'tractor'
trakteren 'to treat'
trap 'stairs'
trein 'train'
treintje 'train' (d)
trommel 'drum'
trommels 'drums'
trompet 'trumpet'
trui 'jumper'
tuin 'garden'
twee 'two'

Uu

uil 'owl'
uit 'out'
uur 'hour'

Vv

vakantie 'holiday'
valt 'falls'
varken 'pig'
vast 'fixed'
vast 'fixed'
verstopt 'hidden'
vies 'dirty'
vijf 'five'
vis 'fish'
visjes 'fishes'
vlag 'flag'
vlecht 'braid'
vlees 'meat'
vlieg 'fly'
vliegen 'to fly'
vliegtuig 'aeroplane'
vlinder 'butterfly'
vlinders 'butterflies'
vlokken 'flocks'
voet 'foot'
vogel 'bird'
vork 'fork'
vracht 'load'
vrouw 'woman'

Ww

wap 'seesaw'
warm 'warm'
wat is dat 'what is that'
water 'water'
WC 'WC'
weg 'gone'
wel 'well'
wil 'want'
Willy *name*
wind 'wind'
winkel 'shop'
wipwap 'seesaw'
woef 'woof'
worm 'worm'
worst 'sausage'
wortel 'carrot'

Yy

yogi 'yogi'

Zz

zak 'bag'
zand 'sand'
ziek 'ill'
zo 'so'
zon 'sun'
zwaaien 'to sway'
zwaan 'swan'
zwanen 'swans'
zwart 'black'
zwarte 'black'
zwembad 'swimming pool'
zwemmen 'to swim'
Zwitserland 'Switzerland'

Appendix C The Dutch Segment Inventory

Consonants

	Voiceless	*Voiced*
a. Plosives	/p/ /t/ /k/	/b/ /d/
b. Fricatives	/f/ /s/ /χ/	/v/ /z/
c. Nasals		/m/ /n/ /ŋ/
d. Liquids		/l/ /r/
e. Glides		/w/ /j/
f. Laryngeals	/h/	

Vowels

a. Long or tense vowels	/a/ /i/ /u/ /e/ /o/ /ø/ /y/
b. Short or lax vowels	/ɑ/ /ɛ/ /ɪ/ /ɔ/ /œ/
c. Schwa	/ə/
d. Diphthongs	/ɑu/ /ɛi/ /œy/

Appendix D Initial Simple and Complex Onsets

1. Jarmo

A. Initial simple onsets

Adult target	P	Ø	h	N	F	L	G
1;4.18	P						
1;6.13	.	Ø/P					
1;7.15	.	.			Ø/P		P
1;7.29	.	.	Ø		.		.
1;8.26	.	Ø/P/h	h/Ø		P/Ø/h		P/h
1;9.9	.	.	.	N/P/Ø/h	.		.
1;9.23	.	Ø/h	.	.	.		.
1;11.20	.	Ø	.	N/P	P	P	.
2;0.4	.	.	.	.	P/F	.	.
2;1.8	.	.	.	.	.	L	P/L
2;2.6	.	.	h	.	.	.	.
2;2.27	.	.	.	.	F	.	.
2;3.9	.	.	.	N	.	.	L/G

Where P = Plosive, Ø = Empty onset, h = /h/, F = Fricative, N = Nasal, L = Liquid, and G = Glide.

indicates that no change has occurred
first appearance of target sound in the child's forms
avoidance of target sound by the child

B. Initial complex onsets

Adult target	PL	FL	PN	FN	PG	FG	/s/P	/s/F	/s/PL
1;4.18	P								
1;7.15	.				P			h/P	
1;8.12	PL				.			.	
1;9.23	.				.		P	.	
2;0.28	.	P			.		.	.	P
2;2.6	PG/PL		P/PG		PG/PL		.	.	.
2;2.27	.	L	.		.		.	F	.
2;3;9	.	F	.		.		.	.	PL
2;4.1	.	FL	.		.		.	.	.

2. Noortje

A. Initial simple onsets

Adult target	P	F	N	L	G	Ø	h
2;1.17	P	P	N		Ø/h	Ø/h	Ø/h
2;3.21	.	h/P	.		.	.	.
2;5.23	.	.	N/P	h/P/N	.	.	.
2;7.17	.	.	.	.	h/G	.	.
2;8.15	.	F/h	.	.	.	.	.
2;11.0	.	.	.	L/h/N/P	.	.	.

Plosives are produced as plosives; they are never replaced by other manners of articulation. Fricatives are produced as plosives in the earliest recording sessions (1a). Later on, they are also produced as /h/ (1b). Still later, they are produced as fricatives (1c).

(1)	a.	fiets	/fiːts/	→	[tiːs]	(2;1.17)
	b.	fiets	/fiːts/	→	[hiːs]	(2;3.21)
	c.	zak	/zɑk/	→	[sɑk]	(2;8.15)

Nasals are produced accurately from the first recording session. From 2;5.23 they are produced as either nasals or plosives. For a discussion see chapter 4. Liquids are produced as /h/, stop or nasal from 2;5.23. They appear as

liquids only in the final recording session, although they are still frequently substituted. Glides in the adult target words are deleted or replaced by /h/ in the early sessions. From 2;7.17 they appear as glides occasionally. (2) gives the order in which the different segment types appear in the child's output forms:

(2) *Onsets in Noortje's productions (first appearance)*
P, Ø, h, N (2;1.17) → G (2;7.17) → F (2;8.15) → L (2;11.0)

B. Initial complex onsets

Adult target	PL	FL	PN	FN	PG	FG	/s/P	/s/F	/s/PL
2;1.17	P				P		P		
2;3.7	.	h			.		.		
2;3.21	.	.			.		.	h	
2;5.23	.	.		h	.	h	.	.	
2;7.17	.	.		.	.	.	.	.	P
2;8.15	.	.	P	.	.	.	.	.	.
2;9.12	.	.	.	.	.	.	P/sP	.	.
2;11.0	.	.	.	.	.	.	.	.	.

(3) *Order of appearance of complex clusters in Noortje's system*
sP (2;9.12)

3. Tom

A. Initial simple onsets

Adult target	P	F	N	L	G	Ø	h
1;0.10	P					Ø/h/P	
1;2.14	.		N		G/P	.	
1;4.14	.	F/P/G	.	L/P/G	.	Ø	
1;5.0	.	.	.	.	.	.	h/Ø
1;5.28	.	.	.	.	.	.	.
1;6.11	.	.	.	.	.	.	.
1;6.25	.	.	.	.	.	.	.
1;7.9	.	F/P	.	L/G	G	.	.
1;8.20	.	.	.	.	.	.	.
1;11.12	.	.	.	.	.	.	

Like all the children, Tom produced adult target plosives as plosives from the start. The next type of segments are the nasals, which are produced accurately when they start to appear, and glides, which are regularly replaced by plosives. Then fricatives and liquids are added to the system, which are also often replaced by plosives and glides. (4) gives the order in which the different segment types appear:

(4) *Onsets in Tom's productions (first appearance)*
P, Ø, h (1;0.10) → N, G (1;2.14) → F, L (1;4.14)

B. Initial complex onsets

Adult target	PL	FL	PN	FN	PG	FG	/s/P	/s/F	/s/PL
1;0.10									
1;2.14									
1;4.14									
1;5.0	P	F	P				P		P
1;5.14	.	.	.		P		.		.
1;5.28	P/PL	.	.		.		.		.
1;6.11	.	.	.	N	.	F	.		.
1;6.25	.	.	.	.	.	.	.		.
1;7.9	PL	PL/FL	.	FL	.	.	.	F	.
1;8.20	.	.	PL	.	.	.	.	.	.
1;11.12	.	FL	.	.	PL/PG	.	.	.	PL
2;0.17	.	.	.	.	.	.	sP	.	.
2;1.14	.	.	.	.	.	.	.	sF	.

(5) *Order of appearance of complex clusters in Tom's system*
PL (1;5.28) → FL (1;7.9) → PG (1;11.12) → sP (2;0.17) → sF (2;1.14)

4. Tirza

A. Initial simple onsets

Adult target	P	F	N	L	G	Ø	h
1;8.5	P	F	N		P	Ø	h
1;10.8	.	.	.	P/L	.	.	.
1;11.19	.	.	.	.	P/L	.	.
2;0.18	.	.	.	L/h	.	.	.
2;1.2	.	.	.	.	G/P/h	.	.
2;2.12	.	.	.	L	.	.	.
2;3.27	.	.	.	.	G/h	.	.

Tirza has plosives, fricatives and nasals from the start, followed by liquids at 1;10.8 and glides at 2;1.2. This is schematised in (6):

(6) *Onsets in Tirza's productions (first appearance)*
P, F, N, Ø, h (1;8.5) → L (1;10.8) → G (2;1.2)

B. Initial complex onsets

Adult target	PL	FL	PN	FN	PG	FG	/s/P	/s/F	/s/PL
1;8.5	P				P				
1;8.26	.	F			.			F	
1;10.8	.	.	P		.			.	
1;11.8	.	.	.		.		s/P	.	
1;11.19	.	.	.		.		.	.	
2;0.18	.	.	.	F	.	F	.	.	
2;1.2	.	PL	.	.	.	.	.	.	
2;1.17		.	L	.	.	.	s	.	
2;2.12	PL	PL/FL	PL	.	.	.	.	.	
2;3.27	.	.	.	.	.	.	.	.	PL
2;5.5	.	.	.	.	.	.	sP	sF	.
2;6.12	.	FL	.	.	.	.	.	.	.

(7) *Order of appearance of complex clusters in Tirza's system*
PL, FL (2;2.12) → sP, sF (2;5.5)

5. Elke

A. Initial simple onsets

Adult target	P	F	N	L	G	Ø	h
1;6.4	P	P	N			Ø	
1;6.25	.	.	.		G	.	
1;9.10	.	.	.		.	.	Ø
1;9.24	.	P/F	.		.	.	.
1;11.28	.	.	.	L	.	.	h
2;1.16	.	F	.	.	.	.	.

Elke has plosives and nasals from the start. Fricatives are invariably produced as plosives until 1;9.24, at which stage they are either produced as plosives or fricatives. Fricatives are produced as such only from 2;1.16. Glides appear at 1;6.25, liquids at 1;11.28. Once adult targets with liquids and glides are produced, they are produced accurately. In other words, she seems to have a selection strategy. The development is given in (8):

(8) *Onsets in Elke's productions (first appearance)*
P, N, Ø (1;6.4) → G (1;6.25) → F (1;9.24) → L, h (1;11.28)

B. Initial complex onsets

Adult target	PL	FL	PN	FN	PG	FG	/s/P	/s/F	/s/PL
1;6.4									
1;6.25								P	
1;8.13	P						P	.	
1;9.10	.						.	.	
1;9.24	.						.	.	
1;11.28	.	F					.	.	
2;0.11	PG	.					.	F	
2;1.16	.	.					.	.	
2;3.27	PL	.					.	.	
2;4.15	.	.					sP/P	.	
2;4.29	.	.	P		P		.	.	

(9) *Order of appearance of complex clusters in Elke's system*
PG (2;0.11) → PL (2;3.27) → sP (2;4.15)

6. Catootje

A. Initial simple onsets

Adult target	P	F	N	L	G	Ø	h
1;10.11	P	h	N	N/h/L	h	Ø	h
1;11.10	.	.	.	h/L	h/G	.	.
2;0.20	.	h/F	.	.	.	.	.
2;3.26	.	.	.	L	.	.	.
2;4.12	.	h/F/G	.	.	.	.	.
2;5.8	.	.	.	.	G	.	.
2;7.4	.	F/G	.	.	.	.	.

Catootje produces adult targets with initial plosives and nasals accurately in the initial recording session. Liquids also appear then, but are often substituted by nasals or /h/. From 2;3.26 they are produced as liquids. Glides start to appear slightly earlier than fricatives. The development is given in (10):

(10) *Onsets in Catootje's productions (first appearance)*
P, h, N, L, Ø (1;10.11) → G (1;11.10) → F (2;0.20)

B. Initial complex clusters

Adult target	PL	FL	PN	FN	PG	FG	/s/P	/s/F	/s/PL
1;10.11	P	h/L	P					Ø/h	
1;11.10	PG						P		
2;0.6	PL	h/L/FL	PL	N	P	F	s-P		PL
2;0.20				FN				s-h	
2;1.3						FG			

(11) *Order of appearance of complex clusters in Catootje's system*
PG (1;11.10) → PL, FL, s-P (2;0.6) → FN, s-h (2;0.20) → FG (2;1.3)

7. Eva

A. Initial simple onsets

Adult target	P	F	N	L	G	Ø	h
1;4.12	P	P/h/Ø	P/N		h	Ø	h
1;4.26	.	.	.	h/P	h/P	.	.
1;7.15	.	P/G	N	.	h/P/G	.	.
1;8.12	.	P/G/F	.	.	.	.	.
1;9.8	.	.	.	.	G	.	.
1;9.22	.	F	.	h/P/L	.	.	.
1;10.3	.	.	.	L	.	.	.

Eva also favours plosives in the initial recording sessions. Nasals do appear, but are often replaced by plosives until 1;7.15. The next type of segments appearing in her system are glides, followed by fricatives. Liquids are mastered relatively late. (12) schematises her development:

(12) *Onsets in Eva's productions (first appearance)*
P, N, h, Ø (1;4.12) → G (1;7.15) → F (1;8.12) → L (1;9.22)

B. Initial complex onsets

Adult target	PL	FL	PN	FN	PG	FG	/s/P	/s/F	/s/PL
1;4.12	P	P			P		P	Ø/h	
1;4.26	.	.			.		.	.	
1;6.1	.	.		N	.		.	.	
1;7.15	.	.		.	.		.	.	
1;8.12	.	.		.	.		.	.	
1;9.8	.	.		F	.		.	F	
1;9.22	.	F		.	.		.	.	
1;10.3	.	.		.	.	F	.	.	

Eva has no clusters at all during the recording sessions.

8. Robin

A. Initial simple onsets

Adult target	P	F	N	L	G	Ø	h
1;5.13	P		N/P			Ø/h	Ø/h
1;6.12	.	F	.			.	.
1;6.25.	.	.	.	F/P		.	
1;7.15	.	.	.	.		Ø	.
1;8.26	.	.	.	.	F	.	.
1;9.6	.	.	.	.	.	.	h
1;11.9	.	.	.	F/P/Ø/h	.	.	
1;11.23	.	.	.	h/P/Ø	F/G	.	.
2;0.6.	.	.	N	.	.	.	
2;1.9	.	.	.	.	G	.	.
2;3.12	.	.	.	L/h	.	.	.

Robin too has nasals and plosives in the early sessions. Fricatives appear shortly after that at 1;6.12. Liquids and glides are substituted by fricatives (or plosives) until respectively 2;3.12 and 2;1.9. Glides appear in his system before liquids. This is schematised in (13):

(13) *Onsets in Robin's productions (first appearance)*
P, N, Ø, h (1;5.13) → F (1;6.12) → G (1;11.23) → L (2;3.12)

B. Initial complex onsets

Adult target	PL	FL	PN	FN	PG	FG	/s/P	/s/F	/s/PL
1;5.13	P								
1;6.12	.						P		
1;6.25	.	P					.	P	
1;8.26	.	.					.	F	
1;9.6	.	F					.	.	
1;10.9	.	.		F		F	.	.	P
2;0.20	.	.		.	P	.	sP	.	.
2;1.9	.	.		N	.	.	.	.	sP
2;2.29	.	.		.	.	.	.	.	.
2;3.24	.	.	P	.	.	.	.	.	.

(14) *Order of appearance of complex clusters in Robin's system*
sP (2;0.20)

9. Leonie

A. Initial simple onsets

Adult target	P	F	N	L	G	Ø	h
1;9.15	P	P	P/N	P		Ø/P/N	Ø
1;9.21	.	P/F	.	.	P/G	.	Ø/h
1;10.4	.	.	.	.	.	.	.
1;10.15	.	.	.	.	.	.	h
1;10.29	.	F	N	P/N/L	.	.	.
1;11.12	.	.	.	L/h/G	G	.	.
1;11.25	.	.	.	.	.	.	.

Again plosives are realised as such across the board. Fricatives and liquids are often replaced by plosives, as are nasals, although they are sometimes produced as nasals. From 1;10.29 both nasals and fricatives are produced accurately. Liquids now are replaced by plosives or nasals. Target glides are produced as glides systematically from 1;11.12. Before that age, they are sometimes produced as plosives. Empty onsets are often filled by the onset

of the second syllable (see chapter 3). Finally, /h/ is in the initial sessions often deleted. From 1;10.15 it is always produced. (15) gives the order in which the different types of segments appear in onset position:

(15) *Onsets in Leonie's productions (first appearance)*
P, N, Ø (1;9.15) → F, G, h (1;9.21) → L (1;10.29)

B. Initial complex onsets

Adult target	PL	FL	PN	FN	PG	FG	/s/P	/s/F	/s/PL
1;9.15	P	P			P		P		
1;9.21	.	.	L				.		
1;10.4	.	.	.	L			.		
1;10.15	.	.	PL				.		
1;10.29	.	L	.				.	N	
1;11.12	L/PL	F	.			F	.		
1;11.25	.	.	.				.		

/sχ/ clusters are produced as nasals (16), presumably by a harmony process.

(16) *Leonie*

schoenen	/ˈsχuːnən]/	→	[ˈŋuːŋɪ]	(1;10.29)
schommel	/ˈsχɔməl/	→	[ˈnɔmɪ]	(1;11.25)

Another remarkable fact is that liquids are not produced as such if the target word starts with a liquid. Single initial target nasals are produced as such. However, nasals in clusters are not produced as nasals, but as single liquids. I have no explanation for this.

(17) *Order of appearance of complex clusters in Leonie's system*
PL (1;10.15)

No data are given from Enzo, David and Leon, because they all have the different types of single onsets from the start. They have also mastered most complex onsets.

Appendix E Onset Clusters in Dutch

1. Obstruent–Obstruent clusters

	p	t	k
s	spar 'pine' spook 'ghost' spuit 'syringe' spin 'spider'	stoel 'chair' stuk 'broken' stil 'quiet' staan 'to stand'	ski 'ski' skelter 'skelter' score 'score' skelet 'skeleton'

	f	χ
s	sfeer 'sphere' sfinx 'sphinx'	schoen 'shoe' schaar 'scissors' school 'school' schop 'kick'

In addition to /s/-initial obstruent-obstruent clusters there are a few loan-words like *Ptolemeus*, *psalm*, *tsaar*, etc. I do not take these into consideration, because no such forms are produced or selected for production by the children.

2. Obstruent–Sonorant clusters

	l	r	m	n	w	j
p	plas 'puddle'	praten 'to talk'	—	—	—	—
b	bloem 'flower'	broek 'trousers'	—	—	—	—
t	—	trein 'train'	—	—	twee 'two'	—
d	—	drie 'three'	—	—	dweil 'cloth'	—
k	kleur 'colour'	krant 'paper'	—	knie 'knee'	kwijt 'gone'	—
f	fles 'bottle'	fries 'Frisian'		—	—	—
v	vlees 'meat'	vracht 'load'	—	—	—	—
s	sla 'lettuce'	—	smak 'smack'	snoep 'candy'	—	—
z	—	—	—	—	zwaar 'heavy'	
χ	glas 'glass'	groen 'green'	—	—	—	—

There are marginal cases with nasal in second position such as in *fnuiken*, *gnoom*, *pneumatisch*, etc. I will not discuss these, because target words with clusters like these are not selected for production by children; nor are such clusters produced by children.

3. Triconsonantal onsets

There are words which have onsets which are a combination of 1 and 2. The following data illustrate this:

spr	str	skr	sχr
springen 'to jump' spreken 'to speak' spruit 'sprout'	straat 'street' strik 'bow' strand 'beach'	script 'script' screen 'screen'	schrik 'fright' schroef 'screw' schrijven 'to write'

spl	stl	skl	sχl
spleet 'slit' split 'slit' splinter 'splinter'	— — —	sclerose 'sclerosis'	— — —

As is clear from the data, not all possible combinations of 1 and 2 are attested.

Appendix F Final Consonants

Age of appearance of final consonants

child	Robin	Tom	Jarmo	Elke	Noortje
F	1;7.13	1;2.27	1;6.13	1;6.4	2;1.17
P	1;7.13	1.2.27	1.7.15	1;6.25	2;2.7
N	1;7.27	1;4.14	1;7.29	1;7.22	2;2.7
L	2;0.4		1;11.20		

Appendix G Acquisition of Rhymes

1. Elke

(1) *The percentages (and raw scores) of deleted final consonants*

STAGE	I		II		III	
Environment						
VC_{obst}	2%	(1/59)	2%	(1/53)	1%	(1/80)
VVC_{obst}	7%	(8/118)	0%	(0/76)	3%	(3/91)
VC_{son}	64%	(9/14)	55%	(6/11)	16%	(7/44)
VVC_{son}	70%	(49/70)	71%	(53/75)	74%	(67/90)

Where: I = 1;6.4 - 1;10.7, II = 1;10.21 - 2;2.6, and III = 2;2.21 - 2;4.29;
C_{obst} = Obstruent, C_{son} = Sonorant, V = Short vowel, and VV = Long vowel.

Observations

1. No developmental trend can be detected for obstruents: deletion is infrequent at all stages.
2. No developmental trend can be detected for sonorants following long vowels, but for sonorants following short vowels the percentage deleted sonorants is decreasing in the course of development.
3. At stage I there is no difference between sonorants following long and those following short vowels. However, at stages II and III deletion of sonorants is more frequent after long vowels.

Conclusion

Vowel length before sonorants plays a role from stage II.

(2) *Percentages of vowel length errors in different environments*

STAGE	I		II		III	
Environment						
VC_{obst}	32%	(19/59)	21%	(11/53)	5%	(4/80)
VVC_{obst}	27%	(32/118)	22%	(17/76)	5%	(5/91)
VC_{son}	50%	(7/14)	64%	(7/11)	18%	(8/44)
VVC_{son}	27%	(19/70)	19%	(14/75)	17%	(15/90)
Total V → VV	36%	(26/73)	28%	(18/64)	10%	(12/124)
Total VV → V	27%	(51/188)	21%	(31/151)	11%	(20/181)

Observations

1. Vowel length errors are decreasing in the course of development.
2. Vowel length is more or less random at I and II before both obstruents and sonorants: both long vowels are shortened and short vowels are lengthened. Vowel length distinctions before obstruents seem to be mastered at stage III.
3. Vowel length errors are particularly frequent in the production of VC_{son} targets.

(3) *Vowel length errors in relation to final C deletion*

a.

STAGE	I		II		III	
Elke's form	VV	VVC	VV	VVC	VV	VVC
Target: VC_{obst}	0% (0/19)	100% (19/19)	9% (1/11)	91% (10/11)	0% (0/4)	100% (4/4)
Target: VC_{son}	100% (7/7)	0% (0/7)	71% (5/7)	29% (2/7)	62% (5/8)	38% (3/8)

b.

STAGE	I		II		III	
Elke's form	V	VC	V	VC	V	VC
Target: VVC_{obst}	3% (1/32)	97% (31/32)	0% (0/17)	100% (17/17)	0% (0/5)	100% (5/5)
Target: VVC_{son}	47% (9/19)	53 (10/19	43% (6/14)	57% (8/14)	40% (6/15)	60% (9/15)

Observations

1. Vowel lengthening before obstruents mainly occur in closed syllables. There is no relation between vowel lengthening and deletion of the final obstruent.

2. Most instances of vowel lengthening before target sonorants occur when the sonorant is *not* realised (compensatory lengthening).
3. Both observations together seem to indicate a closer relationship between the vowel and the sonorant than between the vowel and the obstruent.
4. Vowel shortening before sonorants occur frequently in closed syllables, although it also occurs when the sonorant is not produced.

(4) *Elke*

a.	$VC_{son} \rightarrow VV$				
	bal	/bɑl/	→	[bɑu]	(1;10.21)
	bril	/brɪl/	→	[biː]	(2;2.21)
b.	$VVC_{son} \rightarrow VV$				
	banaan	/baːˈnaːn/	→	[naː]	(1;7.8)
	trein	/trɛin/	→	[tɛi]	(1;7.22)
	trein	/trɛin/	→	[teː]	(1;11.28)
	doen	/duːn/	→	[duː]	(2;0.25)
	schoon	/sχoːn/	→	[χoː]	(2;2.21)
c.	$VVC_{son} \rightarrow VC_{son}$				
	banaan	/baːˈnaːn/	→	[nɛn]	(1;9.24)
	boom	/boːm/	→	[bɔm], [pɔm]	(1;10.7)
	haan	/haːn/	→	[ɑn]	(1;10.7)
	konijn	/koːˈnɛin/	→	[nɛn]	(1;10.7)
	bloem	/bluːm/	→	[bɔm]	(2;1.16)
	pijn	/pɛin/	→	[pɑn]	(2;2.21)
d.	$VC_{obst} \rightarrow VVC_{obst}$				
	tas	/tɑs/	→	[tiːʃ]	(1;6.4)
	vis	/vɪs/	→	[puːf]	(1;7.22)
	fles	/flɛs/	→	[eːs]	(1;8.13)
	pop	/pɔp/	→	[puːp]	(1;9.13)
	kapot	/kaːˈpɔt/	→	[buːt]	(1;8.31)
	nat	/nɑt/	→	[neːt]	(1;9.10)
	pop	/pɔp/	→	[puːΦ]	(1;9.10)
	bed	/bɛt/	→	[peːt]	(1;10.7)
e.	$VVC_{obst} \rightarrow VC_{obst}$				
	poes	/puːs/	→	[pʉs]	(1;6.4)
	kaas	/kaːs/	→	[kɑʃ]	(1;7.8)
	boek	/buːk/	→	[pɔk]	(1;9.10)
	vies	/viːs/	→	[pɪs]	(1;9.24)
	uit	/œyt/	→	[ɑt], [ɔt]	(1;10.21)
	kijk	/kɛik/	→	[kɪk], [kɑk]	(2;1.26)
	brood	/broːt/	→	[pɔt]	(2;2.21)
	stout	/stɑut/	→	[tɔt]	(2;2.21)

f. *Repairs*

schoen	/sχu:n/	→	[tu:ʃ]	(1;6.4)
stoel	/stu:l/	→	[tu:t], [ty:t]	(1;8.31)
trein	/trɛin/	→	[ti:χ]	(1;9.10)
meer	/me:r/	→	[mi:χ]	(1;9.24)
beer	/be:r/	→	[bɛf]	(1;11.7)

2. Robin

(1) *Percentages (and raw scores) of deleted final consonants*

STAGE	I	II	III	IV
Environment				
VC_{obst}	11% (2/18)	5% (3/58)	4% (2/53)	2% (2/88)
VVC_{obst}	8% (6/74)	3% (3/89)	7% (6/82)	6% (10/154)
VN	20% (1/5)	18% (4/22)	4% (1/23)	6% (2/33)
VL	67% (2/3)	100% (2/2)	67% (2/3)	89% (24/27)
VVN	10% (4/42)	3% (2/58)	2% (1/41)	4% (4/106)
VVL	97% (31/32)	79% (31/39)	92% (35/38)	58% (58/100)
VC_{son}	38% (3/8)	25% (6/24)	12% (3/26)	43% (26/60)
VVC_{son}	47% (35/74)	34% (33/97)	46% (36/79)	30% (62/206)

Where: I=1;5.11 - 1;8.7, II=1;8.24 - 1;11.7, III=1;11.21 - 2;1.7, and IV=2;1.26 - 2;4.29; C_{obst}=Obstruent, C_{son}=Sonorant, N=Nasal, L=Liquid, V=Short vowel, and VV = Long vowel.

Observations

1. Nasals and obstruents behave similar, although at stage I nasals are slightly more frequently deleted. Liquids differ from obstruents and nasals: they are most often deleted at all stages.

(2) *Percentages of vowel length errors in different environments*

STAGE	I	II	III	IV
Environment				
VC_{obst}	28% (5/18)	36% (21/58)	13% (7/53)	9% (8/88)
VVC_{obst}	30% (22/74)	28% (25/89)	20% (16/82)	7% (11/154)
VN	20% (1/5)	36% (8/22)	17% (4/23)	12% (4/33)
VVN	38% (16/42)	34% (20/58)	24% (10/41)	3% (3/106)
VL	67% (2/3)	100% (2/2)	67% (2/3)	56% (15/27)
VVL	13% (4/32)	14% (6/39)	17% (10/58)	10% (10/100)
VC_{son}	38% (3/8)	42% (10/24)	23% (6/26)	32% (19/60)
VVC_{son}	27% (20/74)	27% (26/97)	20% (20/99)	6% (13/206)
Total V → VV	31% (8/26)	38% (31/82)	16% (13/79)	18% (27/148)
Total VV → V	28% (42/148)	27% (51/186)	20% (36/181)	7% (24/360)

Observations

1. Vowel length is random at stage I, II, and III in all environments. It seems to be mastered at stage IV. The only exceptions is short vowels before liquids: liquids are often deleted, but trigger vowel lengthening.
2. Vowel length errors decrease in the course of developments, with the exception of short vowels followed by sonorants.

(3) *Vowel length errors in relation to final C deletion*

STAGE	I		II		III		IV	
Robin's form	**VV**	**VVC**	**VV**	**VVC**	**VV**	**VVC**	**VV**	**VVC**
Target: VC_{obst}	20% (1/5)	80% (4/5)	10% (2/21)	90% (19/21)	0% (0/7)	100% (7/7)	12% (1/8)	88% (7/8)
Target: VN	0% (0/1)	100% (1/1)	12% (1/8)	88% (7/8)	0% (0/4)	100% (4/4)	25% (1/4)	75% (3/4)
Target: VL	100% (2/2)	0% (0/2)	100% (2/2)	0% (0/2)	100% (2/2)	0% (0/2)	93% (14/15)	7% (1/15)
Target: VC_{son}	67% (2/3)	33%% (1/3)	30% (3/10)	70% (7/10)	33% (2/6)	67% (4/6)	79% (15/19)	21% (4/19)

STAGE		I		II		III		IV	
Robin's form		**V**	**VC**	**V**	**VC**	**V**	**VC**	**V**	**VC**
Target:	VVC_{obst}	0% (0/22)	100% (22/22)	0% (0/25)	100% (25/25)	13% (2/16)	88% (14/16)	18% (2/11)	82% (9/11)
Target:	VVN	6% (1/16)	94% (15/16)	5% (1/20)	95% (19/20)	0% (0/10)	100% (10/10)	0% (0/3)	100% (3/3)
Target:	VVL	25% (1/4)	75% (3/4)	17% (1/6)	83% (5/6)	20% (2/10)	80% (8/10)	10% (1/10)	90% (9/10)
Target:	VVC_{son}	10% (2/20)	90% (18/20)	8% (2/26)	92% (24/26)	10% (2/20)	90% (18/20)	8% (1/13)	92% (12/13)

Observations

1. VC_{obst}, VN, VVC_{obst} and VVN are produced as VC_{obst}, VN, VVC_{obst} or VVC. VL is produced as either VL or VV; VVL is produced as either VV or VL.

Examples are given below:

(4) *Robin*

a. VL → VV

bal	/bɑl/	→	[boː] (1;6.23)
al	/ɑl/	→	[ɑu] (1;11.7)
rol	/rɔl/	→	[huː] (2;1.26)

b. VVL → VV

stoel	/stuːl/	→	[tyː] (1;7.13)
beer	/beːr/	→	[piː] (1;7.27)
gitaar	/χiˈtaːr/	→	['tiːtaː] (1;9.10)
daar	/daːr/	→	[daː] (1;11.7)
door	/doːr/	→	[toː] (1;11.7)
deur	/døːr/	→	[tøː] (1;11.7)
klaar	/klaːr/	→	[taː] (1;11.21)
school	/sχoːl/	→	[soː] (1;11.21)

c. VVL → VL

dier	/diːr/	→	[tɻ] (1;10.21)
uur	/yːr/	→	[ʉɻ] (1;11.21)
speel	/speːl/	→	[pɪl] (2;0.4)

d. VVN → VN

trein	/trein/	→	[tɑn] (1;7.13)
trein	/trein/	→	[tʉn] (1;7.27)
boom	/boːm/	→	[pɔm] (1;7.27)
		→	[pɔm] (1;8.7)
tuin	/tœyn/	→	[tœn] (1;8.7)
speen	/speːn/	→	[bɪn] (1;9.10)
pijn	/pein/	→	[pɛn] (1;9.24)
trein	/trein/	→	[tɛn] (1;11.21)

e.	VVC_{obst} → VC_{obst}				
	thuis	/tœys/	→	[tœs]	(1;7.13)
	uit	/œyt/	→	[œt]	(1;7.13)
	poes	/puːs/	→	[tʉs]	(1;7.27)
	aap	/aːp/	→	[ɑp]	(1;8.7)
	ijs	/ɛis/	→	[ɛs]	(1;8.24)
	boek	/buːk/	→	[bɔk]	(1;10.7)
	uit	/œyt/	→	[œt]	(1;11.7)
	ziek	/ziːk/	→	[sɪk]	(2;0.4)
	thuis	/tœys/	→	[tœs]	(2;0.4)
	graaf	/χraːf/	→	[fɑf]	(2;1.7)
	niet	/niːt/	→	[nɪt]	(2;1.7)
f.	VN → VVN				
	ton	/tɔn/	→	[tuːn]	(1;9.24)
	in	/ɪn/	→	[eːn]	(1;10.21)
	man	/mɑn/	→	[maːn]	(1;11.7)
	boterham	/ˈboːtərˌhɑm/	→	[ˈbɔˈtaːm]	(1;11.21)
	pan	/pɑn/	→	[paːm]	(2;0.4)
	spin	/spɪn/	→	[speːn]	(2;1.7)
g.	VC_{obst} → VVC_{obst}				
	jas	/jɑs/	→	[seːs]	(1;7.27)
	bad	/bɑt/	→	[paːt]	(1;8.7)
	pop	/pɔp/	→	[puːp]	(1;8.24)
	bus	/bʉs/	→	[byːs], [pyːs]	(1;9.10)
	trap	/trɑp/	→	[paːp]	(1;9.24)
	sop	/sɔp/	→	[fuːp]	(1;10.7)
	bos	/bɔs/	→	[buːs]	(1;10.21)
	stuk	/stʉk/	→	[tyːk], [tiːk]	(1;10.21)
	bed	/bɛt/	→	[piːt]	(1;11.21)
	pet	/pɛt/	→	[piːt]	(2;0.4)

3. Tirza

(1) *Percentages (and raw scores) of deleted final consonants*

STAGE	I		II		III	
Environment						
VC_{obst}	3%	(2/61)	1%	(1/82)	1%	(1/135)
VVC_{obst}	3%	(2/62)	5%	(6/123)	13%	(24/191)
VC_{son}	29%	(2/7)	38%	(12/32)	13%	(9/68)
VVC_{son}	54%	(29/54)	35%	(41/117)	26%	(54/205)

Where: I = 1;8.5 - 1;11.8, II = 1;11.19 - 2;7.1, III = 2;2.12 - 2;6.12;
C_{obst} = Obstruent, C_{son} = Sonorant, V = Short vowel, and VV = Long vowel.

Observations

1. Obstruents after long vowels are more prone to deletion at stage III than at stages I and II; and more prone to deletion than obstruents following short vowels.
2. Sonorants are more prone to deletion after long vowels than after short vowels.

(2) *Percentages of vowel length errors in different environments*

STAGE	I		II		III	
Environment						
VC_{obst}	16%	(10/61)	15%	(12/82)	4%	(6/135)
VVC_{obst}	5%	(3/62)	6%	(7/123)	8%	(16/191)
VC_{son}	14%	(1/7)	38%	(12/32)	10%	(7/68)
VVC_{son}	28%	(15/54)	18%	(21/117)	15%	(30/205)
Total V → VV	16%	(11/68)	21%	(24/114)	6%	(13/203)
Total VV → V	16%	(18/116)	12%	(28/240)	12%	(46/396)

Observations

1. Vowel length is more or less mastered at stage III.

(3) *Vowel length errors in relation to final C deletion*

STAGE		I		II		III	
Tirza's form		**VV**	**VVC**	**VV**	**VVC**	**VV**	**VVC**
Target:	VC_{obst}	10% (1/10)	90% (9/10)	0% (0/12)	100% (12/12)	17% (1/6)	83% (5/6)
Target:	VC_{son}	100% (1/1)	0% (0/1)	92% (11/12)	8% (1/12)	100% (7/7)	0% (0/7)

STAGE		I		II		III	
Tirza's form		**V**	**VC**	**V**	**VC**	**V**	**VC**
Target:	VVC_{obst}	0% (0/3)	100% (3/3)	0% (0/7)	100% (7/7)	0% (0/16)	100% (16/16)
Target:	VVC_{son}	13% (2/15)	87% (13/15)	29% (6/21)	71% (15/21)	33% (10/30)	67% (20/30)

Observations

1. Vowel length errors in VC_{obst} targets mainly occur in closed syllables; those in VC_{son} targets mainly occur in open syllables.
2. Vowel length errors in VVC_{obst} and VVC_{son} targets mainly occur in closed syllables.

Examples are given below:

(4) *Tirza*

a.	$VC_{son} \rightarrow VV$				
	krokodil	/ˌkroːkoːˈdɪl/	→	[ˌtœytəˌtoːl]	(2;0.5)
	wel	/ʋɛl/	→	[ʋɛu]	(2;2.1)
	wil	/ˈʋɪl/	→	[ʋiː]	(2;3.27)
	bal	/bɑl/	→	[boː]	(2;3.27)
b.	$VVC_{son} \rightarrow VV$				
	beer	/beːr/	→	[biː]	(1;8.5)
	deur	/døːr/	→	[døː]	(1;10.22)
	stoel	/stuːl/	→	[tuː]	(1;11.8)
c.	$VVC_{son} \rightarrow VC_{son}$				
	boom	/boːm/	→	[mœm]	(1;8.5)
	aan	/aːn/	→	[ɑŋ]	(1;8.26)
	baan	/baːn/	→	[pɑn]	(2;0.5)
	mier	/miːr/	→	[mɪɹ]	(2;0.5)
	raam	/raːm/	→	[lɑn]	(2;0.18)
d.	$VC_{obst} \rightarrow VVC_{obst}$				
	vis	/vɪs/	→	[siːs]	(1;8.26)
	dak	/dɑk/	→	[daːk]	(1;9.11)
	giraf	/ʃiːˈrɑf/	→	[laːf]	(1;10.22)
	pad	/pɑt/	→	[paːt]	(1;10.22)
	pop	/pɔp/	→	[puːp]	(1;11.8)
	zak	/zɑk/	→	[saːk]	(1;11.8)
e.	$VVC_{obst} \rightarrow VC_{obst}$				
	muis	/mœys/	→	[mɑs]	(1;10.22)
	vlieg	/vliːχ/	→	[sɪχ]	(1;10.22)
	neus	/nøːs/	→	[nɐs]	(1;11.19)
	race	/reːs/	→	[lɛʃ]	(1;11.19)
	buik	/bœyk/	→	[bœk]	(2;1.17)

4. Jarmo

(1) *Percentages (and raw scores) of deleted final consonants*

STAGE	II		III		IV	
Environment						
VC_{obst}	15%	(3/20)	10%	(4/40)	13%	(7/54)
VC_{son}	81%	(13/16)	53%	(10/19)	25%	(6/24)
VVC_{obst}	10%	(6/62)	8%	(6/77)	26%	(28/109)
VVC_{son}	70%	(53/76)	78%	(49/63)	73%	(61/84)

Where: II = 1;6.13 - 1;9.23, III = 1;10.9 - 2;1.8, and IV = 2;1.22 - 2;4.1;
C_{obst} = Obstruent, C_{son} = Sonorant, V = Short vowel, VV = Long vowel.

(2) *Percentage of vowel length errors in different environments*

STAGE	II		III		IV	
Target						
VC_{obst}	60%	(12/20)	25%	(10/40)	13%	(7/54)
VC_{son}	62%	(10/16)	47%	(9/19)	29%	(7/24)
VVC_{obst}	27%	(17/62)	16%	(12/77)	9%	(9/109)
VVC_{son}	37%	(28/76)	16%	(10/63)	8%	(7/84)
Total V → VV	61%	(22/36)	32%	(19/59)	18%	(14/78)
Total VV → V	33%	(45/138)	16%	(22/140)	8%	(16/193)

(3) *Vowel length errors in relation to final C deletion*

STAGE	II		III		IV	
Jarmo's form	VV	VVC	VV	VVC	VV	VVC
Target: VC_{obst}	17% (2/12)	83% (10/12)	20% (2/10)	80% (8/10)	29% (2/7)	71% (5/7)
Target: VC_{son}	90% (9/10)	10% (1/10)	89% (8/9)	11% (1/9)	71% (5/7)	29% (2/7)

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Samenvatting in het Nederlands

Over de verwerving van prosodische structuur

IN DIT PROEFSCHRIFT staat de vraag hoe kinderen lettergreepstructuur en klemtoon verwerven centraal. Deze vraag heeft zowel betrekking op het logische probleem van taalverwerving als op het ontwikkelingsprobleem van taalverwerving. Het logische probleem van taalverwerving betreft de vraag hoe een grammaticaal systeem geleerd kan worden op basis van het taalaanbod dat het kind krijgt, aangenomen dat de Universele Grammatica — de verzameling universele principes en parameters — is aangeboren. In principe kan het logische probleem van taalverwerving opgelost worden zonder naar taalverwervingsdata te kijken. Van belang is of een grammaticale theorie in principe leerbaar is. Het ontwikkelingsprobleem van taalverwerving betreft de vraag welke stadia het taalverwervende kind doorloopt. Hiervoor zijn taalverwervingsdata onontbeerlijk. Deze problemen zijn vaak afzonderlijk onderzocht, maar idealiter worden ze gecombineerd. Dat is beoogd in dit proefschrift.

In dit proefschrift wordt aangetoond dat zowel de verwerving van lettergreepstructuur als de verwerving van klemtoon via verschillende stadia verloopt. De eigenschappen van de stadia worden geanalyseerd in het kader van de prosodische fonologie waarbij tevens een verklaring gegeven wordt voor de transities van het ene stadium naar het volgende. Het doel van het proefschrift is het opstellen van een theorie over de verwerving van prosodische structuur.

In hoofdstuk 1 worden de grondbeginselen en assumpties expliciet gemaakt. Er wordt uitgegaan van een 'principes en parameters' benadering, waarin aangenomen wordt dat kinderen een aangeboren taalvermogen hebben. Dit wordt de Universele Grammatica (UG) genoemd. UG bestaat uit een verzameling universele principes en parameters. De principes gelden voor alle talen, maar talen kunnen verschillen in de waarden voor de parameters. Onder de aanname dat iedere parameter een default (ongemarkeerde) waarde heeft en dat de gemarkeerde waarde alleen gekozen wordt als daarvoor voldoende evidentie is in het taalaanbod, bestaat het taalverwervingsproces uit het veranderen van default parameterwaarden in de gemarkeerde waarden voorzover de taal die geleerd wordt de gemarkeerde

waarden vereist. Deze parameterwaarden vormen de basisgrammatica. Daarnaast moeten ook taalspecifieke eigenschappen geleerd worden.

De taal van de omgeving is één vorm van input: de zgn. positieve evidentie. De basisgrammatica wordt uitsluitend geleerd op basis van positieve evidentie. Daarnaast wordt in deze dissertatie aangetoond dat ook de output van het kind functioneert als input en dat kinderen tevens indirecte negatieve evidentie — het systematisch ontbreken van bepaalde data — gebruiken. Indirecte negatieve evidentie is relevant voor het leren van taalspecifieke eigenschappen. Aangenomen dat kinderen 'conservatieve' leerders zijn, d.w.z. dat ze hun grammaticale systeem alleen veranderen als daar voldoende evidentie voor is, kan worden gesteld dat deze taalspecifieke eigenschappen laat geleerd worden.

De parameterwaarden bepalen hoe het prosodische templaat — de fonologische representatie van prosodische eigenschappen — van het kind eruit ziet. Aanvankelijk hebben alle parameters de default waarde. Voor lettergreepstructuur betekent dat dat iedere kinderlettergreep uit precies één medeklinker (C) en een klinker (V) bestaat: het kind heeft een CV-templaat. Wanneer parameters de gemarkeerde waarde krijgen, gaat het grammaticale systeem van het kind meer op dat van de volwassene lijken. In de vroege stadia is het kindertemplaat erg eenvoudig en kan niet altijd al het segmentele materiaal van het volwassen woord geïncorporeerd worden. Wanneer het kind bijvoorbeeld een CV-templaat heeft, wordt de finale /k/ in een woord als *dik* niet gerealiseerd: de /k/ past niet in het kindertemplaat. Het woord *dik* wordt gerealiseerd als [dɪ]. Het is niet zo dat het kind deletieregels heeft. Het kind projecteert de reeks segmenten (d, i, k) van het volwassen woord op zijn eigen woordtemplaat. Alles wat daar niet in past, wordt niet gerealiseerd. Als het templaat zich uitbreidt tot een CVC-templaat, zal 'deletie' van de /k/ niet meer voorkomen. De vereenvoudiging van het volwassen woord door het kind is een soort reparatiestrategie. Een andere strategie is die van selectie. Daarvan is sprake wanneer het kind alleen die woorden voor zijn productie selecteert die passen op zijn woordtemplaat.

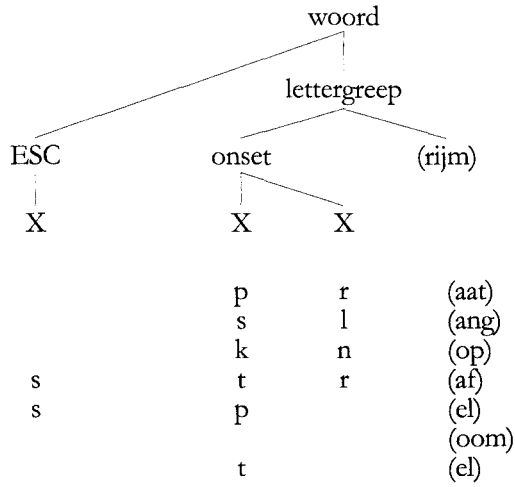
Het onderzoek waarvan in dit proefschrift verslag wordt gedaan is gebaseerd op spontane taaluitingen van 12 Nederlandse kinderen die bij aanvang van het onderzoek tussen de 1;0 (1 jaar) en 1;11 (1 jaar en 11 maanden) waren. Van de kinderen zijn een jaar lang om de week opnames gemaakt. De uitingen zijn fonetisch getranscribeerd en opgenomen in een databank. Hoofdstuk 2 geeft een uitgebreide beschrijving van de data en de methode van gegevensverzameling.

Hoofdstuk 3 verschaft de achtergrond voor hoofdstuk 4 en 5. Het geeft een beschrijving van de twee meest gebruikte theorieën van lettergreep-structuur: de onset-rijm theorie en de moraïsche theorie. In dit proefschrift

worden argumenten gegeven vóór de onset-rijm theorie en tegen de moraïsche. In het tweede deel van dit hoofdstuk wordt een overzicht gegeven van de analyses van de Nederlandse lettergreep. De overige hoofdstukken hebben voornamelijk betrekking op Nederlandse verwervingsdata.

In hoofdstuk 4 wordt de verwerving van de onset behandeld. Een Nederlandse lettergreep kan beginnen met een klinker of met één, twee of drie medeklinkers (zie (1)). Aangenomen wordt dat de onset uit maximaal twee medeklinkers kan bestaan, waarvan de eerste een obstruent (een plof- of wrijfklank) en de tweede een sonorant (een nasaal, liquida of glijder) is. Aan het woordbegin is een extra medeklinker mogelijk (de extrasyllabische consonant (ESC)), maar deze maakt geen onderdeel uit van de onset.

(1) *Onset structuur*



In de verwerving van onsets kunnen grofweg 5 stadia worden onderscheiden.

In **stadium 1** zijn onsets verplicht: alle lettergrepen beginnen met een medeklinker. Kinderen realiseren alleen plofklanken aan het begin van de lettergreep. Andere medeklinkers worden vervangen door plofklanken. In dit stadium zijn alle parameters nog in de default waarde, resulterend in de basislettergreep CV. Onsets zijn verplicht aanwezig en bestaan maximaal (en minimaal) uit één medeklinker. Lettergrepen kunnen nog niet gesloten (eindigend op een medeklinker) zijn. Woorden zoals *auto* worden uitgesproken als ['to:to:] en woorden als *drinken* als ['ti:kə]. In **stadium 2** zijn onsets optioneel: lettergrepen kunnen ook met een klinker beginnen, maar nog niet met twee medeklinkers. De waarde voor de minimale onset parameter gaat van de default naar de gemarkeerde waarde (de minimale waarde voor het aantal medeklinkers in de onset gaat van 1 naar 0). Nu wordt *auto* goed uitgesproken. In **stadium 3** komen medeklinkers met

verschillende wijze van articulatie voor: eerst nasalen, en dan fricatieven, liquidae en glijders. In **stadium 4** worden medeklinkerclusters bestaande uit een obstruent en een sonorant gerealiseerd. De maximale onset parameter wordt naar de gemarkeerde waarde gezet (de maximale waarde voor het aantal medeklinkers in de onset gaat van 1 naar 2). Dus *bloem* wordt gerealiseerd als [blum], maar *stad* als [tɑt]. Nu kunnen woorden met nul, één of twee medeklinkers beginnen. Pas in **stadium 5** worden clusters bestaande uit een /s/ en een obstruent (*sp-*, *st-*, *sch-*) toegestaan. Dit geeft aan dat de extrasyllabiciteitsparameter 'zijn extrasyllabische medeklinkers toegestaan?' gezet is van de default waarde NEE naar de gemarkeerde waarde JA. Sommige kinderen hebben eerst stadium 5 en dan stadium 4, wat aangeeft dat de maximale onset parameter en de extrasyllabiciteitsparameter onafhankelijk van elkaar zijn. De kinderen die obstruent–sonorant clusters hebben in stadium 4 leren nu ook clusters van drie medeklinkers, zoals in de woorden *spreken* en *straat*.

De verwerving van obstruent–sonorant clusters verloopt ook stapsgewijs: eerst worden zulke clusters gereduceerd tot de obstruent. Vervolgens is er een optioneel stadium waarin alleen de sonorant gerealiseerd wordt, en tenslotte wordt het cluster gerealiseerd. Dus een woord als *bloem* wordt achtereenvolgens gerealiseerd als [bum], [lum], en [blum].

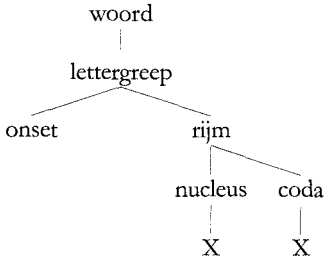
De verwerving van /s/-obstruent clusters gaat ook stapsgewijs: eerst wordt alleen de obstruent gerealiseerd, vervolgens alleen de /s/ en daarna het cluster. Dus een woord als *stad* wordt achtereenvolgens gerealiseerd als [tɑt], [sɑt] en [stɑt]. Het tweede stadium wordt echter niet bij alle kinderen aangetroffen en is dus optioneel.

Wanneer kinderen de maximale onset parameter naar de gemarkeerde waarde gezet hebben (en dus obstruent–sonorant clusters toestaan), maar de extrasyllabiciteits-parameter nog niet, produceren ze ook woorden beginnend met /sl/- en /kn/-clusters. In de standaard analyse van het Nederlands wordt echter aangenomen dat de /s/ in /sl/-clusters en de /k/ in /kn/-clusters extrasyllabisch zijn. In beide gevallen wordt echter het cluster gerealiseerd door kinderen. Kennelijk analyseert het kind deze clusters als obstruent–sonorant clusters. Deze kunnen gerealiseerd worden in het kindertemplaat. Het kind beschikt niet over evidentie voor een andere analyse.

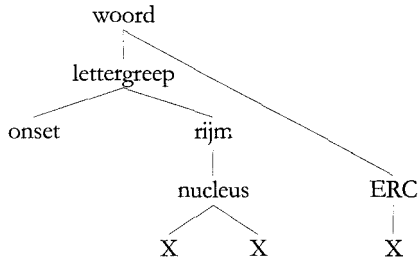
Hoewel kinderen geen positieve evidentie krijgen voor bijvoorbeeld /pw/- en /tl/-clusters, komen ze in kindertaaldata veel voor. Het is een taalspecifieke eigenschap van het Nederlands dat twee medeklinkers in een onsetcluster niet dezelfde articulatieplaats mogen hebben. Kinderen hebben juist een voorkeur voor clusters met één articulatieplaats. Op basis van negatieve evidentie, d.w.z. het ontbreken van /tl/- en /pw/-clusters in het taalaanbod, moet het kind leren dat /tl/- en /pw/-clusters uitgesloten zijn in het Nederlands.

Hoofdstuk 5 beschrijft de patronen die aangetroffen worden in de verwerving van rijmstructuur. In het algemeen wordt aangenomen dat het rijm maximaal twee posities kan bevatten: ofwel een lange klinker (een vertakkende nucleus) ofwel een korte klinker gevolgd door een medeklinker (een vertakkend rijm). Daarnaast kan er aan het woordeinde nog een extra consonant (de extra-rijm consonant (ERC)) komen (zie (2)):

(2) *Rijmstructuur*



(st)	a	d
(kn)	o	p
(fl)	e	s



(st)	aa	n
(kn)	oo	p
(m)	an	
(b)	er	g
(m)	el	k

In de verwerving van rijmstructuur zijn 4 stadia te onderscheiden. In **stadium 1** eindigen alle lettergrepen op een klinker (CV-lettergreep). Bovendien maakt het kind geen *systematisch* onderscheid tussen lange en korte klinkers. Het kind heeft nog geen vertakkende nucleus. Een woord als *paard* wordt uitgesproken als [pɑ] of [paː] en een woord als *stad* als [tɑt] of [taːt]. In **stadium 2** kunnen woorden ook eindigen op obstruenten, maar sonoranten worden altijd gedeleerd. Nu heeft het kind de codapositie geleerd, maar in deze positie kunnen alleen obstruenten (bij voorkeur fricatieven) gerealiseerd worden. Een woord als *paard* wordt nu [paːs] of [pɑt], maar een woord als *boom* wordt [boːm]. **In stadium 3** worden ook sonoranten geproduceerd: eerst nasalen, en dan liquidae. Maar als een sonorant gerealiseerd wordt, is de voorafgaande klinker altijd kort. Als de sonorant gedeleerd wordt, wordt de klinker vaak verlengd. Woorden als *bom* en *boom* worden beide gerealiseerd als [bɔm] of [boːm]. Er bestaat niet een dergelijke relatie tussen klinkerlengte en de realisatie van finale obstruenten: *bad* wordt [bɑt] of [baːt] en *kaas* wordt [kaːs] of [kɑs]. Kennelijk zijn sonoranten onderdeel van de nucleus en obstruenten van de coda. Het kind heeft nu ook een vertakkende nucleus. De data wijzen verder op het bestaan van een universeel principe dat zegt dat een rijm maximaal twee posities heeft. Dit moet wel een universeel principe zijn, gegeven het feit dat de input vele uitzonderingen kent, maar de output van kinderen geen. Met andere

woorden, het kind kan deze eigenschap niet geleerd hebben op basis van positieve evidentie in de input. In **stadium 4** wordt de extra-rijm positie verworven. Nu komen ook finale medeklinker clusters voor, bestaande uit een sonorant en een obstruent.

Hoofdstuk 6 beschrijft de verschillende stadia in de verwerving van klemtoon en de relatie tussen klemtoon en deletie van lettergrepen. In de productie van volwassen tweelettergrepige woorden met finale klemtoon (zoals *ballón* en *konijn*) wordt de onbeklemtoonde lettergreep veel vaker gedeleerd dan in die van tweelettergrepige woorden met initiële klemtoon (zoals *áuto* en *róbot*). Tweelettergrepige woorden met initiële klemtoon ondergaan geen verandering in de loop van de ontwikkeling, maar in de verwerving van tweelettergrepige woorden met finale klemtoon zijn vier stadia te onderscheiden. Een woord als *konijn* doorloopt achtereenvolgens de volgende stadia: eerst wordt het uitgesproken als ['nɛinɔ] of ['nɛin]; vervolgens als ['koːnɛin], dan als ['koː'nɛin] en tenslotte correct als [koː'nɛin].

In **stadium 1** wordt het segmentele materiaal van de beklemtoonde voet aan de rechterkant van het volwassen woord gerealiseerd (*nijn*) en aan het kindervoettemplaat (een kwantiteits-ongevoelige trocheïsche voet, dwz een beklemtoonde lettergreep gevolgd door een onbeklemtoonde) gehecht. Soms wordt een extra finale lettergreep gerealiseerd, omdat een kwantiteits-ongevoelige trochee bij voorkeur bestaat uit een beklemtoonde én een onbeklemtoonde lettergreep. Dus *konijn* wordt uitgesproken als ['nɛin] of ['nɛinɔ]. In **stadium 2** wordt het segmentele materiaal van de lettergreep aan de linkerkant van het volwassen woord geselecteerd en geplaatst voor de segmentele inhoud van stadium 1. Dus *ko* wordt voor *nijn* geplaatst. Deze reeks segmenten wordt gehecht aan het trocheïsche voettemplaat van het kind, met als gevolg dat klemtoon op de eerste lettergreep valt: *konijn* wordt uitgesproken als ['koːnɛin]. In **stadium 3** wordt de reeks segmenten van stadium 2 aan het tweevoetige woordtemplaat van het kind gehecht: elke lettergreep vormt een voet op zich. Omdat de waarde voor de hoofdklem-toonparameter nog niet vastgesteld is, krijgen beide voeten evenveel klemtoon: *konijn* wordt uitgesproken als ['koː'nɛin]. In **stadium 4** wordt de waarde voor de hoofdklemtoonparameter bepaald, waardoor de rechter voet meer klemtoon (hoofdklemtoon) krijgt dan de linker (secundaire klemtoon). Nu wordt het klemtoonpatroon van *konijn* correct gerealiseerd.

Dit hoofdstuk laat zien dat de ontwikkeling goed beschreven kan worden met de middelen die de prosodische theorie tot haar beschikking heeft, mits wordt aangenomen dat het kind voortbouwt op de eigen vorm uit eerdere stadia. Evidentie voor deze aanname wordt gevonden in reduplicatie- en metathesisdata. De analyse laat tevens zien dat het kind niet noodzakelijker-wijs het hele volwassen woord als input neemt, maar een gedeelte ervan (de

linker voet en/of de rechter lettergreep van het woord). De analyse verklaart het ontbreken van een ontwikkelingspatroon voor tweelettergrepige woorden met initiële klemtoon en doet de juiste voorspellingen voor het verwervingspatroon van langere woorden, zoals wordt aangetoond in hoofdstuk 6.

Het ontwikkelingspatroon toont verder duidelijk aan dat klemtoon niet lexicaal geleerd wordt, maar door middel van 'regels' of liever gezegd door het instellen van parameterwaarden. Dit is verder uitgewerkt in hoofdstuk 7: daar worden de resultaten van hoofdstuk 6 geïncorporeerd in een parametrisch leermodel, zoals voorgesteld door Dresher en Kaye (1990). Onderzocht is of en in hoeverre dit model, dat met succes toegepast is op machineleerders, ook toegepast kan worden op kindertaalverwerving. In grote lijnen blijkt het model bruikbaar als verwervingsmodel, maar er wordt in dit hoofdstuk een aantal veranderingen voorgesteld. Machineleerders doorlopen niet, zoals kinderen, verschillende ontwikkelingsstadia, maar gaan van het beginstadium direct naar het eindstadium. Bovendien hebben ze lange woorden nodig om de juiste parameterwaarden vast te stellen, terwijl kinderen klemtoon leren op basis van eenvoudige en korte woorden. Er zijn ook belangrijke verschillen tussen de input van machineleerders en die van kinderen. De input van machineleerders is volledig geparseerd, terwijl kinderen soms maar een deel van het volwassen woord gebruiken als input. De input van machineleerders is volledig gesegmentaliseerd en gesyllabificeerd, terwijl kinderen klemtoon en lettergreepstructuur gelijktijdig leren. De input van machineleerders is niet aan verandering onderhevig, terwijl die van kinderen dat wel is, omdat de eigen output een belangrijke vorm van input is. Die outputvormen veranderen voortdurend. Tenslotte is de input van machineleerders gecodeerd voor verschillende klemtoonniveau's, terwijl kinderen aanvankelijk alleen beklemtoonde van onbeklemtoonde lettergrepen onderscheiden, maar niet hoofdklemtoon van bijklemtoon.

Kort gezegd werkt het voorgestelde model als volgt: de leerder bouwt een prosodische representatie op een reeks segmenten op basis van de parameterwaarden van zijn grammatica. De aldus gecreëerde vorm wordt vergeleken met de inputvorm (het volwassen woord). Als deze vormen niet overeenkomen gaat de leerder op zoek naar een aanwijzing in de data die leidt tot het zetten van een parameter naar de gemarkeerde waarde. Wanneer zo'n aanwijzing gevonden wordt, wordt de bijbehorende parameter in de gemarkeerde waarde gezet. Daarmee verandert de grammatica van de leerder. Deze verandering vindt niet plaats op basis van één vorm, maar de leerder wacht tot hij voldoende evidentie heeft. Dit verklaart het geleidelijke verloop van transities. Op basis van de nieuwe parameterwaarden wordt opnieuw een prosodische representatie gebouwd, die vervolgens vergeleken wordt met de input. Het proces gaat door totdat de grammatica van de leerder gelijk is aan die van de volwassene. De transities van het ene stadium naar het volgende

zijn het resultaat van het zetten van één of meer parameters naar de gemarkeerde waarde.

Wanneer het kind zijn outputvorm ['nɛin] van stadium 1 vergelijkt met de input, dan ontdekt het kind dat klemtoon wel op de goede lettergreep is, maar dat het aantal lettergrepen verschilt. In het volgende stadium wordt daarom een extra lettergreep gerealiseerd. Het kind zal echter geen klemtoonparameters veranderen, omdat daarvoor geen evidentie bestaat. Aangenomen dat de ongemarkeerde voet een kwantiteits-ongevoelige trocheïsche voet is (d.w.z. lettergreepstructuur speelt geen rol bij klemtoontoekenning), is de output vorm van het kind ['koːnɛin]. Wanneer deze vorm vergeleken wordt met de inputvorm ontdekt het kind een klemtoonfout. Het kind gaat nu op zoek naar een aanwijzing in de data om één of meer klemtoonparameters te veranderen. De parameter die nu gezet wordt, is de kwantiteitsgevoeligheidsparameter: lettergreep-structuur speelt een rol bij klemtoontoekenning. Het kind beklemtoont nu alle gesloten lettergrepen. Als gevolg hiervan breidt het woordtemplaat zich eveneens uit van éénvoetig tot tweevoetig. Het resultaat is ['koːˈnɛin]. Nu treffen we ook klemtoonfouten aan in woorden die voorheen goed gingen. Het woord *robot* wordt nu gerealiseerd als ['hoːˈpɔt]: de laatste lettergreep is gesloten en krijgt daarom klemtoon. Dit toont aan dat de grammatica systematisch verworven wordt. Wanneer tenslotte de vorm ['koːˈnɛin] wordt vergeleken met de input, leert het kind dat één van de voeten meer klemtoon heeft: nu wordt de waarde voor de hoofdklemtoonparameter bepaald. Woorden zoals *robot* moeten nu geheranalyseerd worden. Onder de aanname dat, wanneer een parameter eenmaal gezet is naar de gemarkeerde waarde er geen weg terug is, moeten deze woorden als uitzonderingen geleerd worden, in tegenstelling tot de standaardanalyse van Nederlandse klemtoon waarin woorden van het type *ballon* en *giraf* als uitzonderingen beschouwd worden en woorden van het type *robot* en *pinguïn* als regelmatig.

In dit proefschrift is aangetoond dat gelijktijdige bestudering van het logische probleem én het ontwikkelingsprobleem tot vruchtbare resultaten leidt. Hoewel Chomsky en Halle in 1968 wel inzagen dat het bestuderen van uitsluitend het logische probleem van taalverwerving een geïdealiseerd beeld van taalverwerving oplevert, meenden zij dat een meer realistische benadering, waarbij ook het ontwikkelingsprobleem in beschouwing genomen wordt, destijds te gecompliceerd was om tot resultaten te komen. In dit proefschrift is aangetoond dat nu, 25 jaar later, de situatie veel rooskleuriger is. Ondanks alle variatie — variatie tussen kinderen en binnen de data van één kind, variatie in taalkundige analyses, etc. — laat nauwkeurige bestudering van kindertaal ook duidelijke ontwikkelingspatronen zien, die zich laten beschrijven in het kader van een parametrisch prosodische theorie.

Curriculum Vitae

JOHANNA PAULA MONIQUE Fikkert werd geboren op 26 februari 1965 te Hellendoorn. Na het voltooien van haar middelbare schoolopleiding (Gymnasium β) aan het Christelijk Gymnasium te Leeuwarden is de auteur, na een jaar medicijnen te hebben gestudeerd, in september 1984 Nederlandse taal- en letterkunde gaan studeren aan de Rijksuniversiteit Groningen. Op 22 februari 1989 studeerde zij *cum laude* af op een doctoraalscriptie over de verwerving van fonologie, met bijvakken toegepaste taalkunde en algemene taalwetenschap.

Van 1 april 1989 tot 31 maart 1993 was zij in dienst bij NWO. Het eerste deel van het onderzoek is uitgevoerd aan het Nederlands Instituut van de Rijksuniversiteit Groningen; het tweede deel aan de vakgroep Algemene Taalwetenschap van de Rijksuniversiteit Leiden. Van het onderzoek naar kindertaal in het kader van de niet-lineaire fonologie wordt in dit proefschrift verslag gedaan.

Vanaf 1 februari 1994 is de auteur werkzaam als wetenschappelijk medewerker bij de vakgroep Allgemeine Sprachwissenschaft van de Universität Konstanz.

Stellingen

Behorende bij het Proefschrift

On the Acquisition of Prosodic Structure

van

PAULA FIKKERT

I.

Kinderen leren de grammatica van taal op een systematische wijze, welke zich goed laat beschrijven door het 'principes en parameters' model.

(dit proefschrift)

II.

Mora's zijn geen sub-syllabische constituenten. (dit proefschrift)

III.

Het bestaan van een goed werkend model voor het leren van klemtoon door machines betekent niet dat het model ook de verwerving van klemtoon door kinderen representeert. (dit proefschrift)

IV.

De basisgrammatica wordt uitsluitend op basis van positieve evidentie geleerd. Taalspecifieke eigenschappen worden geleerd op basis van indirecte negatieve evidentie. (dit proefschrift)

V.

In de nieuwe Nederlandse vertaling van Winnie-the-Pooh door Mies Bouhuys is 'Heffalump' vertaald met 'Klontemiggel'. Bij deze vertaling hebben semantische aspecten een belangrijke rol gespeeld. Aangezien de naamgeving in het origineel onmiskenbaar gebaseerd is op fonologische aspecten, bieden Nederlandse kindertaaldata een aantal betere alternatieven, zoals 'Honteflang' of 'Hoffalamp'. Enige kennis van kindertaal lijkt dus onmisbaar bij het vertalen van kinderboeken.

VI.

Het ontbreken van de mogelijkheid tot perceptie van de eigen output is een belangrijke factor voor het moeizame proces van het leren van gesproken taal door dove kinderen.

VII.

Het feit dat zwaardere sancties worden uitgesproken door de strafcommissie van de Nederlandse Volleybal Bond wanneer de autoriteit van de scheidsrechters in weloverwogen bewoordingen ter discussie wordt gesteld, dan wanneer de scheidsrechter(s) of tegenpartij beledigd wordt door één- of meerlettergrepige scheldwoorden toont aan dat zij het handhaven van de machtspositie van scheidsrechters belangrijker acht dan sportief gedrag of de rechtspositie van de tegenpartij.

(de Volkskrant 29 maart 1993)

VIII.

Wanneer Noorwegen lid zou worden van de EG zou de gist- en suikerconsumptie per hoofd van de bevolking drastisch afnemen.

IX.

Het ontbreken van een goede definitie van 'kunst' mag er niet toe leiden dat iedere vorm van creativiteit tot kunst verheven wordt.

X.

De migraine-patiënt bestaat niet.

XI.

Het verbieden van dankbetuigingen aan mensen die het meest hebben bijgedragen aan de totstandkoming van een proefschrift door de Rijksuniversiteit Leiden getuigt van een calvinistische opvatting: het leveren van goed werk wordt als vanzelfsprekend beschouwd en dient niet beloond te worden.

XII.

Veel maatregelen van de Nederlandse overheid zijn erop gericht bezuinigingen en/of kwaliteitsverbetering teweeg te brengen. De pragmatische instelling van de overheid leidt er vaak toe dat bij de formulering van de maatregelen de controleerbaarheid ervan belangrijker geacht wordt dan de kwaliteitsverbeterende effecten. Niet zelden leidt de invoering van het controle-apparaat ertoe dat beoogde bezuinigingen niet verwezenlijkt worden, terwijl de nadruk op controleerbaarheid dikwijls de beoogde kwaliteitsverbetering in de weg staat.

Paula Fikkert

On the Acquisition of Prosodic Structure

HIL Dissertations is a series which aims at publishing all dissertations which come out of the Holland Institute of Generative Linguistics (HIL). HIL offers a graduate program in generative linguistics and is a joint enterprise of the Free University in Amsterdam, Leiden University and the University of Amsterdam. The series will contain dissertations in all fields of generative linguistics.

On the acquisition of prosodic structure offers a detailed and systematic account of how the acquisition of syllable structure and stress proceeds. It combines detailed observations of child language with an analysis within a parametric framework. It is argued that transitions from one stage to the next are the result fo parameter setting. Most errors result from the fact that a particular parameter has not yet been fixed, i.e. it has its default value. The parameter values define the child's prosodic template and determine the relationship between the adult input and the child's output. The study furthermore relates the results derived from abstract learnability theory to the actual process of acquisition by children.

Although the book deals primarily with aspects of phonological acquisition by Dutch children, it is of interest to all language acquisition researchers and phonologists.

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