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Department of  
Linguistics

The University of British Columbia  
Vancouver, Canada

Date  October 4, 1991
The goal of this thesis is to develop a parametric model of acquisition which incorporates the idea that phonological systems are underlingly unspecified for certain feature values. I examine two variants of this model: one based on the theory of Radical Underspecification (Archangeli and Pulleyblank 1986), and one based on the theory of Contrastive Underspecification (Steriade 1987). I assume the principles and parameters framework, where the initial phonological system of the child is assumed to be characterized by the unmarked parameter settings of UG. The two types of parameters that are examined in detail are featural parameters and rule parameters. The unmarked settings of featural parameters are supplied by universal redundancy rules. In most cases, the unmarked settings of rule parameters are assumed to be OFF, or non-application.

I provide analyses of the vocalic systems of Hungarian and Spanish, based on the parametric theories of Radical and Contrastive Underspecification, which demonstrate that certain phonological parameters in these languages must be reset to the marked option. The Hungarian analyses focus particularly on spreading processes, while those in Spanish focus on alternations that take place within verb conjugation classes. Given the differences between the initial child state and the adult phonological systems of Hungarian and Spanish, the underspecification acquisition models make certain predictions.
regarding acquisition in these languages. These predictions are then tested using data from children acquiring both Hungarian and Spanish.

The early phonological systems of children acquiring Hungarian and Spanish are found to initially be smaller than predicted by either acquisition model. To account for these results, and still maintain a parametric model, I propose a theory of feature availability, which specifies the order in which features may become part of a child's phonological system. In conjunction with this theory of feature availability, the RU model is able to explain the development of children's early phonological inventories, as well as certain substitution patterns. The contrastive specifications required by the theory of CU cannot account for these aspects of the data.
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CHAPTER 1

Introduction

There is an abundance of evidence in cross-linguistic phonological research that not all segments are fully specified for all feature values underlingly. There is little agreement, however, as to exactly which features may be underspecified or under what conditions underspecification may occur. The theory of Radical Underspecification, outlined in Archangeli and Pulleyblank (1986), maintains that only non-predictable feature values are included in underlying representations. Archangeli and Pulleyblank (1989) argue that radical underspecification of the feature [ATR] is required in Yoruba, while Abaglo and Archangeli (1989) argue that a radically underspecified system is necessary in order to account for the vocalic facts of Gengbe.

An alternate theory of underspecification, that will be referred to here as Contrastive Underspecification, is outlined in Steriade (1987). Contrastive Underspecification assumes that underlying representations contain only those feature values that are necessary to distinguish pairs of segments in a given language. Mester and Ito (1989) argue that contrastive underspecification must be assumed in order to account for the facts of palatal prosody in Japanese mimetics. In a recent dissertation, Calabrese (1988) examines both types of underspecification and suggests that there may
be a parameter which allows languages to choose a phonological system that is either radically underspecified or contrastively underspecified.

Given a theory of Universal Grammar (UG), children's linguistic systems are possible adult grammars, and are therefore constrained by the same sets of principles as adult grammars. Data from first language acquisition should then be a revealing alternate source of evidence for the validity of linguistic theories. In this thesis I propose to use data from phonological acquisition to test the underlying premises of Radical and Contrastive Underspecification. I attempt to determine how these competing theories must be organized in order to represent coherent models of acquisition, and I will examine the predictions these theories make for the acquisition of the vocalic systems of Hungarian and Spanish. These predictions are then tested using real-time acquisition data.

The task the child faces in acquiring the grammar of a language can be shown as in (1.1).

(1.1)

$$\text{Input} \quad \longrightarrow \quad \text{Grammar}$$

The child must determine, on the basis of the input received, the form of the grammar. When the input is examined closely, the schematization of acquisition in (1.1) can be shown to be incomplete. White (1989), summarizing research that has been carried out over the past 20 years, identifies three problems
that relate to input: underdetermination, degeneracy, and the No-negative Evidence Hypothesis.

The problem of underdetermination is that many aspects of grammar are not overtly visible in the input. Traces, for example, which are assumed to be an integral part of the syntactic representation of sentences, are abstract entities which are not present in the spoken language a child hears. The degeneracy problem is one originally addressed in Chomsky (1965), which points out that the language children hear may contain ungrammatical or incomplete utterances. How is it possible for a child to determine which sentences are grammatical, and therefore generated by the grammar, and which are the result of performance errors? The No-negative Evidence problem points out that our grammatical competence allows us to make judgments about the ungrammaticality of sentences as well as their grammaticality. If we assume (as is generally done in this type of research) that children learn only through positive evidence, how can they possibly learn that certain construction types are not generated by the grammar?

These problems demonstrate that children must attain the complex adult grammar using input that does not provide all the clues necessary for the language being acquired. This has been referred to as the projection problem or the logical problem of language acquisition. In an attempt to solve the projection problem, researchers such as Chomsky (1981a,b) have posited a mediating component to (1.1) called Universal
Grammar or UG.

(1.2)

Input ----> UG -----> Grammar

UG is our species-specific endowment for language, which constrains the form of possible human grammars. The conception of acquisition in (1.2) has led to two consequences for linguists interested in acquisition research. First has been the creation of the field of learnability, which investigates the logical problems relating to language acquisition. This field attempts to explain how the child, given an incomplete and imperfect set of input strings, can achieve the adult grammar, i.e. to specify what form the input and UG components of (1.2) must take in order that the grammar be attainable. Secondly, the schema in (1.2) has led to the acceptance of acquisition data as an important and useful source of evidence for the testing of alternative linguistic theories.

1.1 Overview

1.1.1 An Acquisition Model

In this thesis I develop a model of acquisition that is based on the assumption that phonological systems are underlingly unspecified for certain feature values. I examine two variants of this model: one that is based on the assumption that underlying representations lack all predictable information, and one that is based on the
assumption that underlying representations lack only non-contrastive information. I assume that this acquisition model is organized according to the principles and parameters model of grammar originally proposed in Chomsky (1981a,b). The two variants of the acquisition model make certain predictions regarding the acquisition of phonological systems, and I will test these predictions using acquisition data from Hungarian, a Finno-Ugric language, and Spanish, a Romance language. In order to restrict my task somewhat, I have chosen to focus on vocalic systems, because this is where the majority of work in underspecification has taken place. I also restrict my investigations to the types of featural and rule parameters that are required given an RU or CU acquisition model. While parameters have been proposed for many other aspects of phonological organization, these are the two sets of parameters that are the most crucial to a theory of underspecification.

The underlying theme of this thesis is very similar to that of Calabrese (1988). Calabrese develops a hierarchy of universal filters to explain certain facts of phonological acquisition and foreign language transfer. Calabrese argues that UG consists of a set of filters, or negative constraints, which are hierarchically ordered. In the acquisition of a language, children may learn a segment which violates a certain filter if segments violating filters further down the hierarchy have already been acquired.

My objectives differ from Calabrese's in a number of
crucial ways. First, I have chosen to use real-time acquisition data to test the predictions of the parametric theories of RU and CU. This has been done so that cross-linguistic differences and relationships between adult phonological systems and acquisition can be clearly demonstrated. Calabrese attempts only to account for some very general aspects of the Jakobsonian picture of phonological development, which sometimes suffer from having been misinterpreted over the years (see Ingram 1989a). Secondly, while Calabrese attempts only to account for the development of phonological inventories, I attempt to account for the types of substitution processes and phonological rules that young children use, as well as the development of their initial inventories.

The acquisition data that are analyzed in this thesis come from previously published studies of young children acquiring Hungarian and Spanish. The choice of languages studied was made by force rather than by choice. Although there is a large inventory of cross-linguistic acquisition samples to choose from, I wanted to use only languages where data from several different children was available, in order to be certain that the samples were truly representative. I also wanted to choose languages for which previous underspecification analyses of the vocalic systems had been proposed. These two criteria narrowed down the choice of languages considerably.
1.1.2 Components of the Acquisition Model

I have dual objectives in writing this thesis. First, I wish to examine the learnability aspects of the theories of Radical and Contrastive Underspecification, looking at the innate mechanisms that must be attributed to the child and the learning procedures that are required to attain the adult language. Secondly, I wish to examine phonological cross-linguistic acquisition data in order to determine whether the underspecification analyses can correctly account for the patterns of development. In developing an acquisition model which allows me to investigate these issues I have made certain assumptions regarding 1) how underlying representations are structured, 2) the organization of UG, 3) the constraints that hold in an acquisition model such as this, and 4) the nature of phonological development. Some of these issues are addressed in the following sections.

1.1.2.1 Underspecification Theory

The acquisition model developed in this thesis adopts the basic premise that all features have binary values, but that underlying representations lack certain feature values. Two variants of this model are investigated: one based on the theory of Radical Underspecification, and the other based on the theory of Contrastive Underspecification. Radical Underspecification (RU) is based on the notion of minimal redundancy developed in Kiparsky (1982, 1985) and is outlined in detail in Archangeli and Pulleyblank (1986). In this
theory it is assumed that only non-redundant feature values exist in underlying representations. Redundant or predictable feature values are inserted by redundancy rules at some point during the lexical or post-lexical phonology.

Contrastive Underspecification (CU), sometimes referred to as Restricted Underspecification (Mester and Ito 1989), is developed from the theory of feature specifications used in Halle (1959) and is outlined in Steriade (1987). CU is also discussed, in a somewhat revised form, in the works of Clements (1988), Christdas (1988) and Calabrese (1988). Steriade's theory assumes that only contrastive feature values are marked underlyingly, and that non-contrastive feature values are inserted late in the derivation by redundancy rules. The theories of underspecification that are examined here make different claims about how children specify their phonological inventories, and about the role that redundancy rules play in phonological systems.

An alternative conception of the specification of underlying feature values assumes that features are privative, or have only a single functional value. Den Dikken and van der Hulst (1990) argue that all features are privative, while Steriade (1987), Mester and Ito (1989) and Piggott (1990, to appear) argue that certain features are best viewed as being privative. A privative or unary feature can have only one possible marked value in any language, and the unmarked value is never specified, even at some late point in the phonology. The data presented in Chapter 3 for Hungarian present a
challenge to a theory which assumes that all features are privative, because there it is argued that [-round] must be the lexically specified value of Hungarian. I believe that cases like this, where a universally redundant value can be shown to be marked underlyingly on a language-specific basis, will help to demonstrate that some or all distinctive features have binary values available for manipulation.

1.1.2.2 Organization of UG

I assume that UG consists of a set of universal principles, and a set of parameters. Principles are those aspects of UG that are held constant across all languages, while parameters are principles which have several specified options. Syntactic parameters have been proposed to account for differences between languages in the use of "empty" subjects (the Pro-drop parameter, see Hyams 1983 and Wexler and Manzini 1987), subject-aux inversion (Davis 1987), binding theory (Solan 1987) and subjacency (Rizzi 1982). Phonological parameters have more recently been proposed to account for directionality and maximal/minimal effects of the feature hierarchy (Archangeli and Pulleyblank 1986, Piggott, to appear), feature hierarchitectue (Piggott, to appear), branching possibilities of syllabic constituents (Kaye 1987) and stress placement (Hayes 1981, Dresher and Kaye 1988).

While suggestions have been made for parameters with multiple settings (e.g. Wexler and Manzini 1987), I assume that the parameters that are required in an acquisition model
based on underspecification theory have only binary options. I show that universal redundancy rules can be viewed as the unmarked settings of featural parameters, although languages may choose to reset featural parameters to the marked option. The unmarked setting of featural parameters initially constrain the specification of all children's phonological inventories, and consequently, in languages which require the marked setting of a featural parameter, the initial system hypothesized by the child will be different from the adult system. This parametric model can help to explain why many acquisition researchers have noted that cross-linguistically children's early phonological systems are very similar, and only later take on language-particular qualities.

In the principles and parameters model of grammar it is assumed that children's grammars may differ from adults only in the parameter settings that characterize them. This model then places very severe restrictions on the types of phonological systems that can be attributed to children, and on the developments that can occur in the attainment of the adult grammar. I believe that this is an important and necessary constraint on acquisition models, because for far too long acquisition research has ignored advances in linguistic theory and has attempted to exist as an independent field. I believe that theoretical linguistics and acquisition research can both benefit from closer ties between these fields. Acquisition research can help to determine which are the unmarked parameter settings, while theoretical linguistics
can provide a model against which we can test acquisition data.

In the course of this thesis I examine parameters that relate to 1) redundancy rules, 2) phonological rules, and 3) complex vowels. The first two types of parameters are discussed in detail in Chapter 2, as specific to theories of underspecification. The parameter relating to complex vowels is not a particular feature of an underspecification model of acquisition, but is required to account for the acquisition of long vowels in Hungarian and diphthongs in Spanish.

The parameters that relate to phonological rules are identical in RU and CU. Based on work in current non-linear phonology I assume that rule parameters allow for the spreading, deletion or insertion of phonological elements. The unmarked setting of all rule parameters is OFF or non-application. In this thesis I discuss how spreading rules can be used to describe what have been called 'reduplications' in child language.

As stated above, the unmarked settings of redundancy rules are assumed to be provided by UG. In the theory of RU there are two possible types of redundancy rules: context-free rules and context-sensitive rules. At the unmarked setting, context-free rules insert universally unmarked feature values redundantly, while at the marked setting they provide the universally marked values redundantly. At the unmarked setting context-sensitive rules provide universal feature co-occurrence restrictions, while at the marked setting a
context-sensitive rule is suppressed or eliminated in the language-specific grammar, and the universally redundant feature value is marked underlyingly. In the theory of CU only context-sensitive redundancy rules are permitted. At the unmarked setting these rules provide universal feature co-occurrence restrictions (as in RU), while at the marked setting these redundancies do not apply and the contrastive feature values must be marked underlyingly.

1.1.2.3 Constraints

The acquisition model I develop is constrained by the Learnability Condition (Pinker 1979, 1984), the Continuity Condition (Atkinson 1982, Pinker 1984), and the No-negative Evidence Hypothesis (Williams 1976, Baker 1979, Berwick 1985), which are the most commonly held assumptions in the field of learnability research.

Both the Learnability and Continuity Conditions constrain the organization of UG. The Learnability Condition says that any developmental stage posited by an acquisition theory must be attainable via an acquisition mechanism that begins with UG and ends at the adult grammar. The Continuity Condition says that the principles and acquisition mechanisms that are available to the child must be the same throughout the whole course of development. These two conditions are built directly into a principles and parameters model of phonology. Given the parameter setting account of acquisition children's grammars can differ from adults' only in the setting of
parameters, and the only type of acquisition that takes place is the switching of parameters.

The No-negative Evidence Hypothesis, which says that only positive evidence may be used in acquisition, is also be assumed in this thesis. In a parameter setting model, this constraint says that parameter resetting can only be triggered by positive evidence from the input. Given the No-negative Evidence Hypothesis, the ungrammaticality of certain representations or constructions can never be learned, but rather will have to be provided for the child as a principle of UG.

1.1.2.4 The Nature of Phonological Development

In order to attain the phonological system of a language the child must correctly perceive the adult phonetic repertoire, determine the appropriate cues to attend to, and learn which sounds in the language being acquired are used distinctively. I make certain assumptions about each of these steps, some of which result from previous research into phonological development, and some of which follow directly from the acquisition theory assumed.

I assume, following work in perception research, that children acquire the phonetic inventory of their language in advance of phonological organization. In addition, following previous acquisition evidence, I assume that children begin to organize speech sounds into a phonological system sometime in the first half of the second year. Given the parametric model
of acquisition, UG will provide the structure for the child's initial phonological system in the form of a set of universal principles and parameters. The child's first attempts at phonological organization will show the effects of the unmarked featural and rule parameters provided by UG, and positive evidence will be required to trigger the resetting of any one of these parameters.

According to these assumptions, cross-linguistically children's earliest phonological systems will be similar in that they are all constrained by the same set of universal principles and parameters, but may differ in that these constraints may be applied to distinct phonetic inventories. The parametric acquisition theories based on the theories of RU and CU make very similar claims about the types of substitution patterns that will be found in children's early speech.

One type of pattern, that I call paradigmatic substitutions, arise when the unmarked parameter setting provided by UG forces the child to represent distinctive sounds in a non-distinctive fashion. This type of substitution is predicted to occur in languages where the marked setting of context-sensitive parameters is called for. The child's initial phonological inventory will be specified according to the featural parameters (redundancy rules) of UG, while the language being acquired calls for a different pattern of specification. In this case the representations of two sounds may be collapsed and the unmarked sound will be
produced in place of a more marked one. Since both RU and CU allow for context-sensitive rules, and since I assume the same basic set of context-sensitive rules in both theories, the types of paradigmatic substitutions they predict are identical. Different substitution patterns are predicted for Hungarian and Spanish, however, because their phonetic inventories are quite different.

I also assume, again following both previous research and the constraints of the parameter setting model, that the structure of children's word forms is initially provided by a set of templates. These templates provide simple CV and CVCV syllable structures to which featural information can be mapped. In certain cases the adult target will contain more information than the child can represent in the template, and certain elements in the target will be omitted in the child's representation of that form. In other cases the featural information that the child can represent does not exhaustively fill the template, and portions of the template will be underlyingly unspecified. In this case I assume that the Satisfaction Condition (McCarthy and Prince 1986) forces the child to provide featural information for the unspecified slots, either by a paradigmatic substitution provided by UG or through the spread of featural information from another segment or syllable in the word form.

Substitutions that result from a phonological rule filling in the featural information of an underlying empty skeletal slot are referred to as syntagmatic substitutions.
Syntagmatic substitutions then occur across a word form, as opposed to paradigmatic substitutions, which are segment specific. It is predicted that both syntagmatic and paradigmatic substitutions will occur when a sound in the adult target is not present in the child's inventory, or when there is some complexity in the adult form that somehow interferes with how much featural information the child can represent.

1.1.3 Predictions

In Chapter 4 it is shown that the parametric acquisition models based on the theories of RU and CU make remarkably similar claims regarding the child's initial phonological system. Both theories, for example, predict that children acquiring Hungarian and Spanish will initially represent 5 distinct vowels, which will surface as [i], [u], [e], [o] and [a], and that they will represent these inventories using the features [high], [back] and [low]. Both theories predict that children acquiring Hungarian will initially substitute front unrounded vowels for front rounded vowels, a low back vowel for a low front vowel, and short or simple vowels for complex vowels. Both theories also predict similar sets of phonological rule parameters for both Hungarian and Spanish, with the major difference being in how these rules are assumed to operate.

The two variants of the parametric acquisition theory differ in their predictions regarding the number and types of
featural parameters that must be reset in order to achieve the adult systems of Hungarian and Spanish. RU predicts that 4 featural parameters must be reset in the acquisition of Hungarian, while CU predicts only 2. In Spanish, RU predicts that only a single context-free parameter will be reset, while CU predicts that no featural parameters will be reset at all. When a featural parameter is reset the child's phonological system will be restructured to accommodate the new feature markings. RU therefore predicts that a greater number of restructuring stages will take place in both Hungarian and Spanish than is predicted by the theory of CU.

1.1.4 Some General Findings

In both languages it is found that a large number of the mismatches that occur between a child's form and the adult target are the substitution of a short or simple vowel for a complex one. The only predicted paradigmatic substitution pattern that in fact occurs is the substitution of [a] for /ɛ/ in Hungarian. In both languages a large number of mismatches are the result of a rule of Spread filling in underlingly unspecified feature values, so that both vowels in a multisyllabic child form are identical on the surface. The fact that Spread is found in the speech of children acquiring Hungarian and Spanish, even when Spanish does not appear to have a productive Spreading rule is an interesting finding.

One of the main differences between the Hungarian and Spanish data relates to the conditions under which
substitutions occur. In Hungarian, it is found that substitutions generally occur when a sound in the adult target is not present in the child's phonological inventory, although in a few cases substitutions also occur when the adult form is complex in some way, such as containing a consonant cluster or being trisyllabic. In Spanish, however, substitutions seem to be a function of the stress patterns of the language. Vowels whose features spread to another element in the word form are almost exclusively in the stressed syllable in the adult target. It is hypothesized that because of the complex stress system in Spanish children mark stress in every form. This adds to the complexity of the child's form, and as a result only the featural information of the stressed vowel or syllable is mapped to the template.

The early phonological systems of children acquiring Hungarian and Spanish are found to initially be smaller than predicted by the parametric theories of underspecification. While both theories predict that children's earliest systems will contain 5 distinct vowels, the data suggest that children only gradually achieve a 5 vowel system. The first vowel is /a/, followed by the mid vowels /e/ and /o/, then by /i/ and finally by /u/. In Hungarian the last vowels added are the front rounded vowels /u/ and /ø/. To account for these results, and still maintain the parametric model of acquisition, I propose a theory of feature availability, which provides a basic order in which features become available to children. This theory is in part based on the theory of
distinctive features developed in Jakobson and Halle (1956). I maintain a UG perspective of features and assume that children have access to all distinctive features innately, but the theory of feature availability specifies the order in which features can be used when the child begins to organize a phonological system.

It is found that given this theory of feature availability, the RU model is able to account for the development of children's early phonological inventories, while the CU model is not. The types of specifications required in the CU model made it impossible to predict which segments will be added to the child's inventory at a given time. It is also found that the type of underspecification required by the theory of RU is able to explain the idiosyncratic behaviour of [e] in the Spanish data, while this is not possible given a contrastive underspecification system. I therefore conclude that an RU acquisition model is a better representation of UG than the CU model.

1.2 Organization

This thesis is organized in the following fashion. In Chapter 2 I develop the parametric theories of Radical and Contrastive Underspecification, based on the theories outlined in Archangeli and Pulleyblank (1986) and Steriade (1987), focussing on the type of information and feature values that are present in underlying representations and the form of both redundancy and phonological rules. In doing so I first
outline some current aspects of non-linear phonology that are assumed in the course of this thesis, with a particular focus on those aspects of phonology that are assumed to be universal principles. I then discuss some of the basic assumptions of the principles and parameters model of grammar, and of the theory of learnability. Finally I examine the theories of RU and CU as parameter setting models. I describe how UG will be organized given each theory, and the types of input that will be required to trigger the resetting of parameters.

In Chapter 3 I present certain facts regarding the vocalic systems of Hungarian and Spanish, which help to argue for a specific underspecification system. This type of argumentation is more necessary in the parametric theory of RU, since this theory allows for a greater number of language-specific choices than the parametric theory of CU. Each analysis concludes with a summary of how the grammar would be organized, given the proposed feature specifications and phonological rules.

Chapter 4 presents a parametric theory of phonological acquisition. I first present some of the major findings of previous research on phonological acquisition, and then discuss the assumptions that I make regarding these findings. Finally the CU and RU predictions for the acquisition of the vocalic systems of Hungarian and Spanish are outlined, given the analyses developed in Chapter 3.

Chapter 5 presents the acquisition data from Hungarian and Spanish. I present analyses of the phonological
inventories used by these children at two time periods, and the types of substitution patterns that occur in the data.

In Chapter 6 I look more closely at the acquisition data, with an eye to seeing how successful the parametric acquisition theories of RU and CU are at capturing the acquisition facts. First I examine the discrepancies that exist between the inventories used by the Spanish and Hungarian children and the inventories predicted by RU and CU, and show that a theory of feature availability can help explain the early patterns of development. I then attempt to account for the development of these early phonological inventories, the substitution patterns, and the phonological rules used by these two groups of children, given RU or CU. Lastly, I discuss the implications these analyses have both for phonological theory and for a theory of phonological acquisition.
CHAPTER 2

Parametric Theories of Underspecification

In this chapter I examine the theories of Radical and Contrastive Underspecification as representative of principles and parameters models of phonology. This will be a wholly logical enterprise; the development of acquisition models capable of handling real-time acquisition data will be left until Chapter 4. I first outline the two theories of underspecification, showing the types of features and feature values that are left unspecified and how redundancy and phonological rules are dealt with. I will then present some of the basic assumptions of the principles and parameters model of phonology and of learnability theory, and demonstrate how Radical and Contrastive Underspecification may be revised to fit in with these assumptions. Many of these issues have already been faced in Radical Underspecification (RU), since it is presented as a principles and parameters model of phonology in Archangeli and Pulleyblank (1986). Contrastive Underspecification (CU), on the other hand, has not been developed as extensively as Radical Underspecification, and has not been discussed within the principles and parameters framework.

In the 1960s and 1970s it was assumed that language acquisition took place as the child created rules compatible with the linguistic data. An "evaluation metric" would lead
the child to the appropriate adult grammar by allowing the child to choose between competing rules or rule systems. The theory of UG (and in particular the parametric model) gradually replaced this rule-writing model, in part because it was found to be extremely difficult to understand or even characterize the evaluation metric\(^1\). In the theory of UG, the set of possible hypotheses that are necessary for acquisition is assumed to be innate. This type of theory requires more innate machinery than the rule-writing approach, but on the other hand it severely limits the types of hypotheses that children are assumed to make about language.

The parametric model is a specific theory of UG which assumes that the child comes equipped to the language learning process with a set of universal rules or principles and a set of parameters, which together make up UG. Parameters present the child with specific options of a partially unspecified principle\(^2\). Parameters are generally assumed to have binary settings -- one achieves the unmarked option, the other the marked option. Thus in addition to providing the child with a very limited set of possible hypotheses, the parametric framework provides a theory of markedness that will lead to predictions about order of acquisition and complexity of phonological systems.

Fairly recently, the principles and parameters model has become well-integrated into phonological theory. Phonological parameters have been proposed to account for directionality of mapping or association (Archangeli and Pulleyblank 1989,
Piggott, to appear), feature hierarchitect (Davis 1990; Piggott, to appear), branching possibilities of syllabic constituents (Kaye 1987), stress assignment (Hayes 1981, Halle and Vergnaud 1987, Dresher and Kaye 1988) and the underlying selection of feature values (e.g. Archangeli 1988; Archangeli and Pulleyblank 1986, 1989; Abaglo and Archangeli 1989). In this chapter I argue that if a parametric theory of underspecification is adopted, UG will include a set of featural parameters, which insert redundant feature values, and a set of rule parameters, which provide the possible form of phonological rules. RU assumes that UG supplies both context-free and context-sensitive featural parameters. When a context-free rule is reset to the marked option a new rule (called a complement rule) will be created to insert the opposite feature value predicted by UG. When a context-sensitive rule is reset, a marked feature specification will be added to the underlying representation of a segment, but the rule itself will remain in the grammar. CU allows only for context-sensitive rules, and parameter switching will occur and have the same effects as in RU.

This chapter will be organized as follows. In 2.1 I discuss some general issues in current phonological theory, looking specifically at the theory of Lexical Phonology, aspects of phonological and metrical representations, and phonological rules. Many of the issues discussed in 2.1 are both controversial and complex, but rather than outlining all approaches and controversies, I will discuss only those issues
that are crucial for this dissertation. In 2.2 I look at underspecification theory, focussing particularly on the theories of Radical and Contrastive Underspecification. In 2.3 I present some assumptions concerning the principles and parameters model of grammar, and in 2.4 I discuss some of the basic assumptions of learnability theory. In 2.5 the parametric theories of Radical and Contrastive Underspecification are outlined by superimposing the basic premises of these two theories upon the principles and parameters model of phonology.

2.1 Aspects of Phonological Theory
2.1.1 Lexical Phonology

In *The Sound Pattern of English* (henceforth SPE, Chomsky and Halle 1968) the syntactic component was assumed to feed directly into the phonological component of grammar. Word formation processes operated in the syntax. Morphological junctures were represented by boundary symbols, and these remained visible to the phonology. Lexical Phonology developed out of the SPE framework, using insights from the work of Chomsky (1970) and Aronoff (1976) on word formation. In Lexical Phonology boundaries are encoded through sets of bracketings and through levels, rather than through boundary symbols. There are two components to the lexicon -- the lexical component and the post-lexical component. In the lexical component rules apply only to words and/or morphemes, while in the post-lexical component rules apply to the output
of the syntax, i.e. to words, or to larger sets of strings such as phrases or sentences.

### 2.1.1.1 The Lexicon

The work of authors such as Siegel (1974), Aronoff (1976) and Allen (1978) demonstrated that there is often a significant interaction between phonological rules and morphological processes. Certain types of morphological operations appear to trigger certain types of phonological rules, while morphological operations often seem to cluster together. Pesetsky (1979) tried to capture these facts by proposing that phonological rules can apply inside the lexicon, to the output of specific kinds of morphological operations. Groupings of morphological operations are called levels or strata, and the output of each level is subject to the rules of the phonology. Mohanan (1982) and Pulleyblank (1986) assume that there is a single set of phonological rules in the grammar of a language, but a specific rule may be constrained to apply only within the lexical component, only within the post-lexical component, or within both. In this model rules will display different properties depending upon where they apply in the phonology, because of the different constraints that hold of these two components.
### 2.1.1.2 The Cycle

Underived lexical items are fed into the first level of the morphology where they undergo morphological operations. After each morphological operation takes place these forms are fed back into the phonology, and then back into the morphology to undergo another morphological operation, and so on. Each feed through a morphological process and the set of phonological rules is called a cycle. Kiparsky (1982) notes that many phonological processes, such as Trisyllabic
Shortening (TSS), do not operate on underived forms. TSS applies to derived words such as serenity and invitation, while it does not apply to underived forms such as nightingale and ivory. The Strict Cycle Condition was proposed to account for these facts (Mascaró 1976). The statement of the Strict Cycle Condition given in Kiparsky 1982: 41) is reproduced in (2.2).

(2.2) The Strict Cycle Condition (SCC)

a. Cyclic rules apply only to derived representations.

b. A representation \( \Phi \) is derived with respect to rule \( R \) in cycle \( j \) iff \( \Phi \) meets the structural analysis of \( R \) by virtue of a combination of morphemes introduced in cycle \( j \) or the application of a phonological rule in cycle \( j \).

This condition will prohibit forms such as ivory from undergoing cyclic phonological rules such as TSS, since they are underived forms in the sense of (2.2).

Kiparsky (1982) then argues that the SCC can be derived from the Elsewhere Condition (EC), a condition on the ordering of rules that has been adopted as a standard constraint on rule application (Kiparsky 1973, Koutsoudas, Sanders and Noll 1974).
(2.3) The Elsewhere Condition (Kiparsky 1982: 136-7)

Rules A and B in the same component apply disjunctively to a form $ iff:

a. The structural description of $ (the specific rule) properly includes the structural description of $ (the general rule)

b. The result of applying $ to $ is distinct from the result of applying $ to $. In that case, $ is applied first, and if it takes effect, then $ is not applied.

Kiparsky argues that every underived lexical item is in fact an identity rule, which by the EC will block the application of any other phonological rule (since the identity rule will always be more specific). With this assumption, only the formulation of the EC in (2.3) is needed, obviating the specific statement of the SCC in (2.2).

While the SCC (or the EC) was successful in capturing many aspects of the interaction of morphological and phonological processes, there is some evidence that certain types of rules do not obey the SCC. Kiparsky (1982) argued that structure-building rules, such as rules of syllabification and stress assignment, and redundancy rules, which fill in feature values, may apply to non-derived forms (this argument is later refuted in Kiparsky 1985). Halle and Mohanan (1985) argue that the rule of final-n deletion in English, which is not a structure-building rule, must also be
non-cyclic. This rule deletes the \( n \) in forms like \textit{columns}, \textit{hymn-book} and \textit{column}, yet does not apply in forms like \textit{hymnal}. The facts show that this rule is a lexical rule and must apply before compounding and inflections, yet it must not apply on the same level as the \(-\text{al}\) suffix. In addition, this rule applies to underived forms such as \textit{column} and \textit{hymn}. Halle and Mohanan suggest that final-\( n \) deletion is part of a level of the morphology that is non-cyclic. Kiparsky (1985) interprets these facts by saying that either there is only a single lexical level in English, or that brackets are not erased at the end of Level 1.

2.1.1.3 Post-lexical Component

The most relevant criterion for determining whether a rule is lexical or post-lexical is the domain of application. Since post-lexical rules may be fed by syntactic information, they often apply to segments across word boundaries as well as within words. Lexical rules, on the other hand, can apply only within words. The rule of Flapping in English is a typical post-lexical rule. Flaps occur inside words, as in \textit{ladder} ([la\textipa{D}ar]), but also occur across word boundaries, as in \textit{hit it!} [h\textipa{DI}It]. Post-lexical rules always apply in an across-the-board fashion, since they cannot be sensitive to lexically marked exceptions. It has also been suggested that post-lexical rules may be optional and may be sensitive to rate or style of speech (Kaisse and Shaw 1985).
2.1.1.4 Structure Preservation

Kiparsky (1982, 1985) argues that lexical rules are subject to Structure Preservation, while post-lexical rules are not. Structure Preservation is the constraint that features, feature combinations, syllable types or any other structures that are not present underlyingly in the language may not be referenced or derived. In Kiparsky (1985) it is shown that Structure Preservation will restrict the rule of Voicing Assimilation in Russian to apply to obstruents, since voicing is not specified on sonorants anywhere in the lexicon. Kiparsky assumes that the formal work of Structure Preservation is carried out by marking conditions operating in the lexicon. In the case of Russian Voicing Assimilation the relevant constraint is given in (2.4) (Kiparsky 1985: 108).

(2.4) * [+voiced]

[+son]

This constraint says that neither [+voice] nor [-voice] is marked underlyingly on sonorants in Russian, and therefore by Structure Preservation neither feature value may be added to the representation of a sonorant anywhere in the lexical phonology. This prevents sonorants from being affected by the rule of Voicing Assimilation, and allows Voicing Assimilation to be stated without a target condition excluding the sonorant class.

Phonetic implementation rules, such as those that derive aspirated stops in English, are post-lexical rules that are
non-structure preserving since they derive segments that are not underlyingly distinctive. In Russian the constraint in (2.4) must be turned off post-lexically in order that sonorants be phonetically realized as voiced segments.

There have been a number of arguments given in the literature that Structure Preservation as stated by Kiparsky is too strong. Borowsky (1986) claims that Structure Preservation must in fact be turned off before the end of the lexicon in English in order to account for the assimilation of velar nasals. Mohanan and Mohanan (1984) argue that certain places of articulation that are not underlyingly distinctive in Malayalam must be derived in the course of the lexical phonology, and therefore that Structure Preservation does not play a role at all in the lexicon of this language. Sproat (1985) also argues that Catalan violates Structure Preservation. Archangeli and Pulleyblank (1986) employ marking conditions such as (2.4), but argue that it must be stipulated for each constraint whether it holds in the lexical component, the post-lexical component or both. In the following chapters I assume the original version of Structure Preservation (given by Kiparsky 1982, 1985), as there is no evidence either in Hungarian or Spanish that an alternate version is required. It will be shown in 3.3.1 that Structure Preservation can explain neutral vowel behaviour in the Hungarian Back Harmony system.
2.1.2 Representations

2.1.2.1 Non-linear Phonology

The focus of generative phonology, as presented in works such as SPE, was on rule writing, rule ordering and the derivation of lexical items. In the late 1970s, due to such works as Goldsmith's *Autosegmental Phonology* (1976), this focus changed to show a greater interest in representations. Goldsmith proposed that individual features belong to separate tiers, where they can be linked by association lines to one or more than one segment. Autosegmental representations were originally proposed to account for tone patterns, which traditionally posed problems for standard generative approaches, since tones often spread over a domain larger than a segment, or shift from one segment to another by phonological or morphological operations.

It has since been recognized that many melodic features, including nasality, voicing, glottalization and places of articulation can be *autosegmentalized*, or generally act independently of other features. An example is a feature that may be a morphological property of a root and underlyingly may 'float' or be unassociated to any particular segment in that root (e.g. Archangeli and Pulleyblank's 1986 discussion of [-ATR] in Yoruba). Alternatively, a segment may be lexically linked to a single segment but a phonological rule may operate to add association lines between this feature and other segments in a root (e.g. the Type A languages given in Piggott (to appear)). Both these cases are examples of
autosegmentalized features; features which behave independently of the remainder of the melodic representation.

Goldsmith (1976), in his treatment of tone, proposed that tones are always underlyingly unassociated, and that they become anchored segmentally by means of the Wellformedness Condition.

(2.5) Well-formedness Condition (Goldsmith 1976: 27)
   a. All vowels are associated with at least one tone.
   b. All tones are associated with at least one vowel.
   c. Association lines do not cross.

These conventions allowed more than one tone to be linked to a single vowel to create contour tones. Work by Clements and Ford (1979) and Halle and Vergnaud (1982) demonstrated that (2.5) is too weak as it predicts that when there is a mismatch between the number of tones and the number of vowels, several options are possible. In fact, in a given language, there is generally only one method of resolving the mismatch. Clements and Ford argue that (2.5) is also too strong because it predicts that tones may be multiply linked, which is not the case in all languages. Halle and Vergnaud (1982) then propose that a set of association conventions apply only to free or floating tones. These conventions as adopted by Pulneyblank (1986: 11) are given in (2.6).
(2.6) Association Conventions

Map a sequence of tones onto a sequence of tone-bearing units,
a. from left to right
b. in a one-to-one relation

Well-formedness Condition:
Association lines do not cross.

These conventions do not allow for the mapping of more than one tone to a given segment. Multiple linkings of a single tone to more than one tone-bearing unit or of one tone-bearing unit to more than a single tone are accomplished by language-specific rule, according to Pulleyblank (1986). Autosegmentalized features of any sort are assumed to be linked to representations by a set of Association Conventions such as those in (2.6) (e.g. see Piggott, to appear), although in Archangeli and Pulleyblank (1989) and Lieber (1987) it is claimed that the direction of initial association is parameterizable. In the unmarked case association proceeds from left to right, but in marked cases, such as the association of Yoruba [ATR], association operates from right to left. In Chapters 3 and 5 I will adopt the version of the Association Conventions given in (2.6), with the added assumption that the initial direction of mapping is parameterizable.
2.1.2.2 Feature Geometry

It was realized as early as Jakobson and Halle (1956) that segments do not consist of bundles of totally unorganized features, but it was not until Mohanan (1983) and Clements (1985) that the first models of feature geometry were proposed. Feature geometries attempt to account for restrictions on how features interact in human languages. The geometry in (2.7) is one possible model of feature hierarchy that is consistent with recent work in this area (cf. Clements 1985, Sagey 1986).
There is a distinction in (2.7) between nodes and features. Nodes (given as "o") dominate features or nodes, while features (given in [ ] brackets) are the terminal elements in the tree. Three articulator nodes -- Labial, Coronal and Dorsal -- are immediately dominated by the Place node. The vowel features of [back], [high] and [low] are dominated by the Dorsal node, which is the node also used to represent velar and uvular consonants. The Coronal node dominates [anterior] and [distributed] while the Labial node dominates the feature [round], a fourth feature used in the description of vocalic systems.

In Archangeli and Pulleyblank (1986) a feature geometry is proposed in which a separate node, the Secondary Place Node, dominates all vowel features. This node was meant to capture the fact that harmony rules are almost exclusively triggered by vowels and have vowels as their targets. It has since been argued that other aspects of representations and rule types can account for these facts, while incorporating the model in (2.7).³

2.1.2.3 The OCP

The Obligatory Contour Principle (OCP) was originally proposed by Leben (1973) to account for the distribution of surface tones in Mende, a Niger-Congo language. In trisyllabic nouns in Mende the tonal patterns LLH and HHL do not occur. Leben used the OCP to prohibit identical adjacent
tones, so that if a trisyllabic noun has three tonal autosegments, only HLH and LHL patterns will be permitted. Other patterns, such as HLL and LHH will be derived from underlying sequences of HL or LH tones, with spreading of the second underlying tone to the final syllable. In this way the OCP and principles of spreading are able to account for the systematic gap in the tonal patterns of this language.

In McCarthy (1979) the OCP was applied to segmental patterns in Arabic, to account for the systematic lack of roots of the form /C_1C_2C_3/. McCarthy's generalized statement of the OCP is given in (2.8).

(2.8) OCP (McCarthy 1986: 208)

At the melodic level, adjacent identical elements are prohibited.

McCarthy (1986) systematically examines evidence for and counterexamples against the OCP in many different languages. In Afar, for example, a rule of syncope applies to forms in (2.9a) but fails to apply in the forms in (2.9b) where the application of syncope would result in two identical adjacent consonants.
McCarthy concludes that in the vast majority of languages, the OCP appears to hold of segments at the lexical level, but does not necessarily hold at the level of phonetic implementation. He suggests that if convincing examples of the OCP not holding at the lexical level can be found, then the OCP could be regarded as a parameterizable principle of UG, but one that in the unmarked case holds of all non-prosodic information in the lexicon (but see Paradis and Prunet 1990 for a convincing argument that perhaps the OCP does not have parametric options). Recently it has been suggested that the OCP holds not just of entire segments, but of individual features (e.g. Archangeli and Pulleyblank 1986, Mester to appear).

2.1.2.4 Metrical Theory

In generative phonology syllables were not considered to be primitives of the theory, and could only be referenced as some sequence of consonants and vowels. In Kahn (1976) it is argued that syllables are constituents of phonological representations, represented as a separate tier dominating
There have been many subsequent elaborations of the non-linear approach to syllable structure, the most common of which are the rule-based approach (Kahn 1976, Steriade 1982, Levin 1985), the templatic-approach (Selkirk 1978, Halle and Vergnaud 1978) and the government approach (Kaye and Lowenstamm 1984). Here I outline the rule-based approach of Levin (1985), and this framework will be employed in Chapter 3 in the analysis of Spanish syllable structure.

Levin's framework focuses particularly on the universal and language-specific aspects of a theory of syllabicity. Syllabic constituents are generated by a version of X-bar theory, where each syllable contains one and only one head. The universal components of this theory are given in (2.10) (Levin 1985: 12).

(2.10) A. X-bar theory

i. Categorial Component
   a. N-Placement
   b. Complex-N

ii. Projection
   a. Project N''
   b. Project N'

iii. Incorporation
   a. Incorporate into N''
   b. Incorporate into N'

iv. Adjunction (to N'')

B. Condition on Structure-Dependent Rules

C. Sonority Hierarchy
N-Placement is the process which determines the syllable head. N-Placement may be marked in the lexicon or may be determined by a redundancy or phonological rule. Levin assumes that [syllabic] is not an operative feature, but rather that in many languages the category N is erected by rule over segments specified as [-consonantal] and/or [-high]. Complex Ns may exist, controlled by a parameter associated with the Complex-N process of the categorial component. Although Levin does not specifically address the issue of markedness in complex Ns, I assume that Universal Grammar initially tells the child that Ns may not branch, but that based on positive evidence from the input the child may switch this parameter to allow a single N to dominate two skeletal slots (this aspect of Levin's theory will be discussed in Chapter 5). The rules in (2.10) will apply cyclically, so that if an epenthetic vowel is inserted after the initial application of N-Placement, it will receive a designation as a nucleus on a subsequent cycle.

After N is found N" is projected by picking up segments immediately to the left of N. N" is the maximal projection, and therefore the syllable node itself. The final projection is N', and this projection is particularly influenced by language-specific information. Project N' will pick up any remaining post-nuclear segments. Incorporation is a process which then allows additional skeletal slots to be incorporated under N" or N'. This process will allow for both complex onsets and codas on a language-particular basis. The
operation of N-placement, Project N" and N' and N"
Incorporation are shown in (2.11) for the English word trip.

(2.11) a. N-Placement

```
   N
    |
   x x x x
Redundancy
rule inserts [-cons]
[-cons] trip
```

b. Project N"

```
  N"
 /  |
 /  N
 /  |
 x x x x
 | [-cons]
 | trip
```
Each of the operations of N-Placement, Project N" and Project N' must operate within the constraints of the Sonority Hierarchy, as shown in (2.10C). Levin posits a universal hierarchy of features which determine sonority ranking, which serves as the base from which language-particular sonority
scales are developed. If a given string cannot be exhaustively syllabified in adherence with the language-specific sonority scale, then several possible options are available to resolve this problem. The most common option is that a skeletal slot, which can then undergo the rule of N-Placement, is inserted or epenthesized into the representation. This new segment will then serve as the head of a new syllable to which the previously unsyllabifiable segment may be associated.

Zec (1988) discusses such a case of Epenthesis in Bulgarian. In Bulgarian liquids are not able to act as nuclei, and therefore a form such as /grk/ 'Greek' will undergo epenthesis as shown in (2.12).

(2.12) Underlying /grk/

Epenthesis
\[ x \quad x \quad x \quad x \]
\[ g \quad r \quad k \]

Syllabification
\[
\begin{array}{c}
N'' \\
| \\
N' \\
| \\
N \\
| \\
x \quad x \quad x \quad x \\
| \\
[-cons] \\
g \quad r \quad k \\
[grk] \quad 'Greek'
\end{array}
\]
Within this view Epenthesis is seen as an automatic result of the syllabification algorithms in a language, and does not require that such rules be language-specific phonological rules such as rules of spreading or delinking (to be discussed in 2.1.3).

The past decade has also seen much research into a theory of metrical stress. Liberman and Prince (1975) propose a metrical theory in which stress is determined by the relative prominence of syllables, determined through binary branching tree structures erected over syllables. Each node in the tree is labelled as either w (weak) or s (strong), and each binary branching tree is called a foot. Both terminal and non-terminal constituents are labelled for prominence, allowing stress to be assigned to words of more than two syllables. Hayes (1981) revises and expands on this theory of stress, arguing that a theory of metrical tree structure and a small number of parameters can account for stress assignment in the world's languages. Hayes' principles of tree construction are given in (2.13) (Hayes 1981: 48).
Tree Construction

a. Project rimes. Optionally form a subprojection of [+syllabic] segments within the rime.

b. Select either right or left nodes as dominant.

c. Form the largest possible binary branching tree, such that recessive nodes do not branch. Optionally, it may be specified that
   i. All terminal nodes are counted as non-branching.
   ii. Dominant nodes must be terminal.
   iii. Dominant nodes must branch.

The first principle in (2.13a) says that rhymes form the initial projection on which trees are erected, or optionally that this projection is the nucleus. Since Hayes (1981) predates Levin (1985) I assume that in a Levin-style analysis (2.13a) would say 'project N', optionally project N. ' (2.13b) provides the choice of whether the foot is left or right-dominant. By (2.13c) foot construction continues, erecting feet over rhymes or syllables in accordance with (2.13b), where nodes marked w never branch. The parameters in (2.13c) in the unmarked case are OFF, and in the marked case are in effect. If Parameter (2.13ci) is chosen foot construction will be quantity sensitive, ignoring branching within the rhyme or nucleus. If (2.13cii) is chosen, then foot construction is maximally binary rather than unbounded, and if (2.13ciii) is chosen then nodes are labelled s if and only if they branch. Following (2.13) stress will be assigned
to the form *mërepet* from Maranungku using the parameters given in (2.14a and b)(Hayes 1981: 51).

(2.14) a. Going from left to right, construct binary, quantity insensitive, left dominant feet.
    b. Group the feet into a left dominant word tree.
    c. *mërepet*

```
   s w
  /\  
 /   
 s w
```

The most prevalent competing theory of stress assignment is grid theory, where the branching structures of Hayesian tree theory are not recognized (Prince 1983). In the analysis of stress assignment in Spanish given in Chapter 3 I will adopt the Hayesian framework, although I believe nothing hinges on this particular choice of theory.

2.1.3 Rules

Non-linear phonology and theories of feature geometry have led to a much clearer view of how phonological representations are structured. This, along with the move in syntax to limit rule types, has led phonologists to a constrained view of the number and types of phonological rules that may occur in any language. Piggott (to appear), for example, allows for the rules shown in (2.15).
(2.15) Phonological Rules

a. Spread $\alpha$

\[
\begin{array}{c}
\text{A} & \text{B} \\
\cdots \\
\alpha
\end{array}
\]

b. Delink $\alpha$

\[
\begin{array}{c}
\text{A} & \text{B} \\
| & | \\
\alpha_1 & \alpha_3 & \alpha_1
\end{array}
\]

c. Fuse $\alpha_1, \alpha_3$

\[
\begin{array}{c}
\text{A} & \text{B} \\
| & | \\
\alpha_1 & \alpha_3 \\
\vdash
\end{array}
\]

d. Insert $\alpha$

\[
\begin{array}{c}
\text{A} & \text{B} \\
| & | \\
\alpha_1 & \alpha_1 & \alpha_3
\end{array}
\]

Each of these rules is a simple operation which adds or deletes some part of the phonological representation. Spread $\alpha$ is the rule involved in most assimilation processes, adding an association line between a feature already anchored and a new segment. Delink $\alpha$ is the dissimilation rule which deletes some element due to the presence of a second element. Fusion is a process that is not unique to Piggott's work, although it is first discussed as a rule of phonology in Piggott (to appear). Fusion creates a double linking between an element (feature, skeletal slot, etc.) on one tier and two elements on
another tier. Insert $\alpha$ is the process which accounts for the insertion of a feature (or features) into the melodic component.

Although Piggott views Fusion as a separate and distinct rule from those in (2.15a, b and d), it is possible to view Fusion as the insertion of an association line. In the analysis of Spanish and Hungarian presented in Chapter 3 I find no evidence for a separate rule of Fusion and consequently I assume that this rule is simply one possible instantiation of the rule Insert $\alpha$.

Piggott (to appear) assumes that the operation of any one of the rules in (2.15) is regulated by a Directionality Parameter which says that rules may spread leftward, rightward or in a bidirectional fashion. I assume that the unmarked setting of a Directionality parameter is always the same direction as the initial mapping regulated by the Association Conventions.

A more precise statement of how these rules operate will depend upon the theory of feature specification assumed (see 2.2.1 - 2.2.3). For example, Spread $\alpha$ will behave very differently in a theory of Contrastive Underspecification than in Radical Underspecification. In the contrastive model, both feature values may be underlyingly specified, in which case if $\alpha$ spreads to $\beta$ it will also have to delink $\alpha$ from $\beta$. In the radical model, only a single feature value will be present underlyingly, so $\alpha$ will only spread to $\beta$ if $\beta$ is not specified for $\alpha$. A theory which assumes that features are privative
(i.e. have only a single functional value) will assume that Spread α functions as in Radical Underspecification.

2.2 Underspecification Theory

Underspecification has been a part of phonological theory since the days of the Prague School linguists. In Trubetzkoy (1969) archiphonemes are elements represented by the set of features that are common to a group of phonemes if those phonemes are neutralized in some context. Archiphonemes lack those feature values that are involved in the neutralization process. Trubetzkoy discusses the case of word-final devoicing in German (Trubetzkoy 1958/69: 79):

In German the bilateral opposition d-t is neutralized in final position. The opposition member, which occurs in the position of neutralization, from a phonological point of view is neither a voiced stop nor a voiceless stop but "the nonnasal dental occlusive in general".

Archiphonemes are only positional elements -- in contexts where segment contrasts are not neutralized segments are fully specified.

Halle (1959), adopted the Praguian notion of archiphoneme, but also assumed that features and feature values may be unspecified due to distributional constraints, combinatorial possibilities, grammatical context, or the nature of the segment itself. Unspecified feature values are filled in during the course of the derivation by morpheme structure constraints or by phonological rules. Specified features have one of three possible values: "+", "-" or "0".

In the tradition of Halle (1959) underlying
representations in SPE were assumed to be redundancy free (Chomsky and Halle 1968: 381):

Languages differ with respect to the sounds they use and the sound sequences they permit in words. Thus each language places certain conditions on the form of phonetic matrices and hence of the configurations of pluses and minuses (indicating membership in one of a pair of complementary categories) that may appear as entries in the classificatory matrices of the lexicon. These constraints make it possible to predict, in a given language, the specification of features in particular segments. Such predictability applies to segments in isolation (e.g. in Finnish, all obstruents are voiceless) as well as to segments in particular contexts (e.g. in English, /s/ is the only true consonant admissible before a true consonant in word-initial position). Rules describing these constraints can readily be formulated within our framework, and can be interpreted as specifying the coefficients of particular features in particular environments. It is therefore natural to propose that such rules be incorporated in the grammar and that the features that are predictable be left unspecified in lexical entries.

The desirability of underspecification had been questioned by Lightner (1963) and Stanley (1967), however, who argued that the underlying omission of feature values could lead to a system of unwanted ternary contrasts. Chomsky and Halle accepted the Lightner and Stanley arguments and dealt with the problem by ordering all redundancy rules in a block to fill in lexically unspecified feature values before the operation of phonological rules. In this way the underlying specification of features did not interact with the phonological rules of the language. Unspecified feature values were to be interpreted as the unmarked values of features, allowing markedness values to be computed for each lexical item.

Kiparsky (1982) also adopted the premise that underlying representations are free from all redundancy, but dealt with
the Lightner-Stanley objections in a different fashion from Chomsky and Halle (1968). Kiparsky proposed that within a given environment, only a single feature value may be lexically specified, so that if a phonological rule applies to fill in the alternate value a three-way contrast will never be possible within that particular environment.

Chomsky and Halle (1968) believed that ordering redundancy rules before all phonological rules avoided a ternary system and at the same time allowed significant lexical generalizations to be captured. They felt the early application of redundancy rules was warranted because "no good examples have been discovered of empirically significant generalizations that result from ordering these rules" (Chomsky and Halle 1968: 386).

Since that time a number of empirical arguments for the underspecification of segmental features at the time that phonological rules apply have been found. One example is the voicing of obstruents in Japanese (Ito and Mester 1986, Steriade 1987, Mester and Ito 1989). The two phenomena involved are Rendaku and Lyman's Law. Rendaku is a rule which voices initial obstruents in the second element of a compound:

(2.16) Rendaku

- a. ori + kami --> origami 'paper folding'
- b. yo + sakura --> yozakura 'blossoms at night'
- c. yama + tera --> yamadera 'mountain temple'
- d. kake + futon --> kakebuton 'top futon'
Rendaku is a productive phonological rule applying to compounds made up of native Japanese morphemes whose components stand in a modifier-head relationship. It is formulated in Ito and Mester (1986) as a rule associating the feature [+voice] before the second member of a Rendaku compound. This feature will be associated to the first eligible segment in the second member of the compound.

Lyman's Law is a constraint in Japanese which says that Rendaku is blocked if any segment in the second compound member is specified for voicing. In (2.17) the initial consonants of the second member of a compound do not undergo Rendaku because they are followed by a voiced segment.

(2.17) Lyman's Law

<table>
<thead>
<tr>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. siro + tabi</td>
<td>sirotabi 'white tabi'</td>
</tr>
<tr>
<td>b. maru + hadaka</td>
<td>maruhadaka 'completely naked'</td>
</tr>
<tr>
<td>c. taikutsu + sinogi</td>
<td>taikutsusinogi 'time-killing'</td>
</tr>
<tr>
<td>d. doku + tokage</td>
<td>dokutokage 'poisonous lizard'</td>
</tr>
<tr>
<td>e. onna + kotoba</td>
<td>onnakotoba 'feminine speech'</td>
</tr>
</tbody>
</table>

Ito and Mester (1986) formalize Lyman's Law as a rule which deletes the [+voice] Rendaku feature when a [+voice] feature is already part of the representation of the second compound member. (2.17d and e) show that Lyman's Law applies even when a voiceless obstruent surfaces between the initial voiceless obstruent of the second compound member and a voiced obstruent. If voiceless obstruents in Japanese are specified as [-voice] they would be expected to block the operation of
Lyman's Law, since they would make the voicing of the final voiced obstruent invisible to the rule. Ito and Mester suggest that this evidence shows that voiceless obstruents must be underlingly unspecified for the feature [voice] at the point in the derivation where Lyman's Law applies. This gives the representation in (2.18) for the form 'poisonous lizard' in (2.17e).

\[(2.18) \quad [+\text{voice}] \quad [+\text{voice}] \]
\[\begin{array}{c}
\pm \\
\end{array}
\]
\[
[\text{o n n a}] \quad \text{RENDAKU} \quad [k \ o \ t \ o \ b \ a]
\]

'feminine speech'

This analysis demonstrates that in Japanese obstruents are unspecified for voicing at the point in the phonology when certain phonological rules apply\(^7\).

Pulleyblank (1985) presents arguments that in Tiv tone is underlingly unspecified and certain tone bearing units remain unspecified until the postlexical component. Ito (1984) provides evidence that /a/ in Ainu must be unspecified for backness at the point in the derivation where a rule of dissimilation applies. Evidence of this sort has led phonologists to attempt to develop theories of underspecification that will predict when and where underspecified representations exist.

Currently, there are two major theories of underspecification: Radical Underspecification, outlined in Archangeli and Pulleyblank (1986) and Contrastive
Underspecification, outlined in Steriade (1987). These theories will be discussed in 2.2.1 and 2.2.2, and in 2.2.3 I will present some alternative views of feature specification.

2.2.1 Radical Underspecification

2.2.1.1 Elimination of Redundancy

The theory of RU (Archangeli 1984, 1988; Archangeli and Pulleyblank 1986, 1989; Pulleyblank 1986, 1988) is an exploration of the nature of phonological rules and representations which adopts Kiparsky's (1982) view that all redundant feature values are omitted from underlying representations and may remain unspecified throughout the lexicon. Only non-predictable feature values are present in the underlying system of a language, and only a single value of any feature is permitted. Two types of redundancy rules are distinguished. Default rules insert universally predictable feature values, while complement rules insert feature values that are language specific. Both types of rules may be context-free, inserting feature values in general, or context-sensitive, inserting feature values that are based on co-occurrence restrictions.

Redundancy rules are ordered among the phonological rules of a language by the set of ordering constraints given in (2.19).
(2.19) Ordering Constraints (Archangeli and Pulleyblank 1986)

a. Redundancy rules apply as late as possible in the grammar.

b. A redundancy rule must apply at the level at which reference is made to the feature value being inserted (The Redundancy Rule Ordering Constraint or RROC).

c. A redundancy rule applies as early as possible at the level dictated by the RROC.

The interaction of these constraints prohibits the practical use of a ternary system of feature values. At some point in the derivation, before a redundancy rule fills in a value of \([F]\), there will be a contrast between the underlying value of \([F]\) ([\(\alpha F\)]) and \([0F]\). At a later stage in the derivation, if a phonological rule applies to \([-\alpha F]\), the unmarked feature value, then by (2.19b) and (2.19c) the redundancy rule will apply immediately before the phonological rule and there will be a contrast between \([\alpha]\) and \([-\alpha F]\). If there are no phonological rules in the language that manipulate the unmarked feature value, then the redundancy rule inserting \([-\alpha F]\) does not apply until the postlexical component, by (2.19a).

RU also assumes that redundancy rules are subject to the EC (Kiparsky 1973, 1982; Koutsoudas, Sanders and Noll 1974) given in (2.3). The EC will force a context-sensitive redundancy rule to apply before a context-free rule if they reference the same feature value, since the environment for
the application of a context-sensitive rule is more specific. The application of the context-sensitive rule will block the application of the context-free rule in the particular environment specified by the context-sensitive rule. The EC also constrains the ordering of phonological rules with respect to redundancy rules, as in the case of Yokuts Echo Vowel Formation, which is ordered before the more general default rule of [high] insertion (Archangeli and Pulleyblank 1986).

In a hypothetical language which has the 9 consonants /p,t,k,b,d,g,m,n,l/ in its phonological inventory, RU predicts the specification of the features [sonorant], [voice], [lateral], and [nasal] in (2.20), given the accompanying set of default rules.

(2.20) p t k b d g m n l

[sonorant]
[voice] + + +
[lateral] +
[nasal] + +

Default rules:

[ ] --> [-son] [+nasal] --> [+son]
[ ] --> [-lateral] [+lateral] --> [+son]
[ ] --> [-nasal] [+son] --> [+voice]

[-son] --> [-voice]

These consonants will be further specified for place of
articulation, which will then distinguish the labials, alveolars and velars from one another. The feature [sonorant] is completely redundant in this hypothetical system, since the sonorancy values of all segments in (2.20) are given by the context-free rule inserting [-son] and the two context-sensitive rules predicting [+son] on segments marked [+lateral] or [+nasal].

2.2.1.2 Rule Types

Archangeli and Pulleyblank (1986) provide a typology of possible rule types with accompanying markedness statements. Each and every phonological rule has a function and an argument, and may also have a target and/or trigger condition. (2.21) gives the possible specifications of rules, where "I" designates functions or operations, "II" arguments, and "III" trigger/target conditions.

(2.21) I. a. (insert)\textsubscript{default}/delete
   b. (maximal)\textsubscript{default}/minimal
   c. (content)\textsubscript{default}/structure
   d. (same direction)\textsubscript{default}/opposite direction/
      bidirectional

II. node or feature(s)

III. trigger condition
     target condition

There are four function parameters, each of which has a default or unmarked setting. "Insert/delete" indicates that a feature or association line is added to or taken away from the
representation, with "insert" being the unmarked option. The "maximal/minimal" function describes the adjacency of rule targets. At the unmarked "maximal" setting a rule which targets a node or feature scans the highest level of syllabic structure providing access to that target, while at the "minimal" setting a rule scans the tier containing the target. Rules targeting vowels can therefore apply to segments that are not immediately adjacent at the skeletal level, but must be adjacent or local at the level of the nucleus. This constraint on adjacency is termed the Locality Condition in Archangeli and Pulleyblank (1987). "Content/structure" indicates that it is a feature or an association line which is added to the representation by the rule, with "content" being the default or unmarked option. The directionality parameter describes the direction of spreading, with "same direction" indicating that the unmarked setting for this function is in the same direction as the initial association of skeletal slots to melodic structure (as given by a set of Association Conventions such as those in (2.6)).

This typology of rule functions or operations predicts that there are two unmarked types of phonological rules available to children -- default rules and rules of epenthesis. Default rules use only default settings of function parameters and insert arguments that are provided by UG. A context-free default rule inserting the feature [-low] will be stated as in (2.22), where the parentheses indicate the default settings of parameters.
(2.22) Default [-low]

I. a. (insert)
   c. (content)
   d. (same direction)

II. [-low]

(2.22) says that [-low] will be inserted anywhere (a set of Configuration Constraints will dictate where it can attach and where it cannot), and insertion will operate in left-to-right fashion, assuming that this is the unmarked direction of initial association. The maximal/minimal parameter is irrelevant to this rule, since there is no specified target. A context-sensitive default rule will use the same function parameters as in (2.22) but will require the addition of a target condition.

The second type of maximally unmarked rule is an epenthesis rule, where the function parameters are again set to the defaults, with the argument specified as a skeletal slot.

(2.23) Epenthesis

I. a. (insert)
   c. (content)
   d. (same direction)

II. skeletal slot

Such a rule will only be posited when syllabification or other licensing requirements make it necessary. The inserted
skeletal slot will have no featural content; however, since (2.22) is not a redundancy rule, it will not be subject to the Ordering Constraints in (2.18) and will apply in the lexical phonology before the redundancy rules\(^1\). In this way the feature specifications of the epenthetic segment will be provided by the redundancy rules of the language.

If we follow current assumptions about Epenthesis (as discussed in 2.1.2.4) then the unmarked status of (2.23) is explained by the fact that it is simply an automatic result of the syllabification algorithms in a particular language. The rule in (2.23) will not have the same status as other phonological rules (such as those in (2.15), which do not in general have a bearing on prosodic representations.

Rules that will involve setting at least one of the function parameters in (2.22) to the marked value will be those that delete features or structure; spreading or assimilation rules which use the marked "structure" parameter; rules whose targets are specified as "minimal"; and rules that operate in some direction other than the canonical direction of initial association. Thus RU recognizes three of the rule types given in (2.15): Deletion, Spread and Insertion, without allowing for Fusion.

Both the type of underspecification assumed by RU and the rule typology in (2.21) have implications for how phonological rules operate in this theory. Because only a single feature value is present in any environment, Spreading rules will be able to manipulate only a single feature value. The typology
in (2.21) formalizes Kiparsky's claim (Kiparsky 1985) that in the unmarked case features spread only to segments which are 'free' or unspecified for that feature. The fact that a target is free is stated in (2.21) by the lack of a target condition (2.21III). In the analysis of Khalka Mongolian harmony given in Archangeli and Pulleyblank (1986), it is assumed that Round Harmony, which spreads [+round], lacks a target condition, explaining why the rule is blocked by /ü/. It is rare that two values of any feature are specified at once (although it could happen: if a voiceless lateral were present in the inventory shown in (2.20) this lateral would presumably be specified as [-voice]), but if a rule spreading [+F] encounters a segment specified as [-F] spreading should presumably also be blocked).

2.2.2 Contrastive Underspecification
2.2.2.1 Specifications

The theory of CU was first outlined in Steriade (1987), and has been taken up in works such as Clements (1987), Calabrese (1988) and Mester and Ito (1989). Steriade's work was not meant as a theoretical treatise, but rather as an alternative to the theory of RU. As a result, many aspects of the theory are not fully articulated, although most crucial aspects of the theory may be drawn from specific analyses given in Steriade (1987).

Steriade (1987) makes an initial distinction between trivial and non-trivial underspecification. Trivial
underspecification occurs when a segment lacks specification for a particular feature at all stages in a derivation. It arises in the case of monovalent features or articulator nodes, where only a single value of the feature or node is operative, and in the case of features which never acquire a value for a second feature because of restrictions in the feature hierarchy. An example of the latter type of trivial underspecification is a Dorsal consonant which will never receive a specification for [anterior], since [anterior] is a feature that is dependent on the Coronal articulator node (see (2.7)). Non-trivial underspecification occurs when a segment lacks a specification for a feature at some stage in the derivation, but eventually becomes specified for that feature value.

The important distinction within non-trivial underspecification is made between R-values of features, which are redundant feature values, and D-values, which are those values of a feature that contrast within a specific class of segments. R-values are absent from underlying representations, while D-values must both be present. A contrastive specification of the hypothetical consonantal system shown in (2.20) is given in (2.24).
The voiced and voiceless obstruents contrast with regard to the feature [voice] in this system, so voiceless obstruents are underlying marked [-voice] and the voiced ones as [+voice]. /l/ contrasts with /d/ in terms of laterality, so both are specified for a value of the feature [lateral]. The two nasals contrast with the corresponding voiced obstruents, and therefore /b/ and /d/ are specified as [-nasal] while /m/ and /n/ are specified as [+nasal]. In this system [sonorant] is completely redundant.

2.2.2.2 R-Rules

There is no formal contrast in CU between universal and language-specific redundancy (R-rules). R-rules insert R-
values. They are always context-sensitive, since they insert redundant values based on co-occurrence restrictions, and they may have one of two functions (Steriade 1987: 359):

(2.25) a. the enhancement of perceptual salience,
    e.g. [+back] --> [+round], or

b. the demonstration of the restricted distribution of a content feature within the realm of a stricture feature (stricture features are [sonorant], [cons], [continuant], [high], [low])
    e.g. [+son] --> [+voice].

Steriade points out that assuming that R-rules may have only the functions in (2.24) rules out the possibility of an R-rule such as [+round] --> [+high], which is used by Archangeli and Pulleyblank (1986) in the analysis of Nyangumarta. This rule is not excluded on the grounds that it is language-specific, but on the grounds that it does not have one of the functions in (2.25).

The R-rules for vocalic segments used in Steriade (1987) are given in (2.26)\textsuperscript{12}.\hfill
In Steriade's analysis of Hungarian Back Harmony an R-rule is extrinsically ordered before a phonological rule. Two R-rules and a rule of Back Harmony are posited for Hungarian (the CU analysis of Hungarian BH will be discussed in detail in 3.1.5.2):

(2.27) R-rule 1: [+low] \rightarrow [+back]
R-rule 2: [-low, -round] \rightarrow [-back]

Back Harmony (iterative, feature-changing)

\[
\begin{array}{c}
\text{[a\text{back}]} \\
\text{[b\text{back}]}
\end{array}
\quad
\begin{array}{c}
\Downarrow \\
\text{V} \\
\vdots \\
\Downarrow \\
\text{V}
\end{array}
\]

The rule of Back Harmony is ordered between R-rules 1 and 2 in order that the low long vowel /aː/ can act as a trigger of Harmony. R-rule 2 cannot be ordered before Harmony, because it fills in the backness specifications of /i/, /iː/ and /eː/ and these vowels are transparent to the Harmony process. The
EC, which orders specific rules before more general ones, cannot force the ordering of R-rule 1 before Back Harmony, since the structural description of R-rule 1 is not part of the structural description of Back Harmony.

Steriade (1987) also posits an extrinsic ordering relationship between the rule of Round Harmony in Mongolian and the redundancy rule inserting the predictable value of [round]. She argues, however, that language-specific ordering between phonological rules and redundancy rules is unwanted, and instead assumes that in Mongolian [round] acts as a monovalent feature. In this language then the redundancy rule inserting [-round] is not required. Unfortunately, an alternate analysis of the Hungarian facts is not provided.

2.2.2.3 Phonological Rules

Because CU assumes that both values of a contrastive feature are underlyingly specified, the theory must also assume that assimilation rules may be either feature-filling or feature-changing. Steriade (1987: 339) states:

nothing, in my view, prevents a rule of vowel harmony from operating sequentially, by successive spreading and delinking steps, as shown in (1):

(1) F -F -F -F F -F -F
    |   |   |   |   |   |   |   |
    V C V C V C V --> V C V C V C V -->

    F /   /   / F
    |   |   |   |
    V C V C V C V --> V C V C V C V

A rule propagating the feature [F] will therefore not be blocked when a segment is encountered that is specified for
[F], as is assumed in the unmarked case by Radical Underspecification. Steriade provides examples of feature-changing processes in the Height Harmony system of Pasiego, following McCarthy (1984) and in the Back Harmony system of Hungarian, following the analysis of Farkas and Beddor (1987), shown in (2.27). In Pasiego either [+high] or [-high] initiates Height Harmony, spreading to a vowel specified as either [+high]. In Hungarian, Steriade assumes that either [+back] or [-back] initiates the harmony process and that targets may be specified as either [+back]. If rule triggers may be specified for either value of a feature, then these rules will have to be stated using alpha notation, as shown in (2.27).

2.2.3 Alternate Theories of Feature Specification

The majority of current analyses dealing with underspecified values adopt either the Radical or Contrastive framework. Calabrese (1988), Clements (1987) and Christdas (1988) argue for slightly modified versions of CU. Calabrese's revisions involve deriving the pattern of underspecification in a given language from the set of universal filters that are violated language-specifically (this is essential since Calabrese uses filters or negative constraints, whereas Steriade uses universal redundancy or R-rules). Calabrese's claims regarding the hierarchy of universal filters will be discussed in 6.1.2.2. In 2.2.3.1 I will briefly outline Clements' theory. A number of other
works, such as Den Dikken and van der Hulst (1990) and Piggott (1990, to appear) assume that features are privative rather than binary, and therefore do not adopt a theory of underspecification at all.

2.2.3.1 Clements (1987)

Clements' (1987) position on underspecification is that both values of a contrastive distinctive feature are always fully specified in URs, as are the so-called 'primary' or major class features such as [sonorant] and [consonantal]. Incomplete underlying specification of values occurs when features are not used contrastively, or when they represent articulator nodes (i.e. Labial, Coronal and Dorsal in (2.6)). There are no universal default rules to fill in missing values, but language-particular rules may add missing feature values. The hypothetical 9 consonant language specified in (2.20) and (2.24) is specified according to Clements' system in (2.28).

\[(2.28)\]

\[
\begin{array}{cccccccc}
\text{p} & \text{t} & \text{k} & \text{b} & \text{d} & \text{g} & \text{m} & \text{n} & \text{l} \\
\text{[sonorant]} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & + & + & + \\
\text{[voice]} & \text{---} & \text{---} & + & + & + & + & + & + \\
\text{[lateral]} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & [nasal] & \text{---} & \text{---} & + & + & + \\
\end{array}
\]

The feature [sonorant] is fully specified since it is a major class feature, while the features [voice], [lateral] and [nasal] are contrastive. Articulator nodes would behave in a monovalent fashion (i.e. are either present or absent), with
Labial present for /p, b, and m/ and absent for all other features, etc.

In this thesis I will treat the Clements (1987) (and Christdas 1988) view of underspecification as another form of CU, since vowel features, which are neither major class features nor articulator nodes, will be contrastively specified. Clements' treatment of vowels will therefore be equivalent to a contrastive one.

2.2.3.2 Privative Features

Each of the theories of underspecification discussed assume that features are binary, as was first proposed in Jakobson and Halle (1956). Trubetzkoy (1939/69), on the other hand, proposes that featural oppositions may be privative, where features are either present or absent; gradual, where features have degrees; or equipollent, where features have polar distinctions that are each logically possible. In the feature geometry in (2.7) nodes are assumed to behave in a privative (or monovalent) fashion, even by proponents of underspecification theory.

More relevant to a discussion of underspecification is the issue of whether terminal features are binary or privative. Piggott (1990) proposes that the feature [nasal] is universally a privative feature, while Mester and Ito (1989) and Steriade (1987) propose that [voice] and [round] are privative features in Japanese and Mongolian respectively. Den Dikken and van der Hulst (1990) assume that all features
are privative, and Goldsmith (1987) proposes that all features are either privative or equipollent. In the majority of cases it will be impossible to determine whether a feature is privative or whether it is binary but has only a single feature value present underlingly. This is because underspecification theory assumes that underlingly unspecified feature values are filled in by redundancy rules late in the derivation, and therefore redundant values will generally have no phonological effects. Mester and Ito (1989: 283) warn that this may make comparisons of RU and a theory of privative features difficult:

If not all features are privative (see den Dikken & van der Hulst 1988 and references cited there for a strictly single-valued approach), a principled typology of features must be developed. Otherwise private features could be invoked ad libitum whenever it seems that RU is needed.

It is only in the case of a binary feature whose predictable value has phonological effects that we will be able to distinguish it from a privative feature. In RU, the phonological use of predictable features is accomplished by the RROC, given in (2.19b). Some examples of the use of the RROC are presented in Archangeli and Pulleyblank (1986, 1989) for Yoruba and in Archangeli and Pulleyblank (1986) for Yokuts. I believe that it is contingent upon those who assume that features may be privative to account for these cases. In this thesis I assume that terminal features are binary, and always have two possible values. Based on the historical development of distinctive features as binary units, I believe that the binary approach is more conservative than the
privative one.

2.3 Principles and Parameters

The principles and parameters theory of grammar was first outlined in Chomsky (1981a,b) and has been widely used to account for a variety of facts in both syntax and phonology. Parameters are used to explain cross-linguistic differences, and at the same time make predictions about the course of language acquisition. For these reasons, in this thesis I will develop a theory of phonological acquisition that assumes that UG contains both principles and parameters. In the following sections I outline how the principles and parameters model of grammar is organized, and show how some previously proposed parameters are assumed to operate.

The principles and parameters theory emphasizes the universality of the theoretical constructs used in all languages, while predicting that languages differ in certain constrained ways:

What we expect to find, then, is a highly structured theory of UG based on a number of fundamental principles that sharply restrict the class of attainable grammars and narrowly constrain their form, but with parameters that have to be fixed by experience. If these parameters are embedded in a theory of UG that is sufficiently rich in structure then the languages that are determined by fixing their values one way or another will appear to be quite diverse, since the consequences of one set of choices may be very different from the consequences of another set; yet at the same time, limited evidence, just sufficient to fix the parameters of UG, will determine a grammar that may be very intricate and will in general lack grounding in experience in the sense of an inductive basis. (Chomsky 1981a: 3-4)

According to this view acquisition becomes a relatively simple
endeavour. A particular hypothesis is supplied by UG, and evidence from the language being acquired will confirm that this initial hypothesis is correct, or suggest that an alternate hypothesis should be chosen. In the latter case, the child need not create a new hypothesis, but simply "switch" a parameter, and a new hypothesis will be given.

The principles and parameters approach provides a built-in theory of markedness. The parameter settings provided by UG are the default or unmarked settings, while the other setting(s), which can only be achieved via evidence from the input, are marked. A language that makes use of the default setting of a parameter will be less complex or marked than a language that uses the marked setting. In acquisition, then, this model predicts that the child will first assume the unmarked parameter setting, and only switch to a marked parameter setting if there is evidence that this is necessary.

Developmentally, the child's speech should first be characterized by the unmarked parameter setting, and only later be characterized by the marked setting. In Hyams (1983), for example, the acquisition of the "pro-drop" or AGR/PRO parameter (Chomsky 1981a, Rizzi 1982) is discussed. This parameter was proposed to explain differences between languages in the ability to have null-subjects in tensed clauses\textsuperscript{13}. Hyams argues that the unmarked parameter setting allows null-subjects, as in Italian, while the marked setting requires lexical subjects, as in English. The low incidence of lexicalized subjects in the speech of young children
acquiring English is due to the initial unmarked parameter for AGR/PRO (this analysis has sparked much controversy -- see Guilfoyle 1984 and Lebeaux 1987 for two reanalyses of these facts).

2.3.1 Binarity

The majority of parameters that have been discussed in the literature, in both syntax and phonology, have binary settings. For example, Bach (1965) claims that languages have the choice of having a rule of Wh-movement or not (Williams 1987 calls the Wh-movement parameter an "existence" parameter). A phonological example is given in Archangeli and Pulleyblank (1989) where the initial association of autosegmentalized features is assumed to operate in left-to-right fashion in the unmarked case and in right-to-left fashion in the marked case (see 2.1.2.1). Bach's Wh-Movement parameter is a binary parameter that has a choice between ON and OFF, while Archangeli and Pulleyblank's initial association parameter is binary but has two specified choices: LEFT-TO-RIGHT or RIGHT-TO-LEFT.

Suggestions for parameters with multiple settings have been given in Wexler and Manzini (1987) for the governing category of anaphors, or for the direction of spreading in Archangeli and Pulleyblank (1986). Fodor (1989) argues that non-binary parameters can and should be analyzed as sets of parameters, each with a binary choice. Only binary parameters will provide a clear statement of the markedness of parametric
systems. Archangeli and Pulleyblank's direction of spreading parameter (1986) can be stated as two separate parameters, as is done in Piggott (to appear):

(2.29) Directionality Parameter(s)

i. Multiple Settings (Archangeli and Pulleyblank 1986)

Same direction/opposite/bidirectional

ii. Binary Settings (Piggott (to appear))

a. Spread leftward (yes/no)

b. Spread rightward (yes/no)

Archangeli and Pulleyblank's parameter is tied to another parameter which regulates the direction of initial association (see, for example, (2.6)), but Piggott's parameter does not make this connection. The bidirectional setting in (2.29i) is achieved if the YES option is chosen for both parameters in (2.29ii). The featural and rule parameters investigated in 2.5 will all be binary, certain of them providing ON-OFF choices, and others two specified choices.

2.3.2 Multiple Parameters

Dresher and Kaye (1988) encounter cross-parameter dependencies in their account of parameterized stress systems. An example is given involving the three parameters in (2.30).

(2.30) P1 The word-tree is strong on the (LEFT/RIGHT)

P2 Feet are (BINARY/UNBOUNDED)

P5 Feet are quantity sensitive (QS) (YES/NO)
In order for a learner to determine which setting of P1 is required, a "window" at the left or right edge of a word must be sampled. P2 will determine the size of the window, but the setting of P2 is dependent upon the setting of P5. If the NO option of P5 is chosen, then the BINARY option of P2 must also be chosen, and if the YES option of P5 is chosen, then P2 must be UNBOUNDED. Thus the default setting of P2 will depend upon the appropriate setting of P5 in the language. P2 and P5 must somehow be tied together, or the learner may make a choice that it is not possible to retreat from. Williams (1987: xi) says of such interconnections:

The question is, how complicated are such contingencies -- in the worst case, one can imagine the parameters were so paralyzingly interconnected that they all had to be set "at one time" and the evidence was the union of all the evidence relevant for any of them.

Dresher and Kaye do not provide evidence as to how these dependencies are dealt with, but simply note that they exist. Such interdependencies predict that children will remain with the unmarked parameter setting until all the evidence is in, then all parameters will be reset at once. With regard to the interdependence of default values, it remains an empirical question how these problems will be sorted out.

Wexler and Manzini (1987) in their discussion of the parameter associated with anaphors, adopt the Lexical Parameterization Hypothesis (LPH) first discussed in Borer (1984). The LPH assumes that parameters are set for individual lexical items, rather than for a construct as a whole. There will be different parametric possibilities for
each lexical anaphor. Davis (1987) argues that the adoption of the LPH will lead to "undergeneralization" problems, i.e. random scattering of values of a parameter throughout the lexicon. Part of the reasoning behind the development of the parametric model was to capture generalizations that spread through the syntax and the lexicon, and the adoption of the LPH ignores these generalizations. I assume that the featural and rule parameters discussed in this and subsequent chapters are parameters which once set, apply to all eligible lexical and syntactic categories.

2.3.3 Non-parametric Acquisition

While parameters are assumed to account for many aspects of acquisition, they obviously cannot account for everything. Chomsky (1981a: 7-8) makes a distinction between "core grammar" and the "periphery".

Experience -- in part, a construct based on an internal state given or already attained -- serves to fix the parameters of UG, providing a core grammar, guided perhaps by a structure of preferences and implicational relations among the parameters of the core theory...

But it is hardly to be expected that what are called "languages" or "dialects" or even "ideolects" will conform precisely or perhaps even very closely to the systems determined by fixing the parameters of UG. This could only happen under idealized conditions that are never realized in fact in the real world of heterogeneous speech communities. Furthermore, each actual "language" will incorporate a periphery of borrowings, historical residues, inventions, and so on, which we can hardly expect to -- and indeed would not want to -- incorporate within a principled theory of UG. For such reasons as these, it is reasonable to suppose that UG determines a set of core grammars and that what is actually represented in the mind of an individual even under the idealization to a homogeneous speech community would be a core grammar with a periphery of marked elements and constructions.
Lexical acquisition, word meaning, subcategorization requirements and exceptions will all be aspects of the periphery. Children will have to acquire the form and meaning of lexical items and affixes by rote, although UG will certainly supply structure and some content to the lexical entries.

While this separation of core and periphery is logical and probably necessary, it has sparked some concern. Williams (1987) worries that this division may cause non-parametric aspects of acquisition to be neglected. Fodor (1989) warns that we must be careful in assuming different acquisition mechanisms for core and peripheral facts since this may result in positing rule-writing mechanisms all over again. She suggests that the null hypothesis, that the same devices that account for core grammar also hold in the periphery, should be maintained as long as possible. In Chapter 4 I will discuss some aspects of phonological acquisition that I believe to be peripheral to a core system of principles and parameters. It remains an empirical issue whether or not UG will be able to account for all remaining aspects of the acquisition data that will be investigated in Chapter 5.

2.4 Learnability

Learnability theory is the field of inquiry that developed with the conception of acquisition given in (1.2) (e.g. Gold 1967, Wexler and Hamburger 1973, Baker 1979, Berwick 1985). Learnability attempts to account for how the
child constructs the adult grammar based on limited input. Learnability research has focussed on two areas: the principles of UG and the type of input available to the child. While this is not a homogeneous field, there are certain working hypotheses that are held to by the majority of researchers. In the following sections I discuss three such hypotheses that I assume in developing the underspecification acquisition models: the Learnability Condition, the Continuity Assumption and the No-negative Evidence Hypothesis.

2.4.1 The Learnability Condition

The Learnability Condition (Pinker 1979, 1984) is inspired by the fact that all children are ultimately successful at language acquisition. It says that any developmental stage must be attainable via an acquisition mechanism that begins with Universal Grammar and ends up with the adult grammar. Furthermore it must be possible to convert any intermediate rule system into the adult state of grammar by means of the acquisition process. This condition has been instrumental in the development of the principles and parameters model of grammar, since if we assume that both acquisitional stages and language-specific differences are the result of the resetting of parameters, then by definition any acquisitional stage will be a possible human grammar.

While the Learnability Condition appears to be an obvious constraint on acquisition research, only in the last ten or fifteen years has it been generally accepted. The
Learnability Condition would prohibit many of the grammars written for children's speech during the 1960s and 1970s, which were composed of sets of rules that bore absolutely no resemblance to any type of adult grammar. The Learnability Condition tells us that intermediate stages of acquisition cannot be studied in a vacuum -- we must be able to account for how they are achieved, and how they develop into the adult system.

2.4.2 The Continuity Condition

The Continuity Assumption (Atkinson 1982, Pinker 1984) states that the principles and acquisition mechanisms that are available to a child must be the same over the whole course of development. Within the principles and parameters framework the Continuity Assumption says that UG contains all the principles that are both necessary for acquisition and for a characterization of the adult grammar. Cross-linguistic differences are the result of different parametric choices. Developmental changes in the child's grammar are also assumed to be the result of parameter switching, and not the result of changes in the child's cognitive makeup.

An alternative to the Continuity Assumption exists in the form of the Maturational Hypothesis (Borer and Wexler 1987). This hypothesis assumes that language is a biological mechanism that is not fully specified at birth. Certain aspects of UG will "mature" at specified times, and will initiate changes in the child's grammar. Even if the
appropriate evidence is available to a child at some earlier point, a construction will not be "acquired" until the principle regulating it appears in UG. This view of acquisition is a much less constrained one than the Continuity Assumption, since it allows the postulation of new just-matured principles to account for more difficult aspects of acquisition. In this thesis I will assume that the phonological acquisition is constrained by the Continuity Assumption, and that maturation does not play a part in the developmental of a phonological system.

2.4.3 The No-negative Evidence Hypothesis

The primary linguistic data (PLD) or input a child receives is crucial to the acquisition of the grammar of a specific language. Without evidence about the language being acquired the child would never move on from the set of unmarked parameters provided by UG. The No-negative Evidence Hypothesis (Williams 1976, Baker 1979, Berwick 1985) says that only positive evidence is available to language learners. Research by Brown and Hanlon (1970) has demonstrated that direct negative evidence in the form of corrections are rare and Braine (1971) has shown that children do not make use of corrections even if they are provided. The No-Negative Evidence hypothesis also rules out the availability of indirect negative evidence -- the determination of ungrammaticality based on computations of the probability of occurrence in a given amount of input. The acquisition
literature generally assumes that neither type of negative evidence is available, although there have been theoretical suggestions (e.g. Chomsky 1981, Lasnik 1989) that children may make use of indirect negative evidence.

The No-negative Evidence Hypothesis applied to a parameter setting theory of grammar makes predictions about markedness and linguistic systems, in the form of the Subset Principle (Berwick 1985, Wexler and Manzini 1987). If the language being acquired is a proper subset of a language generated by the initial setting of a parameter, the child will never learn on the basis of positive evidence that the incorrect grammar has been chosen. Only if there is some markedness condition associated to parameters stating that the initial parameter setting must generate the more specific language will positive evidence from the PLD be enough to tell the child that the marked parameter setting is required, if the language being acquired is the more general one.

Negative evidence has been discussed in phonological development with regard to negative constraints. Negative constraints have been used in a wide range of work in phonology (e.g. Paradis 1988, Calabrese 1988) to block certain types of structures or feature combinations. In some cases the constraints trigger repair rules which fix-up the disallowed representation. The question is, how can the non-occurrence of some phonological item be learned when it does not occur? Ingram (1990) discusses this learnability issue, arguing that negative constraints can be learned on the basis
of positive evidence. He hypothesizes that the child may first acquire the restriction in the form of an if-then condition, which at some point becomes restructured as a negative condition. Ingram suggests that this restructuring may take place because the negative condition is less complex than the positive condition. In Chapter 3 two types of negative constraints will be posited for Hungarian. The first is a marking condition which is a formalization of Structure Preservation (see 2.1.1.4), and I show that in fact this condition cannot be stated in a positive fashion, given the bounds of a theory of Radical Underspecification. The second is a surface phonetic constraint which appears to trigger a repair strategy that fixes-up the disallowed segment so that it can eventually be realized.

2.5 Parametric Approaches to Underspecification

In this section I will combine the principles and parameters model of grammar with underspecification theory, in order to develop a phonological theory which makes predictions about the course of acquisition. To my knowledge this has been previously attempted only once in Ingram (1990)\textsuperscript{16}. Ingram's work examines the logical learnability of the Wikchamni vocalic system as given in Archangeli (1985). Ingram concludes that it is possible to view the acquisition of this system as a series of developmental stages leading to a radically underspecified adult system. My work differs from Ingram's in two important respects. First, the predictions
for the acquisition of Hungarian and Spanish that will be
developed in Chapter 4 are based entirely on the primitives of
the theories of Radical and Contrastive Underspecification,
without making reference to specific principles of
acquisition. Secondly, I will use real-time language
acquisition data to test the parametric underspecification
predictions, where Ingram uses hypothetical data to argue his
case.

The picture of phonological acquisition that I assume is
the following. UG supplies each child with the innate aspects
of linguistic structure in the form of a set of principles and
parameters. Resetting of a parameter can only be accomplished
given positive evidence from the PLD that the marked option is
called for (No-Negative Evidence Hypothesis, see 2.4.3).
Since the UG system forms a template for the linguistic system
until such time as the parameters are reset, at the very
earliest stages children's phonological systems cross-
linguistically will be characterized by the rules and
parameter settings of UG. Given exposure to the input and
time to change parameters, children's phonological systems
will more closely resemble the adult systems being acquired
and will look less like the systems supplied by UG. The
child's system at any one time will contain all aspects of UG
that are invariable (the Continuity Assumption, see 2.4.2),
and acquisition can proceed given UG and some exposure to the
input (the Learnability Condition, see 2.4.1).

In the following sections, the theories of Radical and
Contrastive Underspecification will be discussed as principles and parameters models of phonology. I will focus on the same two problems that have been the centre of research in learnability theory -- the principles of UG that are necessary with the adoption of either CU or RU, and the input that must be available to the child in order that the underspecification system of a language be determinable. There will be no major changes to the theories as outlined in 2.2.1 and 2.2.2, although there will be certain additions and elaborations that allow these theories to be viewed as parametric models.

2.5.1 Parameters and Radical Underspecification

2.5.1.1 UG in RU

In Archangeli (1984) RU is investigated as a theory of acquisition, although this research was carried out before the principles and parameters approach to grammar was fully developed, and before certain crucial aspects of phonological theory, such as the theory of feature geometry, came to light. Archangeli's acquisition model is given in (2.31).
Archangeli assumes that UG supplies the language learner with the knowledge of how to isolate sounds based on feature oppositions and a set of universal default rules\(^1\). The components of UG, combined with language-specific phonological information serve as input to a procedure called Alphabet Formation, which creates the Alphabet or underlying phonological system of a language. Alphabet Formation selects one value of a feature as the underlingly marked value, with an accompanying redundancy rule filling in the unmarked value.
(2.32) Alphabet Formation

1. Given an opposition \([aF] -- [-aF]\) in environment \(Q\) in underlying representation, one value "\(a\)" (where "\(-a\)" is the universally marked value) is selected as the matrix value for \(F\) in \(Q\) and the other value is specified by an automatically formed complement value:

\[
[ ] \rightarrow [-aF] / Q
\]

2. In the absence of language internal motivation for selecting "\(a\)" as the matrix value for a feature \(F\), the value "\(-a\)" is selected as the matrix value where:

\[
[ ] \rightarrow [aF] / Q
\]

is a member of the set of default rules.

The first clause of (2.32) says that if there is positive evidence in the language that the universally predictable value of a feature must be present underlyingly, then a complement rule will be created to redundantly specify the opposite value supplied by UG. The second clause of (2.32) says that if there is no linguistic evidence that a complement value is required, then the default rule holds. Archangeli assumes that Alphabet Formation includes the Feature Minimization Principle:
(2.33) Feature Minimization Principle (Archangeli 1984: 50)

A grammar is most highly valued when underlying representations include the minimal number of features necessary to make different the phonemes of the language.

and a principle which says minimize the number of feature values specified in the matrix component.

The Alphabet of a language consists of the set of complement rules arrived at after Complement Rule Formation and a matrix component. The matrix is the array of underlyingly marked feature values needed in a language. The matrix includes only feature markings that are not provided by either the default rules of UG or the complement rules of the language.

Several additions must be made to the conception of UG given in (2.31) if RU is to be seriously considered as a principles and parameters model. The first is the addition of the Principles of Systematization and Minimal Redundancy to UG. Since RU is based on the notion that minimal redundancy is an organizing principle of the grammar, I believe the prohibition on redundancy is better stated as a principle of UG than as specific restrictions on the inclusion of redundancy in the learning process as in (2.34).
The Minimal Redundancy Condition (MRC)

a. Underlying representations do not contain redundant information.

b. The most highly valued system contains the minimal number of features and feature values needed to distinguish the inventory of a language.

The MRC will tell the child that underlying representations are set up using only non-redundant featural information. The MRC can also be used as a gauge of markedness, where the least marked segments will be those with the fewest feature markings.

In addition to the MRC, we must also take the acquisition model back one step and assume that there is a principle which tells the child to create a phonological system for the language, in which feature values have possible binary settings, and certain feature values are underlying. This can be stated as the Principle of Systematization.

The RU Principle of Systematization

Feature values that are not predictable are marked. This set of markings forms the underlying matrix of a language.

The MRC will then ensure that redundancy rules exist to fill in predictable feature values and that features whose values are wholly predictable will not be a part of the underlying system. The MRC will also lead the child to realize that a
A segment that is specified only by predictable feature values will not take part in the lexical phonological rules of the language.

Archangeli and Pulleyblank (1986) and Archangeli (1988) assume that default rules are the initial unmarked parameters of UG, but they do not look at what this assumption means for acquisition. The set of default rules for vowels that I will use in this thesis are given in (2.36).

(2.36) Universal Default Rules for Vowels

<table>
<thead>
<tr>
<th>Context-free rules</th>
<th>FCRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. [ ] --&gt; [-low]</td>
<td>5. [+low] --&gt; [-high]</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9. [-back] --&gt; [-round]</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[-low]</td>
</tr>
</tbody>
</table>

Rules 1-3 and 5-6 are taken from Archangeli (1988), rule 4 is taken from Archangeli and Pulleyblank (1986) and rule 8 from Archangeli (1984). Rules 8 and 9 are used in Archangeli (1984). This particular set of rules is used because 1) they appear to define the majority of the feature redundancies that relate to vocalic systems (with the exclusion of the features that relate to [ATR]), and 2) they allow us to use a comparable set of universal rules in both theories of underspecification investigated in this and subsequent
chapters. The context-sensitive rules will be called feature co-occurrence redundancies (FCRs) since they define redundant values based on the co-occurrence of particular feature values. FCRs are often stated in the format \([\ ] --> [+F]/[+G]\) (Archangeli 1984) but Kiparsky (1985), Archangeli (1988) and Steriade (1987) adopt the format \([+G] --> [+F]\). I assume these two formats are notational equivalents, and state the rules using the latter form.

The MRC, the RU Principle of Systematization and the default rules in (2.36) will tell the child to represent a 3 vowel system /i,a,u/ and a 5 vowel system /i,e,a,o,u/ as in (2.37). The RU Principle of Systematization and the MRC tell the child that feature values that are not predictable are marked underlyingly. If the default rules provide the predictable values, then only those values that are not given by the rules in (2.36) will be marked underlyingly.

(2.37)

a. Universal 3 Vowel System  
   i  a  u

| high       | high |    |
| low        | +    | low|
| back       | +    | back|
| round      | round|

b. Universal 5 Vowel System  
   i  e  a  o  u

| high       | high |
| low        | +    |
| back       | +    |
| round      | +    |

/i/ is the totally unspecified vowel in each system, and the least marked vowel in the system by the MRC\(^{22}\). The features [high] and [round] are redundant in the three vowel system and
the feature [round] is redundant in the five vowel system, since all values of these features are totally predictable, given the rules in (2.36). To achieve a fully specified matrix for the vowel systems in (2.37) the default rules in (2.36) apply to the matrix when they can, governed by the Ordering Constraints in (2.19) and the EC in (2.3). I assume that these constraints are also part of UG.

Archangeli and Pulleyblank (1986) argue that the default rules as stated in (2.36) are derivative from the typology of rules given in (2.21), and therefore are easily stated in a parametric framework. I adopt this conception of default rules, although below I will expand on how they will function as parameters. The typology given in (2.21) is repeated here as (2.38).

(2.38) I. a. (insert)_{default}/delete
   b. (maximal)_{default}/minimal
   c. (content)_{default}/structure
   d. (same direction)_{default}/opposite
direction/bidirectional

II. node or feature(s)

III. trigger condition
target condition

A default rule is the instantiation of the default settings of the function parameters (2.38I), with the argument and/or target condition specified by UG ((2.38II) and (2.38III)). (2.22), repeated here as (2.39) is an example of a context-
free default rule stated in terms of the parameters in this
typology. (2.39) inserts [-low] as the redundant
specification of the feature [low].

(2.39) Default [-low]

I. a. (insert)
   c. (content)
   d. (same direction)

II. [-low]

I assume that the target/trigger condition (i.e.
(2.38III)) is not parameterizable, since it refers to a
feature value that must be present in order for the rule to
apply. If positive evidence shows the child that a context-
free default rule does not hold in the language, then several
options are available. Any of the 4 function parameters in
(2.38I) could be switched to the marked option, with the
argument remaining the same. Resetting any one of these
parameters would have no effects in the phonology, however,
since the argument of the rule is not an underlying feature
that can be deleted or spread, directionality is irrelevant,
and there is no target condition to which to relate the
maximal/minimal. The only workable option is to switch the
argument parameter (i.e. (2.38II) to the opposite value, which
will then force the universally predictable value to be used
underlyingly. In this view context-free default rules
represent binary parameters with two specified options. The
unmarked option is given by UG, the other will be arrived at
by switching the argument parameter to the opposite value. An implementation of the resetting of a context-free featural parameter is given in Archangeli and Pulleyblank (1989). There it is argued that Yoruba underlyingly makes use of [-ATR], the value of [ATR] which is generally assumed to be predictable. In the parametric model this means that in Yoruba the parameter for [ATR] has been switched to the marked value. A child learning Yoruba will initially assume the default rules of UG where [-ATR] is predictable. Experience will tell the child the parameter requires resetting, and once this is accomplished [+ATR] will become predictable. The child's underlying vocalic system will be restructured when the parameter for [ATR] is switched\textsuperscript{23}, as shown in (2.40). (2.40a) represents the initial system supplied by UG, while (2.40b) represents the system after the parameter regulating [ATR] has been reset at the marked option (for simplicity's sake only the context-free default rules are given).
(2.40) a. Initial Default rules:

<table>
<thead>
<tr>
<th></th>
<th>+high</th>
<th>-low</th>
<th>-back</th>
<th>-ATR</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
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</table>

b. Yoruba Default rules:

<table>
<thead>
<tr>
<th></th>
<th>+high</th>
<th>-low</th>
<th>-back</th>
<th>+ATR</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
<td>[ ]</td>
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Complement rule:

<table>
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<th></th>
<th>+ATR</th>
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<tr>
<td>[ ]</td>
<td>[ ]</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>high</th>
<th>low</th>
<th>back</th>
<th>ATR</th>
</tr>
</thead>
<tbody>
<tr>
<td>i e E a o O u</td>
<td>- - + + + + +</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>high</td>
<td>- -</td>
<td>+</td>
<td>+ + +</td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>back</td>
<td>+ + +</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATR</td>
<td>+ + +</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

The child's initial hypothesis is that all the default rules of UG hold in the language being acquired, and the child acquiring Yoruba will then initially assume that [+ATR] is the marked feature value. When the child learns that [-ATR] must be the lexically marked feature value (how the child learns this will be discussed in 2.5.1.2), the context-free featural parameter for [ATR] will be switched to the marked option. The effect of this parameter switching will be to replace the default rule for [ATR] with a complement rule which inserts [+ATR] redundantly, and to restructure the underlying feature markings so that [-ATR] is the lexically marked value.

Archangeli and Pulleyblank (1986) do not discuss how FCRs would be dealt with in a parametric model, however; Archangeli (1988) briefly discusses this issue with regard to the vocalic
system of Auca. The inventory of Auca has two low vowels /a/ and /æ/, and does not have a high back vowel. Archangeli argues that the grammar of Auca must formally prohibit application of the default rule [+low] --> [+back] (rule 6 in (2.36)), because in this language the rule does not supply the predictable values of both low vowels. This is equivalent to saying that the unmarked parameter setting of an FCR is ON or APPLICATION and the marked setting is SUPPRESSION. If an FCR is suppressed language-specifically, then the feature value that is no longer predictable must be given underlyingly by the principles in (2.34) and (2.35). Given these assumptions, the child's initial and later representations of the vowels of Auca would be as in (2.41)²⁴.

(2.41) a. Initial system b. Auca system

\begin{align*}
\text{high} & \quad \text{low} & \quad \text{back} \\
{+} & \quad {+} & \quad {+} \\
{-} & \quad {+} & \quad {+} \\
a/æ & \quad e & \quad i & \quad o & \quad a & \quad æ & \quad e & \quad i & \quad o
\end{align*}

In the initial representation, given in (2.41a), the child assumes that the default rules (i.e. those in (2.36)) hold absolutely. Since rule 6 in (2.36) tells the child that [+low] vowels are redundantly [+back], the child will assume that this holds for both [+low] vowels. Both /a/ and /æ/ will be marked solely as [+low] and there will be distinct representations for only 4 vowels²⁵. When the child learns that there are in fact two phonologically distinct low vowels
in the language (how this is learned is discussed in 2.5.1.2), the context-sensitive featural parameter (FCR) will be reset to the marked option. The effect of resetting this parameter will be to underlyingly mark the feature value that was made redundant by the FCR, and to eliminate the FCR from the language-specific grammar. Thus in Auca [+back] will be lexically marked for /a/, since there is no longer a context-sensitive rule to insert [+back] redundantly. The lexical marking of [+back] is required by the RU Principle of Systematization in (2.35), which says that feature values that are not redundant are marked underlyingly. The restructuring that takes place when a context-sensitive parameter is reset to the marked option requires only the addition of feature values to the phonological system, rather than the removal and replacement of feature values as occurs when a context-free parameter is reset.

An alternative conception of the parameterization of FCRs is that resetting does not eliminate the FCR from the language-specific grammar, but rather forces the specification of the marked feature value language-specifically\textsuperscript{26}. In this view the effect of resetting a context-sensitive parameter is not SUPPRESSION of the rule, but rather ADD A MARKED FEATURE VALUE UNDERLYINGLY. Given that I assume rule 6 in (2.36) is notationally equivalent to a rule which says [ ] \(\rightarrow\) [+back] /[+low], both rules say 'the unmarked value of [back] is [+back] for a segment that is also [+low]'. If this is the unmarked setting of the parameter, then the marked setting
will be 'the marked value of [back] is [-back] for a segment that is also [+low]' . In the case of Auca, when the child encounters evidence that [+back] is not redundant for all [+low] vowels, the parameter for rule 6 in (2.36) will be reset to the marked option, which will force [-back] to be marked underlyingly for /æ/. In this conception of parameterization, the default rule will have to remain in the language-specific grammar, in order to supply the universally redundant value. Rule 6 in (2.36) will remain in the grammar of Auca to provide the redundant value of /a/. Given this conception of the marked option of context-sensitive parameters, the child's initial and restructured representations of the vowels of Auca will be as given in (2.42).

(2.42) a. Initial system  

|  |  |  |  |  |  |
|---|---|---|---|---|
| a | æ | e | i | o |
| high | - | - | - | - |
| low | + | + | + | + |
| back | + | - | + | + |

The problem with this second conception of the parameterization of context-sensitive featural parameters (FCRs) can be demonstrated if we assume that Auca has an assimilation rule which spreads the feature [+back]. Given the conception of parameterization where the marked option of a context-sensitive rule is ADD A MARKED FEATURE VALUE UNDERLYINGLY, rule 6 will be a part of the grammar of Auca and
will be ordered prior to the rule spreading [+back] by the Redundancy Rule Ordering Constraint in (2.19b). /a/ and /o/ will then be triggers of the rule, but /æ/, which we would expect to be a target, will not be, since it is specified as [-back]. This is exactly the case that arises in Hungarian, as will be discussed in 3.1.3. In Hungarian it can be shown that the low front vowel must be a possible target of the assimilation rule, and therefore cannot be marked underlingly as [-back]. For this reason I will adopt Archangeli's (1988) conception of context-sensitive parameter resetting, where the marked option is SUPPRESSION of the rule itself, with concomitant marking of the universally redundant feature value.

In the parametric model of RU outlined above there are two ways that the grammar of a specific language can differ from the grammar supplied by UG: 1) the opposite value of a universal context-free feature may be marked underlingly in an across-the-board fashion, as the result of the resetting of a context-free default rule to the marked option; or 2) a universally redundant feature value may be marked in a specific context, as the result of the resetting of an FCR to the marked option. The device which resets a context-free featural parameter is identical to Alphabet Formation in (2.27). Alphabet Formation cannot, however, account for the resetting of an FCR parameter, so I will abandon Alphabet Formation altogether and simply assume that in a parametric RU theory the learning procedure includes a parameter switching
mechanism.

The rule typology in (2.38), in addition to supplying the formal statement of default rules, also supplies the possible phonological rule types for RU, as discussed in 2.2.1.2. Default rules and rules of Epenthesis are the unmarked rules supplied by UG, since these are the rules that require only the default function parameter settings. Deletion, Insertion of an association line and Spread are slightly more marked rules, since they require a function parameter to be reset. In addition, the directionality parameter is assumed in the default case to be tied in to the directionality of the initial association of anchors and autosegments shown in (2.6). If this initial association proceeds from L--->R then that will be unmarked direction of spreading for a phonological rule. If initial association is R--->L, then that again will be the unmarked direction of association for a phonological rule. Only in the marked case will phonological rules and initial association operate in different directions.

Once the RU acquisition model in (2.31) is revised so that UG includes the MRC and Systematization Principles, the possible parameterization of rule operations and arguments, the Ordering Constraints, the principles of Autosegmental and Lexical Phonology discussed in 2.1 (the OCP (2.8), the EC (2.3), Structure Preservation (in 2.1.1.4), and the Association Conventions (2.6)), it will resemble (2.43).
2.5.1.2 Input in RU

If used to constrain a principles and parameters account of grammar, the No-Negative Evidence Hypothesis in 2.4.3 says that only positive evidence can be used as evidence for the resetting of a parameter. In the parametric theory of RU positive evidence will be needed to trigger the resetting of context-free and context-sensitive featural parameters and for the resetting of function parameters controlling the possible types of phonological rules. In order to reset a context-free parameter, the input will have to contain alternations which
demonstrate that a universally predictable feature value must be marked underlyingly. In Yoruba, for example (described in Archangeli and Pulleyblank 1989), the context-free parameter for [ATR] will be reset when the child encounters evidence that [-ATR] must be the underlyingly marked feature value. Such evidence will come from alternations in the input showing that high vowels do not have [ATR] restrictions, that only /a/, /O/ and /E/ are triggers of [ATR] harmony\(^3\), and that /i/ acts as a totally unspecified vowel in the language (see Pulleyblank 1988). Evidence that a vowel has no underlying specifications will come from idiosyncratic behaviour such as transparency in harmony processes or the fact that it regularly disappears in certain environments. The alternations involved in [ATR] Spread will lead the child towards the correct underlying specification of the vowels of Yoruba, and to the correct statement of the rule of [ATR] Spread. Thus there is a great deal of interaction in RU between the determination of how phonological rules operate and the resetting of featural parameters\(^3\).

In the case of Auca, the FCR which says that [+back] is a predictable feature of low vowels must be reset before the child can represent both low vowels distinctly in the phonological inventory. Evidence triggering the resetting of this context-sensitive parameter will come from alternations in the language which demonstrate that /a/ and /æ/ are phonologically distinct segments. Evidence for this will come from minimal pairs or from alternations that result from the
2.5.2 Parameters and Contrastive Underspecification

2.5.2.1 UG in CU

We can envisage a model, similar in structure to that in (2.43), as a CU parameter setting model of acquisition. In order to function as an acquisition theory this model must have a principle which tells the child that only contrastive feature values are present underlingly, and it must have a theory of how redundancy rules function as featural parameters. These are additions to the theory as proposed in Steriade (1987).

As a first step I assume that UG contains a principle telling the child to create a CU phonological system for the language, just as there was a principle regulating the establishment of a phonological system in RU (see (2.35). I state this as the CU Principle of Systematization.

(2.44) The CU Principle of Systematization

Feature values that are used to contrast segments are marked underlingly. This set of markings forms the underlying matrix of a language.

A principle prohibiting non-contrastive redundancy in the system is also required, since CU assumes that only contrastive non-trivial feature markings exist underlingly (see 2.2.2.1). This principle will ensure that only the minimal number of contrastive markings are included in the
matrix, and will lead to a method for determining the markedness of phonological systems.

(2.45) The Restrictive Redundancy Condition (RRC)

a. Underlying representations do not contain feature values that are not used contrastively.

b. The most highly valued system contains the fewest number of features and feature values needed to contrastively distinguish the inventory of a language.

(2.45a) will tell the child to mark only those feature values that are required for contrastive specification or that are not given by universal rules, while the second clause says that a segment (or system) with \( n \) feature markings will be less marked than a segment (or system) with \( n+1 \) markings.

In 2.2.2.2 the \( R \)-rules of CU are discussed. \( R \)-rules are the redundancy rules which fill in feature co-occurrence restrictions. Steriade wishes to eliminate language-specific ordering relationships between phonological rules and \( R \)-rules, even though in practice she does not always do this (see the analysis of Hungarian Back Harmony discussed in 2.2.2.2). She says (Steriade 1987: 357)

By deciding that [round] is single-valued we can also avoid the assumption of language-specific orderings between redundancy rules introducing \( R \)-values and \( D \)-values.

It is clearly Steriade's intent that such language-specific orderings (permitted in RU by the RROC) be prohibited. In addition, in the theory of CU transparency effects can only
exist if a given class of segments lacks redundant feature values in the phonology, and these transparency effects would be destroyed if R-rules were permitted to apply prior to the application of phonological rules. I therefore assume that ordering relationships between phonological rules and redundancy rules are prohibited in the CU parametric model and consequently that R-rules will always apply late in the derivation. I state this ordering restriction as the CU Ordering Principle.

(2.46) CU Ordering Principle

R-rules apply as late as possible in the grammar.

Several obstacles are encountered in attempting to translate the specifics of CU into a principles and parameters model of acquisition. These problems stem from the fact that in each analysis in Steriade (1987) the contrastive specifications of only one or two features are given. As a result it is not always clear which R-rules are needed or what their exact status is. I will attempt to resolve some of these problems by examining the five vowel systems of Ainu (described in Steriade 1987) and Auca (described in Archangeli 1988).

The symmetrical 5 vowel system of Ainu will be contrastively specified as in (2.47) (Steriade 1987 discusses only the specifications of [back] for Ainu -- I have supplied the other values).
The specifications in (2.47) are arrived at by determining which segments contrast within the realm of a single feature. The pairs /i/ and /e/ and /u/ and /o/ contrast with each other in terms of the feature [high], so each receives a specification for that feature. /a/ and /o/ are both back non-high vowels which contrast in lowness, so /a/ is marked [+low] and /o/ is marked [-low]. The four non-low vowels contrast in backness, so the front vowels are marked [-back] and the back vowels [+back]. None of the vowels contrast with regard to the feature [round].

The set of R-rules given in (2.48) will provide the fully specified system of Ainu.

(2.48) R-rules

1. [+low] ---> [-high]
2. [+low] ---> [+back]
3. [+low] ---> [-round]
4. [+back] ---> [+round]
   [-low]
5. [-back] ---> [-round]
   [-low]
6. [+high] ---> [-low]
7. [-high] ---> [-low]
   [-back]
This set of rules is made up of 3 rules given in Steriade (1987) (i.e. rules 1, 2 and 5 in (2.48)), supplemented by rules 3 and 4 which insert the redundant values of [round] and rules 6 and 7 which insert the redundant specifications for [low]. Steriade (1987) argues that [round] may be a monovalent feature, but because it is argued in 3.1 that [-round] must be an accessible feature value in Hungarian, I will assume that [round], like [back], [high] and [low], has binary options. I assume that the rules in (2.48) are the set of R-rules provided by UG, which will constrain children's earliest phonological systems. The first 5 rules in (2.48) are identical to set of universal FCRs given in (2.36) for RU. In RU the redundant specifications for [low] are realized through context-free rule 4 in (2.36), but since CU does not allow for context-free rules, these redundancies must be stated in a context-sensitive manner, as rules 6 and 7 in (2.48).

Auca has a five vowel system which is contrastively specified in (2.49).

(2.49) Auca

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>e</th>
<th>o</th>
<th>a</th>
<th>æ</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>+</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>back</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>round</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The underlying specifications are arrived at as follows. /i/ and /e/ contrast in terms of height, so /i/ is marked [+high]
and /e/ [-high]. /e/, /o/, /a/ and /æ/ contrast in lowness and backness, and so each receives a specification for those features. The feature [round] is totally redundant in this system. In applying the R-rules in (2.48) to this system, it becomes apparent that two additional R-rules must be used to achieve full specification of /o/ and /i/. These rules are required because of the asymmetrical system of Auca, so I will assume that they are language-specific rules. The R-rules needed to fill in all unspecified values in (2.49) are those in (2.50).

(2.50) R-rules of Auca

Universal:

1. [+low] ----> [-high]
2. [+low] ----> [+back]
3. [+low] ----> [-round]
4. [+back] ----> [+round]
   [-low]
5. [-back] ----> [-round]
   [-low]
6. [+high] ----> [-low]
7. [-high] ----> [-low]
   [-back]

Language-specific:

8. [+back] ----> [-high]
   [-low]
9. [+high] ----> [-back]
Steriade (1987) argues that the universal/language-specific distinction is not an important one in underspecification theory. An asymmetrical system such as that of Auca, however, suggests such a distinction must exist insofar as R-rules are concerned. Rules 8 and 9 in (2.50) are essential to achieve full specification of the Auca system in (2.49), yet it is not obvious that we would want to include rules such as these in a universal core set of R-rules.

In applying the universal R-rules to achieve full specification of the Auca system, we find that rule 2 does not serve a role. Rule 2 says that [+low] vowels are redundantly [+back], and while this holds for /a/, it is not true of /æ/. This rule is not used to fill in a the redundant value of [back] for either /a/ or /æ/, since these two vowels contrast with regard to this feature, and therefore by the CU Principle of Systematization in (2.44) both segments are underlyingly specified for backness.

As was discussed earlier, in a parametric account of underspecification theory the universal redundancy rules are assumed to be the unmarked parameters supplied by UG. In CU this means that the R-rules supplied by UG (i.e. those in (2.48)) will apply in the child's initial phonological system, and values not supplied by these rules will be marked underlyingly. When the child discovers through positive evidence that two segments contrast with regard to a given feature value (when UG predicts that these segments do not contrast), the child will have to reset an R-rule parameter.
The effects of the resetting of an R-rule are slightly different than the effects of resetting a context-sensitive featural parameter in RU. In CU resetting means that by (2.44) the contrastive feature specifications will be added underlingly, and the R-rule may remain in the language-specific grammar, although it will no longer have any particular function. Thus in CU we can say that the unmarked setting of an R-rule is ON or application, while the marked setting is simply OFF, with the contrastive values specified underlingly by the CU Principle of Systematization in (2.44).

According to this parametric account of CU, in the initial phonological system of the child acquiring Auca the R-rules supplied by UG will hold absolutely. Feature values that are redundantly supplied by these rules will not be a part of the underlying representation, giving the specifications in (2.51).

(2.51) Initial Specification of Auca

\[
\begin{array}{ccc}
  i & e & o & a/æ \\
  \text{high} & + & - & \\
  \text{low} & - & + & \\
  \text{back} & - & + & \\
  \text{round} & & & \\
\end{array}
\]

Since R-rule 2 in (2.50) gives [+back] as a redundant specification for [+low] vowels, neither /a/ nor /æ/ will be marked for the feature [back] and the representations of these
vowels will be nondistinct. By rule 2 the low vowel will surface as [a]. The contrastive specification of these 4 vowels contrasts /a-æ/ and /o/ for lowness, /i/ and /e/ for height and /e/ and /o/ for backness. Positive evidence will be required to tell the child that in fact /a/ and /æ/ are phonologically distinct vowels. Once such evidence is encountered the parameter giving [+back] as a redundant value on low vowels will be reset, and the contrastive values of the feature [back] will be added to the representations of /æ/ and /a/. This in turn triggers the addition of the contrastive specification [-low] for /e/, which now contrasts with /æ/ with regard to this feature. We can assume that R-rule 2 may remain in the language-particular grammar of Auca, although it will have no particular effect. This distinction between what happens to a context-sensitive rule in CU and RU occurs because the underlyingly specifications in CU are determined by which features contrast, whereas in RU they are determined by what is is non-redundant. Once the child has marked the contrastive values of [back] for /a/ and /æ/, and [low] for /e/, the adult specified system given in (2.49) will have been achieved.

The child acquiring Ainu will also initially assume that the R-rules of UG hold absolutely, and as discussed above, the R-rules that we are assuming are the universal core rules, are the set of rules required for the specification of the vowels of Auca. There will therefore be no positive evidence in the input telling the child that new feature markings must be
specified, and no parameters will be reset. The child's initial contrastive system will be identical to the adult system (i.e. the system in (2.47)).

Because of the fact that both values of features are sometimes present underlyingly in CU, it is crucial that this theory allow for phonological rules that are feature-changing, and for phonological rules to be initiated by both values of a feature. Steriade's rule of Hungarian Back Harmony shown in (2.27) exemplifies both of these characteristics. The trigger of BH is either [+back] or [-back], and the spreading of one of these feature values is not blocked by a segment specified by the alternate feature value. In fact Steriade assumes that it is just those vowels that are unspecified for any value of [back] which are the transparent or neutral vowels in this system\(^3\). Thus the notion of a possible phonological rule is very different in CU than in RU, where only a single value of any feature is ever present within a given context. Since CU does not have a built-in theory of rule types, I assume that in CU phonological rules may spread, delink or insert as discussed in 2.1.3. I also assume that phonological rules operate from L-->R, R-->L or bidirectionally and that the unmarked direction for a particular language is in the same direction as initial association, as in (2.6).

A parameterized model of CU acquisition is given in (2.52) (I again include the OCP, the EC, the SCC, Structure Preservation and the Association Conventions).
UG in (2.52) has fewer components than the RU model in (2.43), since it does not allow for the lexical specification of context-free language-particular feature values. The learning mechanisms for both models are essentially identical: both are parameter switching devices. The Alphabet of CU has fewer components than the Alphabet of RU since again it does not allow for the presence of language-particular context-free rules.
2.5.2.2 Input in CU

In CU evidence from the PLD will be necessary to trigger the resetting of R-rule parameters and for the acquisition of phonological rules. Just as in RU, alternations in the input demonstrating that certain feature redundancies do not operate in the language will be needed if a parameter is to be switched to the marked option. In Auca, for example, the child's initial representation will not distinguish the two low vowels of the language. Evidence that /a/ and /æ/ are phonologically distinct will be required to reset the R-rule parameter [+low] \rightarrow [+back], the subsequent markings of [-back] for /æ/, [+back] for /a/ and [-low] for /e/. This type of evidence will come principally from minimal pairs demonstrating that /a/ and /æ/ are distinct and also from alternations that are the result of the application of phonological rules.

There will be less interaction in CU between the child's discovery of how a phonological rule operates and the resetting of parameters than in RU, since CU does not allow for language-specific values of underlying features. Languages will vary only in the classes of segments that are redundant for a specific feature, and thus phonological rules can only be affected to the extent that they manipulate different sets of possible segments. In CU it will never be the case that a rule of the adult phonology cannot be used at all by a very young child because a given feature value is not yet present underlyingly. It may, however, be the case that a
rule used by a child may apply to an overgeneral or undergeneral set of segments.

Because the theory of CU must assume that phonological rules may operate in a feature-changing fashion and may be initiated by either value of a feature, the child will have to pay particular attention to how a given rule operates in the language. This theory then predicts that children may have some difficulty in determining the exact form of a phonological rule. This contrasts with the RU theory in which the mechanisms of rule operation are largely given by the theory itself, and consequently predicts that children will have little difficulty in determining the exact form of phonological rules.
Notes to Chapter 2

1 Shortness or simplicity was assumed to be involved in the metric, and theories such as the Derivational Theory of Complexity (Miller 1962) grew out of this assumption. Research, however, demonstrated that "simpler" sentences, as defined by the theory of Transformational Grammar (Chomsky 1957) were not necessarily the ones first understood by children (Fodor and Garrett 1967, Fodor Bever and Garrett 1974).

2 This was the original view of parameters, as principles with chunks left out. The parameters then filled in the holes. The more recent view is that the principle itself is fully specified innately and represents the unmarked parameter setting. The marked parameter setting is a different but closely related version of the unmarked setting.

3 Others believe that particular phonological rules are assigned to specific strata, and not to the phonology in general (Kaisse and Shaw 1985).

4 The feature geometry in (2.7) is the model that will be assumed in this thesis, although I will not be arguing for this particular structure.

5 The recent work of E. Pulleyblank (1989) attempts to revise how vocalic features are represented in the geometry. Archangeli and Pulleyblank (1989) propose a geometry where the feature [ATR] is dependent upon its own articulator node, the Tongue Root Node.

6 Ito and Mester (1986) state that the [f] in futon is underlingly /h/. /h/ becomes [f] before [u] by a rule of Labialization and becomes [ɕ] before [i] by Palatalization.

7 Mester and Ito (1989) reanalyze this as support for the fact that [voice] is a privative feature in Japanese.

8 Redundancy rules of the type [+G] --> [-F] are not in fact context-sensitive from a logical or syntactic perspective (see Chomsky 1968). However, in phonological research this type of rule is often referred to as a context-sensitive redundancy rule, and I will maintain this tradition.

9 Archangeli and Pulleyblank (1986: Appendix A: 352) use the maximal function setting in the statement of Epenthesis; however, since the maximal/minimal function is supposed to relate to specified targets only, I assume it is irrelevant.
Archangeli and Pulleyblank (1986) do not discuss markedness of feature arguments. If Epenthesis is the least marked insertion process then a hierarchy of possible arguments is a necessary addition to the rule typology.

This is true as long as one of the redundancy rules is not ordered prior to Epenthesis by the RROC.

Rules (2.26-1 and -2) and (2.26-4 and -5) have the function given in (2.25b), while rule (2.26-3) has function (2.25a).

This parameter was supposed to account for a clustering of properties, such as null subjects and auxiliary behaviour.

Braine (1963), for example, describes children's early word combinations as consisting of Pivots (frequently occurring words) and X-class (infrequently occurring) words. Bloom (1970) lists one sentence type for Kathryn as S --> Pivot + N, where the sentence lacks a VP altogether.

See Carroll and Roberge (1988) for some interesting suggestions on differences between L1 and L2 language learners in the utilization of negative evidence.

There have been several recent attempts to use the tools of current phonological theory to describe acquisition data (e.g. Spenser 1986, Sandanandan 1987, and Iverson and Wheeler 1988).

Later works in the RU framework (e.g. Archangeli 1986, Pulleyblank 1988, Archangeli and Pulleyblank 1986) assume other principles of UG, and these are discussed in 2.1.

In Archangeli (1984) a complement rule is a redundancy rule inserting a predictable value of a feature created on the basis of language-specific evidence, and default rules are all other redundancy rules. Complement rules may therefore insert the same predictable value as a default rule. Archangeli (1984:65) states Alphabet Formation as:

1. Given an opposition [a F] -- [-a F] in environment Q in underlying representation, one value "b" is selected as the matrix value for F in Q and the other value is specified by an automatically formed complement value:

   [ ] --> [-b F] / Q

2. In the absence of language internal motivation for selecting a value as the matrix value for a feature F, the value "b" is selected as the matrix value where:

   [ ] --> [-b F] / Q

is a member of the set of default rules.
The statement of Alphabet Formation I give in (2.32) is a revision of Alphabet Formation which corresponds to the Archangeli and Pulleyblank (1986) definition of complement and default rules. In Archangeli and Pulleyblank (1986) and in subsequent works complement rules are default rules that insert the opposite predictable value from the default rule, rather than rules that are learned from language-specific evidence (if the only property of a complement rule is that it be learned then it is possible that it will be identical to a default rule; while in Archangeli and Pulleyblank (1986) a complement rule must redundantly insert the opposite value from a default rule). I prefer the later version of complement rules because it allows us to distinguish between universally supplied and language-particular feature values.

I have taken this name from Pulleyblank (1988).

I do not include a default rule for [ATR] since it is not required for the analyses in Section 3.

FCR 5 is really a different type of rule from FCRs 6 and 7 since it represents an inviolable dependency, whereas 6 and 7 represent unmarked dependencies. As pointed out in Spenser (1986) the restriction given by rule 5 might be better captured by a revision of feature geometry.

In Chapter 6 I will show that from an acquisition perspective, it appears that the context-free rule for [high] (rule 2 in (2.36)) should be [ ] --> [-high].

Actual statements of default rules are rare in the literature, probably because no one wishes to commit themselves to a set of rules that may prove to be wrong. Archangeli and Pulleyblank (1986) give a set of context-free rules in Appendix A, but the context-sensitive rules are conspicuously absent. I have had to put together a set of rules in order to perform complete analyses of the vocalic systems of Hungarian and Spanish and to develop predictions that will follow from these analyses. If one or some of these rules prove to be incorrect (as I argue may be the case for the context-free rule for [high] in Chapter 5) this does not argue against the theory itself.

This does not by itself imply that /i/ will be the first vowel acquired because the parametric theory of RU predicts that all 5 vowels should be present given the default rules of UG. However, I will show in Chapter 5 that this is not in fact what happens in acquisition.

Unconstrained restructuring means that acquisition data will have little import on issues relating to linguistic theory. The parametric theories of RU and CU discussed in Chapter 2 predict that only certain restricted types of restructuring based on parameter switching will occur (see White 1981 and Ingram 1989 for views on the restructuring debate in acquisition).
This is a similar to the representation of Auca given in Archangeli (1988), except that I have not marked [-high] on the [+low] vowels. Archangeli also shows that a language-specific redundancy rule is needed in Auca to eliminate /u/ from the system. I will not be discuss rules such as this that eliminate segments from inventories, but will focus on redundancy rules that achieve full specification of a given set of segments.

The definition of "distinctness" needed for underspecification theory is different from the definition given in Chomsky and Halle (1968), where two segments are distinct only if they have opposite values for a given feature. If one adopts RU then the lack of a specification for [F] must be enough to make that segment underlyingly distinct from a segment specified as [+F] or [-F].

This alternate hypothesis was suggested to me by P.A. Shaw and is perhaps more feasible from a markedness point of view, since /æ/ will have a greater number of feature markings that /a/. However, markedness and feature markings are not unequivocally related in the theory of RU, as will be shown in Chapter 3, where I argue that /ʊ/ is the totally unspecified vowel in the Hungarian vocalic system in the RU framework.

I include only vocalic featural parameters in (2.42) and later in (2.50) since these are the parameters required for the analyses of the vocalic systems in Chapter 3.

Several of the principles of Autosegmental and Lexical Phonology (especially the OCP and the Association Conventions) may be parameterizable, but I ignore this hypothesis here and list only featural parameters under the category "parameters".

When combined with the rule functions these will produce redundancy rules such as [ ] --> [+high], [+low] --> [+back], etc.

Archangeli and Pulleyblank (1989) argue that [-ATR] is inserted on /a/ by a context-sensitive redundancy rule [+low] --> [-ATR] before the rule of ATR Spread.

Calabrese (1988) discusses this interaction in some detail.

I again assume these rules are notationally equivalent to [ ] --> [+F]/[+G].

For these reasons CU can never contain a principle such as the RROC in (2.19b) because it would completely negate these transparency facts.
CHAPTER 3

The Vocalic Systems of Hungarian and Spanish

In this chapter I will discuss a number of phonological processes which operate in the vocalic systems of Hungarian, a Finno-Ugric language and Spanish, a Romance language. These facts will be analyzed according to the parametric theories of Radical Underspecification (RU) and Contrastive Underspecification (CU) described in 2.5.1 and 2.5.2, in most cases drawing from previous analyses of these facts. In Chapter 4 I outline the predictions that these analyses make for the acquisition of Hungarian and Spanish, and later in Chapter 6 these predictions will be examined in light of acquisition data from both Hungarian and Spanish.

The analyses of the vocalic systems of Hungarian and Spanish presented here are useful for two reasons. First, they help to demonstrate how the theories of RU and CU differ. Hungarian has a large vowel system, with front rounded and unrounded vowels, with both a long and short vowel series. The analyses in this chapter focus on harmony processes which spread values of [back] and [round] throughout a word. Both the RU and CU analyses of Hungarian use the principle of Structure Preservation (Kiparsky 1982, 1985) to explain why certain segments are transparent to Harmony, although the generality and significance of this constraint differs considerably in the two analyses.
The Spanish vowel system is a symmetrical 5 vowel system, which also permits certain types of diphthongs. The Spanish data presented here focus mainly on alternations that take place within verbs. One set of alternations involves a vowel which surfaces as high in some contexts and mid in others, and the second involves a vowel which surfaces in some contexts as a monophthong and in other contexts as a diphthong. The RU and CU analyses of Spanish do not differ as much as the Hungarian analyses, since the RU account of Spanish does not force the early application of redundancy rules within the lexical component. [high] proves to be a particularly important feature in Spanish in both analyses, and its marked values are manipulated by several phonological rules. The majority of rules posited for Spanish by both the RU and CU analyses are sensitive to stress.

The second reason for the existence of the analyses in this chapter is to argue for specific underspecified vowel inventories. This is particularly important in the theory of Radical Underspecification, where either value of a feature may be present in underlying representations. On the basis of the analyses of Hungarian and Spanish I argue that certain featural and rule parameters must be reset by a child acquiring these languages. When a featural parameter is reset from the unmarked option provided by Universal Grammar, the underlyingly marked values in that language will also differ from those provided by UG. The unmarked option of phonological rules is generally assumed to be OFF, although a
language may choose to make use of a particular rule and reset it to ON. In the analyses which follow, I argue that certain language-particular feature markings, and certain phonological rules are required to explain certain types of data in Hungarian and Spanish.

One of the most important difference between the RU and CU treatments of Hungarian harmony is in the ordering of redundancy rules and other phonological processes. The theory of RU assumes the Redundancy Rule Ordering Constraint (RROC), which orders a redundancy rule before a phonological rule which makes reference to that redundant value. The effect of this constraint in Hungarian is to interweave redundancy rules and harmony rules. The theory of CU that is being developed in this thesis does not adopt an ordering principle such as the RROC (although see the discussion of this question in 2.5.2), and all redundancy rules apply late in the phonology, after harmony rules.

This chapter will be organized as follows. In 3.1 I present and analyze the Hungarian data within the parametric theories of RU and CU. In 3.2 the same will be done for the Spanish data. Each section concludes with a summary of the language-specific aspects of the phonology (i.e. those aspects of the phonology that must be learned) given each underspecification account, a schema of how the lexical and postlexical components must be organized according to these analyses, and a comparison of the two analyses. In each case my goal is to determine which analysis presents a more
coherent account of the data, assuming that the learnability of a particular theory should in part be related to its ability to account for a set of data in an elegant and non-stipulative fashion.

3.1 Harmony Systems in Hungarian

In this section I examine how Back and Round Harmony operate in Hungarian, and develop analyses of these facts based on the parametric theories of RU and CU. Although both types of Harmony do operate within loanword vocabulary, there is little agreement about the facts (particularly with regard to Back Harmony), and for this reason I restrict myself to native words. The expectation is that the loanword facts may be analyzeable using the same mechanisms once the facts are better known.

In 3.1.1 the vocalic system of Hungarian is discussed. I pay particular attention to the asymmetries that exist between the short and long vowel system, and show how configuration constraints can be used to describe these asymmetries. In 3.1.2 the RU analysis of the Hungarian data are presented, and in 3.1.3 the CU analysis of these facts is given. In 3.1.4 the analyses are summarized, and a brief comparison of the RU and CU analyses is made.

3.1.1 Hungarian Vowels

The Hungarian vowel system (Standard Budapest dialect) as described in Ringen (1988) is given in (3.1). The vowels are
given both in their orthographic and phonetic forms.

\[(3.1)\]

<table>
<thead>
<tr>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>i[i]</td>
<td>i[i:]</td>
</tr>
<tr>
<td>ö[ø]</td>
<td>ö[ø:]</td>
</tr>
<tr>
<td>e[e]</td>
<td>e[e:]</td>
</tr>
</tbody>
</table>

Phonetically, the short low back vowel is [ɔ] and the short low front vowel [ɛ]. The rounding of [a] is assumed in Vago (1980), Kornai (1987) and Ringen (1988) to be a purely phonetic rule, and the linking vowel effects discussed in 3.1.2.2 provide evidence that this is true. Historically the language contained both mid and low front vowels, but these have been merged in most dialects, including the Standard. The facts of Back Harmony and Round Harmony to be presented in (3.9) and (3.13) demonstrate that the short low front vowel and the long mid front vowel have distinct vowel heights. The low vowel [ɛ] alternates with [a] in Back Harmony, while the mid vowel [ê] is transparent to this process. The long mid vowel alternates with the mid back and mid front rounded vowels in Round Harmony, while the low vowel does not participate in this process.

Stress in Hungarian is rule-governed and always falls on the initial syllable in a word (Kontra and Ringen 1986).

In standard autosegmental theory long vowels differ from short vowels in that long vowels are associated to two skeletal slots and short vowels to only a single slot\(^1\). In the analyses which are to follow I assume there is a single
set of feature specifications for the 8 vowels /i/, /u/, /e/, /o/, /ɛ/, /a/, /ʊ/ and /ʊ/, and that Hungarian has chosen a marked syllabification option which allows for complex or branching nuclei (see (2.10Aib)).

Following Ringen (1988) and Jensen and Stong-Jensen (1989) I assume there are two distinct non-high unrounded front vowels in Hungarian: /e/ and /ɛ/. /ɛ/ alternates with /a/ in the Back Harmony system, while /e/ alternates with /o/ and /ʊ/ in the Round Harmony system. /e/ surfaces as [e] only when it is associated with two skeletal slots dominated by a branching nucleus, which I assume, following Levin (1985), is the representation of a long vowel (see discussion in 2.1.2.4). /ɛ/, on the other hand, can surface only when associated to a single skeletal slot dominated by a nucleus, i.e. when it is a short vowel.

These particular constraints are not a function of Structure Preservation, since syllabic structure in Hungarian will be derived during the course of the lexical phonology (see 2.1.2.4) and since there are underlying feature sets that correspond to these vowels. I therefore assume that the constraints on /e/ and /ɛ/ hold at surface structure after redundancy rules have applied, and that they can be stated as in (3.2).
In this and following chapters, Hungarian data will be given in orthographic form, with the phonetic form of a vowel also provided if it is long or \( \epsilon \).

3.1.2 Parametric RU Analysis of Hungarian

The components of UG that I assume must be part of a parametric RU theory of acquisition are discussed in 2.5.1, and a schematized model is given in (2.43). The most basic principle of UG is the Minimal Redundancy Condition, discussed in 2.5.1.1. This condition, repeated here as (3.3), tells the child that only non-redundant information is present in underlying representations.
(3.3) The Minimal Redundancy Condition (MRC)

a. Underlying representations do not contain redundant information.

b. The most highly valued system contains the minimal number of features and feature values needed to distinguish the inventory of a language.

Redundant information is provided by a set of universal redundancy rules, or default rules, which may be either context-free or context-sensitive. In 2.5.1.1 it is argued that these rules function as featural parameters. UG supplies the unmarked form of the rule, but a particular language may choose to reset a featural parameter to the marked option. If a context-free parameter is reset at the marked option, a complement rule will be created to insert the opposite feature value supplied by UG. The default rule will be lost in the language-particular grammar, and the complement rule will take its place. If a context-sensitive parameter (FCR) is reset at the marked option, the rule will again be eliminated from the language-particular system, although in this case it will not be replaced. This means that the feature value supplied by that rule will no longer be redundant and by the MRC it must be added as a marked feature value.

In RU it is assumed that because redundancy rules are one type of phonological rule, they are subject to the Elsewhere Condition (EC, see (2.3)), which orders specific rules before
more general ones. RU also assumes that redundancy rules are subject to the ordering constraints in (2.19), repeated here as (3.4).

(3.4) Ordering Constraints (Archangeli and Pulleyblank 1986)
   a. Redundancy rules apply as late as possible in the grammar.
   b. A redundancy rule must apply at the level at which reference is made to the feature value being inserted (the Redundancy Rule Ordering Constraint or RROC)
   c. A redundancy rule applies as early as possible at the level dictated by the RROC.

By these constraints redundancy rules will apply as late in the grammar as possible (i.e. post-lexically) unless a phonological rule makes reference to a particular redundant feature value, in which case the redundancy rule will be ordered before the phonological rule. These ordering constraints are crucial to the analysis of the Hungarian vocalic system.

The set of universal default rules that I assume are given in (3.5) (repeated from (2.36)).
(3.5) Universal Default Rules

<table>
<thead>
<tr>
<th>Context-free rules</th>
<th>FCRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. [ ] -- &gt; [-low]</td>
<td>5. [+low] -- &gt; [-high]</td>
</tr>
</tbody>
</table>

[-low]

9. [-back] -- > [-round]

[-low]

In the following sections I argue, on the basis of the facts of Hungarian Back and Round harmony, that the following redundancy rules from (3.5) have been reset to the marked option in Hungarian:

(3.6) Marked Hungarian Featural Parameters

<table>
<thead>
<tr>
<th>Context-free rules</th>
<th>FCRs</th>
</tr>
</thead>
</table>

[-low]

The fact that 4 default rules of UG must be reset in Hungarian is not particularly surprising, since the system is marked, containing front rounded vowels and a front low vowel. According to the parametric view of redundancy rules developed in 2.5.1, the rules in (3.6) will not be a part of the language-particular grammar of Hungarian. The context-sensitive rule parameters will not be replaced, but the
context-free parameters will be replaced by complement rules inserting [-high] and [+round]. This will produce the system of redundancy rules for Hungarian shown in (3.7).

(3.7) Hungarian Redundancy Rules

Default Rules

1. [ ] --> [-low]  
5. [+low] --> [-high]
3. [ ] --> [-back]  
7. [+low] --> [-round]
8. [+back] --> [+round]

Complement Rules

2a. [ ] --> [-high].
4a. [ ] --> [+round]

Applied to the set of rules given in (3.7) the EC will order rule 8 before 4a and rule 5 before 2a.

If the rules in (3.7) are used to insert the redundant values of Hungarian vowels, the marked (i.e. non-redundant) feature values will be those in (3.8).

(3.8) Parametric RU Vocalic System of Hungarian\(^2\)

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>e</th>
<th>ε</th>
<th>u</th>
<th>o</th>
<th>a</th>
<th>ü</th>
<th>ő</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>back</td>
<td></td>
<td></td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>round</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

This system is identical to the radically underspecified system argued for by Jensen and Stong-Jensen (1989).
The underspecified vowel array in (3.8) is not the system of specifications that will be provided for the child by Universal Grammar, and a discussion of how these two systems differ is provided in Chapter 4.

In the following sections I use arguments from several aspects of the vocalic system of Hungarian to show that the system in (3.8) is the radically underspecified system that is required for this language. These arguments focus on demonstrating that the feature values [+back] and [-round] are phonologically active feature values in Hungarian, and more specifically, that these feature values must be lexically specified. In addition, I argue that /o/, represented as the totally unspecified vowel in (3.8), is the epenthetic vowel in Hungarian, and the vowel that will surface if neither Back nor Round Harmony applies in that context.

3.1.2.1 Back Harmony (BH)

Hungarian BH operates both within roots and across certain suffixes. Native Hungarian roots may contain all back vowels, all front vowels, a mixed set of back vowels co-occurring with the neutral vowels /i/ or /e/, or neutral vowels only. The majority of neutral-vowel-only roots are followed by suffixes containing front vowels, but certain roots like hid and cél take back vowel suffixes³.
(3.9) Back Harmony

a. Back vowels

\[\text{ú[u:]t} \quad \text{'road'} \quad \text{útna[כ]k} \quad \text{úttó[о:]l}\]
\[\text{há[a:]z} \quad \text{'house'} \quad \text{háznak} \quad \text{háztől}\]
\[\text{vá[a:]ros} \quad \text{'city'} \quad \text{városnak} \quad \text{várostől}\]

b. Non-neutral front vowels

\[\text{öt} \quad \text{'five'} \quad \text{ötné[ε]k} \quad \text{öttő[ो:]l}\]
\[\text{be[ε]tű} \quad \text{'letter'} \quad \text{betűnek} \quad \text{betűtől}\]
\[\text{öröm} \quad \text{'joy'} \quad \text{örömnek} \quad \text{örömtől}\]

c. Back or front non-neutral vowel and neutral vowel

\[\text{radí[i:]r} \quad \text{'eraser'} \quad \text{radírnak} \quad \text{radírtől}\]
\[\text{kavics} \quad \text{'pebble'} \quad \text{kavicsnak} \quad \text{kavicstől}\]
\[\text{tá[a:]nyé[e:]r} \quad \text{'plate'} \quad \text{tányérnak} \quad \text{tányértől}\]
\[\text{idő[ό]} \quad \text{'time'} \quad \text{időnek} \quad \text{időtől}\]

d. Neutral vowels only

i. \[\text{fillé[e:]r} \quad \text{'penny'} \quad \text{fillérnak} \quad \text{fillértől}\]
\[\text{szí[i:]n} \quad \text{'colour'} \quad \text{színnek} \quad \text{színtől}\]

ii. \[\text{hi[i:]d} \quad \text{'bridge'} \quad \text{hídnak} \quad \text{hídtől}\]
\[\text{cél[e:]l} \quad \text{'goal'} \quad \text{célnak} \quad \text{céltől}\]

BH is also found in loanword phonology, although I will concentrate exclusively on the facts as they pertain to native words.

There is a lack of agreement in the literature over the status of [ε] in the BH system. [ε] is sometimes found in roots with back vowels (ce[ε]ruza 'pencil' and krape[ε]k 'chap') and therefore appears to be a neutral vowel, yet it
alternates with [a] in the dative suffix nak/nek. Vago (1980) assumes [ɛ] is a neutral vowel, receiving identical treatment to the vowels [i], [í] and [é]. Ringen (1988) and Kontra and Ringen (1986) treat [ɛ] as a harmonic vowel, belonging to the same class as the back vowels and the front rounded vowels. I will show that the chameleon-like behaviour of [ɛ] can be explained by assuming that [ɛ] has two distinct sources -- /e/ and /ɛ/.

The facts in (3.9) show clear evidence that there are two phonologically distinct low vowels in Hungarian: /a/ and /ɛ/. The declensions of 'house' in (3.9a) demonstrate that root-initial /a/ is followed by a back vowel, while those of 'pebble' show that root-initial /a/ may also be followed by a neutral vowel ([i], [í] or [é]). Root-initial /ɛ/, as shown by the declensions of 'letter' in (3.9b) may be followed by a front non-neutral vowel, and like all vowels may also be followed by a neutral vowel.

The fact that the nak variant of the Dative suffix always follows back non-neutral vowels while the nek variant always follows front non-neutral vowels also demonstrates that phonologically /a/ and /ɛ/ are distinct segments. If /a/ and /ɛ/ are to have distinct underlying representations then the universal context-sensitive rule [+low] $\rightarrow$ [+back] (rule 6 in (3.5)) cannot hold in Hungarian. Only when this rule is suppressed from the language-particular grammar can the two vowels /a/ and /ɛ/ have distinct specifications for [back]. This conceptualization of how context-sensitive redundancy
rules (FCRs) are parameterized in the theory of RU is discussed in detail in 2.5.1.1.

The BH data in (3.9) also demonstrate that the front unrounded vowels /i/ and /e/ must be phonologically distinct from the rounded vowels /u/ and /o/. /i/ and /e/ can co-occur with either front or back vowels, while /u/ and /o/ co-occur only with other front rounded vowels or with neutral vowels. This demonstrates that these two pairs of vowels must be distinguished using the feature [round], and therefore that context-sensitive rule 9 in (3.5) must also be eliminated from the grammar of Hungarian (see 2.5.1.1). Once this rule is eliminated from the grammar, one member of each pair will be specified for a value of [round], while the other member will be unspecified. The marked value of [round] will depend upon the context-sensitive rule for this feature that the language employs. I will return to the marked specification for [round] in 3.1.2.2.

The basic RU analysis of BH proposed here is taken from Jensen and Stong-Jensen (1989). The default rules of UG, given in (3.5), suggest that in the unmarked case [-back] will be a redundant feature feature value in Hungarian and [+back] the lexically marked, phonologically active value. There is no evidence in the harmony systems of this language to suggest that this UG specification should be overturned, and in fact, there is evidence from the BH system to support the assumption that [+back] must be the lexically specified value. This evidence will be discussed in conjunction with
the marking condition given in (3.11).

Following Jensen and Stong-Jensen I assume that [+back] is a property of the root, rather than of individual segments, and exists in underlying representations as a floating autosegment. Root and suffixal vowels (at least those suffixes which take part in BH) will be underlyingly unspecified for backness. Association of floating [+back] is accomplished by the Association Conventions of UG (see (2.6)), which map this floating feature onto the leftmost eligible target. The Association Conventions apply cyclically, and therefore can reapply once morphological material is added to the stem.

BH is a rule which spreads [+back] from left to right, in the same direction as initial association7.

(3.10) **Back Harmony**

\[
\text{Spread } [+\text{back}] \text{ L }\rightarrow \text{ R}
\]

Domain: lexical (cyclic)

The triggers of BH will be /u/, /o/ and /a/ -- those vowels that are lexically marked as [+back].

How then do we block the application of BH to the neutral vowels [i], [i:] and [e:]? Again following Jensen and Stong-Jensen I assume that the vowels given as /i/ and /e/ in (3.8) are prohibited from undergoing BH by Structure Preservation. The underlying system of Hungarian does not contain non-low back unrounded vowels, so by Structure Preservation these vowels cannot be derived. As discussed
in 2.1.1.4, and following Kiparsky (1985), the formal work of Structure Preservation is performed by marking conditions which hold in the lexicon. The formal prohibition against back non-low unrounded vowels in Hungarian can be stated using the language-specific marking condition in (3.11).

(3.11)  *[+back]
       [-low]
       [-round]

(3.11) does not require any added learning for the child (once these particular feature specifications are acquired), since it is simply a formalization of Structure Preservation, a principle of UG. (3.11) is a checking mechanism which constrains the type of feature combinations that are permitted in underlying representations and throughout the lexical phonology, and it will block association or spread of [+back] to vowels which are specified at that point in the derivation as [-low] and [-round].

We would not expect the neutral vowels to be underlingly specified as [-low] if, as shown in (3.8), [+low] is the lexically marked feature value. Following Jensen and Stong-Jensen, however, I assume that the marking condition in (3.11) is an active part of the phonology, and therefore will be subject to the RROC (see (2.19). Although (3.11) holds of URs, the MRC, given in (3.3), prohibits redundant specifications at this level, and therefore (3.11) will have no active role at this point. During the lexical
phonology, however, (3.11) will come into play to check the outputs of rules such as BH or RH. The effect of this condition will be to force the redundant values mentioned in this condition to be inserted prior to the operation of the rule.

The condition in (3.11), the RROC, and the phonological rules of Hungarian which manipulate the feature [+back] are related in the following fashion. (3.11) acts as a condition on the output of BH, given in (3.10), and the Association Conventions, which provide the initial association of floating [+back] features. (3.11) will trigger the early application of the context-free rule inserting [-low] (rule 1 in (3.5)) and the context-sensitive rule predicting [-round] for [+low] vowels (rule 7 in (3.5)), before BH and before Association of [+back], since these values are specifically mentioned in the statement of the condition. Once these redundancy rules have applied, the vowels /i/ and /e/ will be specified as [-low] and [-round] and by (3.11) [+back] will not be permitted to spread or link to them. Floating [+back] will, however, still be available to associate or spread to another vowel in the stem or suffix. Vowels that are not specified as [+back] either through the initial association of [+back] or through BH will receive their specifications for [-back] by rule 3 in (3.5).

The fact that (3.11) contains the specification [+back] supports our assumption that the lexically specified value of [back] in Hungarian is that provided by UG. (3.11) is a
condition which blocks the derivation of back non-low unrounded vowels, and consequently requires the use of the feature [+back]. If we were to suppose that [-back] was the phonologically active value of [back], [+back] would still have to be present in the statement of (3.11), suggesting that the redundancy rules inserting [+back] are ordered prior to (3.11) and the rule of BH. These [+back] specifications would then block all applications of BH, and there would be no alternating vowels, such as those shown in (3.9). I therefore take this as confirming evidence that [+back] is the lexically specified value in this language.

BH, as shown in (3.9) is a rule which applies both within roots and after morpheme concatenation. The rule is obviously lexical, since it has exceptions and applies only within words. Jensen and Stong-Jensen argue that BH is a postcyclic rule because it must apply after Epenthesis (which they also argue is postcyclic) and because it applies within roots. They argue that there is no specific evidence that BH must apply both cyclically and postcyclically, so by the Principles of Domain Assignment (Halle and Mohanan 1985) it will be postcyclic.

I depart from Jensen and Stong-Jensen's analysis on the issue of domain assignment. Following Levergood (1984), Pulleyblank (1986) and Archangeli and Pulleyblank (1989) I assume that the application of the Association Conventions to link [+back] to a root vowel will create a derived environment root-internally so that the SCC will not block
the application of BH. Thus BH can apply cyclically, and will follow the Association of [+back] and the redundancy rules, which are all structure-building rules. In this way the SCC is maintained and BH can be lexical and still apply within roots.

Neutral-vowel-only roots which surface with back suffixal vowels (i.e. the forms in (3.9dii)) can be analyzed as having a floating [+back] autosegment which is prohibited from attaching to the root vowel by (3.11). This autosegment will remain floating until a suffix is added, and [+back] can then be associated to the suffixal vowel.

The derivation of the native words betűnek, radírtól and célnak will take place as shown in (3.12). For the purposes of these derivations I assume the underlying feature specifications given in (3.8) although I have not yet argued for the lexically marked values of [round] and [high]. I ignore all Round Harmony effects until 3.1.1.2.
(3.12) BH in native words

Underlying

\[
\begin{array}{cccc}
\text{b} & \varepsilon & \text{t} & \text{ü} \\
\text{x} & \text{x} & \text{x} & \text{x} \\
\end{array}
\quad
\begin{array}{cccc}
\text{r} & \varepsilon & \text{d} & \text{i} & \text{r} \\
\text{x} & \text{x} & \text{x} & \text{x} & \text{x} \\
\end{array}
\quad
\begin{array}{c}
\text{c} \text{e} \text{l} \\
\text{x} & \text{x} & \text{x} & \text{x} \\
\end{array}
\]

[ ] -> [-lo]

[+lo] --> [-rd]

Association of [+back] prohibited by

\[
\begin{array}{cccc}
\text{r} & \alpha & \text{d} & \text{i} & \text{r} \\
\text{x} & \text{x} & \text{x} & \text{x} & \text{x} \\
\end{array}
\]

BH

\[
\begin{array}{c}
\text{n/a} \\
\text{Prohibited by} \\
\text{n/a} \\
\end{array}
\]

(3.11)
None of the vowels in these forms have underlying linked values for the feature [back], although radír and célib have a floating [+back] feature. In radír the floating feature will associate to the initial vowel by the Association Conventions, but in célib association will be blocked by the marking condition in (3.11). (3.11) will trigger early application of the redundancy rules [ ] --> [-low] and [+low] --> [-round], shown as rules 1 and 7 in (3.5).

Once [+back] is associated BH can operate, although it is inapplicable in betuí and célib and it is blocked in radír by (3.11). When the suffixes are added Association of [+back] can reapply, and will act to associate the floating feature to the suffixal vowel in the form célibnak, with redundancy rules 1 and 7 in (3.5) applying first. BH can then reapply, and it will spread the [+back] feature linked to the initial root vowel in radír to the suffixal vowel.

Although it could be argued that BH should not apply from the initial root vowel in radír to the suffixal vowel because this operation does not respect the adjacency of target and trigger, Ringen (1988) argues that adjacency (or the Locality Condition as it is called in Archangeli and Pulleyblank 1987) is not relevant in this case. By the marking condition in (3.11) the second root vowel in radír is not a possible target of BH, and we can then assume that the initial root vowel and the suffixal vowel are adjacent for the purposes of this rule.

BH is inapplicable in betűnek because there is no [+back]
feature to spread, and also in célnak, since the [+back] feature links to the suffix.

3.1.2.2 Round Harmony (RH)

Suffixes such as the Dative and Ablative have one alternant containing a back vowel, and one containing a front vowel, but those with short mid vowels generally have three alternants. In these ternary suffixes [o] follows a back vowel, [ö] follows a front rounded vowel, and [ɛ] follows a front unrounded vowel. The forms in (3.13) show the agreement in rounding between root and suffixal vowels in the 2nd person plural, allative and plural forms.

(3.13) Round Harmony

<table>
<thead>
<tr>
<th></th>
<th>2PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. hoz</td>
<td>'bring'</td>
</tr>
<tr>
<td>fő[ö:]z</td>
<td>'cook'</td>
</tr>
<tr>
<td>né[e:]z</td>
<td>'see'</td>
</tr>
<tr>
<td>fe[ɛ]j</td>
<td>'head'</td>
</tr>
<tr>
<td>szí[i:]n</td>
<td>'colour'</td>
</tr>
</tbody>
</table>

Allative ('toward')

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>b. föld</td>
<td>'earth'</td>
</tr>
<tr>
<td>fe[ɛ]j</td>
<td>'head'</td>
</tr>
</tbody>
</table>

Plural

c. gerezd | 'slice' | gerezdek |
| öröm | 'joy' | örömök |

The forms in (3.14) demonstrate that low root vowels do
not trigger RH.

(3.14)  

<table>
<thead>
<tr>
<th>Vowel</th>
<th>Allative</th>
</tr>
</thead>
</table>
| vá[a:]ros | 'city'    | varoshoz  
| lá[a:]nchoz | 'chain'   | lánchez  
| haz   | 'house'   | hazhoz  

If [+low] vowels were triggers of RH we would expect the root and suffixal vowels following the initial root vowels in the forms in (3.14) to surface as [-round], but this is not the case. Neither short [a], nor long [a:] triggers RH.

RH also appears to be more limited than BH in that it affects only short vowels. As noted by Kornai (1987) and Jensen and Stong-Jensen (1989) suffixes which demonstrate the ternary alternation between o/o/e always contain short vowels. Suffixes such as the Ablative, which have long mid vowels, have only the alternants [o] and [ö].

(3.15)  

<table>
<thead>
<tr>
<th>Vowel</th>
<th>Ablative</th>
</tr>
</thead>
</table>
| e[ɛ]mbe[ɛ]r | 'man'     | embertő[ö:]l  
| szí[i:]n   | 'colour'  | színtöl  
| fillé[e:]r | 'penny'   | fillértöl  
| bab   | 'bean'    | babtő[ö:]l  
| hú[u:]r  | 'chord'   | húrtöl  
| cé[e:]l  | 'goal'    | célétöl  

If RH does not operate in these forms, and we wish to maintain that the value of roundness of suffixal vowels is supplied either by the root vowels or by redundancy rules,
this suggests that Hungarian must have a redundancy rule supplying [+round] for the Ablative suffixal vowels. The rounding of the suffixal vowels in the forms for 'bean' and 'chord' is possibly supplied by a redundancy rule which rounds back vowels (these forms do participate in BH); however, this rule cannot supply the roundness values for the other forms. It is then possible that the rounding of these vowels is supplied by a general rule [ ] --> [+round]. If such a rule is to exist in the grammar of Hungarian, then the universal default rule 4 in (3.5) must have been suppressed, and [-round] will be the lexically marked value.

If we assume that [-round] is the lexically specified value in Hungarian, a form such as színtől can be represented as in (3.16).

(3.16) N N
     / \ / \\
   x x x x + x x x x
   \ / \
    [+hi]
    [-rd]

    sz i n t v l

Both the vowel of the root and the suffix are long, and I assume that the suffixal vowel is underlyingly unspecified for the features [round] and [back]. The root vowel is specified as [-round] underlyingly, and is therefore a possible trigger of RH. RH does not apply in this form,
however, because the suffixal vowel is long\textsuperscript{10}.

Jensen and Stong-Jensen (1988) account for the fact that long vowels do not participate in RH by constraining this rule to apply to adjacent moras. They argue that specifying adjacency at the level of the nucleus does not distinguish long from short vowels. Given that I am adopting the syllabic framework of Levin (1985) which assumes that nuclei (and not moras) are primitives, and given that metrical theory recognizes the notion of branching (see 2.1.2.4), I assume that the constraint on the operation of RH can be stated as holding of branching nuclei.

Returning to the question of the lexical specification of [round], a second argument that [-round] may be the specified value in Hungarian comes from the marking condition in (3.11). This condition is used to block the derivation of back unrounded non-low vowels by BH, and as we will see, by RH. It is not possible to state (3.11) using [+round], since the prohibition is against the presence of the back counterparts of /i/ and /e/, i.e. the set of back unrounded vowels.

Given that (3.11) must include the feature value [-round], there are two theoretical possibilities within the theory of RU that could account for the presence of this feature value. The first is that [-round] is the lexically specified value in Hungarian, which in turn means that the context-free default rule for [round], given in (3.5), must be changed to a rule inserting [+round] redundantly.
The second possibility in the theory of RU is that \([-\text{round}]\) is not a lexically specified value, but rather that \([+\text{round}]\) is the lexically specified value and \([-\text{round}]\) is a redundant value inserted prior to (3.11) by the RROC. I believe that there are two reasons to reject this option. The first is that (3.11) is a condition which holds both of URs and throughout the lexical phonology, and if \([-\text{round}]\) were a redundant feature value inserted prior to (3.11) this value would have to be inserted prior to the UR. The MRC, given in (3.3), specifically rules out this possibility.

The second reason for rejecting the option that the \([-\text{round}]\) value used in (3.11) is a redundant value relates to the blocking effects of specified feature values in the theory of RU. The only possible redundancy rule in (3.5) which could fill in redundant [round] is rule 4 in (3.5) (rule 9 in (3.5) inserts \([-\text{round}]\) only on non-back non-low vowels). If rule 4 were ordered prior to (3.11), all vowels underlyingly unspecified for \([+\text{round}]\) would become \([-\text{round}]\) prior to (3.11) and consequently prior to RH, and RH would have no effect in the language. I therefore assume that the fact that the marking condition in (3.11) requires the use of \([-\text{round}]\) is one further piece of evidence that this is the lexically marked feature value in Hungarian.

At this point it is necessary to briefly examine the epenthesis facts of Hungarian. MacWhinney (1974) notes the presence of a 'linking vowel' which surfaces as [o], [ɛ] or [ø], exactly like the vowels of the ternary suffixes in
(3.13). Vago (1980) argues that this linking vowel does not exist underlyingly, but rather is inserted before consonant initial suffixes, such as the accusative \(-t\) or the plural \(-k\), and in the final syllable of certain roots\(^{11}\).

(3.17) Linking Vowel

<table>
<thead>
<tr>
<th>a.</th>
<th>virá[a:]g</th>
<th>'flower'</th>
<th>Plural</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>bo[ö:]r</td>
<td>'skin'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ke[ɛ]nyé[e:]r</td>
<td>'bread'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bab</td>
<td>'bean'</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>te[ɛ]le[ɛ]k</td>
<td>'plot'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>zirá[a:]f</td>
<td>'giraffe'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>te[ɛ]he[e:]n</td>
<td>'cow'</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>/bokr/</td>
<td>'shrub'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>/tehr/</td>
<td>'load'</td>
<td></td>
</tr>
</tbody>
</table>

The forms in (3.17a) show the addition of the linking vowel before the plural suffix \(-k\) and those in (3.17b) show the addition of this vowel before the accusative suffix \(-t\). The forms in (3.17c) demonstrate the presence of this linking vowel root-internally. Vago (1980) argues that the best analysis of the inflectional paradigms of nouns stems such as 'shrub' and 'load' assumes that underlyingly these roots contain only a single vowel and that the surface forms are derived through epenthesis. The quality of the epenthetic vowel will in part be determined by the rules of BH and RH.
In RU it is claimed that the simplest account of an epenthetic vowel is the insertion of a bare skeletal slot (see 2.2.1.2), with all surface feature specifications provided by the redundancy rules of the language. In 2.5.1.1 I discuss Epenthesis in the context of RU, arguing that this rule can be assumed to be an automatic result of syllabification principles. An empty skeletal slot will be added to the representation if certain segments remain unsyllable, and the empty skeletal slot will be interpreted as a syllable head (i.e. a vowel).

Since 2 of the 3 vowels that surface in the epenthetic vowel position in (3.18) are mid, I assume, following Jensen and Stong-Jensen (1989) and Vago (1980), that the vowel that underlies this alternation is both [-low] and [-high]. If the initial feature specifications of this vowel are to be supplied by the redundancy rules of the language, then we must assume that in Hungarian the context-free parameter for the feature [high] has been reset, and the language possesses a complement rule which inserts the feature value [-high].

The quality of the epenthetic vowels in (3.18) provide the strongest source of evidence for the lexical specification of [-round] in Hungarian. The epenthetic vowel and the mid front unrounded vowel cannot be the same vowel since the epenthetic vowel is a target of both BH and RH, while the mid front unrounded vowel is neutral to the BH process. While it could be suggested that the rounding of the linking vowel following a root such as bab in (3.18) is
supplied by the surface rounding of /a/ (see (3.1)), it is just as true that the linking vowel following a root such as virág, where the long low vowel is never rounded, also surfaces as a round vowel.

These facts then suggest that the epenthetic vowel must underlyingly be either /o/ or /ö/, both of which are [+round]. Given the assumption that the feature specifications of epenthetic segments are supplied by redundancy rules, one such rule will have to be [ ] --> [+round].

Following the analysis of RH in Jensen and Stong-Jensen (1989), RH can be stated as in (3.18).

(3.18) Round Harmony

Spread [-round]
L --> R
Target condition: [-high]
Nucleus may not branch

Domain: lexical (cyclic)

Like the feature [+back], [-round] will be lexically unassociated in Hungarian, and will be linked by the Association Conventions prior to the operation of RH. The [-high] target condition is necessary so that only mid and low vowels will be affected by RH. The marking condition given in (3.11) will operate to check the outputs of (3.18), to make certain the back non-low unrounded vowels are not derived. Redundancy rules 1 and 7 in (3.7) must be ordered prior to RH, since these rules insert redundant values that
are mentioned in the marking condition (see the discussion in 3.1.2.1 regarding the relationship of (3.11) and the rule of BH).

If [-high] is a redundant value in Hungarian, as the linking vowel facts suggest, and RH mentions [-high] as a target condition, then the RROC will order all redundancy rules which make reference to [-high] before the operation of (3.17). The triggers of RH will be only those vowels specified as [-round]. /i/ and /e/ will be lexically specified as [-round], while the low vowels /a/ and /ε/ will become specified as [-round] by redundancy rule 7 in (3.7), which will also be ordered prior to (3.18) by the RROC. Low vowels need not be specifically excluded from undergoing RH, since both /a/ and /ε/ are redundantly [-round], and therefore would not be changed by the rule.

The operation of RH is shown in (3.19) in the derivations of nézhez and fejhez from (3.13). I assume the suffixal vowel is underlingly unspecified, as the linking vowel would be. The derivation of these forms begins with the addition of the Allative suffix, after redundancy rules 2a, 5 and 7 from (3.7) have applied within the root.
(3.19)

Morphology

nez + høz

fɛj + høz

<table>
<thead>
<tr>
<th>x x x x</th>
<th>x x x</th>
</tr>
</thead>
</table>

[-rd] [-hi]

[-rd] [-hi]

[-lo]

BH

n/a

n/a

[ ] --> [-hi]

nez + høz

fɛj + høz

<table>
<thead>
<tr>
<th>x x x x</th>
<th>x x x</th>
</tr>
</thead>
</table>

[-rd] [-hi]

[-rd] [-hi]

[-lo]

RH

nez + hez

fɛj + hez

<table>
<thead>
<tr>
<th>x x x x</th>
<th>x x x</th>
</tr>
</thead>
</table>

[-rd] [-hi]

[-rd] [-hi]

[-lo]

BH does not apply in either of these forms, since neither root has a [+back] autosegment. In both forms the [-round] specification of the root vowel spreads to the suffixal vowel by RH, after the redundancy rule [ ] --> [-high] has applied ( [+low] --> [-high] is inapplicable here). The [back] and [low] specifications will be filled in late in the derivation
by redundancy rules 1 and 3 in (3.7).

Following Jensen and Stong-Jensen (1989), I assume that RH must be extrinsically ordered after BH, in order to achieve the correct result with forms such as lanchoz in (3.14). The initial root vowel in this form is both a trigger of BH and a trigger of RH (although /a/ is not underlyingly specified as [-round] it receives this redundant specification by rule 7 in (3.5) before the operation of the rule). The correct derivation of lanchoz is shown in (3.2).

(3.20)

\[
\begin{array}{c}
\text{l } \varepsilon \text{ n c + h } \ddot{o} \text{ z} \\
\text{x x x x x x x x} \\
[+bk] \\
[+low]
\end{array}
\]

\[
[ ] \rightarrow [-lo] \\
[+low] \rightarrow [-rd] \\
\text{x x x x x x x x} \\
[+bk] \\
[+low] \\
[-lo] \\
[-rd]
\]

Association of

\[
\begin{array}{c}
\text{l } \text{a n c + h } \ddot{o} \text{ z} \\
\text{x x x x x x x x} \\
[+bk] \\
[+bk] \\
[+low] \\
[-lo] \\
[-rd]
\end{array}
\]
In this derivation RH is ordered after BH (and therefore by default after the Association of [+back]). Redundancy rules 1 and 7 in (3.7) are ordered prior to the Association of [+back] (they are triggered by the marking condition in (3.11) which serves as a filter on the output of this association). [+back] is linked to the root vowel and then BH operates to spread [+back] to the suffixal vowel. RH is consequently blocked by (3.11), for its application would derive an unrounded non-low back vowel.

If RH were to apply before BH and the Association Conventions (after the application of redundancy rules 1 and 7 from (3.7)), the suffixal vowel would become [-round] and BH would be blocked from applying by (3.11). The output would then be the ungrammatical lâncbez. Although extrinsic ordering among phonological rules is not desirable, it appears to be required in this particular instance.
3.1.2.3 Low Front Vowel Formation

As discussed in 3.1 I have assumed that Hungarian contains the configuration constraints shown in (3.2). A mid short unrounded vowel can be derived through the operation of BH or RH. One such vowel arises in the course of the derivation of \textit{nezhez} given in (3.19). We must assume that there is a rule of Low Front Vowel Formation, as given in (3.21), which will change a short mid front unrounded vowel into a low front unrounded vowel.

(3.21) Low Front Vowel Formation

\begin{itemize}
  \item Insert: [+low]
  \item Target condition: [-low]
  \item [-high]
  \item [-back]
  \item [-round]
\end{itemize}

Non-branching nucleus

Domain: postlexical

(3.21) changes the value of [low] of a non-low, non-high front unrounded vowel. It is a purely phonetic rule which applies after all redundant specifications have been assigned and may apply to the output of both BH and RH. (3.21) appears to be a direct consequence of the surface constraint given in (3.2) on *[e] and (3.2) may then be an example of a dynamic constraint, as has been discussed by Pulleyblank and Archangeli (1990) and LaCharité (1990).
3.1.3 Parametric CU Analysis of Hungarian

The components of UG that I assume are part of a parametric CU theory of acquisition are discussed in 2.5.2 and a schematized model is given in (2.52). The most basic principle of this theory is the Restrictive Redundancy Condition or RRC, given in (2.45) and repeated here in (3.22).

(3.22) The Restrictive Redundancy Condition (RRC)

a. Underlying representations do not contain feature values that are not used contrastively.

b. The most highly valued system contains the fewest number of features and feature values needed to contrastively distinguish the inventory of a language.

In CU D-values of features are those values that contrast within a specific class of segments. D-values are always present underlyingly, while R-values or redundant feature values are provided by R-rules. Contrastively specifying the vocalic system of Hungarian produces the system in (3.23)\(^{13}\).

(3.23) Parametric CU Vowel System of Hungarian

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>e</th>
<th>e</th>
<th>u</th>
<th>o</th>
<th>a</th>
<th>õ</th>
<th>ò</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>back</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>round</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The contrastive specifications are arrived at as follows. /i/, /ü/ and /u/ contrast with /e/, /ö/ and /o/ with regard to the feature [high], and so are each specified for one value of this feature. /ɛ/ and /e/ and /a/ and /o/ contrast with regard to the feature [low] and are therefore each specified for a value of [low]. /u/, /o/ and /a/ are each paired for backness with /ü/, /ö/ and /ɛ/, and so are specified as [+back] or [-back]. /i/ and /e/ contrast in roundness with /ü/ and /ö/, and so each one of these segments is specified as either [+round] or [-round].

In the system in (3.23) /a/ and /o/ also contrast with regard to the feature [round] at a phonological level, even though [a] is [+round] phonetically. I have chosen to represent these segments as contrasting only with regard to the feature [low] for two reasons. First, /a/ does not participate in the RH process, as shown by the forms in (3.14), which we would expect it to if it were specified as [-round]. Secondly, the low vowels /a/ and /ɛ/ participate in a process of Low Vowel Lengthening (MacWhinney 1974, Vago 1980), which does not affect /o/. I will not discuss this process here, but simply assume that it is required in the grammar of Hungarian, and that it requires that /a/ be specified as [+low].

The fact that there is some indeterminacy in the types of contrastive specifications that can be posited for a given language suggests that there may be some learnability problems associated with this type of theory. This issue
will be addressed at length in Chapter 6.

As with the RU analysis presented in 3.1.3, the system in (3.23) assumes that /e/ and /ɛ/ have different sets of feature specifications. /e/ only surfaces when it is associated with two skeletal slots dominated by a branching nucleus, while /ɛ/ can only surface when associated to a single skeletal slot dominated by a nucleus. These restrictions are formalized in (3.2), as phonetic constraints which do not block the derivation of [e] or [ɛ:] during the lexical phonology.

As is discussed in 2.5.2.1, in a parametric theory of CU R-rules are the unmarked featural parameters supplied by UG. These rules insert feature values that are not lexically specified. The set of universal R-rules given in (2.48) is repeated here in (3.24).

(3.24) Universal R-rules:

1. [+low] --&gt; [-high]
2. [+low] --&gt; [+back]
3. [+low] --&gt; [-round]
4. [+back] --&gt; [+round]
   [-low]
5. [-back] --&gt; [-round]
   [-low]
6. [+high] --&gt; [-low]
7. [-high] --&gt; [-low]
   [-back]
Resetting a featural parameter to the marked setting is allowed for, and means that certain specifications that are provided universally by UG must be marked underlyingly because they are contrastive. In RU, when a context-sensitive rule parameter is reset, by the MRC that rule must be eliminated from the language-specific grammar (see discussion in 3.1.3). In CU, however, the R-rule need not be eliminated from the language-particular grammar, because there is not the same relationship between redundant information and redundancy rules, and because redundancy rules play no part in the active phonology (this issue is discussed in 2.2.2.2 and 2.5.2.1).

Every language will therefore have the same core set of R-rules in (3.23), regardless of the underlying markings in the language. As shown in 2.5.2.1, it is possible that language-specific R-rules will have to be added to the grammar of the language in order to achieve full specification of the system.

The data showing BH in (3.9) and RH in (3.13) demonstrate that Hungarian has distinct front and back low vowels and front round and unround vowels. This means that R-rules 2 and 5 in (3.24) have been reset to the marked option in this language.

(3.25) Marked Featural Parameters of Hungarian

*2. [+low] --> [+back]
*5. [-back] --> [-round]
   [-low]

The result of the resetting of these featural parameters
will be that the child contrastively specifies the low vowels for the feature [back] and the front non-low vowels for the feature [round]. When this is done the system shown in (3.23) will be achieved.

In (3.23) /i/ and /e/ are not specified for backness since they do not contrast with back vowels, and the R-rules in (3.24) do not supply the [-back] specifications for these vowels. Consequently, the language-specific rule in (3.26) must be added to the core set of rules to provide these specifications.

(3.26) Hungarian Language-Specific R-rule:

8. \([-\text{low}] \rightarrow [-\text{back}] \]

\([-\text{round}]\]

Given that CU assumes that both values of a feature are lexically marked where these values are used contrastively, there is no requirement in this theory for a set of context-free redundancy rules as in the theory of RU. The child acquiring Hungarian must learn that the featural parameters in (3.25) must be reset, with the result that the contrastive specifications of [back] for low vowels and the contrastive specifications of [round] for front vowels are marked underlyingly.

In Steriade (1987) it is shown that in CU phonological rules may be feature-changing, may be blocked when a segment is encountered that is specified for some value of the spreading feature, and may be initiated by both values of a
feature. In order to further constrain the number and types of phonological rules allowed by this theory, in 2.5.2.1 I assume that the parameteric theory of CU allows only for rules of spreading, delinking, fusion or insertion. These can be viewed as rule parameters, with the unmarked value set at OFF. If there is positive evidence in a language that a rule is operative, then the value of that rule parameter will be set to ON.

In the statement of phonological rules in the theory of CU I state the function of the rule (i.e. spread, delete), the argument (i.e. [+back]) and the trigger/target conditions, as well as the domain of the rule (i.e. lexical (cyclic/postcyclic), postlexical).

In the following sections I present analyses of Hungarian Back and Round Harmony, and also of several more peripheral rules which manipulate vowels in this language. Unlike in the RU analyses, I do not attempt to argue for particular lexical values of features. Rather, I focus on the feature-changing aspects of these rules, and on demonstrating how these rules can account for the data using a set of contrastive specifications.

3.1.3.1 Back Harmony

The parametric CU analysis of BH presented here follows that in Steriade (1987)\textsuperscript{14}. The major problem associated with Steriade's (1987) CU analysis of Hungarian, discussed in 2.2.2.2, can be resolved given the parametric theory of CU
and the assumption that short and long vowels in Hungarian have identical feature matrices. In Steriade's analysis the redundancy rule \([+\text{low}] \rightarrow [+\text{back}]\) is ordered prior to the rule of BH, so that \(/\acute{a}/ [a:]\) can trigger BH. This ordering relationship is not necessary in the parametric theory, given the system in (3.23) in which it is assumed that \(/a/\) contrasts with \(/\varepsilon/\) in backness and is underlingly marked as \([+\text{back}]\). Steriade's analysis focusses particularly on the operation of BH in loanwords, while mine deals almost exclusively with native words.

BH is an iterative, feature-changing rule which spreads \([+\text{back}]\).

(3.27) **Back Harmony**

\[
\text{Spread } [+\text{back}] \ L \rightarrow R
\]

Feature-changing

Domain: lexical (cyclic)

(3.27) is a cyclic lexical rule, and may therefore have exceptions.

In her analysis, Steriade claims that Structure Preservation prohibits BH from spreading \([\text{back}]\) to the vowels \(/i/\) and \(/e/\), since they are underlingly unspecified for the feature \([\text{back}]\), and therefore may not lexically be associated with this feature. I assume, as in the RU analysis, that the conditions encompassed by Structure Preservation are formally given by a set of marking conditions. The prohibition on back non-low rounded vowels can be stated as in (3.28).
(3.28) \* [±back]

[±round]

(3.28), like the RU condition given in (3.11), holds throughout the lexicon, and will therefore be in effect when BH applies. This condition must be turned off postlexically, in order for [a] to receive a phonetic specification for [±round].

The marking condition in (3.28) differs from the RU condition in (3.11) in that the RU condition also includes the feature value [±low]. This difference arises because of the feature specifications required by these two theories. (3.28), the CU condition, does not include the feature [±low] because then only /e/, and not /i/, would be subject to this condition (see (3.23)). (3.11), the RU condition, requires the presence of [±low] so that /ɛ/ is not included as one of the segments that does not have a back counterpart (see (3.8)).

Steriade argues, following Ringen (1980), that it is the SCC (given in (2.2)) which stops BH from operating root-internally in loanwords. Ringen (1980) argues that only the initial root vowel of harmonic roots is specified for the feature [back], while in disharmonic roots (e.g. loanwords), all root vowels are underlyingly specified for a value of [back]. The SCC (or the Revised Alternation Condition as discussed in Ringen 1980) will prevent BH from applying within disharmonic roots, since it could only operate in a
neutralizing fashion, while it would permit BH to apply in harmonic roots because these applications would not be neutralizing. I therefore assume that in native roots (the application of BH in loanwords will not be dealt with here) [back] is specified only for the initial vowel.

The difficulty that arises if we assume that only initial vowels in native words are specified for [back] is that non-initial root vowels may underlingly have different feature specifications than those provided in (3.23). For example, a non-initial vowel which surfaces as [u] after BH, will be underlingly specified only as [+high] and [+round]. There is no vowel given in (3.23) which corresponds to this particular set of feature combinations. We will then have to assume that in CU Structure Preservation prohibits only those feature combinations that have associated marking conditions such as (3.28), and that there is no condition associated with a feature combination such as [+high] and [+round]. This particular interpretation of Structure Preservation contrasts sharply with that given for RU. As discussed in 3.1.2.1, Structure Preservation in RU permits only the sets of underlying feature specifications to exist throughout the Lexical Phonology, and marking conditions (such as (3.11)) will exist to specifically rule out all other feature combinations. In the CU analyses which follow I specify vowels that do not correspond to an underlying feature matrix in (3.23) as 'V'.

Steriade claims that in the unmarked case, suffixal
vowels in Hungarian are specified as [-back]. This is crucial in order to account for the neutral-vowel-only words given in (3.9di). In these forms the root vowel is one of the two neutral vowels, which are unspecified for the feature [back], and therefore do not act as triggers of BH; and yet the suffixal vowel surfaces as [-back]. It is then crucial to assume that suffixal vowels are lexically specified as [-back].

The fact that suffixal vowels must be specified as [-back] then rules out the possibility of positing [back] as a floating autosegment which associates to the initial root vowel. In order to account for neutral-vowel-only forms which take back vowel suffixes (shown in (3.9dii), we would then have to assume that the Association Conventions, which would link a floating autosegment to a suffixal vowel, operate in a feature-changing manner. This is entirely at odds with our conception of the Association Conventions as simple linking mechanisms. I therefore assume that in native roots the initial vowel is lexically linked to some specification for the feature [back].

Steriade did not attempt to account for the neutral-vowel-only roots in (3.9dii) which take back vowel suffixes. I assume that these roots trigger a rule which adds [+back] to the representation. This rule, like BH, will have to be feature-changing, and will be triggered by a small fixed-class set of native roots.
(3.29) Insert [+back]

Insert: [+back]

Trigger Condition: only in roots marked *

Domain: lexical (cyclic)

Feature-changing

The [+back] feature cannot link to the root vowel (by (3.28)), but will be able to link to a suffixal vowel.

We now have all the components necessary to describe the functioning of BH in the forms in (3.9). Derivations of native words betűnek, radírtól and cělnak are shown in (3.30) (ignoring for the moment the effects of RH). In this derivation I have ordered the rule Insert [+back] after BH, although the rules may apply in either order.

(3.30) BH in native words

Underlying  b e t V  r a d i r  *c e l

<table>
<thead>
<tr>
<th>x x x x</th>
<th>x x x x x x</th>
<th>x x x x</th>
</tr>
</thead>
</table>

[-bk]  [+bk]  [+lo]  [+lo]  [-lo]  [+hi]  [+hi]  [-hi]  [+rd]  [-rd]  [-rd]
BH betä

x x x x

[-bk]

[+lo]

[+hi]

[+rd]

Prohibited by n/a (3.28)

Morphology betä + nek radi r + tö l ce l + nek

n/a

[-bk]

[+lo]

[+hi]

[+rd]

radi r + tö l ce l + nek

[-bk]

[+lo]

[+hi]

[+rd]

n/a

[-bk]

[+lo]

[+hi]

[+rd]

n/a

[-bk]

[+lo]

[+hi]

[+rd]

n/a

[-bk]

[+lo]

[+hi]

[+rd]

n/a

[-bk]

[+lo]

[+hi]

[+rd]

*nak

[-bk]

[+lo]

[+hi]

[+rd]

*ce l + nak

[+back]
BH can apply in a structure-building fashion in betü to spread [-back] to the second root vowel from the initial vowel. BH is blocked in radír by (3.28) since /i/ is underlyingly specified as [-round]. BH is not applicable in cêl. The suffixes nek and töl are then added, in which the suffix vowels are both specified as [-back]. BH then reapplies to spread [-back] in betü and [+back] in radír to the suffix. In betünek I assume that BH applies vacuously, while in radírnak it applies in a feature-changing fashion. The final step is for [+back] to be added to the suffixal vowel in cêlnak by (3.29), delinking the original [-back] specification.

In the derivation of radírnak in (3.30) the [+back] feature of the initial vowel is prohibited from associating to the neutral vowel of the root by (3.28). BH can reapply once the Dative suffix is added, and the [+back] feature of the initial vowel will spread over the neutral vowel to link to the suffix. This spreading will not violate the Locality Condition (Archangeli and Pulleyblank 1987) if /i/ and /e/ are assumed to be ineligible targets as a result of (3.28). The initial root vowel and the target suffixal vowel in radírnak can be adjacent, if the intervening nucleus node is ignored for the purposes of the rule of BH.

In a neutral-vowel-only root which does not belong to the exceptional class (i.e. those forms in (3.9di)), the suffixal vowel surfaces as [-back]. This is easily accounted
for if the suffixal vowel is underlyingly specified as [-back] and the initial vowel has no specification for backness.

(3.31)

Underlying  
\[
\begin{array}{c}
\text{Underlying} \\
\text{sz i n} \\
x x x x x \\
[+hi] \\
[-rd]
\end{array}
\]

BH  
n/a

Morphology  
\[
\begin{array}{c}
\text{Morphology} \\
\text{sz i n + n ε k} \\
x x x x x x x x \\
[+hi] \\
[-rd]
\end{array}
\]

BH  
n/a

3.1.3.2 Round Harmony

Steriade (1987) does not attempt to account for the RH facts of Hungarian, but it is possible to develop an analysis using the parametric theory of CU. The three vowels that alternate through RH are [e], [o] and [ʊ], which are all [-high] and [-low]. The forms in (3.14) demonstrate that the
suffixal vowel in the '2nd person plural', 'allative' and 'plural' must be unspecified for roundness, or BH to the suffixal vowel will be blocked by the marking condition in (3.28). And finally, the neutral-vowel-only form színtek in (3.13) demonstrates that the suffixal vowel in these forms must be unspecified for backness, or (3.28) would block the operation of RH to the suffixal vowel in these forms.

Given that none of the three vowels e/o/ò is unspecified for both [round] and [back], we must assume, as was also necessary in the discussion of BH in 3.1.3.1, that the suffixal vowel underlying the RH alternations is not represented by one of the feature sets shown in (3.23). Again it is necessary to assume that this vowel can exist because it is not specifically ruled out by a marking condition such as (3.28).

We could also entertain the proposal that the suffixal vowels which participate in RH are completely unspecified, as in the RU analysis. Given that we must assume that sets of feature specifications can exist which are not specifically listed in (3.23), it could also follow that one possible vowel representation is the absence of any features. This proposal, however, can be seen to be untenable, in light of a form such as földhöz, which would undergo both BH and RH. Assuming that both [-back] and [+round] spread from the root vowel to a totally unspecified suffixal vowel, we then find that there are no redundancy rules given in (3.24) or (3.26) which could add the [-high] and [-low] specifications of the
suffixal vowel. A rule is given in (3.36) which adds precisely these feature specifications; however, this particular rule contains a target condition restricting its application to empty skeletal slots. This rule will then not be able to target a vowel previously specified as [-back] and [+round].

The suffixes which undergo ternary alternations between e, o and ø will then differ from those that undergo only binary alternations involving BH in that the ternary suffixes are unspecified for both backness and roundness, while the binary suffixes are unspecified only for roundness.

RH is a lexical rule which can have exceptions. I assume that in general [round] is linked only to the initial root vowel (as [back] is). The representation of vowels in (3.23) shows that the possible triggers of RH are /i/, /e/, /ɪ/ and /ø/, with the first two specified as [-round] and the second two [+round]. According to this set of specifications the back non-low vowels /u/ and /ø/ will not be triggers of RH. Being specified as [+back], these two vowels will trigger only BH, spreading [+back] to a suffixal vowel, which will then become [+round] by R-rule 4 in (3.24).

[-round] will be prohibited from associating to a vowel specified as [+back] by the marking condition in (3.28), and since we know that only mid vowels participate in RH, a target condition must indicate that only [-high] vowels participate ([a] will be prohibited from participating because of (3.28)). As in the RU analysis, RH will also be
blocked from applying to long vowels.

The rule of RH is given in (3.32).

(3.32) Round Harmony

Spread [+round] L --> R

Target condition: [-high]

Nucleus may not branch

Domain: lexical (cyclic)

Feature-changing

Derivations for házhoz, főztök and fejtek from (3.13) are given in (3.33).

(3.33) Round Harmony

Morphology

<table>
<thead>
<tr>
<th>házhoz</th>
<th>főztök</th>
<th>fejtek</th>
</tr>
</thead>
<tbody>
<tr>
<td>h a z + h V z</td>
<td>f o z + t V k</td>
<td>f e j + t V k</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BH</th>
</tr>
</thead>
<tbody>
<tr>
<td>házhoz</td>
</tr>
<tr>
<td>h a z h o z</td>
</tr>
</tbody>
</table>
The vowels in the 2nd person plural and Allative suffixes are underlyingly specified as [-high] and [-low]. BH and RH may apply in any order. BH applies in all three forms to give the suffixal vowel a specification for backness. RH operates only in \textit{főztők} to specify the suffixal vowel as [+round]. The suffixal vowels in \textit{házhoz} and \textit{fejhez} receive their surface specifications for roundness late in the derivation by R-rules 4 and 5 from (3.24). The final step in the derivation of \textit{fejhez} is the lowering of the suffixal vowel to \[ε\]. This rule will be discussed in 3.1.3.3.

In a neutral-vowel-only root such as \textit{szőntek}, shown in (3.13a), RH will operate as shown in (3.34).
BH is inapplicable in this form. RH will spread [-round] to the suffixal vowel, and the language-particular R-rule in (3.26) will supply the [-back] surface value for this vowel.

There is no reason to posit any ordering relationship between BH and RH as is required in the RU analysis. Each
rule may apply whenever possible, because of the fact that we have assumed that the suffixal vowels are unspecified for either [round] or [back].

3.1.3.3 Peripheral Rules

As discussed in 3.1.2 I assume that there are two distinct non-high unrounded front vowels in Hungarian: /e/ and /ɛ/. /e/ surfaces as [e] only when it is associated with two skeletal slots dominated by a branching nucleus, which I assume, following Levin (1985), is the representation of a long vowel (see discussion in 2.1.2.4). /ɛ/, on the other hand, can surface only when associated to a single skeletal slot dominated by a nucleus, i.e. when it is a short vowel. These constraints are given in (3.2).

When a short front mid vowel is derived through the operation of BH or RH (e.g. fejtek in (3.33)) the constraint on [e] will trigger a rule of Low Front Vowel Formation, given in (3.35).

(3.35) Low Front Vowel Formation

Insert: [+low]

Target condition: [-low]

[-high]

[-back]

[-round]

Non-branching nucleus

Domain: postlexical
(3.35) changes the value of [low] of a mid front unrounded vowel. It is a purely phonetic rule which applies after all redundant specifications have been assigned, and can apply to the outputs of both BH and RH.

The final rule that is necessary for this CU analysis of Hungarian harmony is a rule inserting the features for an epenthetic vowel slot. If we are to maintain that Epenthesis inserts a vowel slot automatically when syllabification requires it, in the CU analysis it will also be necessary to have a rule providing some feature specifications for this empty slot. Such a rule is not necessary in the RU analysis, since the redundancy rules of the language insert the feature specifications of the epenthetic vowel. In CU, however, redundancy rules are only context-sensitive, and it is therefore impossible to add features to an empty skeletal slot.

Since the linking vowel facts in (3.18) show that the epenthetic vowel undergoes the same e/o/ø alternation as vowels affected by RH, I assume that the features that must be inserted are just those required for the suffixal vowels shown in (3.33) and (3.34). This rule can then be stated as in (3.36).

(3.36) Epenthetic Vowel Specification

Insert:  [-high]  
        [-low]  

Target Condition:  an empty skeletal slot  
Domain:  lexical (cyclic)
This rule will insert the features [-high] and [-low] onto a skeletal slot which has no other feature specifications. A vowel which has undergone (3.36) will then be eligible to participate in RH and BH. Since all three of these rules are cyclic lexical rules, there is no specific ordering required between them.

3.1.4 Summary and Comparisons

Following the analyses of BH and RH in 3.1.2 the language-specific information that is required in the grammar of Hungarian, given the RU analysis, is as follows:

(3.37) Marked parameter settings:

**FCRs:** 
* [+low] -> [+back]  
* [-back] -> [-round]  
  [-low]

**Context-free:**  
[ ] -> [-high]  
[ ] -> [+round]

**Syllabification:**  Complex N - ON

**Phonological rules:**

* Back Harmony*  
* Round Harmony*  
* Low Front Vowel Formation*

**Ordering:**

* BH before RH*

**Surface Constraints:**

*/e/  */ε:/*
There are two marked context-free featural parameters required in Hungarian, and two marked context-sensitive featural parameters. The language also requires that the syllabification option allowing for complex nuclei be set to the marked option, so that long vowels can exist.

Three phonological rules are also present in Hungarian. It is not necessary to state the Association of [+back] as a specific rule of Hungarian, since it is an application of the Association Conventions, which are themselves a part of UG. Back Harmony is a relatively simple rule in that it does not involve the statement of any target conditions, while RH requires several. Low Vowel Formation is an unmarked rule in the sense that it inserts content like a redundancy rule; however, it has a complex target condition.

The grammar of Hungarian requires a statement that BH must be ordered prior to RH.

The grammar of Hungarian also contains a marking condition, which is a formalization of Structure Preservation, prohibiting the derivation of a back unrounded non-low vowel. This condition will hold throughout the lexicon, and in fact there is no reason to believe that it is ever turned off. I have not specifically stated this condition since it is a direct result of a principle of UG. The two constraints stated in (3.36) prohibit the feature specifications of /e/ attached to a single non-branching nucleus, and the feature specifications of /ε/ attached to a
branching nucleus. While these particular feature combinations do exist, they do not exist in combination with a particular syllabic structure. These constraints cannot hold of the lexicon as shown by the fact that they do not block the derivation of [e].

The fact that these two configuration constraints exist in Hungarian helps to explain the idiosyncratic behaviour of orthographic e. While e alternates with [a] in the Dative suffix through BH, it sometimes appears to violate BH constraints in forms such as ceruza and krapek. If we assume that e is underlying /e/ in these words (allowed by the fact that the constraint on *[e] is phonetic), and that a floating [+back] autosegment is prohibited from associating to /e/ by the constraint in (3.28), then in fact these forms do not violate BH restrictions.

The interaction of the redundancy rules in (3.7) and the phonological rules and constraints of the language that are dictated by the RROC produce produce the following picture of the phonology of Hungarian:
Lexicon

Rules 1, 2a, 5 and 7 in (3.7)
Association of [+bk]  
BH  
RH

(3.11)

Postlexicon

Rules 3, 4a and 8 in (3.7)
Constraints on /e/ and /ɛ:/
Low Front Vowel Formation

The only extrinsic ordering relationship required is that between BH and RH. All other rules apply when and where they can in conjunction with the Ordering Constraints (see 2.5.1.1) and Universal Grammar.

In the CU analysis of BH and RH the following language-specific information is required:
Marked parameter settings:

* [+low]  -->  [+back]
* [-back]  -->  [-round]

[-low]

Syllabification: complex N - ON

Language-specific R-rule:

[-low]  -->  [-back]

[-round]

Phonological Rules:

Back Harmony
Round Harmony
Epenthetic Vowel Specification
Insert [+back]
Low Front Vowel Formation

Lexical Markings:

Certain native roots are marked * to undergo Insert

 [+back]

* [+back]  -  Holds only in lexicon

[-round]

Constraints:

* [e]  * [ɛ:]  Holds at surface structure

All the phonological rules require resetting of a rule parameter to ON. RH is more complex than BH because it requires a target condition, as does Low Front Vowel Formation. Insert [+back] is probably the most complex rule because it applies only to a small restricted class of words.
In this analysis it is not necessary that RH and BH be extrinsically ordered, as is required in the RU analysis of Hungarian.

The constraints on [e] and [ɛ:] prevent the surfacing of [e] and [ɛ:]. In addition Hungarian also has the constraint given in (3.28) which is supplied by Structure Preservation, but there must be a statement in the phonology of Hungarian that this constraint turns off postlexically.

The behaviour of the vowel which surfaces as [ɛ] can be explained by the interaction of these two types of constraints. Orthographic e may be underlyingly either /e/ or /ɛ/. If it is derived from /e/, the marking condition in (3.28) will prevent it from participating in the lexical rules of BH and RH, while if it is derived from /ɛ/, it will alternate with /a/ through the application of BH.

Because this theory does not adopt the RROC redundancy rules cannot be ordered among the phonological rules of a language. The only rule of Hungarian which applies after (or at the same time as) the R-rules is the phonetic rule of Low Front Vowel Formation, giving the following picture of the phonology of Hungarian.
Comparing the language-specific information required by the RU and CU analyses of Hungarian harmony, we see that the RU analysis posits that 4 featural parameters require resetting in this language, while the CU analysis posits that only 2 featural parameters must be reset.

If, however, we compare the phonological rule systems required by these two analyses, I believe the RU analysis proves to be the superior one. The CU analysis requires a larger number of phonological rules than the RU analysis, since it requires a rule of Insert [+back] in order to account for the small class of neutral-vowel-only roots which take back suffixal vowels, and a rule providing the feature specifications of epenthetic vowels. The exceptional behaviour of the subclass of neutral-vowel-only roots is
accounted for in the RU analysis by assuming that [+back] is a floating autosegment, and that Structure Preservation prohibits this floating feature from associating to neutral vowels. The feature specifications of epenthetic vowels are provided automatically by the redundancy rules of the language.

The CU analysis of Hungarian harmony has one added problem in that these analyses simply do not work unless we assume that certain vowel combinations not present in the basic underlying inventory of the language are permitted to exist. I have hypothesized that certain feature combinations, not specifically outlawed by marking constraints, may be allowed, and supplement the basic contrastive system. Undoubtedly this will add to the load of a language learner.

3.2 Spanish Vocalic Alternations

In the following sections I present analyses of several processes which operate in the verbal system of Spanish. One set of alternations appears in a subclass of 3rd conjugation class verbs, where a root vowel alternates between a mid and high front vowel. The other alternation, which takes place across all 3 conjugation classes, shows variation between a falling diphthong and a simple vowel. These alternations are found in the Castilian dialect of Spanish, the prevalent dialect spoken in Spain.

In 3.2.1 I discuss the Spanish vocalic inventory and
present an analysis of stress. In 3.2.2 I present the RU analysis of the Spanish vocalic alternations, arguing that [+high] must be a lexically specified feature value in this language. These analyses demonstrate that stress and syllabification are integral in the statement of the phonological rules which control vowel/diphthong and high/mid vowel alternations. In 3.2.3 I present the CU analysis of these facts, and here the focus again is on the importance of the feature [high] in this system, and the interaction of syllabification and stress with the other phonological rules. As in the analyses of Hungarian, the CU analysis does not require the same types of argumentation for underlying feature values as in the RU analysis, since both values of the feature [high] are assumed to be marked underlingly.

Spanish data will in general be given in orthographic form, which, particularly for vowels, corresponds quite closely to the phonological system itself. Phonetic representations will sometimes be used for the representation of diphthongs.

3.2.1 Spanish Vowels and Stress

The Spanish vowel system (Castilian dialect) is given in (3.41).

(3.41) Spanish Vowels

\[
\begin{array}{c|c|c|c|c}
& u & o & & \\
\hline
i & e & a & & \\
\end{array}
\]
Phonetically, /e/ varies between [ɛ] and [e] and /o/ between [o] and [ɔ] (Macpherson (1985). There are no long vowels in the language, although both rising and falling diphthongs are frequent\textsuperscript{17}.

Harris (1983) notes that in Spanish rhymes only falling diphthongs may be followed by a liquid, nasal, glide or s, which comprises the set of segments permitted in coda position in Spanish (e.g. \textit{siempre}, \textit{muerte}). Rising diphthongs are not permitted to be followed by consonants. I take this as evidence that only falling diphthongs are representative of complex nuclei and that rising diphthongs must be analyzed as nucleus-coda sequences\textsuperscript{18}. The component elements of a diphthong must come from the set of vowels shown in (3.41). In order to permit complex nuclei Spanish has chosen the marked parameter setting of the Complex N parameter, as discussed in 2.1.2.4. The syllabification mechanisms of Spanish will be discussed in 3.2.2.2.

Stress in Spanish falls on one of the last 3 syllables. Penultimate stress is unmarked on vowel-final words, while final stress is the unmarked pattern in consonant-final forms. Halle, Harris and Vergnaud (1991) demonstrate that the relatively complex stress patterns of Spanish can be dealt with by assuming that word stress in Spanish is assigned both cyclically and postcyclically, and that the Stress Erasure Convention (Halle 1990) applies. The Stress Erasure Convention (SEC) is a universal principle which says
that all metrical structure is erased at the beginning of each level.

Halle, Harris and Vergnaud (1991) argue that the language-particular aspects of stress assignment in Spanish are as given in (3.42).

(3.42)
a. word-final vowels are extrametrical
b. the rightmost visible syllable receives an accent mark
c. Left-headed feet are constructed in binary fashion from right to left
d. Main stress is assigned to the rightmost foot by constructing an unbounded right-headed constituent.

Using the rules in (3.41) and the SEC, Halle, Harris and Vergnaud demonstrate that stress in Spanish is rule-governed. Forms that demonstrate exceptional antepenultimate stress (for vowel-final words) or penultimate stress (for consonant-final forms) rather than the more unmarked penultimate or ultimate stress patterns are treated as being exceptional with regard to the rule in (3.42b).

In the following analysis of Spanish I adopt the stress account of Halle, Harris and Vergnaud (1991), with some elaborations for the verbal forms that I discuss. Stress is particularly important in the analyses of the imperfective forms discussed in conjunction with the high/mid alternation facts.
3.2.2 Parametric RU Analyses of Spanish Vocalic Alternations

The components of UG that are assumed in the parametric RU model are given in 3.1.2. These include the MRC, Ordering Constraints, and Universal Default Rules. In the following sections I demonstrate that [+high] must be the lexically marked value of [high] in Spanish, contrary to the universal markedness considerations that have been assumed in earlier chapters. If [+high] is lexically marked in Spanish, then the context-free parameter for [high] (rule 2 in (3.5)) has been reset at the marked option, and a complement rule has been created to fill in [-high] as the redundant value. Assuming that the other redundancy rules are unchanged from UG, the redundancy rules necessary for Spanish are those in (3.43).
(3.43) Spanish Redundancy Rules

Default Rules

1. [ ] --> [-low]

5. [+low] --> [-high]

3. [ ] --> [-back]

6. [+low] --> [+back]

4. [ ] --> [-round]

7. [+low] --> [-round]

8. [+back] --> [+round]

[-low]

9. [-back] --> [-round]

[-low]

Complement Rule

2a.[ ] --> [-high]

If the rules in (3.43) supply the redundant feature values in Spanish the marked values will be those in (3.44).¹⁹

(3.44) Parametric RU Spanish Vowel System

\[
\begin{array}{cccc}
  i & e & a & o & u \\
\end{array}
\]

\[
\begin{array}{cc}
  \text{high} & + \\
  \text{low} & + \\
  \text{back} & + \\
\end{array}
\]

[round] is a totally redundant feature in this system, and /e/ is totally unspecified. This system is similar to the universal 5 vowel system given in (2.37), except for the lexically marked values of [high].

If Spanish requires only one featural parameter to be reset at the marked option it is a much less complex system than that of Hungarian (discussed in 3.1), since Hungarian
requires that 4 such parameters be reset. The lexical marking of [+high] in Spanish is demonstrated by certain facts relating to verb paradigms, and therefore some general issues regarding the formation of Spanish verbs are first discussed.

3.2.2.1 Spanish Verbal Classes

There are three verb conjugation classes in Spanish. Representative paradigms are given for each class in (3.45).

(3.45) Spanish verb classes

<table>
<thead>
<tr>
<th>Infinitives</th>
<th>Past Participle</th>
<th>First person present indicative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st conjugation</td>
<td>2nd conjugation</td>
<td>3rd conjugation</td>
</tr>
<tr>
<td>theme vowel - /a/</td>
<td>theme vowel - /e/</td>
<td>theme vowel - /i/</td>
</tr>
<tr>
<td>amar</td>
<td>comer</td>
<td>vivir</td>
</tr>
<tr>
<td>pensar</td>
<td>perder</td>
<td>pedir</td>
</tr>
<tr>
<td>avanzar</td>
<td>mover</td>
<td>concebir</td>
</tr>
<tr>
<td>comprar</td>
<td>valer</td>
<td>partir</td>
</tr>
<tr>
<td>past participles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>amado</td>
<td>comido</td>
<td>vivido</td>
</tr>
<tr>
<td>pensado</td>
<td>perdido</td>
<td>pedido</td>
</tr>
<tr>
<td>avanzado</td>
<td>movido</td>
<td>concebido</td>
</tr>
<tr>
<td>comprado</td>
<td>valido</td>
<td>partido</td>
</tr>
<tr>
<td>amo</td>
<td>como</td>
<td>vino</td>
</tr>
<tr>
<td>pienso</td>
<td>pierdo</td>
<td>pido</td>
</tr>
<tr>
<td>avanzo</td>
<td>nuevo</td>
<td>concibo</td>
</tr>
<tr>
<td>compro</td>
<td>valgo</td>
<td>parto</td>
</tr>
</tbody>
</table>
Spanish infinitives are composed of a root, a theme vowel (/a/ in 1st conjugation, /e/ in 2nd conjugation, and /i/ in 3rd conjugation), and the infinitive marker -r.

Harris (1969) argues that a theme vowel is underlingly present in the verb paradigms for all tenses and aspects, but if the tense/aspect marker which follows is vowel-initial, the theme vowel is deleted. This assumption produces the following underlying forms for the present indicative and imperfective of the verbs amar, temer and vivir, of the 1st, 2nd and 3rd conjugation classes, respectively (stressed vowels are shown in capitals).
(3.46) Underlying Representations of Verbal Conjugations

<table>
<thead>
<tr>
<th>Present Indicative Surface</th>
<th>Imperfect</th>
<th>Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a. 1st conjugation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>amar 'to like'</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yo</td>
<td>am + a + o</td>
<td>Amo</td>
</tr>
<tr>
<td>tú</td>
<td>am + a + s</td>
<td>AmAs</td>
</tr>
<tr>
<td>él</td>
<td>am + a + φ</td>
<td>Ama</td>
</tr>
<tr>
<td>nosotros</td>
<td>am + a + mos</td>
<td>amAmos</td>
</tr>
<tr>
<td>ellos</td>
<td>am + a + n</td>
<td>Aman</td>
</tr>
<tr>
<td><strong>b. 2nd conjugation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>temer 'to fear'</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yo</td>
<td>tem + e + o</td>
<td>tEmo</td>
</tr>
<tr>
<td>tú</td>
<td>tem + e + s</td>
<td>tEmes</td>
</tr>
<tr>
<td>él</td>
<td>tem + e + φ</td>
<td>tEme</td>
</tr>
<tr>
<td>nosotros</td>
<td>tem + e + mos</td>
<td>temEmos</td>
</tr>
<tr>
<td>ellos</td>
<td>tem + e + n</td>
<td>tEmen</td>
</tr>
<tr>
<td><strong>c. 3rd conjugation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>vivir 'to live'</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yo</td>
<td>viv + i + o</td>
<td>vIvo</td>
</tr>
<tr>
<td>tú</td>
<td>viv + i + s</td>
<td>vIves</td>
</tr>
<tr>
<td>él</td>
<td>viv + i + φ</td>
<td>vIve</td>
</tr>
<tr>
<td>nosotros</td>
<td>viv + i + mos</td>
<td>vivImos</td>
</tr>
<tr>
<td>ellos</td>
<td>viv + i + n</td>
<td>vIven</td>
</tr>
</tbody>
</table>

The person endings for the present indicative of all three conjugation classes are underlyingly identical, however, we must assume that a /b/ is inserted between the theme vowel
and the person/number marker in 1st conjugation forms. I will not attempt to motivate this insertion rule here.

I adopt this particular analysis of verbs, and assume, following Harris (1969), that a rule of Vowel Deletion accounts for the deletion of the theme vowel in the '1st person singular present indicative' forms. The theme vowel is left intact in all other persons shown in (3.46). Vowel Deletion will delink the leftmost of two adjacent vowels brought together by morphological concatenation, if that vowel is not stressed. The statement of this rule is crucially concerned with stress, as the stressed theme vowel in the imperfective forms is not deleted, while the unstressed theme vowel in the 1st person singular indicative is.

In analyzing the stress patterns of Spanish verbs, I assume, as do Halle, Harris and Vergnaud (1991), that the theme vowel is a cyclic affix, while the imperfective and number/person markers shown in (3.46) are non-cyclic affixes. In addition, I assume that the number/person markers are affixes which are exceptions with regard to (3.42b). Verb stems which contain consonant-final number/person markers will then generally demonstrate penultimate stress, rather than the more unmarked ultimate pattern, since the final visible syllable will not be marked with an accent and stress will be assigned via (3.42c).

Stress will then be assigned in the 1st person singular indicative form *tEmo* as shown in (3.47).
This form is made up of the root and the cyclic theme vowel affix /e/, followed by the non-cyclic number/person marker. The final vowel is extrametrical by (3.42a), and since the number/person marker is an exception to (3.42b), a left-headed foot will be erected supplying stress to the root vowel. If Vowel Deletion applies after stress assignment to
delete the unstressed theme vowel, then the surface form tEmo is explained.

Stress is assigned in the 1st person plural indicative form tEmEmos as shown in (3.48).

(3.48) a. Morphology

```
  x x x + x + x x x
  t e m e m o s
  root theme 1st pers vowel pl. ind.
```

Stress rules

```
  / \     
  /   
  s w
```

```
  x x x + x + x x x
  t e m e m o s
```

This word is consonant-final, so (3.42a) will not apply.

Since the number/person marker is exceptional with regard to (3.42b), a left-headed foot will be erected over the final two vowels, giving the theme vowel primary stress. If a rule of Vowel Deletion is prohibited from applying to stressed vowels, this will explain why the theme vowel remains in this form.

In the imperfective forms shown in (3.46) we see that
stress is always fixed on the theme vowel. Halle, Harris and Vergnaud (1991) discuss only the 3rd person singular imperfective forms of 1st conjugation verbs, and they assume that the final vowel (final [a] in amAbA) is extrametrical (by (3.42a)), accounting for the penultimate stress pattern. In contrast, I assume that these forms can be explained by reference to the fact that the number/person markers in general are exceptional with regard to (3.42b). If we assume that all imperfect forms also have a number/person affix following the imperfective marker (even if the number/person marker is phonologically empty, as it is in the 1st and 3rd person singular), then we can explain the stress patterns in the majority of imperfective forms.

This analysis can then account for imperfective verb forms in all three conjugation classes, whereas the Halle, Harris and Vergnaud account is only able to account for certain forms in the 1st conjugation class. My account is more consistent with the facts of Spanish, in that it assumes that imperfectives, like other verbal paradigms, always contain person/number markers.

The 1st person singular imperfective viviA can be explained as shown in (3.49).
(3.49) a. Morphology:
\[
x x x + x + x + \phi \\
v i v i a
\]
root theme imp. 1st pers vowel sg. ind.

b. Stress rules:

/\  
/  \
/  \
  s w

x x x + x + x + \phi \\
v i v i a

This form is made up of a root, a theme vowel (/i/), the imperfective marker (/a/) and the empty 1st person singular marker. The number/person marker is exceptional to (3.42b), so the final vowel in the form is not accented, and a left-headed foot is erected over the final two vowels, stressing the theme vowel. The theme vowel will then not be eligible for Vowel Deletion.

The stress pattern of the 1st person plural imperfectives (e.g. vivIamos) is still recalcitrant given this analysis, as it is in the Halle, Harris and Vergnaud analysis. I will not attempt to develop an analysis of these forms here, although it is expected that one can be provided.

Vowel Deletion (which I call Vowel Delinking) can now be
stated as in (3.50).

(3.50) **Vowel Delinking**

Delink: skeletal slot from the nucleus

Target Condition: the leftmost unstressed N of two adjacent N's

Domain: lexical (cyclic)

This rule delinks the skeletal slot of the leftmost vowel from a nucleus when two vowels become immediately adjacent due to morphological concatenation. It must be a cyclic lexical rule because it never deletes a vowel intra-morphemically.

The operation of (3.50) in the present indicative and imperfective forms *vivo* and *vivIa* are compared in (3.51).
(3.51)
a.  
\[
\begin{array}{cccc}
N & N & N \\
N & N & N \\
X & X & X & X \\
[+hi] & [+hi] & \\
[+bk] & \\
\end{array}
\]

Present Indicative

[[[ viv ] i ] o ]

root  theme  1st pers
vowel  sg.  ind.

b.  
\[
\begin{array}{cccc}
N & N & N \\
N & N & N \\
X & X & X & X \\
[+hi] & [+hi] & \\
[+bk] & \\
\end{array}
\]

Imperfect

[[[ viv ] i ] a ] \( \phi \)

root  theme  imp.  1st pers
vowel  sg.
In (3.51a) both the theme vowel and '1st person indicative' have been added to the root *viv*. In (3.51b) the root is followed by the theme vowel, the imperfective marker and the 1st person singular marker (which is $\phi$).

Syllabification in Spanish will be ordered prior to the other phonological rules that are to be discussed, since these rules all have target conditions which specify syllabification or stress requirements. Stress is assigned to the root vowel in (3.51a) (see (3.47)) and to the theme vowel in (3.51b) (see (3.49)). Only the theme vowel in (3.51a) will therefore be a target of Vowel Delinking, since the leftmost of the two adjacent nuclei in (3.51b) is stressed. Vowel Delinking will be discussed further with regard to the high/mid vocalic alternations examined in 3.2.2.3.

3.2.2.2 Alternating Vowel/Diphthongs

In certain 1st, 2nd or 3rd conjugation verbs an unstressed mid or high vowel ([i],[e],[o] or [u]) varies with a stressed falling diphthong (shown here as phonetic [ye] for orthographic *ie* and [we] for orthographic *ue*). The second member of such as diphthong is always [e].
(3.52) Alternating vowel/diphthongs

a. Front vowels

\begin{align*}
\text{t[e]ndEmos} & \quad \text{t[yE]nden} & \text{'we/they tend' - 2nd conj.} \\
\text{adqu[i]riO} & \quad \text{adqu[yE]re} & \text{'he acquired/he acquires' - 3rd conj} \\
\text{n[e]gO} & \quad \text{n[yE]ga} & \text{'he denied/he denies' - 1st conj.}
\end{align*}

b. Back vowels

\begin{align*}
\text{c[o]ntO} & \quad \text{c[wE]nto} & \text{'he told/I tell' - 1st conj.} \\
\text{j[u]gAmos} & \quad \text{j[wE]ga} & \text{'we play/he plays' - 1st conj.}
\end{align*}

The most common alternations are those found in forms such as tendemos/tienden and conto/cuento, where a falling diphthong alternates with a mid front or back vowel. Alternations between a falling diphthong and a high front or back vowel, such as those found in jugamos/juega and adquiere/adquirio, are relatively rare.

In some 3rd conjugation verbs there is a ternary alternation pattern between a high vowel, a mid vowel, and a falling diphthong. This pattern is shown in (3.53) with the verb mentir.

(3.53)  "to lie"    Infinitive  mentIr
          Past Participle  mentIdo
          Gerund  minkiEndo
          Present Indicative  Present Subjunctive

\begin{align*}
\text{miEnto} & \quad \text{mentImos} & \text{miEnta} & \quad \text{mintAmos} \\
\text{miEntes} & \quad \text{mentIs} & \text{miEntas} & \quad \text{mintAis} \\
\text{miEnte} & \quad \text{miEnten} & \text{miEnta} & \quad \text{miEntan}
\end{align*}
The root diphthong always appears under stress, but either the high or mid vowel may appear in unstressed positions -- the high vowel when followed by a diphthong or by a morpheme beginning with [a], and the mid vowel when followed by [i].

These alternations have been discussed at great length in the Spanish literature. The vowel underlying this alternation has been described as a simple vowel /e/ which undergoes diphthongization under certain conditions (Harris 1969, Brame and Bordelois 1973), as an underlying diphthong /ie/ (or /ue/) that is sometimes changed to a monophthong (Norman and Sanders 1977), or as a complex lexical entry which includes both a simple vowel and a diphthong (Hooper 1976).

I assume, following Harris (1985), that alternating vowel/diphthongs are underlyingly represented as two skeletal slots, the first of which may or may not have associated vocalic features, and the second of which is totally unspecified. The underlying representation of the roots 'deny' and 'play' from (3.52) are compared to the representations of the roots peg 'beat' and mont 'climb' of the non-alternating class in (3.54).
(3.54)

a. Alternating vowel/diphthong forms

```
x x x x x x x x x
| | | | | | | |
ne g      j u g
```

b. Non-alternating forms

```
x x x x x x x x x
| | | | | | | |
p e g      m o n t
```

In both neg/niej and jug/jueg the root vowel is represented as two skeletal slots, while the root vowels in the non-alternating forms are represented as single skeletal slots.

In outlining how syllabification of the underlying forms in (3.54) will proceed, I adopt the syllabification algorithm of Levin (1985) discussed earlier in 2.1.2.4. The universal components of this theory are repeated here as (3.55).
(3.55) A. X-bar theory

1. Categorial Component
   a. N-Placement
   b. Complex-N

ii. Projection
   a. Project N"
   b. Project N'

iii. Incorporation
   a. Incorporate into N"
   b. Incorporate into N'

iv. Adjunction (to N")

B. Condition on Structure-Dependent Rules

C. Sonority Hierarchy

Vowels project N (by N-placement); N" (onset position) is projected by picking up the segment immediately to the left of N (by Project N'"); and N' is projected to pick up remaining post-nuclear elements (by Project N').

In Levin's framework syllability is derived through the operation of redundancy or phonological rules, or it may be specified lexically. In Spanish, the only segments that may be syllabic are the vowels shown in (3.40) and diphthongs composed of combinations of these vowels, and therefore syllability is a redundant phenomenon in the language. I assume that the redundancy rule projecting N in Spanish is as shown in (3.56).
If consonants are underlyingly marked [+cons], then vowels will be underlyingly unspecified for the feature [cons]. Since (3.56) makes reference to the feature value [-cons], the redundancy rule inserting [-cons] on vowels will be inserted prior to application of (3.56) by the RROC.

The fact that Spanish permits diphthongs demonstrates that it has chosen the marked parameter setting permitting complex nuclei (Complex-N in (3.55)). As discussed in 3.2.1 I assume that the only type of complex N allowed in Spanish is a falling diphthong, and this particular type of diphthong only appears morpheme-internally. All other sequences of vowels will be analyzed as complex rhymes or two adjacent syllable heads. Spanish requires the language-specific statement in (3.57) to indicate when a complex N can be formed.
(3.57) **Complex N Formation**

When two skeletal slots \( X \) marked as \([-\text{cons}]\) are adjacent:

If \( X_2 \) is equal to or more sonorous than \( X_1 \) then \( X_1X_2 \) is syllabified as a branching N. The rightmost member is designated as the head of \( N^{22} \).

Since this rule again makes reference to the feature \([-\text{cons}]\), the redundancy rule inserting that feature value will be ordered prior to this process, by the RROC. (3.57) will join two adjacent skeletal slots into a branching N, provided that the second slot is at least as sonorous as the first.

N Placement and Complex N Formation cannot destroy previously erected syllable structures in Spanish, which accounts for the fact that complex nuclei arise only within morphemes in this language. A theme vowel followed by a vowel-initial suffix is always realized as two distinct syllables, suggesting that N-Placement and not Complex-N Formation is responsible for the placement of the nuclei. If Complex N Formation were able to create new structure, then we would expect that these vowel sequences could also become diphthongs -- a result that is not borne out in the data.

(3.55C) is the sonority hierarchy, which helps to determine how syllabification proceeds. Levin, following Steriade (1982), assumes that the hierarchy of features which participate in sonority are fixed universally, as is the sonority difference between the two values of any feature.
The sonority properties of languages differ only in the inclusion of features in the language-particular sonority scale, and in the Minimal Sonority Distance required between segments in clusters.

Levin (1985: 77-78) discusses how a theory of underspecification, where feature values are not fully specified, can be reconciled with a sonority scale such as that proposed in Steriade (1982). Levin suggests that feature combinations be matched to positions in the sonority hierarchy only if they have identical feature specifications. If features or feature values change during the course of the derivation then they will automatically be reassessed against the sonority scale.

Following Levin's principles, a sonority scale for Spanish vowels is given in (3.58).

(3.58) Spanish Sonority Scale - Vowels

1. [-cons], [+high]
2. [-cons]
3. [-cons], [+low]

The least sonorous vowels are those specified as [-cons] and [+high] and the most sonorous are those specified as [-cons] and [+low]. A vowel specified only as [-cons] (by the context-free redundancy rule) will be more sonorous than a [+high] vowel, but less sonorous than a [+low] vowel. Only the features [cons], [low] and [high] are relevant to this scale -- other feature specifications will be ignored in the
matching algorithm.

Given two morpheme-internal vowel sequences /ie/ and /ai/ we can see the effects of (3.57) and (3.58) as follows:

(3.59)

<table>
<thead>
<tr>
<th>a. x x</th>
<th>b. x x</th>
</tr>
</thead>
<tbody>
<tr>
<td>[-cons] [-cons]</td>
<td>[-cons] [-cons]</td>
</tr>
<tr>
<td>[+] [+]</td>
<td>[+lo]</td>
</tr>
<tr>
<td>[+hi]</td>
<td>[+hi]</td>
</tr>
</tbody>
</table>

/i/ /e/ /a/ /i/

Position in sonority scale

1 2 3 1

Syllabification

N N N

/- \ | | x x x
| | | [-cons] [-cons] [-cons] [-cons]
| | [+lo] [+hi] [+hi]

I assume that underlyingly vowels are not specified for the feature [cons]; however, [-cons] is added to the representations by a context-free redundancy rule immediately prior to N-Placement and Complex N Formation. Each vowel will be matched against the sonority scale in (3.55), which
will specify that /i/ is less sonorous than /e/, while /a/ is more sonorous than /i/. Given the restrictions on sonority in (3.58) only the vowel sequence in (3.59a) will be syllabified as a complex N. In (3.59b) both vowels will be syllabified separately, and will most likely surface as two distinct syllables.

The derivation of the forms jugamos and niega from (3.51) until the assignment of stress are shown in (3.60)²³:

(3.60)

[ ] --> [-cons] n g a j u g a m o s

x x x x + x x x x + x + x x x


[+hi] [+bk]

[+lo] [+lo]

Project N

N N N N N

Complex N

/ | | | | | | |

Formation

n g a j u g a m o s

x x x x x x x x x x x x


[+hi]

[+bk]

[+lo] [+lo]
<table>
<thead>
<tr>
<th>Project N&quot;</th>
<th>N&quot;</th>
<th>N&quot;</th>
<th>N&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>g</td>
<td>a</td>
<td>j</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>[C][-C] [-C] [C] [-C] [-C] [-C] [-C]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[+hi]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[+bk] [+bk]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[+lo] [+lo]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project N'</th>
<th>N&quot;</th>
<th>N&quot;</th>
<th>N&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j</td>
<td>u</td>
<td>g</td>
<td>a</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>[+hi]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[+bk] [+bk]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[+lo]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The root vowels are underlyingly represented with two skeletal slots, indicating that these vowels are of the alternating type. In my analysis of these facts the initial slot in the underlying diphthong in *jugamos* will be specified as [+high] and [+back], while the second slot will be totally unspecified. The [+high] specification of the initial member of the diphthong is required since this vowel surfaces as a high vowel when it is reduced to a monophthong (*jugamos*). The initial slot in the diphthong in *niega* will not be specified as [+high] since this vowel is realized as a mid vowel when it is reduced to a monophthong (*nego*). The second
member of this diphthong will also have no underlying specifications.

Complex N Formation will apply to create a branching N over these vowels, while a single N will be placed over the remaining vowels. Project N" and Project N' will then apply to syllabify the remaining segments. Stress is assigned to the penultimate syllable in both forms: in both cases because the number/person markers do not trigger (3.42b).

Harris (1985) posits three rules to account for the surface realization of the alternating vowel/diphthongs shown in (3.54). Diphthongization is a rule which adds the feature [-cons] to a skeletal slot with no associated featural material in a branching rhyme of a stressed syllable. Default is a rule (or rules) which adds the default features to a vowel specified as [-cons] through Diphthongization. The final rule, High-Glide Formation, inserts [+high] on the non-head member of a branching rhyme, making the initial member a glide.

I adopt Harris' analysis in spirit, although my formulation of these rules is slightly different. Given that I have already assumed that a default rule fills in the feature [-consonantal] before N-Placement, there is no reason to posit an additional rule of Diphthongization. The rule of High-Glide Formation will supply the [+high] feature value for the initial member of a stressed diphthong, such as that in nieqa.
(3.61) High-Glide Formation

Insert [+high]

Target condition: non-head member of a branching stressed N

Domain: postcyclic

High-Glide Formation must apply after stress is assigned and since stress is both cyclic and postcyclic I assume (3.61) belongs to the postcyclic component.

Continuing the derivation from (3.60), I show the operation of High-Glide Formation in the forms niega and jugamos (nuclear slots are underlined).

(3.62)

\[
\begin{array}{cccccccccccc}
\text{n} & \text{g} & \text{a} & \text{j} & \text{u} & \text{g} & \text{a} & \text{m} & \text{o} & \text{s} \\
\text{x} & \text{X} & \text{x} & \text{x} & \text{x} & \text{x} & \text{x} & \text{x} & \text{x} & \text{x} & \text{x} \\
\text{[+hi]} & \text{[+bk]} & \text{[+bk]} & \text{[+lo]} & \text{[+lo]}
\end{array}
\]

High-Glide Formation
High-Glide Formation will apply only to the alternating vowel/diphthong in niega, since the alternating vowel in jugamos does not receive stress. High-Glide Formation will add [+high] to the initial member of the alternating vowel in niega and it will be realized as a front glide.

The surface realization of the alternating vowel/diphthongs in these forms require two further operations. In jugamos the second slot of the alternating vowel must be deleted, so that this vowel surfaces as simple [u]. This rule will be discussed in 3.2.2.4. The second member of an alternating vowel/diphthong always surfaces as [e], as shown in (3.52). If we assume that [+high] is the lexically marked feature specification in Spanish, then the redundancy rules of the language will be as given in (3.43), and will provide all the surface specifications for [e]. The redundancy rules will apply late in the derivation to fill in the feature values of the second member of a stressed alternating vowel/diphthong.

The alternating vowel/diphthongs examined in this section then provide two sources of evidence that [+high] must be a lexically marked feature value in Spanish, and that consequently the context-free featural parameter for [high] must be reset to the marked option in this language. Given that only one feature value is specified underlyingly in the theory of RU, the rule of High-Glide Formation, which adds [+high] to the initial member of an alternating
vowel/diphthong, demonstrates that [+high] must be the lexically marked value of Spanish. In addition, if a totally unspecified vowel in Spanish surfaces with the surface specifications for [e], then again this demonstrates that the redundant specifications must be as shown in (3.43), and consequently that [+high] must be a lexical value in this language.

3.2.2.3 High/Mid Alternating Vowels

Many researchers, such as Malkiel (1966), Harris (1969), Montgomery (1975) and Hooper (1976) note that there are several different types of 3rd conjugation class verbs. *Vivir*, shown in (3.63), is representative of the most standard type.

(3.63) "to live"  

<table>
<thead>
<tr>
<th>Infinitive</th>
<th>Past Participle</th>
<th>Gerund</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>vivIr</em></td>
<td><em>vivIdo</em></td>
<td><em>viviEndo</em></td>
</tr>
</tbody>
</table>

Present Indicative

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>vivO</em></td>
<td><em>vivImos</em></td>
<td></td>
</tr>
<tr>
<td><em>vivEs</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>vivE</em></td>
<td><em>vivEn</em></td>
<td></td>
</tr>
</tbody>
</table>

Imperfect

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>vivIa</em></td>
<td><em>vivIamos</em></td>
</tr>
<tr>
<td></td>
<td><em>vivIas</em></td>
<td></td>
</tr>
<tr>
<td><em>vivIa</em></td>
<td><em>vivIan</em></td>
<td></td>
</tr>
</tbody>
</table>

The root vowel in these forms never varies: it is always [i]. The theme vowel /i/ transparently surfaces in the infinitive, past participle, imperfect, and in the 1st person plural present indicative forms. I assume, following Harris (1969), that the theme vowel also surfaces in all other
indicative forms except the 1st person singular, and that it is subsequently lowered by rule. This rule of Final Vowel Lowering will be discussed in 3.2.2.4.

While the majority of 3rd conjugation verbs behave like *vivir* in (3.63), in a subclass of these verbs the root vowel surfaces as [+high] when stressed or followed by a diphthong, and as a mid vowel when unstressed. Some examples of this type of verb are given in (3.64).

(3.64) Alternating High/Mid 3rd Conjugation Verbs

| "to conceive" | Infinitive       | conc[e]bIr |
|               | Past Participle | conc[e]bIdo |
|               | Gerund          | conc[i]biEndo |

<table>
<thead>
<tr>
<th>Present Indicative</th>
<th>Imperfect</th>
</tr>
</thead>
<tbody>
<tr>
<td>conc[I]bo</td>
<td>conc[e]bImos conc[e]bIa conc[e]bIamos</td>
</tr>
<tr>
<td>conc[I]bes</td>
<td>conc[e]bias</td>
</tr>
<tr>
<td>conc[I]be</td>
<td>conc[I]ben conc[e]bIa conc[e]bIan</td>
</tr>
</tbody>
</table>

Examples of other verbs in this subclass:

- servir "to serve"
- preferir "to prefer"
- repetir "to ask"
- elegir "to elect"
- pedir "to ask"

The root vowel surfaces as [e] if the following vowel is simple [i] (as opposed to a diphthong containing [i]) and surfaces as [i] everywhere else. In the majority of cases a
root vowel surfacing as [i] is stressed; however, forms such as conciblendo demonstrate that the realization of a root vowel as [i] and stress are not always coextensive.

We can use the rule of Vowel Delinking in (3.50) to help explain these high/mid vocalic alternations. We know that the theme vowel in 3rd conjugation verbs is /i/, and also that the root vowel only surfaces as [i] if the theme vowel does not surface. As stated in (3.50) Vowel Delinking delinks the skeletal slot from a unstressed nucleus, leaving everything below the nucleus floating. If we assume that the 3rd conjugation theme vowel is underlingly specified simply as [+high], then a [+high] feature will be available to relink to a root vowel. Given the feature specifications in (3.44), if the root vowel in these forms is underlingly /e/ it will have no underlingly feature specifications and will be available for the floating [+high] to link to. This high/mid alternation will then take place only in a context where a 3rd conjugation theme vowel is delinked, and then is able to reassociate to a root vowel unspecified for the feature [high].

Assuming that /i/ is specified as [+high] and /e/ is underlingly unspecified, the representation of the 1st person present indicative concibo from the alternating high/mid class will be as shown in (3.65).
(3.65)

Underlying 

\[
\begin{array}{cccccc}
N & N & N & N & N \\
| & | & | & | \\
\times & \times & \times & \times & \times \\
| & | & | & | \\
[+bk] & | & [+bk] \\
[+hi] \\
[ k o n [ s V b ] i ] o \\
\end{array}
\]

\[\text{/conceb+i+o/}\]

prefix root theme 1st pers.
vowel sg. ind.

Vowel Delinking 

\[
\begin{array}{cccccc}
N & N & N & N & N \\
| & | & | & | \\
\times & \times & \times & \times & \times \\
| & | & | & | \\
[+bk] & | & [+bk] \\
[+hi] \\
[ k o n [ s V b ] i ] o \\
\end{array}
\]

The stress rules will apply to this form to stress the root vowel, since the final vowel is extrametrical and a left-headed foot will be erected over the final two visible syllables. The theme vowel then meets the structural
description of Vowel Delinking in (3.50), and will be
delinked, leaving a skeletal slot and the feature [+high]
floating. The root vowel in ceb is totally unspecified, and
the floating [+high] specification that is left after Vowel
Delinking can reassociate to the root vowel.

Reassociation is performed by the Association
Conventions given in (2.6), and will associate the floating
feature to a skeletal slot dominated by N. As discussed in
2.1.2.1, the unmarked direction of association is assumed to
be left-to-right, predicting that in (3.65) the prefixal
vowel should surface as [u]. Since this is clearly not the
correct output, we must ask why [+high] reassociates to the
root vowel rather than to the prefixal vowel?

One possible solution to this problem is that in Spanish,
as in Polish (Czaykowska-Higgins 1988, Szpyra 1989) or
Indonesian (Cohn 1989), prefixes behave as distinct
phonological words, and are never affected by within-word
processes. In this view the prefix con will not be a part of
the representation of the root ceb plus its suffixes, and
consequently the vowel of the prefix will never be a possible
landing site for the floating [+high] feature²⁴.

A second explanation for the fact that floating [+high]
does not reassociate to the prefixal vowel is that the
Association Conventions are restricted to the cyclic domain,
and prefixes are added at a post-cyclic level. This
particular restriction on the application of the Association
Conventions is discussed again in 3.2.2.4 in conjunction with
the rule of Final Vowel Lowering. Halle, Harris and Vergnaud (1991) assume that Spanish prefixes are post-cyclic affixes, although their theoretical orientation is not that of Lexical Phonology. I will not attempt to choose between these two possible explanations for why Spanish prefixes do not provide a landing site for a floating [+high] feature, but simply assume that the prefix (for some reason) is not visible at the time that the reassociation of [+high] takes place.

The operation of the Association of [+high] to the form in (3.64) is shown in (3.65).

(3.65)
Association of [+high]

```
  s
  |
N   N
  |
xxx x
  |
  [+bk]
  [+hi]
  [ s i b o ]
```
We have discussed the consequences of a [+high] theme vowel deleting after a [+high] root vowel (vivo) and after a vowel unspecified for height (concibo). The data in (3.45) show that 3rd conjugation verbs can also have root vowels that are [+low]. A form such as parto, however, demonstrates that the deletion of the [+high] theme vowel has no effect on a [+low] vowel. I assume that the [+low] specification of the root vowel precludes the reassociation of [+high], because redundancy rule 5 in (3.43) prohibits Association of [+high] from applying to a low vowel$^{25}$.

This analysis predicts that root vowels of verbs in the alternating high/mid class will only surface as [+high] if the theme vowel is deleted. The data in (3.64) demonstrate that a root vowel can also surface as [i] when the tense/aspect marker begins with a falling diphthong, suggesting that Vowel Deletion also occurs in this case. The
derivation of the form concibiendo is given in (3.67) (again assuming that the prefix is not a relevant part of the representation).

(3.67)  

<table>
<thead>
<tr>
<th>root</th>
<th>theme</th>
<th>Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>participle</td>
<td></td>
</tr>
</tbody>
</table>

Morphology:

s  b  i  i  e  n  d  o

\[ xxx + x + xxxxx \]

| | | [+bk] [+hi] [+hi] |

Syllabification & Stress rules:

s

N"  N"  N"  N"

| | | | |

N'  | N  |

| | | |

N  N  N  N  N

| | | | |

s  i  b  i  i  n  d  o

\[ xxxxxxxx \]

| | | [+bk] |

| | [+hi] [+hi] |
This form is composed of a prefix, root, theme vowel (/i/) and the present participle marker. When the stress rules apply the final vowel will be marked as extrametrical, and an accent will be added to the last visible vowel, which in this case will be the underlying diphthong of the present participle. This vowel will carry the primary word stress. The theme vowel is not stressed, and will therefore meet the structural description of Vowel Delinking, after which the delinked [+high] value of the theme vowel can reassociate to the totally unspecified root vowel. The surface specifications of the diphthong will be provided by High-Glide Formation in (3.61) and the redundancy rules of the language.

The final forms that are left to be accounted for are those with three root vowel alternants, shown in (3.53). The
derivations of mentir, mintiendo and miento are compared in (3.68) (for brevity I omit syllabification information, but nuclear slots are underlined).

(3.68) m nt + i + r m nt + i + i ndo m nt + i + o

xxx x x xxx xxx x xxx x

| | |

[+hi] [+hi][+hi] [+hi] [+bk]

Stress

rules m nt + i + r m nt + i + i ndo m nt + i + o

xxx x x xxx xxx x xxx x

| | |

[+hi] [+hi][+hi] [+hi] [+bk]

Vowel

Delinking n/a m n t i n d o m n t o

x x x x x x x x x

| |

[+hi][+hi] [+hi] [+bk]

Association n/a m n t i n d o m n t o of [+high]

x x x x x x x x x x x x

| | |

[+hi] [+hi] [+hi] [+bk]
In the infinitive *mentir* stress will be assigned to the final syllable (because there is no final vowel to be extrametrical) and Vowel Delinking is not applicable (because the infinitive marker *-r* is a consonant and therefore it does not fit the structural description of the rule). The rule of Unstressed N Reduction, which will be discussed in 3.2.2.4, will delink the second skeletal slot of the unstressed root diphthong to give the surface form *mentir*.

In the present indicative *miento* stress will be assigned to the root vowel (the number/person marker is both extrametrical and exceptional to (3.42b)) and Vowel Delinking will apply to delete the theme vowel before the vowel-initial indicative ending. It is difficult to determine whether the [+high] specification of the deleted theme vowel reassociates to the initial portion of the root-internal diphthong or not, because by High-Glide Formation the diphthong would also surface with a high glide.

The present participle *mintiendo*, however, demonstrates that [+high] does reassociate even to a diphthongal root vowel. If the initial half of the root diphthong in *ment/mient/mint* were specified as [+high], then we would expect that when the root vowel is unstressed it would surface as [*i*]. This is not the case, however, as shown by the infinitival form *mentir*. It must then be the [+high] specification of the deleted theme vowel that provides the root vowel specification in *mintiendo*. I assume the floating
[+high] associates to the first member of the root-internal diphthong, since this vowel is dominated by a branching N, and the sonority of the complex N would be violated if [+high] were to be added to the second member. Given that the second member of the root-internal diphthong is not specified for the feature [high], there will be no crossing of association lines if the floating feature docks onto the first member.

Again these high/mid alternations provide evidence that in Spanish [+high] is a lexically marked value, and that the feature specifications of the Spanish vowels are as given in (3.44). If [-high] were the lexically specified value of the feature [high], there would be no explanation for the fact that we find these alternating high/mid vowels only in a subclass of 3rd conjugation verbs, and that the root vowels in these forms surface as [+high] just in the case that the theme vowel has been delinked.

3.2.2.4 Peripheral Rules

Two additional rules are required to account for the verbal alternations that have been discussed in 3.2.2.2 and 3.2.2.3.

In order to produce the correct surface vowels when an underlying diphthong is unstressed, we must assume a rule of Unstressed Vowel Deletion. This rule accounts for the realization of the root vowels as monophthongs in jugamos in (3.60) and mintiendo in (3.68).
I assume the Branching Condition from Harris (1983: 111) triggers the deletion of the second skeletal slot of the unstressed diphthong in these forms. This condition is a restatement of Hayes' condition on the branching of recessive nodes given in (2.13c).

(3.69) Branching Condition

Foot-nodes labelled w(ek) cannot branch.

This constraint, which I assume is part of UG, will force the delinking of one skeletal slot from a branching N if the N is in an unstressed syllable. The deletion rule is given in (3.70).

(3.70) Unstressed N Reduction

Delink: skeletal slot

Target Condition: head of a branching unstressed N

Domain: postcyclic

Unstressed N Reduction will delink the second skeletal slot in the underlying vowel/diphthong in the root portion of jugamos, since it does not receive stress. (3.70) will apply after the stress rules have taken place because of its target condition.

In order to account for the fact that all word-final unstressed vowels in Spanish are non-high, we must posit a rule of Final Vowel Lowering. The data in (3.46) and (3.53) demonstrate that such a process is pervasive within the verbal paradigms of the language, and Harris (1969)
demonstrates that this process in fact operates across all lexical classes. Given the representation of Spanish vowels in (3.44), Final Vowel Lowering can be stated as in (3.71).

(3.71) **Final Vowel Lowering**

Delink: [+high]  

Target Condition: from a vowel in an unstressed final open syllable  

Domain: postcyclic

This rule will delete the [+high] specification from a vowel that is in unstressed word-final position. Since this is a rule that applies only to words and must follow stress assignment, I assume that it is postcyclic.

There is no evidence that the [+high] feature which is delinked by (3.71) can ever reassociate. If we assume that the Association Conventions which link a floating [+high] feature do not operate post-cyclically, then we can explain why reassociation cannot occur after delinking by (3.71). Pulleyblank (1985) argues that in Tiv the Association Conventions must be cyclic, although he does not rule out the possibility that they also apply post-lexically. Since rules may be restricted to apply in only a single component of the phonology (see 2.1.1.1) I assume that the same restrictions can hold of the Association Conventions.

In Spanish, if the conventions which apply to link a floating [+high] autosegment are cyclic and operate only in
the lexical component then they will then apply to reassociate a [+high] autosegment created by Vowel Delinking (a cyclic rule), but will not apply to reassociate a [+high] autosegment created by (3.71). This particular restriction on the Association Conventions can also account for the fact that [+high] never links to a prefixal vowel, as discussed in 3.2.2.3.

Final Vowel Lowering in (3.71) accounts for the height of the final vowel (which is underlyingly the theme vowel /i/) in 3rd conjugation present indicative forms such as vive and viven, shown in (3.46). This rule provides one more piece of evidence that [+high] must be a lexically marked feature value in Spanish, and therefore that the context-free featural parameter for [high] has been reset in this language28.

3.2.3 Parametric CU Analyses of Spanish Vocalic Alternations

The components of a parametric theory of CU are outlined in 2.5.2, and summarized earlier in this chapter in 3.1.3. The contrastive specifications of the vowels of Spanish are given in (3.72).

(3.72) CU Spanish Vowel System

\[
\begin{array}{cccc}
\text{i} & \text{e} & \text{a} & \text{o} & \text{u} \\
\text{high} & + & - & - & + \\
\text{low} & & + & - \\
\text{back} & - & - & + & + \\
\end{array}
\]

In this symmetrical 5 vowel system /i/ and /u/ contrast with
/e/ and /o/ with regard to the feature [high], so each of these vowels is specified for a value of [high]. /a/ and /o/ contrast with regard to the feature [low], so /a/ is marked [+low] and /o/ [-low]. /u/ and /o/ contrast with /i/ and /e/ in backness, so each is specified for a value of the feature [back]. Since [back] is a marked feature value, [round] becomes totally redundant.

The system in (3.72) is identical to the Ainu system given in (2.47), since both languages have the same inventories. Full specification of this system is achieved by the set of universal R-rules, given earlier in (3.24), repeated as (3.73).

(3.73) Universal R-rules:

1. [+low] --> [-high]
2. [+low] --> [+back]
3. [+low] --> [-round]
4. [+back] --> [+round]
   [-low]
5. [-back] --> [-round]
   [-low]
6. [+high] --> [-low]
7. [-high] --> [-low]
   [-back]

Unlike Hungarian, there are no language-particular R-rules required in this language to achieve total specification of the system in (3.72). Because the system in (3.72) is the
system predicted by UG, and because all the universal R-rules hold absolutely in Spanish, none of the R-rule parameters in (3.73) require resetting.

In the following sections I will demonstrate how the high/mid and vowel/diphthong alternations of Spanish can be captured in the theory of CU.

3.2.3.1 High/Mid Vowel Alternations

In the analysis of the high/mid alternations given in (3.64) I again assume, following Harris (1969), that all verb paradigms include a root, a theme vowel, and a tense/aspect marker. As in the RU analysis a rule of Vowel Delinking is essential in order to explain these alternations:

(3.74) Vowel Delinking

Delink: skeletal slot

Target Condition: the leftmost unstressed N of two adjacent N's

Domain: lexical (cyclic)

(3.74) will delete a theme vowel if it is unstressed, and is immediately adjacent to a following vowel-initial suffix. This rule will account for the lack of a surface theme vowel in forms such as amo, temo and vivo.

In the RU analysis it is assumed that if the theme vowel that is delinked is /i/, its [+high] feature would reassociate to a totally unspecified root vowel in a form such as concibo, and that reassociation would be achieved by
the universal Association Conventions. In CU, however, both high and mid vowels are specified for height, so the reassociation mechanism that we use must be feature-changing. I therefore assume that linking cannot be performed by the Universal Association Conventions, but rather must be performed by a rule such as (3.75).

(3.75) Reassociation of [+high]

Insert: association line from [+high]

Target Condition: an N-dominated skeletal marked as [-high]

Domain: lexical (cyclic)

Feature-changing

(3.75) is a cyclic lexical rule that will add an association line between a floating [+high] feature and a segment specified as [-high]. Reassociation will only occur if the root vowel is /e/ or /o/ (and not /a/), since these are the only vowels in (3.72) specified as [-high].

If we also assume, as was discussed in 3.2.2.3, that prefixes in Spanish either form separate phonological words from the root and its suffixes, or are added to roots at a post-cyclic level, then we can explain why floating [+high] always associates to the root vowel and not to the prefixal vowel in the forms such as concibo.

If the morpheme following the theme vowel is not vowel-initial, Vowel Delinking will not apply, and the root vowel will surface as a [-high] vowel. Derivations of pedIr (see
(3.45)) and **concibiendo** (before the addition of the prefix) are compared in (3.76).

(3.76)

<table>
<thead>
<tr>
<th>root</th>
<th>theme inf.</th>
<th>root</th>
<th>theme</th>
<th>present</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>V</td>
<td>V</td>
<td>participle</td>
<td></td>
</tr>
</tbody>
</table>

Morphology:

- **pedir**: +i +r
- **sebio**: +i +i endo

Stress rules,

<table>
<thead>
<tr>
<th>Stress rules,</th>
<th>s</th>
<th>s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vowel</td>
<td>/ \</td>
<td></td>
</tr>
<tr>
<td>Delinking</td>
<td>pedir</td>
<td>sibiendo</td>
</tr>
<tr>
<td>and</td>
<td>xxxxx</td>
<td>xxx x x x x</td>
</tr>
<tr>
<td>Reassociation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of [+high]</td>
<td>[-hi][+hi]</td>
<td>[+hi][-hi][+hi][-hi]</td>
</tr>
<tr>
<td></td>
<td>[-bk][-bk]</td>
<td>[-bk][-bk][-bk][-bk]</td>
</tr>
</tbody>
</table>

I assume again that the present participle is diphthong-initial. Vowel Delinking applies in **concibiendo**, because the theme vowel is not stressed and the present participle is vowel-initial. The skeletal slot of the theme vowel will be delinked, and the features [+high] and [-back] will remain floating. Vowel Delinking is inapplicable in **pedir**, since the theme vowel receives primary stress. Reassociation of
[+high] can apply in concibiendo to reassociate the floating [+high] feature to the root vowel, delinking the underlying [-high] specification of that vowel. Neither this feature nor the [-back] feature from the delinked theme vowel ever reassociates, and consequently neither one is phonetically realized.

3.2.3.2 Vowel/Diphthong Alternations

In the CU account of Diphthongization I again follow Harris' (1985) analysis in principle. In stems where the vowel alternates between a simple vowel and a diphthong the vowel will underlyingly be represented as a diphthong, the second member of which is associated with the features [-high] and [-back] (the specifications for /e/ in (3.72)), and the first member represented as /i/, /u/, /o/ or /e/²⁹.

The algorithm for N-Placement, given in (3.56), will specify that any [-cons] segment will project N. In the theory of CU, however, vowels, which contrast with consonants, will be underlyingly specified as [-cons]. The Complex-N parameter will be reset to ON, and Complex N Formation will be stated as in (3.57). The sonority scale for Spanish vowels is given in (3.77), and again vowels will be matched to positions in this hierarchy to determine if a complex N is possible.

(3.77) Spanish Sonority Scale - Vowels

1. [-cons], [+high]
2. [-cons], [-high]
3. [-cons], [+low]
As in the RU analysis, features or feature values not mentioned in the scale are irrelevant and can be ignored for matching purposes. Given the contrastive specification of vowels in (3.72) /a/ will be more sonorous than all the other vowels, while /e/ and /o/ will be more sonorous than /i/ and /u/.

I assume again that the stress rules of Spanish are as given in (3.42). If stress is assigned to a diphthong, High-Glide Formation will add the feature [+high] to the non-head member. High-Glide Formation applies vacuously if /i/ or /u/ is the initial member of the diphthong, but applies in a feature-changing fashion if the initial member is /o/ or /e/.

(3.78) High-Glide Formation

Insert [+high]

Target: non-head member of a branching stressed N

May be feature-changing

Domain: postcyclic

(3.78) applies only after syllabification and stress assignment have taken place, since the target must be part of a branching rhyme. Since I follow Halle, Harris and Vergnaud (1991) in assuming that stress in Spanish is both cyclic and postcyclic, High-Glide Formation will also be postcyclic.

The operation of Complex N Formation and High-glide Formation in niEga and jugAmos from (3.52) is given in (3.79).
(3.79)

<table>
<thead>
<tr>
<th>root</th>
<th>theme 3rd pers.</th>
<th>root</th>
<th>theme 1st pers.</th>
</tr>
</thead>
<tbody>
<tr>
<td>V sg. n</td>
<td>V plural</td>
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**Morphology**

<table>
<thead>
<tr>
<th>neega</th>
<th>juega</th>
<th>mos</th>
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</thead>
<tbody>
<tr>
<td>x x x x + x + φ</td>
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</tr>
</tbody>
</table>

\[ \text{\[-hi\]} \quad \text{\[+hi\][-hi]} \quad \text{\[-hi\]} \]
\[ \text{\ [+lo]} \quad \text{\ [+lo]} \quad \text{\ [-lo]} \]
\[ \text{\ [-bk]} \quad \text{\ [+bk][-bk]} \quad \text{\ [+bk]} \]

**Syllabification**

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<table>
<thead>
<tr>
<th>neega</th>
<th>juega</th>
<th>mos</th>
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<table>
<thead>
<tr>
<th>[-hi]</th>
<th>[+hi][-hi]</th>
<th>[-hi]</th>
</tr>
</thead>
<tbody>
<tr>
<td>\ [+lo]</td>
<td>\ [+lo]</td>
<td>\ [-lo]</td>
</tr>
<tr>
<td>\ [-bk]</td>
<td>\ [+bk][-bk]</td>
<td>\ [+bk]</td>
</tr>
</tbody>
</table>
Both forms have underlying diphthongs root-internally. Stress is assigned to the penultimate syllable in each form, since each contains a number/person marker which is an exception to (3.42b). High-Glide Formation will provide the [+high] specification of the glide in niega (I assume that when the geminate is split up both components are specified as [-back]).

A rule of Unstressed Vowel Deletion will be required to delete the second member of an unstressed diphthong, in order to achieve the surface specification for jugamos in (3.78). Since this rule is somewhat peripheral to the analyses at
hand, it will be discussed later in 3.2.3.3.

We might expect that High-Glide Formation would be blocked from applying to the diphthong in niega because of geminate blockage or inalterability (Hayes 1986, Schein and Steriade 1986). In Spanish, however, long vowels are not permitted and the root vowel in niega will be ruled out unless some operation applies to change it to a diphthong. I therefore assume that High-Glide Formation acts as a repair strategy for representations in which a single set of vowel features are associated to two skeletal slots. The R-rules will provide the redundant surface specifications of these forms.

In the class of 3rd conjugation verbs exemplified by mentir in (3.53), Vowel Delinking and High-Glide Formation will interact, both in the root, and in certain of the tense/aspect markers. The derivations of miEnto and mintsEnto are compared in (3.80).
(3.80)

**Morphology**

\[
\text{meent } + i + o \quad \text{meent } + i + \text{endo}
\]

\[
x \ x \ x \ x \ x \quad x \ x \ x \ x \quad x \ x \ x \ x \ x
\]

\[
\text{stress rules}
\]

\[
N \quad N
\]

\[
\text{meent } + i + o \quad \text{meent } + i + \text{endo}
\]

\[
x \ x \ x \ x \ x \quad x \ x \ x \ x \quad x \ x \ x \ x \ x \ x \ x \ x
\]

\[
\text{vowel delinking}
\]

**Delinking**

\[
\text{meento} \quad \text{meenti} \quad \text{endo}
\]

\[
x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x
\]

\[
\text{stress rules}
\]

\[
N \quad N
\]

\[
\text{meent } + i + o \quad \text{meent } + i + \text{endo}
\]

\[
x \ x \ x \ x \ x \quad x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x
\]
Reassociation of [+high]

m i e n t o m i e n t i e n d o

x x x x x x x x x x x x x

I I I I I I I I I I I I I I I

[+hi][-hi]   [+hi][-hi]   [-hi][-hi]   I

[-bk][-bk][-bk][+bk] [-bk][-bk][-bk][-bk][-bk] [+bk]

Each form is made up of a root, a theme vowel, and a final suffix. In /meent+i+o/ stress is assigned to the root vowel and to the underlying diphthong in the present participle. Vowel Delinking can then operate in both forms to delink the theme vowel, leaving the [+high] and [-back] features floating. The [+high] feature will reassociate to the root vowels, delinking its underlying [-high] specification. The [-back] specification will never reassociate, and so will not surface phonetically.

When [+high] reassociates to the root vowels in (3.80), it is relinked to a long vowel. I assume that as in the case of relinking to a short vowel (see (3.76)), the underlying [-high] specification of the root vowel is delinked to become a floating feature. What is different about the short and long vowel cases is that the delinked [-high] specification never reassociates in the short vowel cases (since there is no possible target that is not specified for [high]), while in the case of a long vowel root the floating [-high] can reassociate to second element in the surface diphthong.

Since surface long vowels are not permitted in Spanish, Vowel Delinking and the eventual reassociation of the
floating [+high] serve to repair a prohibited segment type. The diphthong is formed by splitting the long vowel in two, and given the restrictions on complex nuclei in (3.57), the [+high] specification (coming originally from the theme vowel) will become part of the first member of the diphthong, and the floating [-high] specification (coming originally from the long root vowel) will be linked to the second member of the diphthong. We can further assume that both members of the diphthong can either share the [-back] underlying specification, or that that [-back] will become a part of both halves of the diphthong.

There is no crossing of association lines involved in the creation of the root diphthongs in (3.80) since the underlying long root vowels are initially linked to only a single [-high] specification.

3.2.3.3 Peripheral Rules

If stress is not assigned to an alternating vowel/diphthong a rule of Unstressed N Reduction will apply to remove one skeletal slot from the diphthong. A form such as jugAmos from (3.59) shows that the monophthong will retain the features of the initial member of the diphthong, so we can specify that Unstressed N Reduction must delete the second member, or the head.
(3.81) **Unstressed N Reduction**

Delink: \( x \)

\[
\begin{array}{c}
[-\text{high}] \\
[-\text{back}]
\end{array}
\]

Target Condition: head of a branching unstressed N  
Domain: postcyclic

Unstressed N Reduction can only apply after both syllabification and stress assignment have taken place, since the target is specified as the head of a branching unstressed nucleus. This rule can again be thought of as a direct consequence of the Branching Condition in (3.69).

The second rule that will be required to achieve the surface specifications of 3rd conjugation verbs is a rule of Final Vowel Lowering. This is given in (3.82).

(3.82) **Final Vowel Lowering**

Insert: \([-\text{high}]\)

Target Condition: a vowel in a final unstressed open syllable

Domain: postcyclic

May be feature-changing

(3.82) will insert the feature value \([-\text{high}]\) onto an unstressed final vowel postcyclically. Final Vowel Lowering will apply to any unstressed final vowel, and if that vowel is underlyingly \([+\text{high}]\) it will apply in a feature-changing
fashion. If the vowel is a mid vowel, application of (3.82) will be vacuous, and if a low vowel, this rule will insert the value [-high] that would ordinarily be inserted redundantly by R-rule 1 in (3.73). As in the RU analysis, we must assume that the Association Conventions, which could relink a [+high] feature value delinked through the operation of (3.82), are restricted to the cyclic lexical domain.

When a 2nd conjugation theme vowel deletes, the features [-high] and [-back] will be left floating, given the specification of /e/ in (3.72). If we again assume that the feature [back] cannot reassociate, only [-high] will be left, and this feature value cannot change the height of either a mid or low vowel. In the case of a 1st conjugation theme vowel deletion, the feature [+low] will be left floating, and as in the RU analysis, some stipulation will be required to explain why this feature value cannot associate to the root vowel.

3.2.4 Summary and Comparisons

Following the RU analyses of vocalic alternations presented in 3.2.2 the language-specific aspects of the grammar of Spanish are as given in (3.82) (I do not include rules of stress assignment):
(3.83) Language-specific aspects of an RU grammar of Spanish

Marked parameter setting:

Context-free: [ ] --> [-high]

Complex N - ON

Phonological rules:

Unstressed N Reduction
Vowel Delinking
High-Glide Formation
Final Vowel Lowering

Complex N Formation

There is only one featural parameter that requires resetting in Spanish, and this is the context-free rule for the feature [high]. Spanish also requires the resetting of the parameter that controls the formation of complex nuclei. With this parameter set to ON, the language will allow two different vowels to fall under a single branching nucleus.

There is also evidence that 4 phonological rules have an effect on the vowels of Spanish. Unstressed N Reduction, Vowel Delinking and Final Vowel Lowering are delinking rules, while High-Glide Formation is an insertion rule. High-Glide Formation and Final Vowel Lowering both manipulate the feature value [+high]. Spanish also requires the language-
specific Complex N Formation statement given in (3.57) to show that complex nuclei can only be derived in certain configurations.

Prominence relations play a very important role in the phonology of Spanish. High-Glide Formation applies only to a stressed target vowel. Unstressed N Reduction, Final Vowel Lowering and Vowel Delinking all apply to a target vowel that is unstressed.

The only cyclic lexical rule of Spanish that arises from this analysis is Vowel Delinking. The other rules — Unstressed N Reduction, High-Glide Formation, and Final Vowel Lowering — apply in the postcyclic lexical component. This gives the following picture of the phonology of Spanish:

(3.84) RU Phonology of Spanish

<table>
<thead>
<tr>
<th>Rule</th>
<th>Cyclic</th>
<th>Lexicon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vowel Delinking</td>
<td></td>
<td>Cyclic</td>
</tr>
<tr>
<td>Unstressed Vowel Reduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-Glide Formation</td>
<td></td>
<td>Postcyclic</td>
</tr>
<tr>
<td>Final Vowel Lowering</td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rule</th>
<th>Postcyclic</th>
<th>Postlexicon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redundancy rules</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Unlike Hungarian, Spanish does not require that redundancy rules be ordered among the phonological rules. None of the phonological rules given in (3.83) and (3.84) make reference to redundant feature values, so the RROC will not be invoked, and redundancy rules will apply in a block late in the
derivation (the only exception is the context-free rule [ ] --＞ [-cons], which is ordered prior to syllabification processes).

The CU analyses of Spanish presented in 3.2.3 predict that the following language-specific information will be part of the grammar of Spanish:

(3.85) Language-specific aspects of a CU grammar of Spanish

No marked featural parameter settings

Marked syllabification mechanism:

Complex N - ON

Phonological rules:

Unstressed N Reduction
Vowel Delinking
High-Glide Formation
Final Vowel Lowering
Reassociation of [+high]
Complex N Formation

Each of the phonological rules shown here represents a marked parameter setting. The CU analysis requires an extra rule that is not required in the RU analysis -- Reassociation of [+high]. This rule must be stated as a language-particular aspect of the grammar, because it is feature-changing, and therefore its effects cannot be attributed to the universal Association Conventions. This analysis, like the RU one, assumes that Spanish also requires the language-specific statement of Complex N Formation given in (3.57) to indicate
where complex nuclei may be formed.

In this analysis, as in the RU analysis, stress plays an important role. Vowel Delinking, Unstressed N Reduction, Final Vowel Lowering and High-Glide Formation are each sensitive to rule-assigned stress.

The only cyclic lexical phonological rules in this analysis are Vowel Delinking and Reassociation of [+high]. Unstressed Vowel Deletion, High-Glide Formation and Final Vowel Lowering are all postcyclic rules. This suggests that the phonology of Spanish is organized in the following manner:

(3.86) CU Phonology of Spanish

\[
\begin{align*}
\text{Vowel Delinking} & \quad \text{LEXICON} \\
\text{Reassociation of [+hi]} & \quad \text{LEXICON} \\
\text{Unstressed Vowel Reduction} & \quad \text{Postcyclic} \\
\text{High-Glide Formation} & \quad \text{Postcyclic} \\
\text{Final Vowel Lowering} & \quad \text{Postcyclic} \\
\text{Redundancy rules} & \quad \text{POSTLEXICON}
\end{align*}
\]

Comparing the RU and CU analyses of the Spanish alternations presented here, we find that the RU analysis predicts that one featural parameter requires resetting to the marked option while the CU analysis predicts no such resetting. Looking at the rule parameters, however, we find that the CU analysis requires one extra rule -- Reassociation
of [+high] -- which is not required in the RU account. This is because this reassociation is performed in the RU analysis by the universal Association Conventions, since this operation is not feature-changing.

Several aspects of the CU account appear to make it more stipulative and less explanatory than the RU one. First, the rule of Reassociation of [+high] must specify both that it is feature-changing and that the rule only target vowels that are [-high]. While this captures the facts, it can only do so by singling out one specific type of vowel and deleting pre-existing feature values. In the RU account of the same phenomenon, reassociation to a mid root vowel need not be stipulated, but rather occurs only if an adjacent root vowel is unspecified for the feature [high]. The explanation for why reassociation occurs in just this environment is achieved both by the radically underspecified feature specifications assumed for Spanish, and in the assumptions regarding how rules operate in this theory.

A second stipulative aspect of the CU account exists in the fact that a 3rd conjugation theme vowel, specified underlyingly as [-high] and [-back], is delinked by Vowel Delinking, but only the [-high] feature reassociates to a preceding root vowel. This analysis provides no explanation for why [-back] is left unassociated. In the RU account the 3rd conjugation vowel is specified only as [+high], so only this one feature value is available for reassociation.
Notes to Chapter 3

1 Hayes (1986) shows that this can be derived from the OCP (see (2.8)).

2 In both the RU and CU analyses of Hungarian I treat /ɛ/ as a [+low] vowel. The possible features that distinguish /e/ from /ɛ/ are [low] and [ATR], and I have chosen [low], as is done in most current analyses of the Hungarian facts.

3 Ringen (1978) says there are approximately 50 roots in this exceptional class. Vago (1980) lists 52 roots of this type.

4 I am indebted to my informant, Katalin Hegedűs, for her assistance with the data. She is a native speaker of the standard Budapest dialect.

5 The loanword facts are complex. They have been discussed in many places, including Kontra and Ringen (1986), Steriade (1987), Ringen (1988) and Jensen and Stong-Jensen (1989).

6 An alternative conception of what could happen when context-sensitive parameters are reset to the marked option is also presented in 2.5.1.1, although it is discarded as being inconsistent with the way phonological rules are assumed to operate in the theory of Radical Underspecification.

7 Since BH is a rule which applies only to vowels it must be considered a maximal rule in the sense described in 2.2.1.2. Archangeli and Pulleyblank (1987) discuss cases where transparency effects within harmony systems can be accounted for by assuming that a rule applies in a minimal fashion, i.e. it scans for adjacent targets at the level of the node or feature which contains the spreading feature or node. For example, the transparency of Khalka Mongolian /i/ in both Back and Round Harmony processes of this language is accounted for by assuming that /i/ is a totally unspecified segment in Khalka, and therefore has no structure on the (Secondary Place) tier which is scanned in the operation of these rules.

It is impossible to account for the transparency effects of /i/ and /e/ in the Back Harmony system of Hungarian in the same fashion as in Khalka because there are two vowels which are both transparent. Two distinct vowels cannot both be totally unspecified, and in fact the arguments laid out in 3.1.2 regarding the feature specifications required in Hungarian suggest that /i/ must be specified for the Dorsal feature [+high] and both /i/ and /e/ must be specified for the Labial feature [-round].

8 In this and subsequent derivations I assume [ɛ] is underlingly /ɛ/ unless there is evidence to the contrary.
Kornai (1987) discusses several quaternary suffixes as well, which have the vowel alternants [a], [ɛ], [o] and [ö]. This type of suffix is beyond the scope of the analysis here.

Archangeli and Pulleyblank (1987) argue that blocking effects should follow from the fact that a rule is maximal. However, this does not work in Hungarian since both BH and RH are "maximal" rules (i.e. are rules which scan for targets at the highest level of structure providing access to the spreading feature) affecting only vowels, yet long vowels are possible targets of BH and not of RH.

MacWhinney (1974) says that the exact placement of the linking vowel "requires detailed research across various idiolects" (136). However, it appears that the linking vowel is used to break up consonant clusters which would fall in coda position, unless they are composed of a liquid, sibilant or apical nasal followed by another apical. Thus [ld] and [zd] are permitted in coda position, while [kr], [hr], [gk] [rk] etc. are not.

This is a phonological alternation between a long and short vowel that I do not discuss.

Steriade (1987) assumes that short and long /a/ are specified differently with regard to the feature [back]. This violates current views of how these two types of vowels are represented and it is problematic since it leads to many different feature specifications for short and long vowel pairs. For example /i/ will not have a contrastive specification for the feature [high], since it does not contrast in height with any other front unrounded vowels, yet /ɻ/[iː] will be marked as [+high], in contrast to /ɛ/[eː] which is [-high]. /ö/ will not be marked contrastively for the feature [round], yet /oː/[öː] will be [+round], in contrast with /ɛ/ which is [-round].

Steriade's analysis is very brief and lacks details, so much of the CU analysis proposed here is based on conjecture.

If one objects to the assumption that some segments are underspecified for [back] in the CU analysis then it would be possible to assume that underlingly all vowels are specified for the harmonic features and then before BH and RH operate some rule delinks all but the root-initial specifications. I have not used this particular analysis since the backness specifications for non-initial root vowels would have to be arbitrarily chosen, since on the surface all non-neutral vowels agree in backness with the initial vowel.

A second possibility is that these roots are accompanied by a floating [+back] autosegment, but given the fact that suffixal vowels must be assumed to be specified underlingly as [-back], we would then have to assume that the linking conventions operated in a feature-changing fashion.
Diphthongs can be made up of all possible combinations of two different vowels.

Rising diphthongs followed by a liquid, nasal, glide or s would involve ternary branching of the rhyme, which would be prohibited.

This is similar to the RU underspecification system proposed in Archangeli (1984) for Spanish, except that she uses the feature [round] rather than [back]. The default rules I use suggest that [round] is dependent upon [back] rather than vice versa.

Another possibility is that this '1st person singular' marker is in fact /o/ as it is in the present and that another rule of Vowel Delinking operates in this context.

I use [y] for the high front glide since orthographic j in Spanish is the voiceless fricative [x] (see MacPherson 1975).

Headship or headedness in phonology has been discussed as an issue in feature hierarchitecture in Shaw (1987).

I will show in 3.2.3.3 that in fact a process of Vowel Delinking also applies in these forms.

In attempting to test the validity of this particular analysis I performed an examination of all 1st, 2nd and 3rd conjugation verbs provided in the 1986 Webster's Third International Dictionary and Britannica World Language Dictionary. I found no examples of bisyllabic monomorphemic roots. All bisyllabic roots that were found contained one of the prefixes: a-, con-, des-, di-, in-, pre- or re-.

The 1st conjugation verbs forms shown in (3.45) suggest that when the 1st conjugation theme vowel is deleted, the feature [+low] does not have the same ability to reassociate to the root vowel as does the feature [+high]. This may be because of some specific restriction on these root vowels, or it may be because the feature [high] has some special status in Spanish. When a 2nd conjugation theme vowel deletes there will be no features to reassociate to the root vowel since /e/ is the totally unspecified vowel.

It is possible that the sonority scale in (3.58) also acts like a filter. Levin (1985: 78) assumes that sonority scales can be used as filtering devices.

The exceptions to this rule pointed out in Harris (1969: 68 footnote 6) are the clitics mi, tu, su and casi, some words of Greek origin such as enfasis and dosis, the Latin words espiritú, tribu and impetu, and affective words such as mami, papi and fuchi.
I have not accounted for the high theme vowel in past forms of 2nd conjugation verbs. Harris (1969) accounts for the height of this theme vowel by a Raising rule, which applies only in 2nd conjugation forms, and only in the past tense.

Exactly the same processes will be applicable to diphthongs which are phonetically realized as [ya] and [wa]. These diphthongs are not included in the analyses since they never alternate with simple vowels.
In their exploration of learnability theory, Wexler and Culicover (1983) state that an obvious extension of this area of research is to use a specific linguistic theory to account for real-time developmental data. Developing a theory of acquisition is a laborious undertaking: the intricacies of the developmental data must be worked out with regard to a particular linguistic theory and then viewed in light of the learnability constraints. There have been several attempts to develop acquisition theories in syntax, and several more recent attempts to develop theories of phonological acquisition.

Pinker (1984) is generally viewed as the first syntactic theory of acquisition. Pinker's theory is based on Lexical Functional Grammar (Bresnan 1978, 1982) and is constrained by both the learnability and continuity conditions, discussed in 2.4. One of the main focusses of Pinker's work is to show that semantic categories are the building blocks that children use to develop syntactic categories.

O'Grady (1987) performs a similar enterprise employing the Categorial Grammar framework (Ajdukiewicz 1935, Dowty, Wall and Peters 1982). The principles and categories O'Grady attributes to the child are general cognitive abilities, not principles of a specific linguistic faculty. O'Grady shows that grammatical categories can plausibly be constructed from
general cognitive principles such as adjacency and dependency. Davis (1987) uses the Government and Binding framework to examine parametric aspects of the acquisition of auxiliary systems. This study is similar to Pinker's in that it adopts the constraints of learnability theory, but Davis also assumes that an acquisition theory must adhere to Chomsky's requirement of epistemological priority (Chomsky 1981a). A theory which is epistemologically prior is one which is based on principles and concepts that will plausibly allow the child to map prelinguistic systems onto linguistic systems.

Perhaps the first attempt at combining phonological theory, learnability constraints and empirical data is Dresher and Kaye (1988), who develop a learning model for metrical theory, with a focus on the parameters that are involved in stress systems. This is a computational model, rather than a model of real-time acquisition, but nevertheless many of the issues surrounding human language acquisition are explored. Dresher and Kaye look at the nature of the Primary Linguistic Data (PLD), the types of learning procedures that can be attributed to learners and several other issues that relate specifically to parsing mechanisms.

There have been two recent examinations of the learnability of underspecification, although neither one attempts to account for real-time acquisition data. Calabrese (1988) proposes that UG provides the language learner with a set of phonological filters which are hierarchically ordered. Filters are similar to redundancy rules, in that they help determine the feature values that will be underlyingly
specified, although they are not actively able to fill in feature values. A marked segment will violate filters up to a certain point in the hierarchy, while a less marked segment will violate filters lower down the hierarchy, or will not violate filters at all. The filter hierarchy is used to account for some general findings regarding the markedness of phonological systems, acquisition order and language dissolution.

Ingram (1989b) attempts to integrate some general learnability questions into a theory of phonological acquisition, with particular emphasis on the theory of underspecification. The learnability of three possible types of underlying representations are examined: fully specified representations, radically underspecified representations and contrastively specified representations. Ingram's study uses mainly hypothetical data in charting the development of children's representations.

Acquisition theories such as these require three components: 1) a linguistic theory, 2) a set of learnability constraints, and 3) a set of assumptions about how acquisition proceeds in real-time. The first two components of a theory of acquisition based on a parametric theory of underspecification have been outlined in Chapter 2. There, the theories of Radical and Contrastive Underspecification as outlined in Archangeli and Pulleyblank (1986) and Steriade (1987) were discussed, and later reanalyzed as being representative of a principles and parameters model of phonology. In Chapter 3 the parametric theories of RU and CU
were used to develop analyses of the vocalic systems of Hungarian and Spanish.

In this chapter I will develop a set of assumptions regarding how real-time phonological development proceeds, given previous acquisition research and the parametric theories of underspecification outlined in Chapter 2. In 4.1 I will describe some of the general findings of phonological acquisition research over the last 20 years. In 4.2 I will outline the assumptions for early phonological acquisition that I believe follow from the research presented in 4.1. 4.3 will outline the specific predictions that the parametric theories of Radical and Contrastive Underspecification make for the acquisition of the vocalic systems of Hungarian and Spanish. In doing so I will attempt to show where the predictions of these two theories are similar, and where they differ.

4.1 Aspects of Phonological Development

4.1.1 Speech Perception

Infant speech perception research shows that from as early as three or four months of age children demonstrate categorical perception of sounds. Using different research techniques, such as the High Amplitude Sucking (HAS) technique or the Visually Reinforced Infant Speech Discrimination (VRISD) paradigm, it can be shown that infants can make judgments on whether sounds are the "same" or "different". The categorical aspect of perception refers to the fact that children's judgments are most robust when the acoustics of the
sound tested do not fall on or near a phoneme boundary. There is some argument in the literature over whether children require exposure to the input language before certain sounds are correctly perceived (see Eilers, Gavin and Oller 1982 vs. Jusczyk, Shea and Aslin 1984) but most researchers agree that by several months of age children can perceive a vast number of speech sounds, including many not present in their native language.

Recent work by Werker and Tees (1984) demonstrates that by approximately 10 months of age children begin to lose the ability to discriminate sounds not present in the language being acquired. Infants acquiring English who previously had been able to perceive distinctions between Hindi retroflex and alveolar stops were not able to perceive this difference when they reached 10 to 12 months of age. There are similar results involving differences in Voice Onset Time\(^2\) (Lisker & Abramson 1970, Singh and Black 1966), and certain places and manners of articulation (Goto 1971, MacKain, Best and Strange 1980, Werker and Tees 1984).

Even though perception research has shown that children have astounding perceptual ability at an early age, it generally does not address the issue of the child's ability to perceive linguistic stimuli, i.e. to classify the perceived sounds phonologically. It is not enough to be able to perceive the differences between two speech sounds; those sounds must be integrated into a phonological system based on how the sounds differ from each other. The one major study on this aspect of perception was performed by the Russian
linguist Shvachkin (1948/73). Shvachkin tested Russian children's abilities to perceive phonemic contrasts between approximately one and two years of age. He taught children nonsense words for objects, and then tested minimal contrasts between those words. It was found that during the period from one to two Russian children gradually acquire phonemic perception, passing through an orderly set of stages. Contrasts between vowels are perceived first. The first, most general consonantal contrasts are between the presence and absence of a consonant or between a sonorant and an obstruent. Later more specific contrasts include labials versus non-labials and voiced versus voiceless obstruents. By 2;0 children have acquired all the Russian contrasts in simple CVC or VC syllables.

Shvachkin's study has been replicated for English by Garnica (1973) and Edwards (1974) with similar findings, although it was found that the stages of perception were not as well-defined as Shvachkin found in Russian. Edwards found that the perception of a given sound generally precedes production of that same sound, and the orders of development in production and perception are roughly equivalent.

4.1.2 Speech Production
4.1.2.1 Stages of Phonological Development

In Ingram (1976, 1989a) early phonological acquisition is divided into four stages: 1) the prelinguistic period, 2) the acquisition of the first 50 words, 3) the phonology of single morphemes, and 4) later developments. The prelinguistic
period begins at birth and lasts until approximately 1;0. During this period children progress from cooing to canonical babbling (Oller 1974). Oller argues that many factors influence linguistic development in this period, including intentional linguistic exploration, maturation and the linguistic environment. Jakobson (1941/68) claims that there is an abrupt discontinuity between the babbling stage and later linguistic acquisition. He suggests that children use all the sounds of the languages of the world in their babbling repertoires and that many of these sounds are lost when the child begins to acquire "real" words. However, available studies of the babbling period demonstrate that there probably is no such discontinuity; that in fact the repertoire of sounds used during babbling is quite similar to the repertoire used in the first words (Lewis 1936, Irwin 1951).

The period during which the first 50 words are acquired lasts from about 1;0 to 1;6 and spans the time when children are producing mainly single word utterances. Vocabulary development during this period is relatively slow, and the child's words tend to be more idiosyncratic than during the later stages. During this period some children avoid producing adult targets containing particular sounds or classes of sounds (Schwartz and Leonard 1982). Beginning at about 1;6 most children demonstrate a rapid increase in their vocabularies and begin to combine words into utterances. After approximately 4;0 children may still have to acquire or perfect the more difficult sounds in the language and acquire morphophonemic variants.
Jakobson's universalist theory of phonological acquisition (Jakobson 1941/68) is probably the most widely known account of the early stages of phonological development. Jakobson examined diary studies of children from different linguistic backgrounds as well as phonological systems from many different languages. He proposed two stages of phonological development: an early stage during which all children produce approximately the same sounds, and a later stage where children of different linguistic communities have different phonological systems. Jakobson (1941/68: 50) says:

the child possesses in the beginning only those sounds which are common to all the languages of the world, while those phonemes which distinguish the mother tongue from the other languages of the world appear only later.

The early stage begins with the cessation of babbling and ends when the child has achieved the minimal consonantal and vocalic systems ([p,t,k] and [i,u,a]) and appears to roughly correspond to the period when the child acquires the first 50 words. During this period children's syllables are CV or reduplicated CVCV's. The first consonant is usually a forward articulated one and the first vowel a wide one such as [a]. The first consonantal opposition is between nasal and oral stops, followed by labials and dentals. Once contrasts develop in the child's vocalic system, the system develops into the triangular systems /i/, /u/ and /a/, or /i/, /e/ and /a/.

The first contrasts in the consonantal system are between a nasal and an oral stop (e.g. /m/ vs. /p/), followed by further contrasts between labials and dentals (e.g. /m/ vs. /n/ and /p/ vs. /t/).
Jakobson's later period of phonological development is characterized by further contrasts, all which follow the "laws of irreversible solidarity". These laws are a set of implicational universals determined through an examination of the phonological systems of different languages. The predictions made by the laws of irreversible solidarity for phonological acquisition, as discussed in Jakobson (1941/68), are given in (4.1)\textsuperscript{3}.

(4.1) Jakobson's Predictions for Acquisition

a. the acquisition of fricatives presupposes the acquisition of stops.

b. the acquisition of back consonants presupposes the acquisition of front consonants.

c. affricates are acquired only after fricatives of the same series.

d. a vocalic opposition of a narrow degree of aperture is acquired before an opposition between two vowels of a wider degree of aperture, /a/ vs. /e/ is acquired before /a/ vs. /æ/.

e. an opposition between unrounded vowels according to the degree of aperture is acquired before the same opposition between rounded vowels, i.e. /i/ vs. /e/ is acquired before /u/ vs. /o/.

f. rounded secondary vowels (/y/, /ø/ and /œ/) are not acquired until after the corresponding nonrounded vowels are acquired.

In Jakobson and Halle (1956) a number of changes are made to
Jakobson's original theory. One of these changes is to divide distinctive features into the classes sonority, protensity and tonality. The acquisition of features within any one class follows a fixed progression, although there is independence between the classes. These feature classes will be discussed again in Chapter 6 in light of the acquisition data presented in Chapter 5.

4.1.2.2 Consonantal Inventories

Early productive development has generally been studied using large sample studies, where many children are tested on their ability to articulate a large inventory of sounds, or through diary studies, where one or two children are followed longitudinally by a researcher (usually a parent). Large sample studies, such as Templin (1957) have focussed on production in older children. The diary studies that have been found to be methodical and accurate unfortunately tend to be studies of children acquiring more than a single language at one time (e.g. Leopold 1947, Velten 1943, Smith 1973). To my knowledge it has never been shown whether or not the phonological systems of bilingual or trilingual children are normative for children acquiring a single language.

Ingram (1981) presents a basic inventory of initial consonants for English-speaking children between the ages of 1;5 and 2;2, using the methodology that will be outlined in 5.1.1. These results are based on diary studies of his own and other children.
(4.2) Consonant Inventory of Children Acquiring English

(sounds in parentheses are marginal or infrequent).

\[ \begin{align*}
\text{p} & \quad \text{t} & \quad \text{k} \\
\text{b} & \quad \text{d} & \quad \text{(g)} \\
\text{(m)} & \quad \text{n} \\
\text{(f)} & \quad \text{(s)} & \quad \text{h} \\
\text{w} & \\
\end{align*} \]

In general, stops are acquired before fricatives and voiceless obstruents before voiced obstruents. Labials and dentals are generally acquired before velars. The liquids /l/ and /r/ are not included in this set, nor are the affricates /tʃ/ and /dʒ/, the glide /j/, the velar /n/ or the palatal fricative /ʃ/.

While some cross-linguistic work on phonological acquisition has been carried out over the years, it is mainly descriptive and anecdotal. An exception is a study by Pye, Ingram and List (1987), which uses the methodology developed in Ingram (1981) to systematically examine the consonant inventories of children acquiring K'iche, a Mayan language. A composite phonological inventory for K'iche children between the ages of 1;7 and 3;0 is given in (4.3)*.
(4.3) Consonant Inventory of Children Acquiring K'iche

\[
\begin{array}{c}
p \quad t \quad k \quad ? \\
(P') \quad x \\
t_y \\
(m) \quad n \\
l \\
w
\end{array}
\]

There is a marked difference between this inventory and that in (4.2) for English-speaking children. Although K'iche contains a set of voiceless ejectives rather than voiced stops, only the labial ejective is even marginally acquired by 3;0. The affricate /t_y/ is acquired in K'iche, while this same sound is a late acquisition in English. /l/ is acquired in K'iche but not in English. In K'iche the first fricative acquired is the velar one, while in English the first fricatives are the labiodental and the alveolar. Pye et al. also found marked differences in the set of substitutions used by the two groups of children. /r/ was replaced by [l] in the K'iche data, and /s/ was often replaced by [ʃ]: substitution patterns not found in the systems of English-speaking children (the English patterns will be discussed in 4.1.2.3).

Pye, Ingram and List account for the differences between K'iche and English by claiming that children first acquire the contrasts that are the most 'salient' in their language, where saliency is defined in terms of functional load. Functional load is the importance of a given phoneme in the system of
contrasts in a language, and is measured by dividing the frequency of occurrence of a segment by the number of lexical types in which it is found. These results are taken as support for a universalist theory of acquisition, where the variation that exists between the two groups of children can be accounted for by environmental factors, rather than by differences between children's linguistic capabilities.

4.1.2.3 Natural Processes

Much of the research on children's early phonological acquisition concerns the type of substitution processes that replace one sound with another. This research generally assumes the work of Stampe on Natural Phonology (cf. Stampe 1969, Miller 1972, Rhodes 1973). In Natural Phonology the innate phonological system is assumed to consist of a set of universal phonological processes which specify the restrictions on the speech capacity that every child is born with. In the acquisition of a language, a child may revise the innate system by ordering, limiting or suppressing these natural processes. In ordering two processes the context for the second rule may be narrowed or eliminated. Limiting involves narrowing the particular context for the application of a rule or decreasing the number of sounds to which the process applies. Suppression is the total elimination of a process from the language-particular grammar. Children are free to revise processes in any manner they wish, although every child will attempt to revise the innate system to achieve the same language-particular system. Assimilation
processes, word final devoicing and denasalization are examples of natural processes which have been limited and ordered from their innate application.

Some of the substitution or natural processes that have been found in early phonological acquisition data, as discussed by Ingram (1976) and Locke (1983) are given in (4.4). These processes have been used mainly to describe the speech of children acquiring English.

(4.4) Substitution Processes

a. Stopping replacing a [+cont] segment with a homorganic stop

b. Fronting replacing palatals and velars with alveolars

c. Denasalization nasals are replaced by homorganic stops

d. Liquid replacement [l] and [r] are replaced by homorganic stops

e. Frication glides occasionally are replaced by fricatives

f. Vocalization a vowel replaces a syllabic nasal or liquid

g. Vowel neutralization vowels are replaced by [ə] or [a]
h. Initial Stop Voicing initial voiceless stops are realized as voiced ones

i. Final consonant devoicing final voiced stops are replaced by voiceless ones. This is a later process since initially children do not have CVC words.
In Natural Phonology adult phonological systems are assumed to be composed of natural processes, which have been limited or ordered, and "rules". "Rules" are language-specific morphophonemic operations such as English Velar Softening. Unfortunately, Stampe only discusses anecdotal examples of how rules develop or processes change in individual children's phonologies.

4.1.2.4 Early Syllable Structures

Jakobson (1941/68) claims that children's earliest phonological productions appear in CV or reduplicated CVCV words. This claim appears to be supported by the evidence that exists on children's early syllable structures. Winitz and Irwin (1958) is one of the earliest experimental studies of children's early syllable types. They examined the frequency of occurrence of 6 different syllable types in the speech of children aged 1;0 - 1;5. At 1;0, it was found that the most common syllable types were CVCV structures, where either the consonants or vowels are identical (these structures are generally referred to in the acquisition literature as partially reduplicated forms). The next most common structures were CV and CVCV, where both the consonants and vowels are identical. By 1;5 the most common structure was CV, followed by partially reduplicated CVCVs. Ingram (1978) examined the syllable structures used by his daughter Jennika in monosyllabic and disyllabic words, from 1;3 to 2;3. Some of the more general results are shown in (4.5) (this
At 1;3 89% of all of Jennika's monosyllabic productions were CVs. By 1;6 this percentage had decreased to 14%. At 1;3 only 11% of monosyllabic forms were of the shape CVC. 87% of all disyllabic productions were CVCVs (we are not told whether or not these are partially or totally reduplicated forms) at 1;3, and this percentage decreased to .47 by 1;6. By 2;0, 13% of all monosyllabic productions were CVs and 79% CVCs.

Much of the work that has been done on children's early syllable structures has focussed on how children simplify target structures. The most common syllable structure simplification processes which have been discussed in the acquisition literature are given in (4.6). These processes have generally been viewed as being innate natural simplification processes, much like the segmental simplification processes listed in (4.4). Examples are taken from my own data from Christopher at approximately 2;0.
Syllable Structure Simplification Processes

a. Final consonant in deletion
final consonants are deleted

<table>
<thead>
<tr>
<th>Target CVC syllables</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. cat --&gt; [kæ]</td>
</tr>
</tbody>
</table>

b. Deletion of unstressed deleted syllables
an unstressed syllable is deleted

| e.g. banana --> [nænʌ] |

c. Cluster Reduction
a consonant cluster becomes a single consonant

| e.g. clothes --> [kəz] |

d. Reduplication

i. total
a CV target syllable becomes

<table>
<thead>
<tr>
<th>$C_1V_1C_1V_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. Patrick --&gt; [bæbæ]</td>
</tr>
</tbody>
</table>

ii. partial
a CV target syllable becomes

<table>
<thead>
<tr>
<th>$C_1V_1C_2V_1$ or $C_1V_1C_1V_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. Peter --&gt; [bɪbə] Andrea --&gt; [æjə]</td>
</tr>
</tbody>
</table>

Final consonant deletion (4.6a) is a fairly common syllable structure simplification process that is lost between 1;6 and 3;0 (Ingram 1976). The deletion of unstressed syllables (4.6b) may affect either pre-tonic syllables or post-tonic unstressed syllables, and may persist in longer words for years. In cluster reduction (4.6c) it is often difficult to predict which member of a cluster will surface. Ingram (1976) discusses some cluster simplifications from Smith (1973), showing that Smith's son A would most often delete the /s/ in an /s/-obstruent cluster, the liquid in a liquid + obstruent
cluster, and the nasal in a nasal + obstruent cluster. He also shows, however, that there are examples in the data of opposite member of the cluster being deleted.

Reduplication (4.6d) is one of the most discussed syllable structure simplification processes. 'Reduplication' is the term used to describe partial or total agreement between the quality of syllables in children's productions. It is not a morphological process, as it is in adult speech. Vihman (1978) examined the types of partial or full reduplication found in data from 13 children acquiring 6 different languages, focusing on similar consonants. She hypothesized that reduplication occurs to provide a substitution for a sound the child cannot pronounce, or to reduce the overall complexity of a word form. She concludes that reduplication is not a universal innate process, since it occurs very frequently in the speech of some children and only rarely in the speech of others.

Fee and Ingram (1980) examined both partial and full reduplication in the speech of 24 children from different linguistic backgrounds. The results show that reduplication is a developmental phenomenon used to some degree by all children, but used most frequently by younger children. Their findings also show that reduplication is a strategy used by children attempting to acquire multisyllabic forms. Children who are frequent reduplicators tend to have more difficulty producing final consonants than children who are not frequent reduplicators.
4.1.3 Some General Issues

Certain theoretical complications arise in any attempt to account for acquisition data. These problems will be encountered regardless of the researcher's theoretical bias or the type of data being examined. In this section I will discuss three such issues: variability, levels of representation, and units of organization, and I will outline the assumptions I will make with regard to these issues.

4.1.3.1 Variability

An extremely salient characteristic of young children's productive speech is variability. Two possible types of variability are found: inter-subject and intra-subject. Inter-subject variability occurs when individual children differ in their renditions of an adult target. Intra-subject variability occurs when a child's version of a target varies across a lexical item (token variability), or when the rendition of a particular sound or rule varies across lexical items (type variability). Type variability can occur in the form of "phonological idioms" (Moskowitz 1971), which are child words that appear to be highly advanced in relation to the bulk of the child's productions, or in the form of child words which appear to be phonologically less complex than the child's system at a given time. The important question that must be answered with regard to variability is whether it is a reflection of the child's competence (i.e. UG) or whether it is due to performance factors.

In the 'cognitive model' developed by Ferguson and
Farwell (1975) and Macken and Ferguson (1983) it is assumed that all tokens of lexical items are representative of the child's phonological system at any one time. This means that a great deal of intra- and inter-subject variation will have to be accounted for. Similarities between children are assumed to be due to the physiology of the speech apparatus or ease of articulation. Goad and Ingram (1987), in contrast, argue for a universalist model of acquisition where intra-subject variability is mostly due to phonetic, rather than phonological factors. They claim that once intra-subject variation is eliminated (using the methodology developed in Ingram 1981, 1989a) it can be shown that English-speaking children have very similar phonological systems (as in (4.2)).

In this thesis I assume (as do Goad and Ingram) that much of the variability that is found in children's speech is the result of performance or phonetic factors, and therefore should be ignored in an account of phonological acquisition. In this thesis I will use the methodology developed in Ingram (1981, 1989a) which eliminates a great deal of variability normally found in the acquisition samples. This methodology sets up criteria for deciding when a child uses a sound systematically, making comparisons across children and across languages possible. It is further possible to eliminate variability from phonological consideration if we remember that many of the variable characteristics of children's speech occur at the very onset of phonological development, during the acquisition of the first 50 words. It is possible that at this very early stage, children have not yet acquired enough
words to force them to systematize the sounds being used. These early words may be learned by rote, perhaps as whole units rather than as combinations of feature bundles. Ingram (1976: 22) says of this period:

The word appears to play an important role in acquisition here, and contrasts seem to occur more between words than sound classes. The child does not seem to have a productive sound system, a development that becomes the major part of the next stage of acquisition, when the child begins the active process of acquisition of a complex set of linguistic rules.

4.1.3.2 Levels of Organization

Until fairly recently, many acquisition researchers assumed that the child's system was a unique one which bore no relationship to a system of adult phonology. This led to a number of different proposals for how the child eventually achieves an adult system. Menn (1978) proposes a four-level model of phonological organization where the underlying representations hypothesized by the child and the child's intended pronunciation are mediated by an input lexicon.
(4.7) Menn's (1978) Two-Lexicon Model of Phonological Organization

Levels A and B will initially coincide, until such time as the child has determined some of the phonological rules of the language. Levels B and D are separated by a set of reduction rules or output constraints, which are of 4 types: consonant harmony constraints, consonant sequence constraints, relative-
position constraints and absolute-position constraints. Of these four, the first three are processes which operate across words. Only the absolute-position constraints describe processes which delete individual segments, or substitute one segment for another. Levels D and E are mediated by a set of production rules or performance constraints that Menn claims may be quite severe when the child is very young.

A second type of multi-level model is discussed in Ingram (1989) as being representative of the analyses assumed in Velten (1947), Jakobson (1968) and Ingram (1976). In this model the mediating level is a strictly organizational one, separate from the child's output and the child's perception of the adult form.

(4.8) Three-Level Model of Phonological Organization

```
A  Underlying Perceptual representation

B  Organizational representation

C  Child's intended output
```

Ingram exemplifies the working of this model in a discussion of a child's acquisition of alveolar stops. If a child can correctly perceive voicing distinctions within the stop
series, yet does not produce them, voicing will be present at Level A but not at Level B. Level B, where voicing is not represented, represents the child's phonological system at any one time.

In this thesis, I assume a two-level model of phonological organization, similar to that assumed for adult phonology. This two level model contains an underlying level based on the hypothesized adult forms, and an output level, which reflects the child's intended output, without performance factors taken into account.

(4.9) Two-Level Model of Phonological Organization

Initially, the two levels in (4.9) will be very similar or will coincide since the child will know little or nothing about the phonological rules of the language. These levels will become differentiated as the child determines the rules of the language, and resets the appropriate rule parameters. The child's URs will change as the child determines how the
featural parameters supplied by UG must be changed or eliminated.

The reason I adopt the model in (4.9) rather than Menn's model in (4.7) is because of the Continuity Assumption, discussed in 2.4.2. The parametric model of acquisition does not allow for reduction rules that are specific to the child's phonology, but rather must assume that they are somehow due to the child's initial parameter settings. I will assume that the type of processes that Menn calls "reduction rules" will be reflected in the model in (4.9) as differences between the child's hypothesized underlying representation and the true underlying representation. I adopt the model in (4.9) over Ingram's model in (4.8) because I assume that only when phonological knowledge is reflected in both the child's perception and production will it be represented at the underlying level. An example from a related field might elucidate this assumption. While a second language learner may be able to perceive or process certain syntactic constructions in the language being acquired, I would argue that these constructions are not necessarily a part of the learner's grammar until they can be accessed and used in some fashion.

4.1.3.3 Units of Organization

The final theoretical issue to be addressed is the basic unit of phonological organization. I will assume, following most current work in non-linear phonology, that this unit is the feature. Most researchers working in the field of
phonological acquisition have assumed that the unit of acquisition is the segment. Some notable exceptions to this are Moskowitz (1970), who assumes the syllable is the basic unit of sound first acquired, and Ferguson and Farwell (1975) who argue that the word is the first unit of organization. Macken (1979) argues that the organizational unit is first the word, then the phoneme, and only later the feature. Each of these authors was working within the research model prevalent in the late 1960s and 1970s (and unfortunately, still held to by some researchers today) that can be characterized by the statement:

Child language is a form of linguistic communication, but it is not a form of adult language. (Menn 1978: 157)

Child phonology was a subject unto itself, and researchers in the field felt no need to be bound by the constraints and primitives of phonological theory. Again, in adopting the Continuity Assumption I am compelled to assume that the primitives of a theory of acquisition are the same as for phonological theory in general.

The question of 'epistemological priority' (Chomsky 1981, Davis 1987), or the innate plausibility of linguistic mechanisms, must be looked at in a theory of phonological acquisition, just as in any theory of acquisition. Research on infant speech perception (presented in 4.1.1) and infant vocalizations (presented in 4.1.2.1) demonstrates that children know from birth (or from a very early age) what features are and how they operate. I will therefore not attempt to argue for the epistemological priority of the
feature: I will simply assume it. In practice it may be difficult to talk about acquisition in featural terms since the phonetic reality that seems to be most accessible is a bundle of features, i.e. the segment. The methodology described in 5.1 looks at the productivity of segments rather than features, and so much of the discussion of phonological acquisition in Hungarian and Spanish will be presented in segmental terms.

4.1.3.4 Phonological Rules

In the literature on child phonology "rules" generally refer to natural processes such as those given in (4.4) and (4.6). There has been very little discussion of how the rules of adult phonology are manifested in children's speech. One notable exception is MacWhinney (1974, 1978), who presents data from several longitudinal diaries and experimental studies on the acquisition of Hungarian morphophonology. MacWhinney (1974) examined errors in the use of Hungarian Back Harmony⁶ (see 3.1.1.1) reported in the Hungarian acquisition literature and found that violations of BH are very rare. MacWhinney suggests that a Back Harmony rule is productive in the speech of Hungarian children relatively early, and in the case of one particular subject by 1;8.

MacWhinney (1978) presents a series of experimental studies which examine the acquisition of Hungarian morphonology in 4 age groups of children aged 2;6 to 7;5. The results show that the ability to insert the appropriate
linking vowel (see the forms in (3.5)) varied with the type of suffix. At 2;6 there were at most 17% omissions of the linking vowel before the Superessive suffix -n and 18% omissions before the Plural -k, but these omissions increased to as much as 53% before the Accusative -t.

The use of Round Harmony (see the forms in (3.4)) was tested using the Allative Suffix (-höz/-hez/-höz) and the linking vowel. The results show that errors were relatively frequent in the speech of the younger subjects. A significant increase in the overgeneralization of Round Harmony to irregular or inapplicable suffixes was found between 3;8 and 4;9. This suggests that a rule of Round Harmony is being used around this time, and it is being applied in an across-the-board fashion.

MacWhinney's (1978) findings on Back Harmony facts substantiate the earlier findings that this particular rule is acquired significantly earlier. There were very few omissions or errors in the backness values of suffixal vowels, even in the speech of the youngest children at 2;6. MacWhinney concludes that Back Harmony is a fully productive rule by the middle of the third year, but he does not speculate how early it might first be used.

Unfortunately, I know of no comparable studies on the acquisition of Spanish vowels. Studies on Spanish phonological acquisition have generally focussed on consonantal acquisition (e.g. Macken 1975, 1979; Stoel 1974).
4.1.4 Implications for the Acquisition of Vocalic Systems

A number of findings in both perception and production research relate directly to the acquisition of vocalic systems. First, in Russian, Shvachkin (1948/73) found that vocalic distinctions were generally perceived before consonantal ones, and since the order of acquisition in both perception and production are similar, these findings predict that vowels should be acquired early in production. A study by Templin (1957) suggests that this is true. In an articulation test given to 480 English-speaking children Templin found that the English vowels were produced correctly by children at 3;0, while a number of consonants were not productively acquired until 6;0 or 7;0.

Jakobson (1941/68) argues that during the acquisition of the first 50 words, the minimal vocalic system /i/, /u/(or /e/), /a/ is acquired. After the first 50 words, the laws of irreversible solidarity (see (4.1)) make predictions about the order of acquisition of vowels. These predictions say that the opposition /a/ vs. /æ/ will only be acquired after the contrast /a/ vs. /e/; and /u/ vs. /o/ or /y/ vs. /ø/ will only be acquired after /i/ vs. /e/. /ɪ/, /ɛ/ and /æ/, which occur at the perimeters of the vocalic triangle, will be acquired before /y/, /ø/ and /o/, which are more centrally located and rounded. Finally, the natural process of Neutralization in (4.4g) indicates that early in acquisition children may substitute /a/ or // for other vowels.

The results from MacWhinney's studies (1974, 1978)
suggest that a rule of Back Harmony may be in evidence in the speech of Hungarian children as young as 2;0, while the insertion of the linking or epenthetic vowel and the rule of Round Harmony may be later acquisitions. MacWhinney (1974) lists a series of vocalic substitutions noted by previous Hungarian acquisition researchers such as Csapodi (1905), Balassa (1893) and Meggyes (1971). The substitutions that occur frequently are the substitution of [a] for target /e/, [u] and [i] for target /u/ and [o] and [ɛ] for target /ɔ/. While it is impossible to determine how productive these patterns are, they are at least suggestive of what may be found in the acquisition data presented in Chapter 5. Also reported in MacWhinney (1974), Meggyes (1971) found that confusions between long and short vowels occurred until approximately two years of age. I am aware of no comparable research demonstrating the phonological rules or substitution patterns used by young children acquiring Spanish.

4.2 Assumptions for a Model of Phonological Acquisition

In the following sections I will outline the assumption that I will make for a theory of phonological acquisition, based on the parametric theories of underspecification outlined in Chapter 2 and the acquisition research outlined in 4.1. The discussion will focus on perception, general phonological development, and substitution patterns.
4.2.1 Perception

In 4.1.1 it was shown that children have remarkably good speech perception skills at a very early age, and that in general children can perceive phonetic distinctions before they can produce them. Based on this evidence, I will adopt the Acoustic Feature Hypothesis in (4.10).

(4.10) Acoustic Feature Hypothesis

Before phonological organization begins, children have full knowledge of the set of features that are used to phonetically represent speech sounds.

(4.10) says that by the time children begin to acquire a phonological system, they know what features are and how they are used to represent phonetic speech sounds. I assume that phonological organization begins when children realize that certain phonetic distinctions can signal a change in meaning, and it is at this point that the innate phonological structure of UG will begin to take effect.

Given the Acoustic Feature Hypothesis in (4.10) children acquiring different phonetic inventories should be able to represent those inventories in some fashion. Children acquiring languages with different inventories will apply the unmarked parameters of UG to a different set of phonetic entities. In Chapter 5 it will be shown that the universal redundancy rules will be applied to an 8 vowel phonetic inventory in Hungarian, and to a 5 vowel phonetic inventory in Spanish.
4.2.2 Phonological Development

Following the research presented in 4.1.2 I assume that phonological organization begins between 1;0 and 1;6, when the child's vocabulary has become too large to manage without some organizational system. Given the principles and parameters model of grammar presented in Chapter 2, I assume that UG will constrain the child's earliest phonological system by providing a set of universal principles and parameters. UG will provide the unmarked settings of parameters, and positive evidence from the input will be required before parameters can be reset to the marked option (the No-Negative Evidence Hypothesis, see 2.4.3).

4.2.2.1 Featural Parameters

Featural parameters, as provided by redundancy rules, are one possible type of phonological parameter. In RU redundancy rules are of two types: context-free rules or context-sensitive rules. In CU redundancy rules may only be context-sensitive. The unmarked setting of featural parameters is that provided by UG, but languages may choose to reset parameters to the marked option. In the case of a context-free rule, resetting means that the universally redundant feature value will become lexically marked, the universal redundancy rule will be eliminated from the language-specific grammar, and a complement rule will be created to insert the new redundant feature value. In the case of a context-
sensitive featural parameter, the universally redundant feature value will be marked underlyingly (and in the case of contrastive specification the paired contrastive value will also be marked). In RU the universal context-sensitive rule must be eliminated from the language-particular grammar, while in CU the rule may remain in the system.

When featural parameters in either theory are reset, restructuring of the phonological inventory may take place. Restructuring will involve the addition of new feature values and/or the removal of others. Restructuring operations will represent developmental stages in the child's acquisition of phonology. Examples of the resetting of featural parameters and restructuring of the child's system are discussed in 2.5.1.1 for the theory of RU, and in 2.5.2.1 for the theory of CU.

### 4.2.2.2 Rule Parameters

The second type of phonological parameter is a rule parameter. Rule parameters provide the child with an inventory of possible phonological rules. As discussed in 2.2.1.2 and 2.2.2.3 the unmarked setting is generally assumed to be OFF, but languages may choose to adopt the marked ON setting. The parametric rules assumed in Chapters 2 and 3 are given in (4.11).
(4.11) Parametric Phonological Rules
a. Spread
b. Insert
c. Delete

These are the rules that are used to account for the vocalic systems of Hungarian and Spanish in Chapter 3.

One explanation for the child reduplication data discussed in 4.1.2.4 is that the unmarked option of the rule of Spread is ON, rather than OFF. I will adopt a different analysis of the reduplication facts, which assumes that the presence of Spread in children's early word forms reflects the fact that at this early age feature specifications are mapped onto word templates, and that children are not always able to provide underlying feature specifications for all segments. If a principle exists that tells the child to satisfy all elements in the template, the child simply uses whatever is possible to fulfill this principle. The mechanisms behind this process are discussed in more detail in 4.2.3.2. By making this assumption about Spread in early child forms, we do not have to assume that children acquiring languages without operative Spread rules do not have to 'unlearn' a rule. This question will be returned to in Chapters 5 and 6.

4.2.2.3 Other Parameters

The only parameter that does not relate to redundancy rules or phonological rules that has been discussed in any
detail in previous chapters is the Complex N parameter. This was discussed in 2.1.2.4 in conjunction with Levin's syllabification algorithm, and has been discussed in Chapter 3 as a necessary parameter for both Hungarian and Spanish. In Chapter 2 it was assumed that the unmarked setting of this parameter is OFF, meaning that in the unmarked case languages do not allow branching at the level of the nucleus. In the marked case, however, languages such as Hungarian and Spanish will reset this parameter so that branching of the nucleus is permitted. In Hungarian a branching nucleus indicates that a long vowel is present, while in Spanish it indicates that a falling diphthong is present. In Chapter 3 I have assumed that Spanish requires a language-specific statement which says that complex nuclei may be only be formed if the feature specifications of the two skeletal slots dominated by the nucleus are not the same, and the initial element is less sonorous than the first. In Hungarian I assume a language-particular statement is not necessary, since a complex nucleus may only dominate two skeletal slots that share a set of feature combinations.

The only acquisition data that are relevant to this parameter are the data discussed in Meggyes (1971). Meggyes points out that confusions between long and short vowels are common until approximately two years of age, suggesting that the Complex N parameter is reset at approximately 2;0. I will assume that once the Complex N parameter is reset to the marked option, children should be able to produce either long
or short renditions of all vowels in their phonological inventory.

4.2.3 Substitution Processes

Previous acquisition research, such as that discussed in 4.1.2.4, has shown that early in phonological development children have a very limited set of syllable and word structures that they can produce. I will formalize this by saying that at this early period children have a restricted set of word templates, to which melodic features must be mapped. These early templates will generally be of the form CV or CVCV, with some children also having a CVC template fairly early.

Research such as Fee and Ingram (1980) suggests that there may be some individual choice in the templates that a child can focus on at a given stage in development. Waterson (1971) made a similar proposal regarding templates, although her claim was that children have templates to which only specific features may attach. For example, her son P used a Labial Structure for words containing labial consonants, that restricted these words to the shape wV(wV) (e.g. [wæwæ] 'barrow'). Sibilants, on the other hand, only occurred in words of the shape (C)V, e.g. [ʃ] 'fish'. This issue of word templates is a complex one, and given a parametric theory of acquisition must somehow be tied to parameter settings. Here I will not attempt to argue as to what the set of templates is or how they arise; instead I will focus on how features or
segments are mapped to templates.

In the mapping of melodic features onto these early word templates, children may encounter several difficulties. First, the target form may have a greater number of skeletal slots than the template, in which case some element or elements of the target will not be mapped to the template. If the target form contains a consonant cluster, for example, and the child's template contains only a single consonant, then only one-half of the cluster will be mapped to the template. This type of mismatch has traditionally been described as Cluster Reduction (see (4.6c)). If the child's template is CV and the target contains a final consonant, then the final consonant will not be mapped to the template. This type of mismatch has traditionally been called Final Consonant Deletion (see (4.6a)). If the template contains one less syllable than the target, then an unstressed syllable may be omitted in the mapping process. This type of mismatch is called Deletion of Unstressed Syllables in (4.6b).

A second type of mapping difficulty may arise when the number of skeletal slots that the child can provide featural information for is less than the number of slots in the template. I will assume that this type of mismatch can occur for two reasons: 1) because a target sound is not in the child's phonological repertoire, or 2) because some complexity in the target makes it too difficult for the child to represent every element (these assumptions are similar to those made by Vihman 1978 concerning why children
reduplicate). Two types of substitution processes may arise to resolve this particular type of mismatch. A paradigmatic substitution will occur if the redundancy rules of UG supply a replacement set of feature specifications for a target sound not in the child's phonological inventory, and a syntagmatic substitution will occur if a phonological rule operating supplies a replacement sound or set of replacement sounds from elsewhere in the word. These two types of substitutions will be discussed in the following sections.

4.2.3.1 Paradigmatic Substitutions

Given a parametric theory of acquisition, substitution processes, such as those in (4.4), can only be the result of the operation of an unmarked parameter setting in the child's phonological system, when a marked parameter setting may be required in the language being learned. In 4.2.2.1 the resetting of context-free and context-sensitive featural parameters are discussed.

Paradigmatic substitutions will occur in the child's speech if the child's phonological system is still characterized by the unmarked setting of a context-sensitive rule, when the adult system being learned requires the marked setting of that same parameter. When a context-sensitive parameter in the child's system is set at the unmarked option, rather than the marked option, the effect will be to collapse the representations of certain classes of sounds. If, for example, in a child's early productions liquids are replaced
by homorganic stops (see Liquid Replacement in (4.4d)), this can be explained as resulting from a universal context-sensitive redundancy rule providing stops as the unmarked consonant type. In the child's initial phonological system the representation of liquids and stops will be identical until evidence from the input shows that these two classes of sound are phonologically distinct in the language being acquired. Once this evidence is in, the child will reset the featural parameter to the marked option, and liquids will be represented in a distinct manner from stops.

Viewing substitutions in this manner, we can see that both the theories of RU and CU predict that certain types of paradigmatic substitutions will occur, although not necessarily those given in (4.4). The specific types of paradigmatic substitutions predicted by the RU and CU theories for Hungarian and Spanish will be discussed in 4.3.1. and 4.3.2.

A second type of paradigmatic substitution will occur in a child's speech if the unmarked setting of the Complex N parameter, discussed in 4.2.2.3, is in effect in the child's system, when the adult system calls for the marked setting of this parameter. At the unmarked setting, children will be incapable of representing long vowels, and both short and long vowels will be represented as short vowels. This type of substitution will occur until such time as the child learns that these two types of vowels are phonologically distinct.
4.2.3.2 Syntagmatic Substitutions

I assume that syntagmatic substitutions occur in children's speech when the child is not able to provide unique featural specifications for all elements in a template, and those specifications are provided from elsewhere in the word. Syntagmatic substitutions will arise as a result of the Satisfaction Condition in (4.12).


All elements in a template are obligatorily satisfied.

(4.12) is a condition of the theory of Prosodic phonology outlined in McCarthy and Prince (1986). McCarthy and Prince argue for a theory in which all segments are organized into prosodic constituents such as the mora, syllable, word, foot, etc., and where templates can only consist of prosodic constituents. When features or segments are mapped to elements of templates, the mapping must satisfy (4.12). Given a situation where there are more elements in the child's template than the child has featural information for, a phonological process may be used to provide a syntagmatic substitution.

The processes of partial and total reduplication in (4.6d) will occur when the melodic information that the child is able to represent does not fill a CVCV or CVCCVC template. In the acquisition literature, as discussed above, partial and total reduplication have been thought to be part of the same process. Using the constructs of current phonological theory
children's reduplications will represent the functionning of a rule of Spread, from (4.11).

In examining how current phonological theory would account for the reduplication data in (4.6d), the feature geometry in (4.13) will be assumed (this was given earlier in (2.7)).

(4.13) Feature Geometry
Vowels are specified using the features [back], [high], and [low] from the Dorsal Node, and the feature [round] from the Labial Node. Consonants, in the unmarked case, are not specified using these vocalic features. The separation of features used for consonants and vowels, along with the Crossing Constraint given in (2.5c), helps to explain the types of assimilation processes that are found in the languages of the world. Consonantal assimilation processes are rare, while vocalic assimilation processes are found in many different languages. Given that features used to specify vowels are not generally used to specify consonants, vowel features can spread across consonants without affecting the consonant and without the consonant blocking the rule.

Archangeli and Pulleyblank (1986) argue that a second reason that vowel assimilation processes are more frequent in adult phonological systems is because of the maximal/minimal parameter, given in (2.21I). If a rule is designated as being maximal, then the adjacency of the trigger and target is defined at the highest possible node dominating those segments. If the trigger and target are vowels, then the highest node dominating them will be a nucleus node, possessed only by vowels. Consonants can then be skipped in the determination of adjacency, and the rule will target only vowels. Maximality will explain vowel assimilation processes which operate even when the feature or node which spreads is one possessed by an intervening consonant.
Child reduplications that involves the spreading of vowels (e.g. [æjæ] from (4.6dii)) will be analyzed as a spreading process that adds an association line from the same node or feature of one vowel to a second skeletal slot. This rule will take place when the child cannot provide the appropriate features for one vowel in a multisyllabic form. If this rule is maximal, spreading should be permitted to cross any consonant. This is shown in the derivation of [æjæ] from (4.6dii).  

(4.14)  

<table>
<thead>
<tr>
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<tr>
<td>C</td>
<td>V</td>
<td>C</td>
<td>V</td>
<td>C</td>
</tr>
</tbody>
</table>

Place

Coronal

Dorsal

[+lo]

æ j æ j æ

Underlyingly the child uses a CVCV template, mapping the sounds /æ/ and /j/ to the template, leaving the initial consonant empty as it is in the target. The second vowel in the form is represented as a bare skeletal slot, since the child is not able to provide features for it (either because
the related sound in the target is not part of the child's phonological inventory, or because of some other complexity in the word itself). I assume that the initial vowel is specified only as [+low], and that the consonant is specified with a Coronal Node. If spreading is defined as being maximal, or if the consonant which intervenes between the two vowels is not specified with Dorsal features, then the vowel specification can spread across the consonant to the second vowel.

We can also use a rule of Spread to account for forms which have identical consonants, such as [bæbæ] in (4.6di), given certain restrictions on the type of spreading that occurs. (4.15) shows one possible representation of the form [bæbæ].

(4.15)
The initial consonant is specified with a Labial Node and the initial vowel is specified as [+low] dominated by a Dorsal Node. There are no feature specifications provided underlingly for the consonant or vowel of the second syllable.

Spreading of the initial consonant in (4.15) to the second C slot will be permitted because the vowel is not specified with a Labial Node. If, however, the vowel is specified using the feature [round], which as shown in (4.13) is dominated by the Labial Node, then we would predict that Spreading would be blocked by the Crossing Constraint in (2.5c). Maximality cannot help in this case either, since the maximal node of a consonant is the skeletal slot (shown here as a C), and therefore both consonants and vowels will be adjacent at this level and spreading of the consonantal features will still be blocked. Spreading in a form such as (4.15) will occur when the child is incapable of providing marked feature values for an entire syllable.

I will leave until Chapter 5 the exact determination of whether it is a node or a feature which spreads in these child reduplications. Once we view the data it should be possible to decide at what point in the feature geometry the association line is added. We would wish to assume that Spread operates high enough up the tree so that we can posit only a single rule, rather than a number of individual spreading rules.
Thus the mechanisms of current phonological theory provide us with a set of tools to examine children's early Spreading processes. These mechanisms show us how Spreading rules should operate and at the same time place restrictions on the types of Spreading that should occur. In Chapters 5 and 6 I present examples of both the Spreading of consonants and vowels, although I investigate in detail only those Spreading processes which relate to vowels.

An alternate analysis of partial and total reduplication in acquisition is presented in Iverson and Wheeler (1987). There it is claimed that:

many of the common processes in child phonology may be explained in terms of incorrect hypotheses a child may make, assuming that phonological segments are hierarchically organized into constituents. In particular, we will argue that one of the major sources of errors is the incorrect hypothesis that features are associated with suprasegmental constituents. (Iverson and Wheeler (1987: 249-50)

The authors claim that a partially reduplicated form such as [gag] 'dog' can be explained by the feature [-anterior] incorrectly associating at the word level, rather than in its appropriate place in a hierarchical feature geometry such as that in (4.13). With the feature associated at the suprasegmental level, Spreading can operate across a vowel without violating any principles of non-linear phonology. According to this view of acquisition, two types of phonological development occur: the segmentalization of
features which are initially associated at some suprasegmental level, and the enrichment of hierarchical structures.

I reject Iverson and Wheeler's view of reduplication since I believe it allows for too many unrestricted possibilities in phonological development. The acquisition model that I adopt says that acquisition can only mirror the rules and principles of adult phonological systems. In my view of Spread I assume that the theory of feature geometry tells the child exactly where particular feature values are associated, and while it is possible that individual features are autosegmentalized, it is not possible for them to be reassociated at some level outside the melody. I believe that the Continuity Assumption (see 2.4.2) should be maintained, unless there is incontrovertible evidence that it is wrong.

Within my view of acquisition a form such as [gag] for 'dog' can be accounted for in two possible ways. First, it may be that the initial [g] is a paradigmatic substitution, created by the unmarked parameter settings of UG. Secondly, it may be that the initial [g] is the result of spreading from the final consonant. The spreading principles discussed above predict that such a form will only occur if the vowel is not specified with a Dorsal Node, and therefore is unspecified in some fashion. Which of these alternatives is the right one would require an in depth analysis of the child's phonological system and word types.
4.2.4 Summary

The assumptions that I will adopt for a model of acquisition, following the research on phonological acquisition presented in 4.1, the constraints on learnability, and the principles and parameters theory discussed in Chapter 2 are summarized in (4.16).

(4.16)

a. The basic unit of phonological organization is the feature.

b. UG provides the structure for phonological systems in the form of a set of principles and parameters. Featural parameters provide the universally unmarked and marked values of features. Possible phonological rules are given by UG, where the unmarked value is OFF or non-application of the rule and the marked value is ON, or application of the rule.

c. Children acquire the phonetic inventory of their language in advance of phonological organization.

d. The first 50 or so words may be produced without the benefit of a phonological system. When the child's productive vocabulary reaches this size UG will be brought into play to help organize a phonological system. Acquisition during the first 50 words may be qualitatively different from subsequent phonological acquisition.
e. Positive evidence from the PLD will be required to trigger the resetting of parameters to their marked values. Resetting of featural parameters will involve restructuring of the phonological system.

f. Substitution patterns may vary cross-linguistically based on the set of sounds being acquired and the parameters that require resetting. Two types of substitutions processes may be found in children's early speech. Paradigmatic substitutions may occur when a target sound is not in the child's phonological inventory and an unmarked context-sensitive featural parameter (redundancy rule) supplies a replacement sound. Syntagmatic substitutions may occur when the child is not able to represent features for all elements in a template, and a rule of Spread provides features from elsewhere in the word.

According to these assumptions, children's earliest phonological systems cross-linguistically will differ in the phonetic inventories that the constraints of UG are applied to. This assumption is very similar to Jakobson's universalist model (1941/68), in that cross-linguistic variation is expected. The model developed here differs from that of Pye, Ingram and List (1987) discussed in 4.1.2.2 insofar as I assume two factors may cause children's phonological systems to differ: the phonetic inventories of
different languages, and the parameter settings required by different languages. Pye et al. argue that the phonological inventories used cross-linguistically by children will differ because of differences in the functional load of the component sounds. They assume a sound will be acquired earlier in one language if its functional load is higher than in a second language. The parametric theory of grammar makes no provision whatsoever for functional load, nor for any other frequency effects in acquisition. It is possible that functional load could be integrated into the parametric model as a "peripheral" factor, as was discussed in 2.3.3, although in Chapters 5 and 6 I will attempt to account for the acquisition data solely on the basis of "core" phenomena such as principles and parameters.

4.3 Predictions for the Acquisition of Hungarian and Spanish Vowels

In Chapter 2 I outlined how the theories of Radical and Contrastive Underspecification would be organized if we assume that UG consists of a set of principles and parameters. In Chapter 3 analyses of the vocalic systems of Hungarian and Spanish were presented, based on these parametric theories of RU and CU. These analyses suggest that certain featural and rule parameters must be reset in the acquisition of these languages. In this section I outline the predictions that these analyses make for the acquisition of vowels in Hungarian and Spanish.

Given that UG helps to provide the initial phonological
representations and that the grammars presented in Chapter 3 represent the adult system, certain developments must take place in order for the child to get from the UG-controlled system to the adult system. For each of the two theories I first outline the phonological system that is constrained by the unmarked principles and parameters of UG, and then detail the developments that must occur in order to achieve the adult grammar. I focus on two particular aspects of acquisition: 1) the acquisition of marked featural parameters, and 2) the acquisition of parametric rules.

In developing these acquisition scenarios for Hungarian and Spanish I adopt the assumptions for a theory of acquisition given in (4.16). In terms of real-time acquisition I assume that the child's initial phonological system will occur at about the time that approximately 50 words are being used (at 1-1½ years of age), and that the parameters which control underlying feature markings and phonological rules will be applied to a language-particular set of featural combinations. The child will learn, on the basis of the Primary Linguistic Data (PLD), that certain aspects of UG do not hold true in the language being acquired. The child will then reset the appropriate parameters to the marked option.

In addition to featural and rule parameters there are other types of phonological parameters that I have given only passing reference to. In 2.1.3 a Directionality Parameter was discussed which controls the direction of application of a
particular phonological rule. The unmarked option of this parameter is that phonological rules operate in the same direction as the initial mapping of skeletal slots and autosegments, while at the marked option phonological rules operate in the opposite direction to initial mapping. In 2.1.2.4 and 3.2.3.2 a Complex N Parameter was discussed, which controls whether or not a language has branching nuclei, with the universal unmarked option prohibiting branching nuclei. In a language such as Hungarian or Spanish which permits complex vowels, a nuclei must be able to dominate two skeletal slots, and the Complex N parameter must be reset to the marked option. This parameter predicts that children will initially assume vowels are represented as a single skeletal slot dominated by a nucleus until they discover that this is not true.

4.3.1 RU Predictions

In 2.5.1.1. and 3.1.2 I discuss the principles of RU which initiate the development of a phonological system. The most important of these is the Minimal Redundancy Condition, originally given in (2.34), and repeated in (4.17)\textsuperscript{13}.

(4.17) The Minimal Redundancy Condition (MRC)

a. Underlying representations do not contain redundant information.

b. The most highly valued system contains the minimal number of features and feature values needed to distinguish the inventory of a language.
The MRC tells the child that only non-redundant feature values are marked underlingly. The RU model also assumes that UG provides the child with a set of redundancy rules which give universally predictable feature values. The universal redundancy rules (default rules), originally given in (2.36) are repeated in (4.18).

(4.18) Default Rules

<table>
<thead>
<tr>
<th>Context-free rules</th>
<th>FCRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. [ ] --&gt; [-low]</td>
<td>5. [+low]  --&gt; [-high]</td>
</tr>
<tr>
<td></td>
<td>[-low]</td>
</tr>
<tr>
<td></td>
<td>9. [-back] --&gt; [-round]</td>
</tr>
<tr>
<td></td>
<td>[-low]</td>
</tr>
</tbody>
</table>

These are the rules that children initially assume hold of their language. At the intial point of phonological acquisition the child will have phonetic representations for the vowels of the language being acquired, but the initial hypotheses about which vowels are phonologically distinct will be made on the basis of the rules in (4.18). Given that the rules in (4.18) supply redundant feature values, the child will assume that all other values are to be marked underlingly.
I assume that the child acquiring Hungarian has phonetic representations for the 8 vowels /i, ü, u, ő, o, a, e, e/, as discussed in 3.1.2. The long/short distinction will be worked out independently of the phonetic representations, in conjunction with the parameter settings for the Complex N Parameter (see (2.10)). The Hungarian child will also have to learn the surface constraints that prohibit [ε:] and [e].

Given the redundant values supplied by the default rules in (4.18) the child will initially specify the 8 phonetic segments as in (4.19).

\[(4.19) \text{ Initial Representation of Hungarian Vowels - RU} \]
\[
\begin{array}{cccccc}
\text{i/ü} & \text{e/ő} & \text{a/ɛ} & \text{u} & \text{o} \\
\text{high} & - & - & & \\
\text{low} & & + & & \\
\text{back} & & & + & + \\
\end{array}
\]

In the initial system /i/ and /ü/ and /e/ and /ő/ will have identical representations, because FCR 9 in (4.18) predicts [-round] as a redundant feature of front non-low vowels. The low front and back vowels will also have identical representations, since FCR 6 in (4.18) predicts [+back] as a redundant feature on [+low] vowels. In this system there are distinct phonological representations for 5 vowels, with [+round], [-high] and [+low] being the marked feature values. The redundant values provided by the rules in (4.18) will make the 5 vowels in (4.19) surface as [i], [e], [a], [u] and [o].
In (4.19) the vowel which surfaces as [i] has no underlying feature specifications. According to the RU concept of Epenthesis, this is the vowel that a child will use epenthetically. The epenthetic or linking vowel of adult Hungarian is /œ/, as discussed in 3.1.3.1. In order to achieve total underspecification of /œ/ several featural parameters must be reset, and the system in (4.19) must be restructured. The evidence from MacWhinney (1978) suggests that the linking vowel is probably not in full use at this early period of acquisition, and so there may not be empirical evidence as to which vowel in the child's early system is totally unspecified. It is possible that a totally unspecified vowel may be used in some idiosyncratic fashion, for example as a substitution for a vowel not yet in the child's phonological inventory, or as a placeholder for some partially unspecified template.

According to the RU analysis of Hungarian given in 3.1.2, three phonological rules control the vocalic alternations of the language. These rules, as well as examples for each, are given in (4.20).
(4.20) Phonological Rules of Hungarian – RU

a. Back Harmony (BH) (see (3.10))

Spread [+back]
L --> R
Domain: lexical (cyclic)
e.g. út-nak 'road, dat.'
    öt-nek 'five, dat.'
    radír-nak 'eraser, dat.'

b. Round Harmony (RH) (see (3.17))

Spread: [-round]
L --> R
Target condition: [-high]
Nucleus may not branch
Domain: lexical (cyclic)
e.g. hoztok 'bring, 2nd pi.'
    főztök 'cook', 2nd pi.'
    néztek 'see, 2nd pl.'

c. Low Front Vowel Formation (see (3.21))

Insert: [+low]
Target condition: [-low]
[-high]
[-back]
[-round]
Non-branching nucleus
Domain: postlexical
e.g. fejtek [fɛjtɛk]
    néztek [neːztɛk]
BH is a spreading rule which spreads [+back] lexically from left to right, and requires the marked ON parameter setting. Forms such as hidnak and őtnek in (3.9) demonstrate that front rounded and unrounded vowels can behave differently with respect to the BH system. /e/ and /i/ are neutral vowels in the BH system (and therefore can sometimes trigger a suffixal back vowel even if the root vowel is front), while /ő/ and /ü/ both trigger and undergo BH (and will therefore never be followed by a back suffixal vowel). Alternations like these should be enough to tell the child that /i/ and /ő/ and /e/ and /ő/ are distinct segments, and consequently that the redundancy rule predicting [-round] on [-back] and [-low] vowels is not part of the grammar of the language.

In the BH system /ɛ/ and /a/ both trigger BH, and both are possible targets. A low suffixal vowel will surface as [ɛ] when the preceding root vowel is front, and as [a] when the preceding root vowel is back. These differences should tell the Hungarian child that /ɛ/ and /a/ are distinct, and that the redundancy rule predicting [+back] on [+low] vowels must be reset. This will force the marking of /a/ as [+back] and will eliminate the redundancy rule from the grammar of Hungarian.

The RU analysis of Hungarian assumes that the vowels /i/ and /e/ are neutral with regard to the BH system because of a marking condition which prohibits the derivation of back non-low unrounded vowels. This prohibition is not a learned
aspect of the grammar, but rather one that is supplied by Structure Preservation, a principle of UG. Structure Preservation (see 2.1.1.4) says that feature matrices which are not underlying may not be derived in the course of a derivation, and this will outlaw the back unrounded vowels. The formal statement of this marking condition (given in (3.11)) will aid the child in the realization that [-round] must be a marked feature value in Hungarian. Given the assumption that it is a principle of UG which stops the neutral vowels from participating in BH, we would not expect that BH would ever be overgenerated to include /i/ and /e/ as possible targets, which we might expect if a language-specific aspect of the grammar excluded these vowels as targets.

RH is another spreading rule which spreads [-round] to short non-high vowels, and also requires the marked ON parameter setting. UG predicts that [+round] is the marked feature value, but if [+round] is the lexically marked value in Hungarian, neither the BH or RH facts can be captured. The arguments for the lexical specification of [-round] in Hungarian are presented in 3.1.2.2. These arguments come from the marking condition in (3.11), the quality of the linking vowel, and certain forms with long suffixal vowels. This evidence will tell the child acquiring Hungarian that the context-free parameter for [high] must be switched to the marked option, and this will automatically create a complement rule to insert [+round] as the predictable feature value. The RH alternations (shown in (3.13)) will
provide additional evidence for the resetting of FCR 9 in (4.19). Suffixal vowels following /ü/ and /ö/ are [+round] (földhöz), while those following /e/ and /i/ will be [-round] (néztek), demonstrating again that these particular vowels have distinct phonological representations.

Low Front Vowel Formation is a feature-changing rule which lowers a mid front unrounded vowel derived in certain BH and RH contexts. This rule requires the marked ON parameter setting, and also requires the statement of a target condition. This rule must take place in the phonetic component of the grammar since it appears that [e] can be derived through BH and RH. Low Vowel Formation will not be learned until the child has acquired the constraint given in (3.2) on the surface appearance of [e]. Ingram (1990) has discussed the learnability of negative constraints, particularly constraints which trigger repair rules such as Low Vowel Formation (see 2.4.3). He concludes that such constraints are learned initially as if-then conditions, and are only later translated into negative conditions. If this is the case, then both the constraint and the rule of Low Vowel Formation may be late acquisitions.

These phonological rules will lead the child acquiring Hungarian to the realization that the featural parameters in (4.21) must be reset at the marked option.
All four parameters will be eliminated from the grammar of Hungarian, although the context-free rules will be replaced by complement rules which redundantly supply the opposite feature value from that provided by UG.

Since there are four featural parameters in Hungarian which require resetting, there are four possible stages of restructuring which may show up developmentally. It is predicted that at one stage children acquiring Hungarian will make no distinction between back and front [+low] vowels, and only at a later stage will learn to suppress the FCR [+low] --> [+back] and therefore have distinct representations for both types of low vowels. In a similar fashion, these children will initially represent all front non-low vowels as [-round], and only at a later stage will suppress the FCR [-back], [-low] --> [-round] and have distinct representations for front non-low rounded and unrounded vowels.

The fact that two context-free parameters require resetting in Hungarian suggest that there should be an initial stage (or stages) where [+high] and [-round] are the lexically
specified features, and only at some later stage (or stages) will these children use the correct lexical specifications for Hungarian: [-high] and [+round].

The 4 parameters in (4.21) may or may not be reset one at a time, so it is possible that fewer than four stages may actually be apparent in the acquisition data from this language. The phonological rules of the language will not be used at all or will be incorrectly used until the related featural parameters have been correctly switched by the child.

4.3.1.2 Spanish

The set of universal default rules in (4.18) will give the initial specification of the 5 vowels of Spanish in (4.22).

(4.22) Initial Spanish Vowel System - RU

\[
\begin{array}{cccc}
\text{i} & \text{e} & \text{a} & \text{o} & \text{u} \\
\text{high} & - & - & - & - \\
\text{low} & + & - & - & - \\
\text{back} & + & + & - & - \\
\end{array}
\]

Each of the five vowels has a distinct representation in this system, and the surface realizations of these vowels will be [i], [e], [a], [o] and [u]. The features [high], [low] and [back] are the operative underlying features, and /i/ is the totally unspecified vowel, since [+high], [-low] and [-back] are the redundant values given by UG. This system differs from the adult system of Spanish shown in (3.44) only in the
lexically marked value of [high].

The RU analysis of the Spanish vocalic alternations is given in 3.2.2. The rules which are assumed to apply in Spanish and examples of each are listed in (4.23).

(4.23) Phonological Rules of Spanish - RU

a. Unstressed N Reduction (see (3.70))

Delink: skeletal slot
Target: head of a branching unstressed N
Domain: lexical (postcyclic)
e.g. t[e]ndEmos t[yE]nden
c[o]ntO c[wE]nto

b. High-Glide Formation (see (3.61))

Insert: [+high]
Target: non-head member of a branching stressed N
Domain: lexical (postcyclic)
e.g. t[e]ndEmos t[yE]nden
c[o]ntO c[wE]nto

c. Vowel Delinking (see (3.50))

Delink: skeletal slot
Target Condition: the leftmost unstressed N of two adjacent N's
Domain: lexical (cyclic)
e.g. am + a + o --> amo
tem + e + o --> temo
viv + i + o --> vivo
d. Final Vowel Lowering (see (3.71))

Delink: [+high]

Target condition: from a vowel in an unstressed final open syllable

Domain: lexical (postcyclic)

e.g. viv + i + φ --> vive
viv + i + n --> viven

Unstressed N Reduction deletes a skeletal slot in an unstressed syllable. This rule appears to be a direct consequence of the Branching Condition given in (3.69), which says that weak nodes may not branch. This rule uses the delink rule option (deletion of an association line), and requires the statement of a target condition.

High-Glide Formation is again an insertion rule, inserting the feature [+high] postcyclically. This rule applies only to the initial non-head member of a branching rhyme, and will apply vacuously if that segment is underlyingly specified as [+high]. High-Glide Formation provides further evidence that [+high] must be an operative feature value in the adult grammar, and this rule will not be used by a child until such time as the context-free parameter for [high] is reset at the marked option.

Vowel Delinking is another deletion rule, removing the skeletal slot of a vowel when two vowels become adjacent through morphological concatenation. Only the skeletal slot is deleted, so any associated features will be left floating
and will be reassociated through the Association Conventions to an unspecified root vowel.

The final rule assumed for Spanish is Final Vowel Lowering, which deletes the [+high] specification of a final unstressed vowel. This rule again provides evidence that [+high] must be a lexically marked feature value in Spanish, and will not be possible until the context-free parameter for [high] is reset. When this parameter is reset, rule 2 in (4.18) will be eliminated from the grammar of Spanish, and the complement rule in (4.24) will be added.

(4.24) Marked featural parameter in Spanish

\[
[ ] \rightarrow [-high]
\]

At this point [+high] will be the lexically marked feature value and [e] will become the unspecified vowel in the system.

The RU analysis of Spanish predicts that stress will crucially interact with the development of the phonological system, since it is present in the target conditions of Unstressed N Reduction, High-Glide Formation, Vowel Delinking and Final Vowel Lowering. Spanish children will have to determine how stress operates in their language before they can use these 4 rules in an appropriate fashion. The exceptional aspects of the stress system (e.g. which affixes are exceptional with regard to the application of the stress rules) will have to be learned before the stress rules will be acquired correctly.

The Complex N parameter must also be reset to the marked
option in Spanish. This parameter controls the number of skeletal slots that a nucleus may dominate. The unmarked option is that a nucleus may dominate only a single skeletal slot, while the marked option says that the nucleus may branch.

There final aspect of the phonology of Spanish that must be learned by the child is the statement in (3.57) which outlines the conditions under which a branching nuclei may be formed in Spanish. This type of statement is not required for Hungarian, since Hungarian allows only for long vowels, where a branching nucleus dominates a single feature matrix.

4.3.2 CU Predictions

In the theory of CU, the guiding principles of acquisition are the CU Principle of Systematization in (2.44) and the Restrictive Redundancy Condition, originally given in (2.45) and repeated in (4.25).

(4.25) The Restrictive Redundancy Condition (RRC)

a. Underlying representations do not contain feature values that are not used contrastively.

b. The most highly valued system contains the fewest number of features and feature values needed to contrastively distinguish the inventory of a language.

The RRC tells the child that feature values not used to contrast the segments of a language are omitted form
underlying representations. In the acquisition of a language a child will have to work out which segments in a language are in fact contrastive, and the initial hypotheses towards this end are provided by the universal R-rules. These rules were originally given in (2.48) and are repeated here in (4.26).

(4.26) Universal R-rules
1. [+low] --- [−high]
2. [+low] --- [+back]
3. [+low] --- [−round]
4. [+back] --- [+round]
   [−low]
5. [−back] --- [−round]
   [−low]
6. [−high] --- [−low]
7. [−high] --- [−low]
   [−back]

If a child discovers that a particular set of feature markings that are provided redundantly by the rules in (4.26) are contrastive in the language, a featural parameter (one of the R-rules) will be reset at the marked option. The RRC tells the child that if a set of segments contrast with regard to a particular feature then those feature values must be lexically marked. When a featural parameter is reset, the universal R-rule need not be eliminated from the language-particular grammar. This is in direct contrast to what occurs in the parametric theory of RU. Every language will have the core
set of R-rules in (4.26), and may have additional language-specific R-rules to provide non-contrastive feature specifications.

4.3.2.1 Hungarian

If we assume that the Hungarian child has phonetic representations for the 8 vowels /i, ü, u, ö, o, a, e, e/, and that the rules in (4.26) provide the initial hypothesis concerning which feature values must be marked underlyingly, these 8 sounds will be specified as shown in (4.27).

(4.27) Initial Representation of Hungarian Vowels - CU

<table>
<thead>
<tr>
<th></th>
<th>i/ü</th>
<th>e/ö</th>
<th>a/ε</th>
<th>u</th>
<th>o</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>low</td>
<td></td>
<td>+</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>back</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

In this system [round] is a totally redundant feature, given R-rules 3, 4 and 5. This initial system has 5 vowels, exactly as in RU. Based on R-rule 2, which predicts that low vowels will be redundantly [+back], /a/ and /ε/ will have identical representations. R-rule 7 predicts that front non-low vowels will be unround, and following this hypothesis /i/ and /ü/ and /e/ and /ö/ will have identical representations. Given that the rules in (4.26) provide the redundant feature specifications of the marked system in (4.27), the underlying vowels in (4.27) will surface as [i], [e], [a], [u] and [o].

The CU analysis of Hungarian in 3.1.4 shows that the
rules in (4.28) must be part of the grammar of Hungarian
(examples are given only if the rule was not given in (4.20)).
(4.28) Phonological Rules of Hungarian - CU

a. Back Harmony (BH) (see (3.27))

   Spread [+back]
   L --> R
   Feature-changing
   Domain: lexical (cyclic)

b. Round Harmony (RH) (see (3.32))

   Spread [+round]
   L --> R
   Target condition: [-high]
   Nucleus may not branch

   May be feature-changing
   Domain: lexical (cyclic)

c. Low Front Vowel Formation (see (3.35))

   Insert: [+low]
   Target condition: [-low]
       [-high]
       [-back]
       [-round]
   Non-branching nucleus

   Domain: postlexical
d. Insert [+back] (see (3.29))

Insert: [+back]

Trigger condition: only in roots marked *

Domain: lexical (cyclic)

Feature-changing

e.g. hí[i:]d-nak 'bridge, dat.'

cě[e:]l-nak 'goal, dat.'

e. Epenthetic Vowel Specification (see (3.36))

Insert: [-high]

[-low]

Target Condition: an empty skeletal slot

Domain: lexical (cyclic)

BH is a cyclic lexical rule that spreads either value of [back] from left to right, and it may change feature values. This rule requires the marked ON parametric option in order to apply. In the initial phonological inventory in (4.27) the vowels i/ü, e/ö, /u/ and /o/ are marked as either [+back] or [-back] so only these 4 vowels will act as triggers of BH. /a/, /ü/ and /ö/, which are triggers in the adult Hungarian BH system, will not be triggers at this initial stage in the phonology. The BH data in the input, such as that shown in (3.9) will tell the child that /i/ and /ü/ and /e/ and /ö/ are distinct segments in Hungarian, and that /a/, /ü/ and /ö/ do take part in BH. This will lead to the correct contrastive feature markings.

The vowels /i/ and /e/ are neutral with respect to BH in
Hungarian. This fact is explained by the marking condition given in (3.28), which is not a learned aspect of the grammar, but rather a direct consequence of the principle of Structure Preservation. Again, as discussed in 4.3.1.1, if it truly is a principle of UG that restricts the possible targets of BH, then we would not expect the child to ever derive back unrounded vowels through this rule.

RH is also a spreading rule that applies cyclically in the lexical component. RH spreads either value of the feature [round] to a short vowel target that is [-high]. In the initial system shown in (4.27) [round] is not an operative underlying feature, and therefore a rule of RH will be impossible at this stage. Alternations such as those in (3.13) - (3.15) will demonstrate for the child that [round] is an operative feature value in the language, and that /i/ and /u/ and /e/ and /o/ must be contrastively specified for this feature.

RH must be extrinsically ordered after BH, in order to achieve the correct output with forms possessing a low back root vowel. While the ramifications of extrinsic ordering are not entirely clear, it is possible that the child learning Hungarian might first use the incorrect ordering of these two rules, producing incorrect forms. We would probably expect that the correct ordering would be a late acquisition.

Low Vowel Formation is a late postlexical rule that forces a mid front unrounded vowel to surface as [ɛ]. As in
the RU analysis, this rule cannot be acquired until the constraints on long and short unrounded front vowels are acquired, and therefore should be a late acquisition.

Insert [+back] inserts a [+back] feature value into the representation of certain neutral-vowel-only roots. This feature cannot associate to the root vowel by Structure Preservation (i.e. the marking condition in (3.28)), but will associate, in a feature-changing fashion, to a following suffixal vowel. Because this rule applies only to a small class of roots, it should be a late acquisition.

The final rule posited for Hungarian is Epenthetic Vowel Specification, which provides the features required for an empty skeletal slot that is inserted by Epenthesis. In the RU analysis this rule is not required because the features of the epenthetic vowel are supplied by the redundancy rules of the language. In CU, however, R-rules are only context-sensitive, so redundant features cannot be supplied for a slot that is underlyingly totally unspecified.

The alternations involved in the rules of BH and RH will lead the child learning Hungarian to the realization that certain feature markings predictable by the R-rules in (4.26) must be marked in the language.

(4.29) Marked featural parameters of Hungarian

* [+low] --> [+back]

* [−back] --> [−round]

[−low]
The first R-rule parameter in (4.29) is a crucial one for the child. Until the child realizes that this rule does not hold, the representations of /a/ and /ɛ/ will be collapsed, and neither vowel will participate in BH (if indeed the child uses such rules at this time). Until the second rule is reset, the representations of the non-low front unrounded and rounded vowels will be collapsed, and [round] will be an inoperative feature. At this initial stage a rule of RH will be impossible. The second parameter in (4.29) will be reset once the PLD demonstrates that front rounded and unrounded vowels behave in a phonologically distinct fashion.

The final parameter that must be reset in Hungarian is the Complex N parameter. This will allow branching nuclei, making possible the presence of long vowels.

According to the CU analysis of Hungarian there are some aspects of this grammar which must be learned without the benefit of parameters. These include the language-specific R-rule given in (3.26), the constraints on [e] and [ɛ:], the knowledge that in certain neutral-vowel-only roots the rule of Insert [+back] must apply, and the knowledge that the marking condition in (3.28) must be turned off post-lexically.

4.3.2.2 Spanish

Given that the universal R-rules in (4.26) provide the initial hypotheses that children make about the phonological specification of their language, the child's initial system of Spanish will be as given in (4.30).
This is identical to the adult contrastive system given in (3.72). Since the systems are identical, there will be no featural parameters to be reset, and no parameter-related stages in the acquisition of Spanish.

The phonological rules used in the CU analysis of Spanish in 3.2.3 are given in (4.31).

(4.31) Phonological Rules of Spanish - CU

a. High-Glide Formation (see (3.78))

Insert: [+high]

target: non-head member of a branching stressed N

May be feature-changing Domain: postcyclic

b. Unstressed N Reduction (see (3.81))

Delink: x

| [-high] [-back]

Target condition: head of a branching unstressed N

Domain: postcyclic
c. Vowel Delinking (see (3.74))

Delink: skeletal slot

Target condition: non-head member of a branching unstressed N

Domain: lexical (cyclic)

d. Reassociation of [+high] (see (3.75))

Insert: association line from [+high]

Target condition: an immediately adjacent skeletal slot on the left marked as [-cons], [-high]

Feature-changing

Domain: lexical (cyclic)

e.g. conc[e]bir conc[i]bo
     conc[e]bia conc[i]biendo

e. Final Vowel Lowering (see (3.82))

Insert: [-high]

Target condition: an unstressed final vowel

Domain: postcyclic

May be feature-changing

High-Glide Formation, which adds [+high] to a branching N, may be a feature-changing rule in CU, since both values of [high] will be present underlyingly. This rule adds the feature [+high] to the non-head member of a diphthong so it will be realized as a glide. High-Glide Formation is a relatively complex rule as it requires the statement of a target condition.
Unstressed N Reduction deletes the skeletal slot of the head of an unstressed diphthong, causing the vowel to surface as a monophthong. This rule applies postcyclically, and it must apply after the stress rules of the language. In order to apply it requires the marked ON setting, and also a target condition.

Vowel Delinking is a cyclic lexical rule which deletes the leftmost vowel when two vowels become adjacent after a morphological operation. This rule delinks the skeletal slot of the vowel from the nucleus, leaving the features free to reassociate elsewhere. Again, Vowel Delinking is a fairly marked rule, since it involves a target condition.

Reassociation of [+high] is a cyclic lexical rule that reassociates the [+high] feature left behind by Vowel Delinking. The ordering of these two rules need not be stated, since Reassociation will not apply until a feature value is floating. For this rule to apply the rule parameter must be set of ON, and the [-high] target condition must be acquired.

The last rule posited for Spanish is Final Vowel Lowering which I assume applies postcyclically to replace the [+high] specification of a final unstressed vowel with [-high]. This rule applies only to the final unstressed syllable in a word and is therefore a lexical rule. It requires both the ON parameter setting, and a target condition statement.

The CU analysis predicts that there will be no developmental stages relating to the resetting of featural
parameters. One final aspect of the grammar of Spanish that must be learned are the exceptional aspects of the stress system. While stress appears to be rule governed, there are certain types of affixes which are exceptional with regard to the application of these rules.

4.3.3 Comparison of RU and CU Predictions

4.3.3.1 Hungarian

For the child acquiring Hungarian, RU predicts that the initial UG phonological system, present at the time the child has approximately 50 words productively, will have the following characteristics:

(4.32) Child's initial system of Hungarian - RU

a. The child's phonological system will consist of 5 distinct vowels realized as [i], [u], [a], [o] and [e].

b. Initially, only the features values [+back], [+low] and [-high] will be available for phonological manipulation.

c. [i] may occur as a substitute for /I/, [e] may occur as a substitute for /O/ and [a] may occur as a substitute for /ɛ/. Initially short vowels will be substituted for long vowels.

d. The epenthetic vowel will be /i/.

e. Since [round] is a totally redundant feature, a rule of RH will not be possible.
f. If a rule parameter for BH has been reset to ON, the initial triggers will be /u/ and /o/, and not /a/.

CU predicts the characteristics in (4.33) for this early UG-constrained system:

(4.33) Child's initial system of Hungarian - CU

a. The child's phonological system will consist of 5 distinct vowels realized as [i], [u], [a], [o] and [e].

b. Initially, only the feature values [+high], [+low] and [+back] are available for phonological manipulation.

c. [i] may occur as a substitute for /ü/, [e] may occur as a substitute for /ö/ and [a] may occur as a substitute for /ɛ/. Initially short vowels will be substituted for long vowels.

d. If the rule parameter for Epenthesis has been reset to ON, any vowel will be a possible epenthetic vowel, until such time as the child learns the appropriate vowel.

e. Since [round] is a totally redundant feature, a rule of RH will not be possible.

f. /a/, /ü/ and /ö/ will not be marked for backness and therefore will not initially act as triggers of Back Harmony.
These two initial systems are very similar. They both assume that there will be 5 phonologically distinct vowels, and they both predict that the representations of /i/ and /ʊ/, /e/ and /ʌ/, and /a/ and /ɛ/ will be collapsed. Given the assumptions outlined in 4.2.3, these two theories predict the same types of initial paradigmatic substitutions. As the redundancy rules in both RU and CU give [+back] as the redundant feature value of low vowels and [-round] as the redundant feature value of front non-low vowels, this predicts that [i] may act as a substitute for /ʊ/, [e] may act as a substitute for /ʌ/ and [a] may act as a substitute for /ɛ/. These substitution patterns are predicted to persist until the featural parameters of the language are reset. Both theories also predict that short vowels will be substituted for long vowels until such time as the Complex N parameter is reset.

The marked parameters of Hungarian required by the RU and CU analyses are compared in (4.34).
(4.34) Marked Parameters in Hungarian

RU

Featural Parameters

* [+low]  -->  [+back]  
* [-back]  -->  [-round]  
[-low]  
[ ]  -->  [-high]  
[ ]  -->  [+round]

Rule Parameters

Back Harmony
Round Harmony
Low Front Vowel Formation
Insert [+back]
Epenthetic Vowel Specification

CU

Complex N

The RU analysis of Hungarian predicts that 4 featural parameters will have to be switched from the initial system provided by UG to the adult system. Two of these rules are context-sensitive and two are context-free. The CU analysis predicts that 2 featural parameters require resetting to achieve the adult grammar of Hungarian, and these are both context-sensitive rules. The CU analysis therefore posits fewer restructuring stages than does the RU analysis.

Evidence for the resetting of the context-sensitive parameters will come from data that demonstrates that the
segments initially collapsed by the context-sensitive rules are in fact phonologically distinct. Evidence for the resetting of context-free parameters will come from other sources, in particular the operation of phonological rules.

The rule parameters required by the RU and CU analyses are also given in (4.34). In the RU analysis 3 rules are required, while in the CU analysis 5 rules are required. In CU each of the 5 rules represents the ON marked option of a rule parameter, suggesting that at some initial stage, none of these 5 rules will be used by children. In RU each of the 3 rules represents the ON marked option of a parameter. RU also requires that an ordering relationship between Back Harmony and Round Harmony be learned, while CU does not require this specified order.

Both RU and CU also assume that the Complex N parameter must be reset in Hungarian in order to permit long vowels. The fact that this is a parameter predicts that initially children will not make a phonological distinction between long and short vowels. As discussed in 4.2.2.3 I assume that once this parameter is reset, the child will be capable of representing all phonologically distinct vowels in either long or short format.

4.3.3.2 Spanish

Within the theory of RU, it is predicted that the initial phonological representation of Spanish vowels, at the time that the child has approximately 50 words productively, will
have the characteristics in (4.35).

(4.35) Child's initial system of Spanish - RU

a. The system represents the 5 vowels /i, u, e, o, a/ as distinct segments.

b. The features [high], [low] and [back] will be operative.

c. There will be no paradigmatic substitutions relating to the resetting of context-sensitive redundancy rules, but short simple vowels will be used in place of diphthongs until the Complex N parameter is reset.

d. [-high] will be the lexically marked value.

e. The epenthetic vowel will be /i/.

This system differs from the adult system of Spanish (shown in (3.44)) only in terms of the lexically marked value of the feature [high]. This difference predicts that initially the child will not be able to use rules such as High-Glide Formation and Final Vowel Lowering which require the use of [+high], since this will be a redundant feature in the system. It also predicts that if a child uses an epenthetic vowel, it will be /i/. Since there are no FCRs that require resetting in this language, there will not be any initial collapsing of phonological elements, and this predicts that no paradigmatic substitutions should occur at the initial period.

CU predicts that the initial system will have the
characteristics in (4.36).

(4.36) Child's initial system of Spanish - CU

a. The system represents the 5 vowels /i, u, e, o, a/ as distinct segments.
b. The features [high], [low] and [back] will be operative.
c. There will be no paradigmatic substitutions relating to the resetting of context-sensitive redundancy rules, but short simple vowels will be used in place of diphthongs until the Complex N parameter is reset.
d. Both [+high] and [-high] will be lexically marked.
e. If a rule of Epenthesis is in use, the vowel that surfaces in epenthetic positions can be any one of the 5 vowels in the system.

The initial and adult featural representations will be identical in the theory of CU. This means that no featural parameters will require resetting, and all features and feature values necessary in the adult system will be available to the child in the first phonological system. This again predicts that Spanish children should not make any substitution errors that are due to the initial collapsing of feature matrices, although they will replace underlying diphthongs with simple vowels.

The marked parameters assumed by RU and CU for Spanish are given in (4.37).
(4.37) Marked Parameters in Spanish

<table>
<thead>
<tr>
<th>RU</th>
<th>CU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Featural Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>[ ] --&gt; [-high]</td>
<td>none</td>
</tr>
<tr>
<td><strong>Rule Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Unstressed N Reduction</td>
<td>Unstressed N Reduction</td>
</tr>
<tr>
<td>High-Glide Formation</td>
<td>High-Glide Formation</td>
</tr>
<tr>
<td>Vowel Delinking</td>
<td>Vowel Delinking</td>
</tr>
<tr>
<td>Final Vowel Lowering</td>
<td>Final Vowel Lowering</td>
</tr>
<tr>
<td>Reassociation of [+high]</td>
<td></td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td></td>
</tr>
<tr>
<td>Complex N</td>
<td>Complex N</td>
</tr>
</tbody>
</table>

In RU it is assumed that the context-free parameter regulating the feature [high] must be reset in Spanish, producing a complement rule which gives [-high] as the predictable feature value. In Spanish there are no featural parameters to be reset between the child's initial system and the adult system, and consequently no developmental restructuring stages. In the RU analysis 4 rule parameters must be reset to the ON option to achieve the adult system, while the rule of Epenthesis is provided by UG. In the CU analysis 5 rules must be reset to the marked ON option to achieve the adult phonological system. In RU it is predicted that High-Glide Formation and Final Vowel Lowering will not be possible rules until the featural parameter for [high] has
been reset.

Both theories also assume that the Complex N parameter requires resetting in Spanish, allowing for underlying diphthongs. Since complex nuclei can only result from the marked setting of this parameter, it is predicted that initially children will not be able to use diphthongs in a phonologically distinct manner.

4.3.3.3 Summary

The initial phonological inventories predicted for both Hungarian and Spanish by the parametric theories of RU and CU are identical, although the marked specifications of the RU and CU systems are quite different. Both theories predict that the phonological inventories provided by the default rules of UG will contain 5 segments that will be realized as [i], [e], [u], [o] and [a]. Both predict that in the acquisition of Hungarian [i] will occur as a paradigmatic substitution for /u/, [e] will be used as a paradigmatic substitution for /ε/, and [a] will be used a substitute for /ɛ/.

The lexical markings of the RU system are those that are not provided by the universal default rules. In the Hungarian system, shown in (4.19), and the Spanish system, shown in (4.22), [i] is the totally unspecified vowel, [a] is marked [+low], [u] [+back], [e] and [-high], and [o] is marked as both [-high] and [+back]. The MRC in (4.17), interpreted as a statement of acquisitional markedness, predicts that [i]
should be the first vowel acquired, and [o] the last, based on the number of feature markings these segments have.

In CU, the representation of the initial phonological system of Hungarian is supplied by the RRC in (4.25) and the universal R-rules. In the Hungarian system, given in (4.29), and the Spanish system, given in (4.30), [a] is the least marked member of this set, as it is specified only as [+low], while [o] is the most marked, since it is specified as [-high], [-low] and [+back]. Given the RRC interpreted as a predictor of acquisitional markedness, [a] should be the first vowel acquired, and [o] the last.

Where the two parametric theories of underspecification differ is in their predictions for acquisition after the initial stage provided by UG. In Hungarian, the RU theory predicts that 4 featural parameters -- two context-sensitive and two context-free -- will have to be reset to the marked option to achieve the adult system of Hungarian. In contrast, the CU system predicts that only two context-sensitive rules will be reset. RU then predicts that there may be up to 4 restructuring stages in the acquisition of the vocalic system of Hungarian. CU, on the other hand, predicts that only two stages of phonological reorganization will occur in the acquisition of Hungarian. In Spanish RU predicts that a single context-free featural parameter will require resetting to achieve the adult system of Hungarian, while CU predicts that there will be no changes between the initial system hypothesized by the child and the adult phonological system.
RU then predicts at least one developmental reorganization of the phonological system, while CU predicts no such reorganization.

The rule systems for Hungarian and Spanish assumed by both RU and CU are similar, with the CU system utilizing at least one extra rule for each language. It is assumed in both theories that in order for these rules to apply, the rule parameters must be switched to ON.

I wish to make several comments concerning how the predictions made by the two parametric theories of underspecification relate to previous research on phonological development. Both theories of underspecification predict an initial 5 vowel system, while the research outlined in 4.1.2 and 4.1.4 show that the initial vocalic inventories used productively by children are small two or three segment systems. Jakobson, for example, proposed that the triangular /i/, /a/, /u/ (or /e/, /i/, /a/) system is the universal vocalic inventory.

How then do we reconcile a predicted 5 vowel system with an observed smaller system? Calabrese (1988) attempts to solve this particular question using a hierarchy of UG filters. These filters are similar to redundancy rules, except that they are stated in a negative fashion. Calabrese proposes that initially children are not able to violate any of the filters, and this will produce a triangular 3 vowel system. In Chapter 5 I will make a slightly different claim -- that phonological theory must incorporate a theory of
feature availability which will impose a universal order on how features are added to a phonological system. This is not an original claim, but one that was made in Jakobson and Halle (1956). It is possible that this theory of feature availability can be incorporated into a theory of feature geometry. The reason I have chosen this solution, rather than one like Calabrese's, is that it can be integrated into a theory of underspecification without having to totally revise the theory.

The parametric underspecification model developed in Chapter 2 and discussed in this chapter predicts that resetting of a phonological parameter should be an instantaneous event. Acquisition research discussed in 4.1 shows that in fact real-time acquisition is not instantaneous. Children learn rules and structures in a gradual fashion, over a period of time. Previous research has demonstrated that children learn new segments (or features) slowly, sometimes integrating them into new lexical items one at a time. Davis (1987) argues that it is not inconceivable that the parameter-switching device also operates in this fashion. He proposes that parametric learning can proceed as in the parallel distributed processing (PDP) model discussed in McLelland and Rumelhart (1986). The PDP model shows how learning can follow a U-shaped learning curve, how it can occur an item at a time, and how it will initially lead to overgeneralization and later to retreat. While I will not argue for a PDP model of parameter-switching, I will simply assume that some such model
can explain non-instantaneous learning. Gradual acquisition will then be a function of the learning mechanism, and does not represent an inadequacy of the parametric model itself.
Notes to Chapter 4

1 The High Amplitude Sucking paradigm and the Visually Reinforced Infant Speech Discrimination paradigm are described in Eilers (1980).

2 Voice Onset Time (VOT) is the measurement of the lag between the release of a prevocalic consonant and the moment at which voicing begins.

3 This is in part taken from Ingram (1989a).

4 K'iche children appear to be later language learners than English-speaking children. See Pye (1985) for some suggestions on why this might be true.

5 This question is discussed in Archangeli (1988). Archangeli argues that the feature is the basic unit in Radical Underspecification, but that because contrastive specifications must be determined on the basis of segmental contrasts, the segment and not the feature is the basic unit in Contrastive Underspecification. I would argue that if we assume that the universal R-rules initially constrain the child's initial specification of a phonological inventory, then in fact the feature is the basic unit of organization.

6 MacWhinney (1978) calls this process Fronting Harmony.

7 My statement of the Acoustic Feature Hypothesis is based on the Acoustic Representation Hypothesis given in Ingram (1989: 10). His hypothesis says:

Children first represent their early vocabulary in the form of fully specified phonetic features matrices.

I have revised this hypothesis because I do not wish to commit myself to the view that a phonetic/acoustic representation is fully specified. There is evidence from phonetic research that this may not be so (Keating 1985), and it seems to me that if one assumes underspecification for phonological representations, then the same should be true of other representations.
Although I will specify these templates using CV notation, I do not mean to suggest that these C's and V's represent skeletal slots that have inherent melodic information. Rather, I assume the theory of syllabification given in Levin (1985) where skeletal slots are bare timing units. The CV notation I use is simply an abbreviatory device to represent the difference between skeletal slots that will project nuclei and those that will not. The hypothesis about the earliest templates being CV or CVCV will involve some basic revisions of Levin's X-bar theory presented in (2.10). If we assume that the unmarked syllable (or word) template is CV, then we must also assume that Project N' and Incorporation are more marked mechanisms than Project N" and N-Placement. Since this is not the focus of this thesis I will not attempt these revisions, but merely assume that they exist.

McCarthy and Prince (1986) assume that the "elements" in (4.12) cannot be skeletal slots; however, I assume that they may be.

Since I will investigate only vowel phenomena in subsequent chapters, I will not attempt to account for partial reduplications involving consonants in any detail.

Presumably this empty consonantal slot will be phonetically filled by a glottal stop.

As will be seen in Chapter 5, sometimes the unspecified syllable is the initial syllable, and sometimes it is the final syllable.

Calabrese (1988) suggests that there may be a parameter which allows languages to choose between a radically underspecified phonological system and a contrastively underspecified system. I do not allow for this possibility.

In general I will cite Hungarian examples using orthographic form, however, in the case of long vowels and [ɛ], I will give both the orthographic and phonetic forms.
CHAPTER 5
Vocalic Acquisition in Hungarian and Spanish

In Chapter 4 a parametric model of phonological acquisition is outlined. This theory assumes that Universal Grammar provides the child with the set of principles and parameters that provide structure for the initial phonological system. This particular theory of acquisition adopts the basic premise that underlying representations lack certain types of redundant information. Two variants of this theory are outlined: one based on the theory of Radical Underspecification (RU), as outlined in Archangeli and Pulleyblank (1986), and the other based on the theory of Contrastive Underspecification (CU), outlined in Steriade (1987). RU assumes that only non-predictable information is present in underlying representations, while CU assumes that only contrastive non-redundant information is present underlingly. In 4.3 the predictions made by these theories for the acquisition of the vocalic systems of Spanish and Hungarian are outlined, based on the analyses presented in Chapter 3.

In this chapter I will look at early phonological acquisition in the two languages discussed in Chapter 3: Hungarian and Spanish. The data come from previously published acquisition studies of 4 Hungarian children and 3 Spanish children. The samples were organized into two sets:
one at an early period (Time 1) between 1;0 and 1;6 representing the child's earliest phonological system, and a second at a later period (Time 2) 4 to 6 months later. Based on the assumptions of the parametric model of acquisition given in 4.2, the child's phonological system at the earlier time should be highly constrained by the principles and parameters of UG, while the later system should have been restructured to more closely resemble the language-particular system (if restructuring is predicted).

Two criteria had to be met in order for an acquisition sample to be included in this study. The most crucial was that data had to be presented in phonetic form. A second, less crucial characteristic was that there had to be some indication that the data had been systematically collected. If only anecdotal utterances are recorded by an investigator, there is no guarantee that the sounds used by the child will be representative of their phonological system. I originally intended to use only longitudinal data from individual children; however, this did not prove to be possible for all children.

The data presented in this chapter are initially analyzed using the Phonetic Inventory and Phonological Contrasts methodology (Ingram 1981, 1989a). This is the only systematic method of analysis that has been developed to analyze data on normal phonological acquisition. It provides a set of well-defined steps for determining which of the child's forms will be included in the analysis, and eliminates much of the
variability in production data that may be due to performance errors or phonetic details. As such, it leads to a relatively clear picture of the child's phonological system, and makes cross-subject and cross-linguistic comparisons possible. The only drawback to the PIPC methodology is that it is based on the assumption that children acquire segments or segment contrasts, rather than features. The analyses will show, however, that when combined with a theory of parametric acquisition, many of the results produced by the PIPC can be translated into a featural account.

Two particular aspects of the acquisition data are focussed on: the phonological inventories used by Hungarian and Spanish children at two relatively early periods of phonological development, and the substitutions or mismatches used by these same children. These data demonstrate that both Hungarian and Spanish children generally acquire the vowels /a/, /e/ and /o/ first, that /u/ is the last of the core 5 vowels to be used productively, and that simple vowels are acquired in advance of long vowels or diphthongs. In Chapter 6 I attempt to account for the development of these vocalic inventories using the parametric theories of Radical and Contrastive Underspecification developed in Chapter 2.

The systematic substitutions or mismatches that occur between adult targets and child forms in both Hungarian and Spanish are examined in some detail. These mismatches are important, since as discussed in 4.2.3, they can help to provide interesting insights into the organization of the
child's phonological system. In Chapter 4 two types of
substitution processes were predicted to occur: paradigmatic
substitutions, which are those that are the result of the
unmarked featural parameters of UG applying in the child's
system, and syntagmatic substitutions, which are the result of
the rules of UG operating in the child's system.

Almost half of the vocalic errors that were found in both
sets of acquisition data were due to the paradigmatic
substitutions of a simple vowel for a complex one. Of the
remaining errors, the majority could be accounted for by a
syntagmatic process of Spread, where the features of either a
single vowel or an entire syllable are spread across the
child's word form. One surprising difference between the two
sets of acquisition data is that in Spanish the vowel or
syllable which spreads is generally the stressed one, while in
Hungarian this generalization does not hold true. These
substitution patterns, and the differences them, are discussed
in more detail in Chapter 6.

This chapter will be organized as follows. In 5.1 I
outline the Phonetic Inventories and Phonological Contrasts
methodology, and then present the results of the PIPC analyses
for Hungarian and Spanish. In 5.2 the types of substitution
patterns used by the two groups of children will be
investigated. A detailed analysis of these substitution
patterns and their relationship to the theories of RU and CU
will be left until Chapter 6.
5.1 Phonetic Inventories and Phonological Contrasts

Methodology

In the following sections I will outline the methodology developed by Ingram (1981, 1989a) with illustrative examples from small subsets of data from Borzone de Manrique and Massone (1985) and Alatorre (1976). In some cases the methodology has been revised slightly to deal with vocalic systems, and I will indicate where these changes have been made.

5.1.1 Phonetic Inventories

Step 1 is the determination of the child's phonetic inventory. The child's forms are given in a broad phonetic transcription, paired with a corresponding adult target. Variable pronunciations of a single adult target are phonetic tokens and the adult targets are lexical types. A typical phonetic type for each lexical type is then chosen, following the rules in (5.1) (this step is only necessary if a number of phonetic tokens are given for a single lexical type). The examples are taken from a set of data provided in Alatorre (1976) for her Spanish-speaking son at 2:9.
(5.1) Rules for choosing phonetic types (Ingram 1989a: 204)

a. If a phonetic type occurs in a majority of the phonetic tokens, select it\(^1\).

   e.g. moco [pete] 3x
     [bete] 1x
     [Bete] 1x

   choose [pete]

b. If there are three or more phonetic types, select the one that shares the most segments with the others.

   e.g. Gerardo [xelala]
         [xelaldo]
         [xeldaldo]

   choose [xelaldo]

c. If there are two phonetic types, select the one that is not pronounced correctly.

   e.g. bata [pata]
         [bata]

   choose [pata]

d. If none of the above work, select the first phonetic type listed.

   e.g. carne [xanen]
         [kanen]

   choose [xanen]

(5.1a) says that if a single phonetic token occurs in over 50% of the total attempts, then that token will become the phonetic type. (5.1b) comes into play when no token is more
frequent than all others. In this situation the phonetic type will be the token that contains the most representative set of segments. In the example given, 3 phonetic tokens have been used for the target Gerardo, each one occurring only once. In two of these forms the onset of the third syllable is [d], and in two the second syllable is [la]. By (5.1b) the form [xelaldo] will be chosen as the phonetic type since its second syllable is [la], and the onset of the third syllable is [d], and neither of the other phonetic tokens has both these characteristics. (5.1c) is used when neither (5.1a) nor (5.1b) is applicable. This criterion says that given a choice between two tokens, one which is correct, and one which is not, choose the incorrect form. This particular criterion helps keep the claims about the child's speech as conservative as possible. The final criterion in (5.1d) is used only when none of the previous rules works, and it simply says that when all else fails, choose the first phonetic type listed. While this rule is obviously arbitrary, it makes a decision that will be consistently applied in all cases. The sample that is achieved after applying the criteria in (5.1) is called the phonological lexicon.

The phonetic inventory is arrived at using the phonological lexicon. Ingram suggests that phonetic inventories be determined separately for initial and final consonants, and for single consonants and consonant clusters. The rationale behind this is that it has been shown that consonants are first acquired in initial position, and lastly
in final position, and that clusters are later acquisitions than single consonants (Templin 1957). The first step in determining the phonological inventory is to calculate the total number of phonetic forms that a given phone occurs in. This is done separately for each position (e.g. initial, medial, final) and for each sample. In (5.2) a phonological lexicon from a small set of data from Ignacio at 2;0 (Borzone de Manrique and Massone 1985) is given, sorted according to the vowels found in the initial syllable of each phonetic type².

(5.2) Ignacio's initial vowels at 2;0³

<table>
<thead>
<tr>
<th>Initial Vowel</th>
<th>Phonetic forms</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>ti, tila</td>
<td>2</td>
</tr>
<tr>
<td>o</td>
<td>ota, lor</td>
<td>2</td>
</tr>
<tr>
<td>e</td>
<td>pepe, cela, pelo, meja, eo, perta</td>
<td>6</td>
</tr>
<tr>
<td>a</td>
<td>aka, awa, mame, tato, kata</td>
<td>5</td>
</tr>
<tr>
<td>u</td>
<td>upa, lu</td>
<td>2</td>
</tr>
</tbody>
</table>

The next step in the analysis is to apply a frequency analysis to the sounds in the phonetic inventory. Ingram uses a set of frequency criteria to class sounds as marginal, used or frequent according to the sample size. Ingram's analyses are based on consonantal data, and since specific vowels tend to occur more frequently than consonants, I have made these criteria slightly more stringent for the vocalic data presented in this chapter. The frequency criteria for a sample of 68-87 lexical types given in Ingram (1981) are 2
(marginal), 3-5 (used) and 6 and up (frequent), while these numbers are increased by one in my criteria, shown in (5.3).

(5.3) Criteria of frequency

<table>
<thead>
<tr>
<th>No. of lexical types in samples</th>
<th>Marginal ( )</th>
<th>Used</th>
<th>Frequent *</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-25</td>
<td>1</td>
<td>2,3</td>
<td>4 and up</td>
</tr>
<tr>
<td>26-37</td>
<td>2</td>
<td>3,4</td>
<td>5 and up</td>
</tr>
<tr>
<td>38-67</td>
<td>2</td>
<td>3-5</td>
<td>6 and up</td>
</tr>
<tr>
<td>68-87</td>
<td>3</td>
<td>4-6</td>
<td>7 and up</td>
</tr>
<tr>
<td>88-112</td>
<td>3</td>
<td>4-7</td>
<td>8 and up</td>
</tr>
<tr>
<td>113 and up</td>
<td>4</td>
<td>5-8</td>
<td>9 and up</td>
</tr>
</tbody>
</table>

These criteria say that in a sample with 70 lexical types (i.e. adult targets), a vowel must occur a minimum of 3 times in order to be classed as marginal, 4, 5 or 6 times in order to be classed as used, and a minimum of 7 times to be classed as frequent. The criteria increase with sample size, since presumably the more lexical types, the greater the chance a sound will occur.

According to the criteria in (5.3) the data given in (5.2) will be assigned the following phonetic inventory, based on a sample size of 29 lexical types.

(5.4) Phonetic inventory for Ignacio's initial vowels at 2;0

(i) (u)

*e (o)

*a
[i], [u] and [o] appear in parentheses, which indicates that they are marginal sounds. Each of these sounds occurs twice in the mini-sample, and by the criteria in (5.3) this makes them marginal. Asterisks indicate that /e/ and /a/ are frequent, since they both occur at least 6 times in the sample. Sounds without diacritics of any sort are classed as used, although there are no such sounds in this sample.

5.1.2 Substitutions

Step 2 is the determination of the child's substitutions. These are found by comparing the adult targets with the child's phonetic types and noting whether the child produces the sound correctly or incorrectly. If incorrect, the substitute is given, or it is shown to be deleted. The proportion correct for each segment is determined by dividing the number of correct segments by the number of lexical types that contain that segment. The substitution patterns and proportions correct for each phonetic sound in Ignacio's sample at 2;0 are given in (5.5). Syllables in parentheses are those omitted by the child.
The child's matches are determined from the proportion correct for each sound. If the proportion correct is over 50%, then it is a match. A marginal match occurs when the child attempts a sound only once, and the attempt is correct. For the data in (5.5) there are five matches ([u], [a], [i], [e] and [o]) and no marginal matches.

5.1.3 Phonological Inventories

The final step in the analysis is to determine the child's phonological inventory. A sound is considered part of
the child's phonological system when the criteria in (5.6) are met:

(5.6)     a) it is frequent, or

b) it is used, and it appears as a match, or a substitute. (Ingram 1989a: 207)

Looking at Ignacio's phonetic inventory in (5.4) we see that [e] and [a] are frequent, while [i], [u] and [o] are marginal. [i], [u] and [o] are also matches as shown in (5.5), but since matches are only relevant if a sound is classed as used, they will not be part of the phonological inventory. Only [e] and [a], which are frequent in (5.4) and matches in (5.5) will be included in a phonological inventory.

(5.7) Ignacio's phonological inventory of initial vowels at 2;0

\[ e \]

\[ a \]

Composite phonological inventories can also be determined for several children acquiring the same language following the previously outlined steps. A composite consonantal inventory is given in Ingram (1981) for English and in Pye, Ingram and List (1987) for K'iche. Composites are obtained by using just those sounds that occur in the samples of a majority of the subjects. In this way it is possible to arrive at a standard phonological inventory for a given age group of children acquiring the same language.

Longitudinal samples provide the best evidence for the
emergence of phonological contrasts. Each sample is submitted to the PIPC method of analysis although Ingram suggests that phonetic types from previous sessions be included in the phonological lexicon of a later sample, provided that the child does not produce a new phonetic type for the same target in the later sample.

In adapting the PIPC methodology for use with vowels, I determined separate inventories for the vowels found in initial and non-initial syllables in each phonetic type. Samples were treated longitudinally, i.e. later samples included phonetic forms from earlier sessions as long as they were not altered by the child at the later sample. If an entire syllable was omitted by the child, then the vowel in that syllable was ignored. If, however, only the vowel and not the consonant was omitted, then the vowel was considered to have been deleted in some fashion. Finally, in determining matches, a marginal match was assumed to occur if the sound was correctly produced each time, but the sound only occurred a marginal number of times as determined by the criteria of frequency given in (5.3).

5.2 Vocalic Acquisition in Hungarian

I will first outline the Hungarian acquisition samples used, and then present a summary of the vowel system of Hungarian. I will then present the results of the PIPC analyses of the vocalic systems at Times 1 and 2, and some data on the mismatches and vocalic substitution patterns that
occur in the Hungarian children's word forms.

5.2.1 Samples

The Hungarian acquisition data used in this study are outlined in (5.8)*.

(5.8) Hungarian Samples

<table>
<thead>
<tr>
<th>Child's Name</th>
<th>Sex</th>
<th>Source</th>
<th>Age</th>
<th>No. of Lexical Types</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T.A.</td>
<td>M</td>
<td>Gõsy (1978)</td>
<td>1;2-1;5</td>
<td>37</td>
</tr>
<tr>
<td>Jolán</td>
<td>F</td>
<td>Endrei (1913) in</td>
<td>1;2-1;5</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(MacWhinney 1974)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laci</td>
<td>M</td>
<td>Balassa (1893) in</td>
<td>1;1-1;3</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(MacWhinney 1974)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Time 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T.A.</td>
<td>M</td>
<td>Gõsy (1978)</td>
<td>1;6-1;10</td>
<td>142</td>
</tr>
<tr>
<td>M.</td>
<td>F</td>
<td>Meggyes (1971)</td>
<td>1;8-1;11</td>
<td>144</td>
</tr>
</tbody>
</table>

The first sample for T.A. and the samples from Jolán and Laci will be used to represent Time 1. For all 3 children Time 1 occurred between 1;1 and 1;5. The first available data from M. are at 1;8, so M.'s data will represent Time 2, along with the second sample from T.A.*. The data from all 4 Hungarian children come from diary studies, where parents or researchers followed the children and recorded their utterances. Data for all children were given in relatively broad phonetic transcription.
The main dialectal difference that affects the vocalic system of Hungarian is in the surface realization of the vowels that I will call /e/ and /ɛ/, a mid front unrounded vowel and a low front unrounded vowel, respectively (Vago 1980). In many dialects, including the Standard Budapest dialect, both phonemes are realized as [ɛ]. In Chapter 3 I have discussed this issue at length, and I assume that a phonetic rule of Front Vowel Lowering, given in (3.22) accounts for the surface realization of the mid front unrounded vowel as the low vowel [ɛ]. Presumably in dialects where both [e] and [ɛ] exist, the rule of Front Vowel Lowering does not. The studies outlined in (5.8) do not indicate which dialects of Hungarian are being acquired by these children, and I will simply assume that in each case it is the Standard.

5.2.2 Hungarian Vowels

The adult vocalic system of Hungarian (Standard Budapest dialect) first given in (3.1) is repeated in (5.9). Vowels are given in both their orthographic and phonetic forms.

(5.9) Hungarian vowel system

<table>
<thead>
<tr>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>i[i]</td>
<td>i[i:]</td>
</tr>
<tr>
<td>u[y]</td>
<td>u[y:]</td>
</tr>
<tr>
<td>o[o]</td>
<td>o[o:]</td>
</tr>
<tr>
<td>e[ɛ]</td>
<td>e[e:]</td>
</tr>
<tr>
<td>a[ɔ]</td>
<td>a[a:]</td>
</tr>
</tbody>
</table>

Phonetically, the short low back vowel is [ɔ] and the short low front vowel is [ɛ]. As discussed in 3.1.1 I assume,
following Vago (1980), that the rounding of the short low back vowel is purely phonetic. Historically the language contained both mid and low front vowels, but these have been merged in most dialects, with the result that the short vowel is low and the long vowel is mid in the Standard dialect (see discussion in 5.1.2.1 above). Syllable structure in Hungarian is predominantly CV(C), although both complex onsets and codas are permitted. Words are most often consonant-final although vowel-final words do occur. Stress always falls on the initial syllable in a word (Kontra and Ringen 1986).

As discussed in 3.1.1, I follow current phonological theory in assuming that in general long and short vowels have identical feature specifications, but that long vowels are associated to two skeletal slots, while short vowels are associated to only one. In Hungarian this means that there are distinct feature specifications for the 8 vowels in (5.10).

(5.10)  

\[
\begin{array}{ccc}
  & i & \ddot{u} & u \\
  e & \delta & u \\
  \varepsilon & a \\
\end{array}
\]

Two surface configuration constraints and a rule of Front Vowel Lowering account for the asymmetries between the system in (5.10) and the phonetic vowel systems in (5.9). The constraints and the rule of Front Vowel Lowering, originally given in (3.20) and (3.22), are repeated in (5.11).
(5.11)  a. Configuration Constraints
\[
\begin{array}{ccc}
  * N & * N \\
  / \ & | \\
 x & x & x \\
 \backslash / & | \\
  [-high] & [-high] \\
  [+low] & [-low] \\
  [-back] & [-back] \\
  [-round] & [-round] \\
\end{array}
\]

*\[e:]\] *\[e\]

Domain: post-lexical

b. Low Front Vowel Formation

Insert: [+low]

Target condition: [-low]

[-high]
[-back]
[-round]

Non-branching nucleus

Domain: post-lexical

The constraints in (5.11a) prohibit the realization of a mid front unrounded vowel associated to a single skeletal slot, and a low front unrounded vowel associated to two skeletal slots. The constraint on *[e] triggers the rule of Front Vowel Lowering given in (5.11b), which changes the
specification of [low] of a front non-low unrounded vowel. Given the rule and constraints in (5.11) and the phonological inventory in (5.10), the vowel which surfaces as [ɛ] may be underlyingly /e/ or /ɛ/. A detailed analysis of how the vowels in (5.10) interact phonologically is given in 3.1.

5.2.3 Phonological Inventories

In presenting the results of the PIPC analysis for the Hungarian samples in (5.8) I will first outline the data from individual children and then the composite inventories. The analyses were performed separately on vowels found in initial and non-initial syllables (based on the vowels in the child's phonetic types). It was found that very little qualitative difference existed between the two set of vowels, and therefore in the examination of the phonological inventories these two categories were collapsed. Initial vowels were more frequent than non-initial vowels (i.e. vowels in initial and non-initial syllables) at Time 1, but more non-initial vowels than initial vowels were attempted at Time 2 (Time 1 - 88(initial), 49(non-initial); Time 2 - 292(initial), 336(non-initial). Data for long and short vowels will be presented separately.

The phonetic inventories, matches and phonological contrasts for 3 Hungarian children at Time 1 are given in (5.12).
(5.12) Hungarian - Time 1

<table>
<thead>
<tr>
<th>Phonetic Inventory</th>
<th>Matches</th>
<th>Phonological Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T.A.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>a,ε,o,u,i,(ǜ)</td>
<td>i</td>
</tr>
<tr>
<td>ü</td>
<td></td>
<td>u</td>
</tr>
<tr>
<td>u</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ǜ)</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td>(ō)</td>
<td></td>
<td>o</td>
</tr>
<tr>
<td>*ε</td>
<td>*a</td>
<td>*ā</td>
</tr>
</tbody>
</table>

| **Jolán**          |             |                        |
| *i                 |             | a,ε,o,i,(ǜ)            |
| (ū)                |             | i                      |
| (ō)                | *o          | *ō                      |
| *ε                 | *a          | *ā                     |

| **Laci**           |             |                        |
| *i                 |             | a,ε,o,i               |
| (ū)                |             | i                      |
| (ō)                |             | o                      |
| *ε                 | *a          | *ā                     |

The most startling aspect of these data is the difference between the short and long vowel inventories. In each case the inventory and matches for long vowels are a much smaller set. It is also striking that neither of the front rounded vowels are represented in the phonological inventories. In T.A.'s phonetic inventory [ū] is classed as used and [ō] is both marginal and a match. Jolán uses [ō] as a marginal phonetic segment and as a marginal match, but neither child uses the front round vowels consistently enough to have them included in their phonological inventories.
The composite phonological inventory for Hungarian at Time 1, assuming that 2 out of 3 children must have a given sound in their phonological inventory is given in (5.13).

(5.13) Composite Phonological Inventory for Hungarian at Time 1

<table>
<thead>
<tr>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td></td>
</tr>
<tr>
<td>o</td>
<td></td>
</tr>
<tr>
<td>ε</td>
<td>a</td>
</tr>
<tr>
<td>a</td>
<td>à</td>
</tr>
</tbody>
</table>

The short vowel system lacks three vowels of the adult language: /u/, /ʊ/ and /ɵ/; while the long vowel set includes only the low back vowel.

The phonetic inventories, matches and phonological contrasts data for 2 Hungarian children at Time 2 (approximately 4 months later) is given in (5.14).
(5.14) Hungarian - Time 2

<table>
<thead>
<tr>
<th>Phonetic Inventory</th>
<th>Matches</th>
<th>Phonological Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.A.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*i ʌ *u</td>
<td>a,e,o,u,i,ʊ,ʌ</td>
<td>i ʊ u</td>
</tr>
<tr>
<td>*o *e ʊ *o</td>
<td>a,e,ʊ,ʌ</td>
<td>o ʊ e ʊ e</td>
</tr>
<tr>
<td>*ɛ *a *ã</td>
<td>e a ŋ</td>
<td></td>
</tr>
</tbody>
</table>

| M.                 |         |                        |
| *i *ʌ *u            | a,e,o,u,i,ʊ,ʌ  | i ʊ u                  |
| *o *e (ɛ) *o        | a,e,ɛ      | o ʊ e ɛ               |
| *ɛ *a *ã           | e a ŋ       |                        |

There is still a fairly marked difference between the short and long vowel systems. T.A. has 7 short vowels and 4 long vowels in his phonological inventory, while M. has 7 short vowels and only two long ones.

The composite phonological inventory for Time 2 is given in (5.15). This inventory includes only those vowels that occur in the phonological inventories of both T.A. and M. (i.e. 2 out of 2 children).
(5.15) Composite Phonological Inventory for Hungarian at Time 2

<table>
<thead>
<tr>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>ã</td>
</tr>
<tr>
<td>ó</td>
<td>o</td>
</tr>
<tr>
<td>e</td>
<td>é</td>
</tr>
<tr>
<td>ε</td>
<td>a</td>
</tr>
</tbody>
</table>

This system contains all 7 short vowels of the adult language, but only /ã/ and /é/. The front rounded vowels and /u/ and /é/ have been added to the inventory since Time 1.

5.2.3 Mismatches

As was discussed in 4.2.3, several possibilities can arise when a child attempts an adult target. First, the child may produce the sound correctly, in which case it will show up as correct in an analysis such as that shown in (5.5). The second possibility is that there will be a mismatch between the child's form and the adult target. According to the parametric acquisition model a child's phonological system can differ from the adult system only in the setting of phonological parameters. In 4.2.3 it is shown that this leads to the predictions that the two types of substitution patterns in (5.16) can account for these mismatches.
(5.16) Substitution Patterns

a. Paradigmatic - the substitution is produced by the universal context-sensitive rules of UG

b. Syntagmatic - the substitution is provided by the rule parameters.

A paradigmatic substitution will occur when the universal setting of a parameter is in effect in the child's early system, when the adult system being learned requires the marked parameter setting. Two specific types of paradigmatic substitutions are discussed in 4.2.3.1: those resulting from the unmarked setting of a context-sensitive featural parameter (redundancy rule), and those resulting from the unmarked setting of the Complex N parameter. The effect of the unmarked setting of these types of parameters will be that certain sounds that are distinct in the adult system may not be in the child's. Some specific examples of paradigmatic substitutions are given in 4.2.3.1.

Syntagmatic substitutions occur when the child's form contains an empty skeletal slot, and featural information from some other segment in that form is spread onto the empty slot. In 4.1.2.4 it was hypothesized that the structure of children's early word forms are provided by fairly simple templates, to which featural information is mapped. In certain cases the child may be unable to provide feature specifications for all elements in the template, and one or
more skeletal slots will be totally unspecified. The Satisfaction Condition, given in (4.13), will force the child to provide feature specifications for the empty slot(s) from elsewhere in the word.

The acquisition literature shows that Spreading appears to be the most common process that is used to provide syntagmatic substitutions. Forms that have traditionally been called 'partial' reduplications in the child language literature can be accounted for by a rule of Spreading which spreads only the vowel (I am concerned here only with those forms where the child's vowels differ from those in the target forms), while those that have traditionally been called 'total' reduplications can be accounted for by a rule which spreads the features of both the consonant and vowel in a single syllable.

In this section I will investigate the mismatches that occur in both Hungarian and Spanish. I will look generally at the number and proportion of mismatches that occur at both time periods and, more specifically, at the proportion of the mismatches that are due to confusions between long and short vowels. The specific mismatches that occur at both times will be given, and I will show how these can be accounted for by paradigmatic and syntagmatic substitution processes.

The number of vowels attempted, number and proportions of initial and non-initial mismatches, and proportion of all mismatches that involve short vowel/long vowel confusions for the Hungarian data at Times 1 and 2 are given in (5.17).
(5.17) Mismatches at Times 1 and 2 - Hungarian

<table>
<thead>
<tr>
<th>Vowels attempted</th>
<th>Prop. due mismatches to long/short confusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 1</td>
<td>137</td>
</tr>
<tr>
<td>Time 2</td>
<td>628</td>
</tr>
</tbody>
</table>

Of 137 attempted vowels at Time 1 and 628 attempted vowels at Time 2, approximately 15% were mismatches. Of these errors, 45% at Time 1 and 50% at Time 2 occurred when a long vowel target was replaced by a short vowel or a short vowel target was replaced by a long vowel.

The patterns of vowel use and misuse were similar for some children and quite different for others. The breakdown of number and proportion of initial and non-initial vowels attempted, total number of vowels attempted, proportion of mismatches to total number of vowels attempted and the proportions of mismatches that are due to long/short vowels confusions for each child at Time 1 are given in (5.18).

(5.18) Mismatches - Time 1

<table>
<thead>
<tr>
<th>Vowels Attempted</th>
<th>Mismatches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prop. of vowels</td>
</tr>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Child</td>
<td>No.</td>
</tr>
<tr>
<td>T.A.</td>
<td>37</td>
</tr>
<tr>
<td>Jolán</td>
<td>26</td>
</tr>
<tr>
<td>Laci</td>
<td>25</td>
</tr>
</tbody>
</table>
Of the vowels attempted by T.A. and Laci approximately two-thirds are initial vowels and one-third are non-initial, while Jolán's proportion is slightly higher at .70. The proportion of vowels attempted that were mismatches varied between .05 for Jolán and .20 for Laci. The two children with the highest proportions of mismatches (T.A. and Laci) are also the two children who attempted the largest proportions of non-initial vowels. .88 of all errors made were due to confusions between long and short vowels for Laci. This proportion decreases drastically to .20 for T.A., and none of Jolán's mismatches were due to long/short vowel confusions.

The specific mismatches that are not due to long/short confusions for T.A., Jolán and Laci at Time 1 are given in (5.19)⁷. These involve apparent deletions from the adult target and substitutions.

(5.19) Individual Mismatches - Time 1°

Initial Vowels

<table>
<thead>
<tr>
<th>Child</th>
<th>Mismatch</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.A.</td>
<td>ā --&gt; a</td>
<td>cipo --&gt; [popo]</td>
</tr>
<tr>
<td></td>
<td>i --&gt; o</td>
<td>viz  --&gt; [zūs]</td>
</tr>
<tr>
<td></td>
<td>i --&gt; ū</td>
<td>toronj --&gt; [tɔnjo]</td>
</tr>
<tr>
<td>Jolán</td>
<td>u --&gt; a:</td>
<td>guritsd --&gt; [ga:]</td>
</tr>
<tr>
<td></td>
<td>u --&gt; o</td>
<td>pucol --&gt; [pojts]</td>
</tr>
<tr>
<td>Laci</td>
<td>o --&gt; a</td>
<td>hoppā --&gt; [appa:]</td>
</tr>
</tbody>
</table>
Non-initial Vowels

Child | Mismatch | Example
---|---|---
T.A. | o --> - | auto --> [aut]
| ü --> - | csücsül --> [tɕütʃ]

Several of these forms are 'partial reduplications', which as discussed in 4.2.3.2 can be accounted for by a rule of Spread which operates across words. In T.A.'s speech the word magnő becomes [magna] with the second vowel changing to agree with the initial vowel. In Laci's speech the word hoppä becomes [appa:] with the initial vowel taking on the quality of the final vowel. T.A.'s word for cipo is a reduplicated form, where the vowels in both syllables are identical, although the quality of both vowels differs from the vowels in the target. The only examples of apparent deletions or omissions of vowels from the target are shown in the speech of T.A. In both cases the vowel that is deleted is a non-initial one.

The analysis of vowels attempted and proportion of mismatches for T.A. and M. at Time 2 are given in (5.20).

(5.20) Mismatches - Time 2

<table>
<thead>
<tr>
<th>Vowels attempted</th>
<th>Mismatches</th>
<th>Prop. of</th>
<th>Prop. due</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.A.</td>
<td>145</td>
<td>.53</td>
<td>129</td>
</tr>
<tr>
<td>M.</td>
<td>147</td>
<td>.41</td>
<td>207</td>
</tr>
</tbody>
</table>
T.A. produced only slightly more initial vowels than non-initial ones, while M. produced proportionately more non-initial vowels than initial ones. Both children at this stage produce a greater proportion of non-initial vowels than the children at Time 1, shown by comparing (5.20) to (5.18). The proportions of mismatches to total vowels attempted are similar at both times. In M.'s speech twice as many mismatches occur that are due to long/short vowel as in the speech of T.A.

The mismatches that are not related to long/short vowel confusions for T.A. and M. at Time 2 are provided in (5.21).

(5.21) Individual Mismatches - Time 2

<table>
<thead>
<tr>
<th>Child</th>
<th>Mismatches</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.A.</td>
<td>u  --&gt; a</td>
<td>ce[ε]ruza --&gt; [saga]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>huszár --&gt; [hasa]</td>
</tr>
<tr>
<td></td>
<td>ő  --&gt; a</td>
<td>óra --&gt; [aga]</td>
</tr>
<tr>
<td></td>
<td>u  --&gt; i</td>
<td>bugyi --&gt; [bidji]</td>
</tr>
<tr>
<td></td>
<td>u  --&gt; o</td>
<td>uborka --&gt; [obojka]</td>
</tr>
<tr>
<td></td>
<td>i  --&gt; o</td>
<td>cipo --&gt; [posi]</td>
</tr>
<tr>
<td></td>
<td>i  --&gt; o:</td>
<td>írógép --&gt; [o:jig]</td>
</tr>
<tr>
<td></td>
<td>á  --&gt; ε</td>
<td>bácsi --&gt; [bɛʃ]</td>
</tr>
<tr>
<td></td>
<td>ε  --&gt; a</td>
<td>e[ε]szik --&gt; [atsi]</td>
</tr>
<tr>
<td></td>
<td>e  --&gt; i</td>
<td>éne[ε]el --&gt; [ikɛj]</td>
</tr>
<tr>
<td></td>
<td>ü  --&gt; ε</td>
<td>fütyi --&gt; [sɛpi]</td>
</tr>
<tr>
<td></td>
<td>ő  --&gt; -</td>
<td>lóci --&gt; [lɔtsi]</td>
</tr>
</tbody>
</table>
Several of the mismatches that occur in T.A.'s speech are 'partial' or 'total reduplications' (e.g. [saga], [aga], [hasa], [obojka], [tsistsis], [pi\$pi\$]), while there are only two such forms in M.'s speech ([k\$ste], [k\$st\$t]). The majority of T.A.'s substitution patterns can be explained as examples of Spread, or the omission of target sound. In a
large number of cases the target vowel that is affected by Spread is one which is not in the child's repertoire, or is a vowel that is only added to the repertoire at Time 2. In T.A.'s form [aga], for example, long /ʊ/ [oː], which as shown in (5.12) is not in the child's repertoire at Time 1, is replaced by /a/, which is. In M.'s form for kesztyű, /ʊ/, which only becomes part of the Hungarian child's repertoire at Time 2, is replaced by [ɛ] which is an earlier acquired sound. These patterns will be discussed further in 5.2.1.

5.2.5 Substitution Patterns

The two types of substitution patterns that will be discussed in this section and in 5.3.5 are given in (5.16). Paradigmatic substitutions occur when an unmarked parameter setting supplies a substitution for a sound that is not in the child's phonological inventory, and syntagmatic substitutions occur when the replacement sounds or features are supplied from elsewhere in the word. In this section I will focus on substitutions which do not involve the Complex N parameter, i.e. those that do not involve long/short vowels confusions in Hungarian and diphthong reductions in Spanish.

5.1.5.1 Syntagmatic Substitutions

Representative samples of the errors which do not involve confusions between long and short vowels at Times 1 and 2 in Hungarian are given in (5.19) and (5.21). Almost half of these remaining errors can be called 'partial' or 'total'
reduplications, which, as discussed in 4.2.3.2, can be accounted for by a rule of Spread operating in a child's multisyllabic forms. In (5.22) the proportion of multisyllabic forms used individually and overall by Hungarian children at Times 1 and 2, as well as the proportion of multisyllabic forms containing differentiated vowels are given.

(5.22) Multisyllabic Phonetic Types - Hungarian

<table>
<thead>
<tr>
<th></th>
<th>Proportion of multisyllabic types</th>
<th>Proportion containing differentiated vowels</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T.A.</td>
<td>.68</td>
<td>.24</td>
</tr>
<tr>
<td>Laci</td>
<td>.73</td>
<td>.26</td>
</tr>
<tr>
<td>Jolán</td>
<td>.59</td>
<td>.35</td>
</tr>
<tr>
<td>Mean</td>
<td>.67</td>
<td>.28</td>
</tr>
<tr>
<td><strong>Time 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T.A.</td>
<td>.78</td>
<td>.53</td>
</tr>
<tr>
<td>M.</td>
<td>.88</td>
<td>.62</td>
</tr>
<tr>
<td>Mean</td>
<td>.83</td>
<td>.58</td>
</tr>
</tbody>
</table>

At Time 1 approximately two-thirds of the children's phonetic types are multisyllabic, although only about one-quarter of those contain differentiated vowels, i.e. two vowels with different qualities. This means that in almost three-quarters of children's multisyllabic forms the specification of one of the vowels can be accounted for by a rule of Spread⁹. At
Time 2 the proportion of multisyllabic forms increases to a mean of .83, and the proportion of forms containing differentiated vowels increases to .58. Less than half of children's multisyllabic forms at Time 2 are affected by Spread.

The individual examples of Spread that appear in the speech of the Hungarian children at Times 1 and 2 are given in (5.23). These are divided up into two categories: those where two syllables in a child's form are identical, and those where only the vowels are identical. The first will be referred to as CV Spread, and the latter as V Spread.

(5.23) Syntagmatic Substitutions in Hungarian

<table>
<thead>
<tr>
<th>CV Spread</th>
<th>V Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>cica</td>
<td>c[e]ruza</td>
</tr>
<tr>
<td>piskóta</td>
<td>[pi]ra</td>
</tr>
<tr>
<td>cipo</td>
<td>[popo]</td>
</tr>
<tr>
<td>pancakesi</td>
<td>[puntipunt]i</td>
</tr>
<tr>
<td></td>
<td>huszár</td>
</tr>
<tr>
<td></td>
<td>uborka</td>
</tr>
<tr>
<td></td>
<td>ke[e]sztyű</td>
</tr>
<tr>
<td></td>
<td>ke[e]sztyút</td>
</tr>
<tr>
<td></td>
<td>minde[e]nke[e]</td>
</tr>
<tr>
<td></td>
<td>magnó</td>
</tr>
</tbody>
</table>

Only 4 of these forms represent 'total reduplication' or CV Spread, while a possible 9 are examples of V Spread. In 2 of 3 forms undergoing CV Spread the initial vowel is spread onto
a following syllable (in the fourth case the adult form is also a reduplication). In the forms which undergo V Spread, in 4 of the 9 the features of the vowel in the initial syllable are spread onto a vowel in a non-initial syllable, while in 5 cases the reverse is true. These processes then appear to operate in any direction that they can. If the specified vowel is initial, then they will operate from left-to-right, and if the specified vowel is final, they will operate from right-to-left.

The target vowels whose features are provided by V Spread are /o/, /o/, /u/, /u/ and [ɛ]. /u/ is not part of the Hungarian child's repertoire at Time 2, as shown in (5.15), while /u/ and /u/ are added to the repertoire between Times 1 and 2. The one form which targets /o/ contains a geminate consonant, and the target of [mindexkki] is trisyllabic. The vowels whose feature specifications are provided by CV Spread are /ø/ [ø:], /ø/ and /a/. The data in (5.23) seem to support the assumptions in 4.2 that syntagmatic substitutions occur when 1) a vowel in the target is not present in the child's phonological repertoire at that time, or 2) the target is complex in some fashion.

5.1.5.2 Paradigmatic Substitutions

Approximately one-half of the mismatches that occur in the Hungarian data cannot be explained as syntagmatic substitutions, and therefore are possible paradigmatic substitutions. Since these individual mismatches have not
been subjected to any frequency criteria, I will arbitrarily assume that a substitution must occur 3 times before it can be called systematic. The substitutions that occur at least 3 times in the Hungarian data at Times 1 and 2 are given in (5.24).

(5.24) Paradigmatic Substitutions

\[
\begin{array}{l}
e[\varepsilon]szik \rightarrow [atsi] \\
ce[\varepsilon]ruzát \rightarrow [talusa:t] \\
me[\varepsilon]nj \rightarrow [maj] \\
kukurit \rightarrow [kokulit] \\
rókaurat \rightarrow [ro:kaolat] \\
pucol \rightarrow [pojts]
\end{array}
\]

The two substitutions that are frequent (and hence can be called patterns) are the replacement of /u/ with [o], and /ɛ/ with [a]. The latter pattern is predicted both by RU and CU, as discussed in 4.3.3.1, since it is assumed that the context-sensitive rules of UG give /a/ as the low vowel unmarked for backness. The pattern /u/ \rightarrow [o] is not predicted by either theory. What is interesting is that both patterns involve the replacement of a sound which is acquired only at Time 2 with a sound acquired at Time 1 (see (5.13) and (5.15)). The fact that the substitution of [a] for /ɛ/ occurs even at Time 2 (see [atsi] and [talusa:t] in (5.21)), when both /ɛ/ and /a/ have been acquired according to the PIPC analysis, suggests that these paradigmatic substitutions may continue even once
the child uses a sound productively.

The initial RU and CU systems of Hungarian, as discussed in 4.3, predict that /ð/ should be realized as [i] and that /ɵ/ should be realized as [e]. There is no evidence for these substitution patterns in the Hungarian data. One possible explanation for their non-occurrence is that syntagmatic process such as CV and V Spread are somehow more powerful, and destroy the possible contexts for these processes.

5.3 Vocalic Acquisition in Spanish

As in the previous section, I will first outline the Spanish acquisition samples used, then I will present the results of the PIPC analyses and the mismatch data.

5.3.1 Samples

The Spanish acquisition data are outlined in (5.25).
(5.25) Spanish Samples

<table>
<thead>
<tr>
<th>Child's Name</th>
<th>Sex</th>
<th>Source</th>
<th>Age</th>
<th>Lexical types</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Florencia</td>
<td>F</td>
<td>Borzone de Manrique &amp; Massone (1985)</td>
<td>1;0-1;5</td>
<td>35</td>
</tr>
<tr>
<td>Ignacio</td>
<td>M</td>
<td>Borzone de Manrique &amp; Massone (1985)</td>
<td>1;5-1;7</td>
<td>28</td>
</tr>
<tr>
<td>Claudio</td>
<td>M</td>
<td>Alatorre (1976)</td>
<td>2;0-2;5</td>
<td>16</td>
</tr>
<tr>
<td><strong>Time 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Florencia</td>
<td>F</td>
<td>Borzone de Manrique &amp; Massone (1985)</td>
<td>1;6-2;0</td>
<td>67</td>
</tr>
<tr>
<td>Ignacio</td>
<td>M</td>
<td>Borzone de Manrique &amp; Massone (1985)</td>
<td>1;8-2;0</td>
<td>57</td>
</tr>
<tr>
<td>Claudio</td>
<td>M</td>
<td>Alatorre (1976)</td>
<td>2;6-2;11</td>
<td>75</td>
</tr>
</tbody>
</table>

Claudio is Mexican, while Florencia and Ignacio are Argentinian. The first samples from all 3 children will be used to represent Time 1, and the second samples Time 2. Alatorre (1976) states that Claudio's phonological development was slow and late, and at 2;0 he appears to be at a comparable stage to Ignacio and Florencia in the first half of the first year. The samples from Claudio are part of a diary study, while Ignacio and Florencia were taperecorded weekly in naturalistic play sessions for 1-1½ hour periods.

The Latin American dialects of Spanish differ primarily from Castilian Spanish in the phenomenon known as seseo, in
which the interdental fricative is replaced by /s/ in all positions (Macpherson 1975). I will then assume that there are no major differences between the vocalic systems being acquired by these children and that of Castilian Spanish, discussed in the next section.

5.3.2. Spanish Vowels

The 5 vowel Spanish system, first given in (3.41), is repeated here in (5.26).

(5.26) Spanish Vocalic System

i   u

   e   o

   a

In addition to these 5 simple vowels, Spanish has a set of diphthongs. Following the reasoning given in 3.2.1 I assume that falling diphthongs, such as those in camion and puerta, whose first member is a high glide, are the only complex nuclei possible in Spanish. Other vowel sequences may form either a branching rhyme (heavy diphthong) or two separate syllables. The creation of branching nucleus over a falling diphthong will be governed by the Complex N parameter, discussed in 2.1.2.4. In this section data for falling diphthongs (hereafter called diphthongs) will be presented along with data from simple vowels. Diphthongs will be grouped together into sets represented as [wV] for those whose initial member is a high back glide and as [jV] for those whose
initial member is a high front glide. A detailed analysis of the Spanish vowels is given in 3.2.

In Spanish complex onsets are permitted only if the second member is a liquid, and complex consonantal rhymes are permitted only if the second member is s (Harris 1983). The preferred syllable type is CV and consequently words are most often vowel final. Stress in Spanish is in general rule-governed, as is discussed in 3.2.1, although there are certain roots and suffixes which are exceptional with regard to the stress rules of the language. The stressed syllable is always one of the last 3 syllables in a word. Penultimate stress is unmarked on vowel-final words, while final stress is the unmarked pattern in consonant-final forms (Harris 1983, Halle, Harris and Vergnaud 1991).

The categories of vowels found in initial and non-initial syllables were collapsed in the PIPC analysis in Spanish, as in Hungarian, since little qualitative difference was found between the two sets. Non-initial vowels were less frequent than initial vowels at Time 1, while the reverse was true at Time 2 (Time 1 - 79(initial), 76(non-initial); Time 2 - 212(initial), 219(non-initial).

5.3.3 Phonological Inventories

The phonetic inventories, matches and phonological contrasts data for 3 Spanish children at Time 1 are given in (5.27).
(5.27) Spanish - Time 1

Phonetic Inventory    Matches    Phonological Inventory

**Florencia**

*i*   a, e, o, u, i, (wV)   i

*e*   *o*

*a*

**Ignacio**

*i*   a, e, o, u, i, (wV)   i   u

*e*   *o*

*a*

**Claudio**

(i)   (u)   a

*e*   *o*

*a*

At this initial time none of the children are able to consistently produce diphthongs, although Ignacio made some correct attempts. Claudio makes more production errors than Ignacio or Florencia, which is reflected in the fact that he has fewer matches.

The composite phonological inventory for Spanish at Time 1, assuming that sounds must exist in the phonological inventories of 2 out of 3 children, is given in (5.28).
(5.28) Composite Phonological Inventory for Spanish at Time 1

\[
\begin{align*}
\text{i} & \\
\text{e} & \quad \text{o} \\
\text{a} \\
\end{align*}
\]

This composite is identical to the inventories of Claudio and Florencia in their first samples, and lacks the high back vowel and the diphthongs of the adult system.

The phonetic inventories, matches and phonological contrasts data for 3 Spanish children at Time 2 is given in (5.29).

(5.29) Spanish - Time 2

<table>
<thead>
<tr>
<th>Phonetic Inventory</th>
<th>Matches</th>
<th>Phonological Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florencia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*i u</td>
<td>a,e,o,u,i,(wV)</td>
<td>i u</td>
</tr>
<tr>
<td>*e *o</td>
<td>e o</td>
<td>(wV)(jV) a</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ignacio #2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*i *u</td>
<td>a,e,o,u,i,(jV)</td>
<td>i u</td>
</tr>
<tr>
<td>*e *o</td>
<td>e o</td>
<td>(wV) jV a</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Claudio #2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>a,e,o,i</td>
<td>i</td>
</tr>
<tr>
<td>*e *o</td>
<td>e o</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>a</td>
</tr>
</tbody>
</table>
Florenza and Ignacio increase their phonological inventory by one member (/u/) from Times 1 to 2, while Claudio's matches have increased since Time 1 but his system still lacks the high back vowel. Both Ignacio and Florenza have diphthongs in their phonetic inventories, although only Ignacio has a diphthong in his phonological inventory.

The composite phonological inventory for Time 2, assuming that 2 out of 3 children have a segment in their phonological inventories, is given in (5.30).

(5.30) Composite Phonological Inventory for Spanish at Time 2

\[
\begin{array}{ll}
i & u \\
e & o \\
a &
\end{array}
\]

(5.30) represents the full phonological inventory of the language excluding the diphthongs.

5.3.4 Mismatches

The number of vowels attempted, number and proportion of attempted vowels that are mismatched, and proportion of mismatches that involve the reduction of a diphthong to a single vowel at Times 1 and 2 in the Spanish data are given in (5.31).
(5.31) Mismatches at Times 1 and 2 - Spanish

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Vowels attempted</th>
<th>Mismatches</th>
<th>Prop. due to diphthong reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 1</td>
<td>79</td>
<td>.51</td>
<td>76</td>
<td>.49</td>
</tr>
<tr>
<td>Time 2</td>
<td>212</td>
<td>.49</td>
<td>219</td>
<td>.51</td>
</tr>
</tbody>
</table>

At Time 1 the Spanish children produce slightly more initial vowels than subsequent ones, and this relationship is reversed at Time 2. Approximately the same proportion of vowels attempted in Spanish as in Hungarian are mismatches (cf. (5.31) and (5.17)). Of the total substitution errors approximately one-third are due to a diphthong being reduced to a simple vowel at both Times 1 and 2. Of the remaining mismatches (involving simple vowels) none represent omissions from the adult target.

As in Hungarian, the mismatches of individual Spanish children vary to a large degree. The individual patterns of attempted vowels and mismatches for 3 Spanish children are provided in (5.32).
(5.32) Mismatches - Time 1

<table>
<thead>
<tr>
<th>Child</th>
<th>Vowels attempted</th>
<th>Mismatches</th>
<th>Prop. of vowels attempted</th>
<th>Prop. due reduction to diphthong</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial No. Prop.</td>
<td>Non-initial No. Prop.</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Florencia</td>
<td>35 .47</td>
<td>38 .52</td>
<td>73</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ignacio</td>
<td>28 .55</td>
<td>23 .45</td>
<td>51</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Claudio</td>
<td>16 .52</td>
<td>15 .48</td>
<td>31</td>
<td>.42</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All 3 children produce similar proportions of initial and subsequent vowels at Time 1, although only Florencia produced a larger proportion of non-initial vowels than initial ones. Ignacio and Florencia at this early stage made few mismatches, while almost half of Claudio's productions were mismatches. Claudio made relatively few mismatches when the target was a diphthong, while Ignacio and Florencia's mismatches with diphthongs were more frequent.

In the Spanish data, the types of mismatches that occur for initial and non-initial vowels are very similar, since non-initial vowels were never omitted. No distinction will therefore be made between these two classes of vowels. Mismatches from 3 Spanish children at Time 1 that do not involve the reduction of a diphthong to a simple vowel are given in (5.33).
(5.33) Individual Mismatches - Time 1

<table>
<thead>
<tr>
<th>Child</th>
<th>Mismatch</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florencia</td>
<td>e --&gt; a</td>
<td>de nada --&gt; [nanana]</td>
</tr>
<tr>
<td>Ignacio</td>
<td>o --&gt; a</td>
<td>pato --&gt; [papa]</td>
</tr>
<tr>
<td>Claudio</td>
<td>e --&gt; a</td>
<td>perro --&gt; [wawa]</td>
</tr>
<tr>
<td></td>
<td>o --&gt; a</td>
<td>banco --&gt; [mamna]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mango --&gt; [mamna]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mano --&gt; [mama]</td>
</tr>
<tr>
<td></td>
<td>u --&gt; e</td>
<td>dulce --&gt; [eBi]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>columpio --&gt; [eBje]</td>
</tr>
<tr>
<td></td>
<td>we --&gt; o</td>
<td>huevo --&gt; [oBo]</td>
</tr>
<tr>
<td></td>
<td>a --&gt; e</td>
<td>toalla --&gt; [eja]</td>
</tr>
<tr>
<td></td>
<td>i --&gt; e</td>
<td>meti --&gt; [pete]</td>
</tr>
</tbody>
</table>

At this early stage all but two of the substitution patterns that occur with simple vowels are 'partial' or 'total reduplications' and can be accounted for by a rule of Spread. The exceptions are [eBi] 'dulce' and [eja] 'toalla'. In some cases the vowel which spreads is the vowel of the initial syllable (e.g. [mamna], [papa]), while in other cases it seems to be the vowel of the non-initial syllable which spreads (e.g. [oBo]).

The analysis of vowels attempted and proportions of errors for individual Spanish children at Time 2 are given in (5.34).
Each child produces approximately the same proportion of initial and non-initial vowels as at Time 1. Claudio makes relatively fewer mismatches than at Time 1, while Ignacio and Florencia make more. The proportion of mismatches due to the reduction of a diphthong to a simple vowel varies from .30 to .40.

The mismatches made by these children at Time 2 that are not due to diphthong reductions are given in (5.35).
(5.35) Individual Mismatches - Time 2

<table>
<thead>
<tr>
<th>Child</th>
<th>Mismatch</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florencia</td>
<td>e --&gt; i</td>
<td>colectivo --&gt; [pipiBo]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tren --&gt; [tin]</td>
</tr>
<tr>
<td></td>
<td>e --&gt; a</td>
<td>el sol --&gt; [a(\text{sol})]</td>
</tr>
<tr>
<td></td>
<td>a --&gt; o</td>
<td>pantalon --&gt; [palolon]</td>
</tr>
<tr>
<td></td>
<td>a --&gt; e</td>
<td>sala --&gt; [sale]</td>
</tr>
<tr>
<td>Ignacio</td>
<td>a --&gt; e</td>
<td>zapata --&gt; [pepe]</td>
</tr>
<tr>
<td></td>
<td>o --&gt; a</td>
<td>zapato --&gt; [papa]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>quiero --&gt; [kela]</td>
</tr>
<tr>
<td>Claudio</td>
<td>a --&gt; e</td>
<td>zapato --&gt; [pepe]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pastel --&gt; [peste]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pate --&gt; [pete]</td>
</tr>
<tr>
<td></td>
<td>e --&gt; a</td>
<td>cerada --&gt; [sayaya]</td>
</tr>
<tr>
<td></td>
<td>e --&gt; o</td>
<td>espejo --&gt; [poxo]</td>
</tr>
<tr>
<td></td>
<td>o --&gt; e</td>
<td>conejo --&gt; [nenexo]</td>
</tr>
<tr>
<td></td>
<td>o --&gt; a</td>
<td>lado --&gt; [jaja]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>moxado --&gt; [maxaxo]</td>
</tr>
<tr>
<td></td>
<td>u --&gt; e</td>
<td>dulce --&gt; [eBle]</td>
</tr>
<tr>
<td></td>
<td>i --&gt; e</td>
<td>libro --&gt; [eBle]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>jardinero --&gt; [nenexo]</td>
</tr>
</tbody>
</table>

As at Time 1 all 3 children use Place Spread in their multisyllabic forms, although Claudio makes use of these
processes most often. The vowel which is spread, as is the case at Time 1, is sometimes the vowel of the initial syllable, as in Claudio's form for lado; and sometimes the vowel of the non-initial syllable, as in Claudio's form for pastel. These forms will be further discussed in 5.3.5.1.

5.3.5 Substitution Patterns
5.3.5.1 Syntagmatic Substitutions

The Spanish substitutions which do not reflect difficulties with complex nuclei are given in (5.33) and (5.35). The two syntagmatic substitution patterns which appear to operate in these data are CV and V Spread, which account for almost four-fifths of this type of mismatch. Since these processes are ones affecting multisyllabic forms, the frequency of multisyllabic phonetic types was investigated. The proportions of multisyllabic types found at each time for each child and the proportion of these forms which contain differentiated vowels are presented in (5.36).
(5.36) Multisyllabic Phonetic Types - Spanish

<table>
<thead>
<tr>
<th></th>
<th>Proportion of multisyllabic types</th>
<th>Proportion containing differentiated vowels</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Florencia</td>
<td>.97</td>
<td>.50</td>
</tr>
<tr>
<td>Ignacio</td>
<td>.82</td>
<td>.52</td>
</tr>
<tr>
<td>Claudio</td>
<td>1.00</td>
<td>.38</td>
</tr>
<tr>
<td>Mean</td>
<td>.93</td>
<td>.47</td>
</tr>
<tr>
<td><strong>Time 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Florencia</td>
<td>.95</td>
<td>.61</td>
</tr>
<tr>
<td>Ignacio</td>
<td>.88</td>
<td>.56</td>
</tr>
<tr>
<td>Claudio</td>
<td>.97</td>
<td>.52</td>
</tr>
<tr>
<td>Mean</td>
<td>.93</td>
<td>.56</td>
</tr>
</tbody>
</table>

The mean proportions of multisyllabic forms are identical at Times 1 and 2, although the proportion of multisyllabic forms containing differentiated vowels increases from one time to the next. This means that the proportion of vowels affected by Spread decreases from Time 1 to Time 2. Claudio has the largest proportion of multisyllables and the lowest proportion of differentiated vowels at both times. Although the proportions of multisyllabic forms at both sessions are the same, forms containing 3 or more syllables are more frequent at Time 2. Spanish-speaking children produce a higher proportion of multisyllables than Hungarian children, shown by
comparing the data in (5.36) and (5.33). This is probably a reflection of the syllable structures of the languages.

The Spanish forms affected by CV and V Spread are presented in (5.37). Stress is indicated in the adult targets by capital letters.

(5.37) Syntagmatic Substitutions in Spanish

<table>
<thead>
<tr>
<th>CV Spread</th>
<th>V Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>de nAda --&gt; [nanana]</td>
<td>bAnco --&gt; [mamna]</td>
</tr>
<tr>
<td>pAto --&gt; [papa]</td>
<td>mAngo --&gt; [mamna]</td>
</tr>
<tr>
<td>pErro --&gt; [wawa]</td>
<td>huEvo --&gt; [oBo]</td>
</tr>
<tr>
<td>colectIvo --&gt; [pipiBo]</td>
<td>mEti --&gt; [pete]</td>
</tr>
<tr>
<td>zapAta --&gt; [pepe]</td>
<td>pastEl --&gt; [peste]</td>
</tr>
<tr>
<td>zapAto --&gt; [papa]</td>
<td>patE --&gt; [pete]</td>
</tr>
<tr>
<td>lAdo --&gt; [jaja]</td>
<td>cerAda --&gt; [sayaya]</td>
</tr>
<tr>
<td>jardinEro --&gt; [nenexo]</td>
<td>espEjo --&gt; [poxo]</td>
</tr>
</tbody>
</table>

There are equal numbers of forms affected by CV and V Spread. The vowel which is spread is either /a/, /i/ or /e/. The triggers of V Spread are /a/, /o/ and /e/ while the vowels which receive their feature specifications are /a/, /o/, /i/ and /e/ in the adult targets. It does not seem to be the case then that either of these processes fills in feature values of vowels not in the child’s repertoire, as seems to be the case in Hungarian. If, however, we look at the stress patterns of forms undergoing CV and V Spread, we find that in almost every case the vowel that spreads is the stressed one.
The exceptions are zapato where it is not entirely clear which syllable is reduplicated, huévo and espéjo. It is possible then that stress is a complex matter in Spanish and adds to the complexity of a target. At this early point in acquisition, Spanish children may only pay attention to stressed vowels, and ignore unstressed ones. These substitution patterns will be discussed further in Chapter 6.

5.3.5.2 Paradigmatic Substitutions

The systematic substitutions found in the Spanish data which are not the result of diphthong reductions or a syntagmatic substitution process are given in (5.38).

(5.38) Paradigmatic Substitutions in Spanish

\[
\begin{align*}
toalla & \rightarrow [e\text{ja}] \quad a \rightarrow e \\
zapato & \rightarrow [\text{pepe}] \\
sala & \rightarrow [\text{sale}]
\end{align*}
\]

While there are other substitutions, the only pattern which occurs 3 or more times in these data is the substitution of [e] for /a/. This pattern is not predicted by either variant of the acquisition theory, since neither theory predicts that any context-sensitive rules require resetting in the acquisition of Spanish. I will return to the problem of the substitution of [e] for /a/ in 6.2.2.

5.4 Summary

The data presented in the preceding sections show some
remarkable similarities in the phonological systems of the children acquiring both Hungarian and Spanish at Time 1. The inventories for both languages at the early time contain 4 vowels. In Hungarian this inventory is /i/, /ɛ/, /a/ and /o/\(^{13}\), while in Spanish it is /i/, /e/, /a/ and /o/. At this early stage there is very little evidence that children can represent complex nuclei, and consequently long vowels in Hungarian and diphthongs in Spanish do not appear to be productive. The long vowel /á/ is the only long vowel used systematically in Hungarian at this early period. This is an interesting fact in itself, since we would expect that if a child is able to form complex nuclei then all vowels in the child's phonological inventory would be productive in both long and short configurations. This does not appear to be the case.

The mismatch data for both Hungarian and Spanish are also quite similar. In both languages syntagmatic substitutions, provided by the operation of CV or V Spread, represent a large proportion of the mismatches found in these data. One major difference between Hungarian and Spanish appears to be that in Hungarian empty skeletal slots exist in the child's form either because a sound is not present in the child's phonological repertoire or because the form itself is too complex, while in Spanish they exist only because of the complexities associated with stress. In many of the Spanish child's forms, only the stressed syllable or vowel has underlying feature specifications, while the other syllables
or vowels are left to acquire their specifications through the operation of Spread.

In (5.17) it is shown that of all vocalic errors made by Hungarian children, almost half are due to long/short vowel confusions, where a short vowel generally replaces a long vowel. (5.31) shows that approximately one-third of all errors made by Spanish children are due to the reduction of a diphthong to a simple vowel. These errors result from the child's inability to deal with the structures associated with complex vowels. In a parametric theory they can be attributed to the unmarked parameter setting of the Complex N parameter, and are therefore a specific type of paradigmatic substitution.

Long vowels and Spanish diphthongs will have the representations in (5.39).

(5.39) Complex Vowels

<table>
<thead>
<tr>
<th>Hungarian</th>
<th>Spanish</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>/ \</td>
<td>/ \</td>
</tr>
<tr>
<td>x x</td>
<td>x x</td>
</tr>
<tr>
<td>\ /</td>
<td></td>
</tr>
<tr>
<td>[+F]</td>
<td>[+F] [+G]</td>
</tr>
<tr>
<td>[+G]</td>
<td></td>
</tr>
</tbody>
</table>

In Hungarian both skeletal slots will be associated to the same set of features, while in Spanish each segment may have its own set of feature specifications. At the point in
acquisition investigated in this chapter Hungarian and Spanish children have not yet reset the Complex N parameter permitting the structures in (5.39), and they will map all vocalic feature specifications to a skeletal slot dominated by a non-branching nucleus.

Two paradigmatic substitution patterns, not relating to the Complex N parameter, were found in the Hungarian data. These are the substitution of [a] for /e/ and [o] for /u/. Only the first pattern is predicted in 4.3.3.1 by the theories of RU and CU as being due to the functioning of the unmarked setting of a context-sensitive featural parameter. In Spanish only one substitution pattern that did not relate to the Complex N parameter was found. This is the substitution of [e] for /a/, and again this pattern is not predicted in 4.3.3.2 by the opposing theories of underspecification.
Notes to Chapter 5

1 The symbol [B] is used to represent IPA [\&].

2 I will call these initial vowels throughout Chapters 5 and 6 even though they are generally not word-initial, but rather occur in the initial syllable of a child's phonetic type.

3 Falling diphthongs are also analyzed in the Spanish data; however, for simplicity's sake I have omitted diphthongs in the discussion in 5.1.1.

4 MacWhinney (1974) also presents data from a Hungarian child named Zoli. I have not used these data because only a small number of examples for each session are actually provided.

5 This, unfortunately, is one of the problems that acquisition researchers, like any field linguists, have to contend with. Using published data solves some of the many problems associated with data collection, but it is not always possible to find appropriate samples. In the case of M. I must assume that her early phonological system is comparable to that of the other Hungarian children.

6 To my knowledge the differences between long and short vowels in acquisition has never been systematically studied.

7 These, and all other mismatch data that will be discussed involved only vowels. There are many other examples of mismatches between adult and child forms that involve only consonants.

8 Adult lexical types are given in Hungarian orthography. The correspondences are as follows:

<table>
<thead>
<tr>
<th>Orthographic</th>
<th>IPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>s</td>
<td>[$]</td>
</tr>
<tr>
<td>c</td>
<td>[ts]</td>
</tr>
<tr>
<td>cs</td>
<td>[t$]</td>
</tr>
<tr>
<td>gy</td>
<td>[dz]</td>
</tr>
<tr>
<td>sz</td>
<td>[s]</td>
</tr>
<tr>
<td>y</td>
<td>[j]</td>
</tr>
<tr>
<td>zs</td>
<td>[j]</td>
</tr>
</tbody>
</table>

8 Macken (1979) discusses data from a Spanish-speaking child, but these are not used in this study because she does not provide the entire sample.

9 The results given in (5.22) and (5.36) support the findings in Fee and Ingram (1980) that children's reduplications decrease developmentally.
Florencia is the only Spanish child to produce trisyllabic phonetic types at Time 1. At Time 2 phonetic types larger than 2 syllables account for 25%, 9% and 15% of all multisyllabic forms for Florencia, Ignacio and Claudio, respectively.

It is possible that it is just coincidence that two vowels in a word are identical, but according to the OCP, discussed in 2.1.2.3, adjacent identical representation are prohibited. The OCP would either outlaw the representation entirely, or force a phonological operation to delete one of the feature matrices associated with one of the identical vowels, and spread or fuse the remaining feature matrix to both vowels.

Although this may not be justified I assume the child's phonetic [ɛ] is underlyingly /ɛ/ and not /e/. Short [ɛ] and [ɛ] are not differentiated in the phonetic data given for these children, and so it is impossible to determine if the child in fact makes a distinction between these two short vowels.
CHAPTER 6
Testing the Predictions

In 4.3 two sets of predictions for the acquisition of the vocalic systems of Hungarian and Spanish are outlined: one based on the theory of RU and the other on the theory of CU. The characteristics of the adult systems are given in Chapter 3. In Chapter 5 acquisition data from Hungarian and Spanish are presented, which demonstrate the phonological inventories and substitution patterns used by young children during the second year of life. In this chapter I will examine the acquisition facts in light of the predictions made in 4.3. I will focus on three particular areas: the acquisition of phonological inventories, the types of substitution patterns used by Hungarian and Spanish children, and the comparison of the phonological rules required in the adult languages with the rules that are found in the children's speech.

This chapter will be organized as follows. In 6.1 I discuss two major discrepancies that exist between the attested acquisition data presented in Chapter 5 and a parametric theory of acquisition, and I will show how these discrepancies can be resolved without abandoning the parametric model. In 6.2 I attempt to account for the development of the phonological inventories of Hungarian and Spanish given the principles and feature specifications required by the parametric theories of RU and CU. In 6.3 the
substitution patterns used by these two groups of children are discussed in light of the theories of RU and CU. In 6.4 I attempt to determine if there is evidence that the parametric phonological rules proposed in Chapter 3 are operative in the early phonological systems of children acquiring these languages. In 6.5 I summarize these results, which show that the RU theory is more successful at accounting for several aspects of the acquisition facts than the CU theory. In 6.6 I discuss some of the implications that these results have both for phonological theory and for a theory of phonological acquisition.

6.1 Predicted vs. Attested Phonological Inventories

In this section I will look at two of the most general differences that exist between the initial phonological inventories predicted for Hungarian and Spanish in 4.3 and the attested inventories described in Chapter 5. In 4.3.3 it is shown that many of the predictions made by the theories of RU and CU for the initial phonological systems of Hungarian and Spanish are identical. Both theories predict that initially Hungarian and Spanish children have 5 distinct vowels realized as [i], [u], [a], [o] and [e], that these systems are specified using the features [low], [back] and [round], and that they are unable to represent complex vowels. These theories also predict that children acquiring Hungarian will initially substitute front non-low unrounded vowels for rounded ones, and the low back vowel for a low front vowel,
and that there will be no substitutions of this type in Spanish\(^1\). The major differences that exist between the two variants of the acquisition theory relate to the underlying feature specifications attributed to children's early vowels, and the stages of restructuring that will occur over the course of development.

6.1.1 The Inventories

In 5.1.2 and 5.1.3 composite phonological inventories for Hungarian and Spanish children at Times 1 and 2 are presented\(^2\). These composite inventories are derived by determining phonological inventories for individual children and then including sounds used only by a majority of children acquiring that language. In 4.3.3 the predicted initial inventories for these two languages are discussed. The composite inventories and the inventories predicted for Time 1 by both the RU and CU parametric theories are compared in (6.1)\(^3\).
The comparisons for Hungarian are made in (6.1a) and those for Spanish in (6.1b). I have assumed that both the theories of
RU and CU adopt the Complex N parameter, and that the initial OFF setting of this parameter tells children that nuclei do not branch. This parameter will have to be reset at some point in the acquisition of Hungarian or Spanish in order to allow long vowels or diphthongs.

In (6.1a) it is shown that the vowel system used by Hungarian children at Time 1 differs from the predicted system in two crucial ways. First, only the long vowel /á/ is part of this system at Time 1, while the two long vowels /á/ and /é/ are part of the system at Time 2. The predictions relating to the Complex N parameter, outlined in 4.3.3, are that once this parameter is reset, the child should be able to produce complex vowels for all distinct sets of feature specifications. If a Hungarian child is able to represent long vowels at Time 1, then there should be 5 such vowels, rather than the 1 that is attested. At Time 2 we would expect 7 distinct long vowels, rather than the 2 that are attested. In (6.1b) it is shown that there is little evidence that the Complex N parameter has been reset by a majority of Spanish-speaking children by Time 2. The individual data (see (5.26)) show that only one child, Ignacio, uses diphthongs productively at Time 2, and these are always diphthongs beginning with a high front glide. Thus it appears that in Spanish, as in Hungarian, complex vowels enter the child's system slowly.

The second major discrepancy between the predicted and attested inventories shown in (6.1) is their size. The
composite inventories for both Spanish and Hungarian children at Time 1 contain 4 vowels, while the predictions in both cases are for 5 vowel inventories. The evidence in both languages from individual children's data is that initially the phonological inventories may be even smaller than the four vowel inventories shown in the composites since in (5.27) it shown that the vocalic inventory used by Claudio (the least advanced of the Spanish children) at Time 1 consists of the three vowels /e/, /o/ and /a/.

In addition, as discussed in above, the long vowel inventories in Hungarian appear to develop gradually. In (5.12) and (5.14) it is shown that the long vowel inventory begins with /á/, and then /é/ is added and later /ő/. Given the assumption of current non-linear phonology that long vowels are simply short vowels associated to two skeletal slots (discussed in 2.1.2.4 and 3.2.1) the order of acquisition of long vowels should be identical to that of short vowels. While this data from long vowels is suggestive about an earlier period of development that that demonstrated in (6.10), the data on long vowels is also more variable than that given for short vowels, and I will base by analyses solely on the short vowel results.

6.1.2 Gradual Acquisition of Complex Vowels

The data in (6.1) suggest that the acquisition of the Complex N parameter is not an instantaneous event, as is predicted in Chapter 4. It appears that once this parameter
is reset, it is applied in a gradual fashion, first beginning with the feature combination for /a/, and then slowly being extended to the feature sets for /e/ and /o/. The problem of accounting for gradual acquisition within a parametric model is discussed in 4.3.3.3. This problem is certainly not specific to the acquisition of long vowels. The acquisition of word-final consonants and consonant clusters (Ingram 1976) have also been noted to develop in a slow and gradual fashion.

Davis (1987) suggests that gradual acquisition can be reconciled with the parametric view of rules if we assume that it is the learning mechanism which accounts for the non-instantaneous nature of specific acquisitions, and not the grammar itself. Davis suggests that the learning mechanism may function in the manner of a parallel-distributed-processor (PDP), a learning device outlined in McLelland and Rumelhart (1986). This type of processor initially acquires skills item by item, until knowledge becomes generalized as a rule. At that point overgeneralization may occur, when the rule is applied in an overly broad manner. Positive evidence will force the processor to retreat from overgeneralizations until the rule is eventually applied only in the appropriate contexts.

Although I will not argue for a PDP type mechanism specifically, I will assume that a learning mechanism with similar characteristics can account for the type of acquisition that often occurs in language development. Given this assumption, the gradual acquisition of complex vowels
that we find in the Spanish and Hungarian data (particularly in Hungarian) can be attributed to some aspect of learning outside the parametric model. Once the Complex N parameter is reset by a child acquiring a language with complex vowels, complex vowels will be acquired one at a time. Complex vowels will be later acquisitions than simple vowels because their representation will require both the resetting of the Complex N parameter and the appropriate feature combinations. The order in which vowels are acquired will be controlled by the factors discussed in 6.1.3.

6.1.3 Gradual Acquisition of the Inventory

The size discrepancy between the attested and predicted inventories in (6.1) also points to a more gradual type of acquisition than that predicted by the parametric theory. It is not clear, however, that this aspect of the system can be attributed to a specific characteristic of the learning mechanism, as is done in 6.1.2 for the gradual acquisition of complex vowels. There is no specific parameter that has been posited to account for the order in which segments appear in early phonological inventories.

The Spanish data for individual children at Time 1 presented in (5.24) shows that Claudio's inventory contains only three vowels, while both the Spanish and Hungarian composites at Time 1 contain the vowels /a/, /e/ and /o/ plus the high front vowel /i/. Only at Time 2 do we see the high back vowel appear in the composites of both Spanish and
Hungarian (shown in (5.15) and (5.27)). In the Hungarian Time
2 composite the front rounded vowels /u/ and /ø/ have been
added. Based on these pieces of evidence, I suggest that we
can envision the gradual development of phonological
inventories given in (6.2) (ignoring for the moment the low
front vowel in Hungarian).

(6.2) a. e o b. i
     a e o
     a

     c. i u d. i ü u (Hungarian
e o e ø o only)
     a a

At the first stage we have a contrast between /e/ vs. /a/ vs.
/o/, shown in (6.2a). We therefore have a contrast based on
the feature [low] and another based on the feature [back]. At
the following stage, shown in (6.2b), the high front vowel /i/
will be added. This is the stage shown in the composites at
Time 1 in Spanish. In (6.2c) the high back vowel /u/ is added
to the system, giving the inventory shown in the Spanish Time
2 composite. The final stage, shown in (6.2d) is applicable
to Hungarian only, and shows that final addition of the front
rounded vowels.

The acquisition stages in (6.2a–c) do not follow directly
from the predictions of the parametric theories of RU and CU
described in 4.3. How then do we account for these data? I
believe the parametric theory can be saved if a theory of feature availability is adopted to explain why children's phonological inventories are initially smaller than predicted. Such a theory will not weaken the acquisition theory as long as it is assumed to be a part of UG, perhaps even built into a theory of feature geometry such as that shown in (2.7). UG will supply the child with the knowledge of what features are and how they work, a set of redundancy rules which supply redundant feature values, and a feature geometry which will include a hierarchy of vocalic features. When the child begins to develop a phonological system, features will become available slowly. Universal redundancy rules will always be present to give universally predictable feature values as soon as a new feature becomes available to the child.

6.1.3.1 Jakobson and Halle (1956)

In Jakobson and Halle (1956) a theory of distinctive features is developed, which assumes that children acquire features in a specific order. Jakobson and Halle propose three classes of distinctive features: sonority features, protensity features, and tonality features. Although this set of features is able to distinguish three vowel heights, in their discussions of the acquisition of vocalic systems only two vowels heights are assumed. Based on Jakobson's earlier work (Jakobson 1941/68) Jakobson and Halle argue that the first vowel acquired is /a/, and then further vowel contrasts develop as outlined in (6.3).
(6.3) Vowel Acquisition (adapted from Jakobson and Halle 1956: 55)

a. Narrow vs. wide
   e.g. /i/ or /e/ vs. /a/

b. Narrow vowels: palatal vs. velar
   e.g. /i/ vs. /u/ or /o/,
       or /e/ vs. /u/ or /o/

c. i. Wide vowels: palatal vs. velar
   e.g. /æ/ vs. /a/

   ii. Narrow palatal vowels: rounded vs. unrounded
       e.g. /y/ vs. /i/ or /ɨ/ vs. /e/

   iii. Velar vowels: unrounded vs. rounded
       e.g. /u/ vs. /u/ or /ɨ/ vs. /o/

dii. Wide palatal vowels: rounded vs. unrounded
    e.g. /ɶ/ vs. /ɛ/

The numbering in (6.3) demonstrates specific ordering relationships. The acquisitions in (6.3b) follow those in (6.3a), and those in (6.3c) follow those in (6.3b), although the acquisitions within (6.3c) are not ordered with respect to one another. The acquisition in (6.3dii) is ordered after the acquisition in (6.3cii), yet is not ordered with respect to any other acquisitions in (6.3).

The stages of acquisition in (6.3) beginning with (6.3b) are similar to those outlined in (6.2), except that the stages in (6.2) contain an extra height distinction. The opposition in (6.3b) as well as that shown in (6.2a) is between a non-low
back vowel, a low back vowel and a non-low front vowel. After this stage, Jakobson and Halle say that either a low front vowel, a rounded version of the existing non-low front vowel, or the unrounded counterpart to the non-low back vowel may be added to the system. The contrast can then be another [+back]/[-back] one, or a new [+round]/[-round] contrast. The data from Hungarian suggest that a further contrast in backness will occur before the [round] contrast, but neither Hungarian nor Spanish provide evidence for when a back unrounded vowel appears, since neither language contains such a vowel.

The attested stages of acquisition for Hungarian and Spanish shown in (6.2) also demonstrate that in a three height vowel system (such as Hungarian), the high vowels become productive after the mid ones, with the high back vowel being the last addition of the core 5 vowels.

The features used by Jakobson and Halle (1956) are quite different from those that I use in this thesis. Translating into current feature theory (as shown in (2.7)), the stages in (6.3) predict that features become available in the order in (6.4).

(6.4) Order of Acquisition of Vocalic Features (based on Jakobson and Halle 1956)

a. [low]
b. [back]
c. [round]
According to the stages shown in (6.3) there is some room for variation within the specific contrasts that develop based on a given feature (either between children or between languages), although the specific ordering of features in (6.4) is inviolable. For example, Jakobson and Halle would claim that a contrast based on the feature [low] always develops before a contrast based on the features [back] or [round], but we are not told why the initial low contrast develops between /a/ and a front non-low vowel. In 6.1.3.3 I will show that the exact contrasts can be predicted if a theory such as Jakobson and Halle's is combined with a parametric theory of underspecification.

Notice that there are fewer observed stages given in (6.2) for Hungarian and Spanish than are predicted by Jakobson and Halle (1956). Jakobson and Halle suggest that the first vowel used is /a/, which initially contrasts only with a consonant. After this vocalic distinctions begin to develop, with the first contrast developing between a narrow and a wide vowel, i.e. between /a/ and /e/ or /i/. Only at this point is the back mid vowel /o/ added to the system, when a contrast based on backness is added. In the data presented in Chapter 5, there is little evidence for these very early stages, unless we take into account the data from long vowels. This may be because the samples used were from children beyond the initial stages of acquisition detailed in Jakobson and Halle (and in many other acquisition reports). In the following sections I attempt to account only for the data reported on
here, and only in 6.6 will I attempt to relate the data from Hungarian and Spanish to the predictions of Jakobson and Halle (1956).

6.1.3.2 Calabrese (1988)

Calabrese (1988) attempts to provide an explanation for several phenomena in phonology, one being the stages of acquisition outlined in (6.3). Calabrese's theory utilizes a set of filters, which are a set of negative constraints on feature co-occurrence, and a hierarchy, which orders the set of filters. Both the filters and the hierarchy are provided by UG. Calabrese argues that negative filters are preferable to positive constraints because of the blocking effects and repair strategies that are exhibited in the languages of the world.

Calabrese's theory is similar to the theory of Natural Phonology (Stampe 1969), discussed in 4.1.2.3, in that it assumes that every filter in the hierarchy is operative innately, and that in the process of acquiring a language, a child learns that certain filters can be violated. Calabrese goes one step further than Stampe in providing the hierarchy of filters. A child can only acquire a segment which violates a filter at some given position in the hierarchy when a segment violating a filter at a lower position in the hierarchy has already been acquired. The hierarchy of filters needed for vowel systems is given in (6.5).
(6.5) Calabrese's Hierarchy of Vocalic Filters (from Calabrese 1988: 266)

```
* [+syllabic, +low]
  |
  |
* [+syllabic, +high]
  |
  |
* [+high, -lo]
  |
  |
* [-high, +ATR]
  |
  |
* [+low, -back]  * [+back, -round] / [__, -low]
  |
  |
* [+high, -ATR]  * [-back, +round]
  |
  |
* [+low, +round]
  |
  |
* [+low, +ATR]
```

Calabrese claims that if all vocalic features are freely combined, the feature combinations corresponding to /i/, /u/ and /a/ will result. These three vowels represent the universal vocalic system that all children initially have. Children gradually learn that to achieve the inventory of their language certain filters will have to be violated. Children first learn to violate the filters at the bottom of
the tree in (6.5) and then work their way up. If only the filter *[+low, +ATR], is violated, Calabrese says the child will achieve a canonical 5 vowel system: /i/, /u/, /a/, /ɛ/ and /ɔ/. A filter such as *[-high, -low] will not be violated until all filters below it have already been violated.

While Calabrese's theory is able to capture the gradual acquisition of a phonological inventory, it is impossible to integrate into the RU or CU parametric theories as previously outlined*. Both theories of underspecification assume that one of the components of UG is a set of redundancy rules, which supply feature co-occurrence constraints. Calabrese's filters would perform much the same function as the redundancy rules, and combining his theory with one of the underspecification theories would result in two sets of machinery doing the same work. I believe a better account of the gradual acquisition of inventories can be achieved if we integrate a theory of feature availability, such as that outlined in Jakobson and Halle, with the parametric acquisition theories examined here.

6.1.3.3 A Theory of Feature Availability

I assume that a parametric theory of acquisition, based on a theory of underspecification, must also include a theory of feature availability which specifies the order in which distinctive features may become part of a phonological system. Based on the order of features given in (6.4) and the stages of acquisition in (6.2) I will assume that the order of
availability is as given in (6.6).

(6.6) Order of Feature Availability

   a. [low] & [back]
   
   b. [high]
   
   c. [round]

There is no evidence in the data from Hungarian and Spanish
for an ordering between the features [low] and [back], so I
assume that they enter the system together. The results from
Hungarian demonstrate that a high vowel contrast will be added
before a contrast involving the feature [round]. This
particular contrast is not one noted by Jakobson and Halle
(1956).

As discussed in 4.2 I continue to assume that features
are innately available to children on a phonetic level (see
4.2). At an early age children have access to all vocalic
features, and can use them to represent phonetic entities.
Sometime in the first half of the second year the information
load becomes too great to simply remember which features go
with which words, and the child will set about developing a
phonological system. The child will focus on a particular
feature at a particular time, and will focus on learning how
to use this feature productively. Once this feature is firmly
productive in the child's system, the child will go on to the
next feature, and to the next, until all vocalic features are
in use. If UG tells the child which features are the first to
be systematized and provides the redundancy rules for these
features, then each and every child will develop a similar system.

In applying this order of feature availability to the stages of development in (6.2) we see that the order itself cannot entirely explain which vowels enter the system at a given time. For example, when the feature [high] enters the system, either a front or back high vowel could initially contrast with the other vowels in the system. The Spanish and Hungarian data demonstrate that this contrast will initially be represented through the addition of /i/ and not /u/ to the system. In the following sections I show that the order of acquisition given in (6.2) can only be explained using both the order of features in (6.6) and the default rules and underlying feature markings used in RU. Neither the order of feature availability nor the mechanisms of a theory of underspecification can alone capture the acquisition facts.

In terms of a feature geometry such as that given in (2.7) (repeated in (4.14)) we can see that the features [low], [back] and [high] are all dominated by the Dorsal node, while [round] is dominated by the Labial node. While it might be tempting to in part explain the order in which vocalic features become available to a child by this distinction in nodes, this explanation by itself suggests that Dorsal consonants should be acquired before Labial ones, when in fact the opposite is generally true (see discussion in 4.1.2). While some revisions of the theory of feature geometry may help to solve this problem, I do not attempt to determine
exactly how a theory of feature availability can be incorporated into our current ideas of phonological representations.

In the following sections I discuss in detail how the RU and CU analyses compare to the phonological inventories shown in (6.2) when the idea of feature availability is taken into account.

6.2 Inventories

6.2.1 Hungarian

The composite phonological inventories for Hungarian, as determined by the PIPC methodology in Chapter 5 are given in (6.7).

(6.7) Vocalic Inventories - Hungarian

a. Time 1

\[
\begin{align*}
&i \\
&ó \\
&ɛ & a & à \\
\end{align*}
\]

b. Time 2

\[
\begin{align*}
&i \, ù \, u \\
&ø & o & ē \\
&ɛ & a & à \\
\end{align*}
\]

At Time 1 the inventory consists of 4 short vowels and 1 long vowel, and at Time 2 the inventory consists of 7 short vowels
and 2 long vowels. Since the acquisition of long vowels has been discussed in 6.1.1 I will not deal specifically with those vowels here.

Until this point I have ignored the issue of the origins of the two vowels designated as /ɛ/ and /é/ in (6.7). /ɛ/ is shown as a short low front unrounded vowel which contrasts with back /a/. /é/ is a long mid front unrounded vowel, which is shown in Chapter 3 to contrast with /ö/. The vocalic system of Hungarian is discussed in detail in 3.1, and the adult vocalic system argued for there is given in (6.8)⁴.

(6.8) Hungarian Vowels

```
i ü u
 e ö o
ɛ a
```

In this system the short version of /e/ never surfaces as [e] since a rule of Front Vowel Lowering changes it to [ɛ]. A phonetic mid front rounded vowel can only surface when dominated by two skeletal slots and a branching nucleus, i.e. when it is a long vowel. The vowel /ɛ/ in (6.8) is realized as [ɛ] when it is short, and is prohibited from being associated to two skeletal slots dominated by a branching nucleus. Thus the vowel [ɛ] has two underlying sources in Hungarian: /ɛ/ or /e/.

The data in (6.7) show that phonetic [ɛ] is part of the child's inventory at both Times 1 and 2 and that [é] is part of the child's inventory at Time 2. Unfortunately, it is
impossible to determine the underlying source of these vowels since in the published data the child's forms are given in orthographic form, and no distinction is made between [e] and [ɛ]. Given this problem, I assume that both /e/ and /ɛ/ are part of the child's phonological inventory at both Times 1 and 2, and therefore that the inventories at these two times are better represented as in (6.9).

(6.9) Revised Vocalic Inventories - Hungarian

a. Time 1

i
e  o
ɛ  a

b. Time 2

i ü  u
e ø  o
ɛ  a

Given that the child's long vowel inventory at Time 2 (as shown in (6.7)) contains long /é/ the inclusion of both /e/ and /ɛ/ at this time is relatively safe. It is less clear that the same is true for Time 1.

The discussion in 6.1 focuses on the discrepancies that exist between the attested phonological inventories of Hungarian and Spanish and the systems predicted by RU and CU. It is shown that by taking data from individual children into account, and by assuming that the long vowel inventory
develops in the same fashion as the short vowel inventory, several previous stages of acquisition can be deduced prior to Time 1. Given the assumption that both /e/ and /ɛ/ are in the child's inventory at Time 1 as well as at Time 2, the stages of phonological development I attempt to account for in Hungarian are given in (6.10).

(6.10)  

a.  
e  
ɛ  
a  
o  

b.  
i  
ɛ  
a  
o  

6.2.1.1 RU Account

The components of a parametric theory of RU are outlined in detail in 2.5.1. and again in 4.3.1. The most important aspects of this theory with regard to the acquisition of phonological inventories are the Minimal Redundancy Condition (MRC), given in (4.17) and the universal redundancy rules, given in (4.18). In addition, the featural parameters that are argued to require resetting in Hungarian are given in (4.21).

Assuming the order of feature availability given in (6.6) and the default rules in (4.18) we can see there is a problem in relating the feature [high] to the developmental stages in (6.10). In previous chapters it has been assumed that UG
supplies [+high] as a predictable context-free value, as shown by rule 2 in (4.18). If this is the case then mid vowels should be underlyingly marked as [-high], and according to the order of feature availability in (6.6) a vowel with the marked value of [high] should only enter the child's phonological system after contrasts have been established using the features [low] and [back].

The stages in (6.10) (and for that matter the Jakobsonian data in (6.3)) demonstrate, however, that /e/ is one of the earliest vowels acquired. Two solutions are available at this point. We can abandon the theory of RU, or we can assume that UG in fact supplies [-high] as a predictable value and [+high] as an initial marked value. I will adopt the latter solution and assume that the revised set of default rules that constrain children's earliest phonological systems are those given in (6.11).

(6.11) Revised Default Rules

<table>
<thead>
<tr>
<th>Context-free rules</th>
<th>FCRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. [ ] --&gt; [-low]</td>
<td>5. [+low] --&gt; [-high]</td>
</tr>
<tr>
<td></td>
<td>[-low]</td>
</tr>
<tr>
<td></td>
<td>9. [-back] --&gt; [-round]</td>
</tr>
<tr>
<td></td>
<td>[-low]</td>
</tr>
</tbody>
</table>

Assuming that the rules in (6.11) supply the predictable feature values, the initial marked specifications of Hungarian
vowels will be those in (6.12), rather than those proposed earlier in (4.27)\(^7\).

(6.12) Revised Initial Representation of Hungarian - RU

\[
i/\ddot{u} \quad e/\ddot{e} \quad a/\epsilon \quad u \quad o
\]

<table>
<thead>
<tr>
<th>high</th>
<th>+</th>
<th>+</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>back</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

The representations in (6.12) eliminate the need to assume that the marked context-free parameter for [high] (rule 2a in (6.11)) must be reset in Hungarian, and consequently only 3 featural parameters will require resetting to the marked option in the acquisition of Hungarian. These are given in (6.13).

(6.13) Marked Featural Parameters of Hungarian

<table>
<thead>
<tr>
<th>Context-free</th>
<th>Context-sensitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>4a. [ ] --&gt; [+round]</td>
<td>6. *[+low] --&gt; [+back]</td>
</tr>
<tr>
<td></td>
<td>9. *[-back] --&gt; [-round]</td>
</tr>
<tr>
<td></td>
<td>[-low]</td>
</tr>
</tbody>
</table>

In accounting for the stages of acquisition in (6.10), (6.6) tells us that the first features that are available to the child are [low] and [back], so the first vocalic contrasts should be based on these features. Given that the marked values of these features are [+low] and [+back] (based on the context-free default rules 1 and 3 in (6.11)) these first contrasts should be between a vowel marked as [+low], one
marked as [+back] and one unspecified for both features. The specifications given in (6.12) then predict a contrast between /a-/e/, /e-o/ and /o/, with the default rules giving surface values for those three vowels as [a], [e] and [o]. These are the only possible contrasts based on the availability of just the features [low] and [back] and the vowel specifications in (6.12).

While we do not have evidence for this three vowel system, we do have evidence for a four vowel system, which includes the low front vowel [ɛ]. This vowel arises as the result of the resetting of the context-sensitive parameter marking [+back] on low vowels (rule 6 in (6.13)). Once [low] and [back] are available to the child, this rule can be reset, since that rule references only the features [low] and [back]. When this parameter is reset, the child will add /ɛ/ to the phonological inventory, and will restructure the inventory so that /a/ is also marked as [+back]. The theory of RU combined with the order of feature availability in (6.6) therefore predicts two stages: one with [a] vs. [e] vs. [o], and a slightly later one where the low front vowel [ɛ] has been added to the system. While we do not have specific evidence that the first stage exists, we do have evidence for the later stage.

The child can do nothing more based on the features [low] and [back] and the next acquisition will occur when [high] enters the system. At this point, we again face a problem. Both /i/ and /u/ in (6.12) are marked for the feature [high],
with /i/ marked as [+high] and /u/ marked as [+high] and [+back]. Given the assumptions we have made until now, there is nothing to predict which vowel will be acquired first, although the data demonstrate that /i/ is acquired before /u/. Since /i/ is marked with the fewest number of feature values, I will assume that the MRC can be interpreted as a principle of acquisitional markedness, saying that the segment with the fewest number of feature markings will be acquired first. This principle must be interpreted in conjunction with the theory of feature availability, and the other assumptions of the parametric theory. Given this view of the MRC /i/ should enter the child's system first, and later /u/.

(6.6) says that the final feature to become available is [round], and the correct use of this feature will necessitate resetting the context-free parameter for [round] and the context-sensitive rule predicting [-round] for front non-low vowels (rules 4a and 9 in (6.13)). In order to reset the context-sensitive rule, the child need only discover that front non-low round and unround vowels are phonologically distinct in Hungarian. To reset the context-free parameter, the child must discover that the harmony rules of the language require this particular feature specification. The child can acquire all the appropriate segments of the language without resetting the context-free rule, so I assume that the context-free parameter is reset after the adult inventory has been acquired. Once the context-sensitive rule given as rule 9 in (6.13) is reset, /ð/ will be marked only as [+round], while
/ʊ/ will be marked as both [+round] and [+high]. If we again assume the MRC as predicting acquisitional order, /ʊ/ should be acquired before /ü/.

The preceding picture of acquisition in Hungarian can be schematized as in (6.14).

(6.14)

a. e a o  
   [+low]  
   [+back]

b. e a o ⍵  
   [+low]   [+low]  
   [+back][+back]

c. e a o ⍵ i  
   [+low]   [+low]  
   [+back][+back]  
   [+high]

d. e a o ⍵ i u  
   [+low]   [+low]  
   [+back]  
   [+back]   [+back]  
   [+high] [+high]

e. e a o ⍵ i u ʊ u  
   [+low]   [+low]  
   [+back]  
   [+back]   [+back]  
   [+high] [+high]  
   [+rd] [+rd]
This schema differs from that in (6.10) only with relation to the vowel /ɛ/. In (6.14) /ɛ/ is assumed to enter the child's system after /e/ and /o/, while in (6.10), the initial inventory includes both these vowels. Since we have no firm evidence to suggest that a stage such as that shown in (6.14a) cannot exist prior to the data we have evidence for, I will assume that the account shown in (6.14) is plausible.

6.2.1.2 CU Account

The two most important components of UG in the parametric theory of CU are the Restrictive Redundancy Condition (RRC), given in (4.25), and the universal R-rules, given in (4.26).

The initial Hungarian vocalic system predicted by the theory of CU is given in (6.15) (repeated from (4.27)).

(6.15) Initial Representation of Hungarian Vowels - CU

\[
\begin{array}{cccccc}
\text{i/ũ} & \text{e/ő} & \text{a/ɛ} & \text{u} & \text{o} \\
\text{high} & + & - & + & - \\
\text{low} & + & - \\
\text{back} & - & - & + & + \\
\end{array}
\]

Again, given the R-rules in (4.26), the 5 distinct segments in (6.15) will surface as [i], [e], [a], [u] and [o]. In order to achieve the adult system of Hungarian CU predicts that the same two context-sensitive rules must be reset to the marked option as in RU. These marked parameters are given in (6.16).
(6.16) Marked Featural Parameters - CU

2. * [+low] --> [+back]
5. * [-back] --> [-round]
  [-low]

When context-sensitive parameters are reset in CU it is not necessary that the rules be eliminated from the grammar; however the feature values made redundant by these rules will be marked underlyingly and by the RRC any Contrastive specifications will also be added to the underlying representation.

Given the theory of feature availability, the RRC and the other assumptions of CU, we can attempt to account for the stages of Hungarian acquisition in (6.10). Following the order of availability in (6.6) we first assume that only the features [low] and [back] can contrast in this system. While /a-ɛ/ is marked only as [+low] in (6.15), there are no other vowels in this system that are marked with just the features [low] and [back]. The only option available to the child then is to reset the context-sensitive rule predicting [+back] on [+low] vowels (rule 2 in (6.16)), after which /ɛ/ will be marked as [-back] in contrast with /a/, which will then be marked as [+back] and [+low]. This account then predicts that the first vowel contrast will be between /a/ and /ɛ/. This is not a stage for which we have evidence, as shown in (6.10).

When [+high] next becomes available, we find that three segments in (6.14) are marked only for the features [high] and
If we interpret the RRC in (4.25) as saying that the segments with the fewest number feature markings will be acquired first, we predict that /u/, /i-ʊ/ and /e-ð/, which will surface as [u], [i], [e], will be added to the system next. The second stage of development will then be one which includes the vowels /a/, /ɛ/, /u/, /i/ and /e/. This will be closely followed by a third stage where /o/ is added to the inventory.

When [round] becomes an operative feature the child will be able to reset context-sensitive rule 5 in (6.16), which involves the features [low], [back] and [round]. Once this is reset /ʊ/ will be specified as [+high], [-back] and [+round] and /ð/ as [-high], [-back] and [+round]. Both segments will be specified with three values and should therefore be added to the inventory at approximately the same time.

This account predicts the stages of vocalic acquisition in (6.17).

(6.17) a. a ɛ
d. a ɛ e i u o ü ð

These stages are very different from the stages that have been observed in the Hungarian acquisition data, given in (6.10).
The only similarities are that /ʊ/ and /ø/ are the last vowels to be acquired. It therefore does not seem possible, given the assumptions of the parametric theory of CU and a theory of feature availability, to account for the development of the phonological inventories in Hungarian.

6.2.2 Spanish

I assume, following the reasoning given in 6.1.1, that the initial vocalic contrasts of Spanish develop as shown in (6.18).

(6.18) a. e o b. i
a e o

a

These are the identical to the first 3 stages posited for Hungarian, except that Spanish does not have a low front vowel. The initial 3 vowels are /a/, /e/ and /o/, followed by the high front vowel and later the high back vowel.

6.2.2.1 RU Account

In using the RU acquisition theory to account for the developmental stages for Spanish given in (6.18), I again assume the order of feature availability in (6.6) and the MRC as a predictor of acquisitional markedness. In addition I
assume that the context-free default rule for the feature [high] should be [ ] --> [-high] rather than [ ] --> [+high] and that the set of universal default rules is as given in (6.11). Given that the rules in (6.11) supply the redundant feature specifications for the 5 vowel inventory of Spanish, the marked values will be as given in (6.19).

(6.19) Initial Spanish Vowel System - RU

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>e</th>
<th>a</th>
<th>o</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>back</td>
<td></td>
<td></td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

The system in (6.19) is revised from that originally given in (4.22) in that the opposite value of [high] is marked underlyingly. This means that the totally unspecified vowel in the system will initially be /e/, rather than /i/, and that the context-free parameter for [high] need not be reset in the acquisition of Spanish. As this was the only parameter assumed in Chapter 4 to require resetting in Spanish, I now assume that there are no featural parameters to be reset in this language.

Given the theory of feature availability and the specifications in (6.19) we can predict the stages of acquisition that will occur in Spanish, and compare these to the observed stages as outlined in (6.18). The first features that becomes available are [low] and [back], predicting that
the first segments should have contrasts based on some combination of these features. As in the Hungarian system, the vowels /a/, /e/ and /o/ are the only three in the system that contrast with regard to just these features.

When [high] becomes available, /i/ will be added to the inventory first, since it is marked only as [+high]. /u/, which is marked as [high] and [+back], will be the last vowel acquired. The ordering of /i/ and /u/ is predicted by the MRC. The addition of [round] will have no effect on this system, since this feature is not operative in any way in the proposed Spanish system.

These predicted stages are identical to the stages in (6.18). These stages are schematized in (6.20) using the RU vowel specifications.

\begin{align*}
(6.20) & \quad a. \quad e \quad a \quad o \\
& \quad \quad \quad [+low] \\
& \quad \quad \quad [+back] \\
& \quad b. \quad e \quad a \quad o \quad i \\
& \quad \quad \quad [+low] \\
& \quad \quad \quad [+back] \\
& \quad \quad \quad [+high] \\
& \quad c. \quad e \quad a \quad o \quad i \quad u \\
& \quad \quad \quad [+low] \\
& \quad \quad \quad [+back] \quad [+back] \\
& \quad \quad \quad [+high] \quad [+high]
\end{align*}
The developments shown in (6.20) differ from the initial stages shown in (6.14) for Hungarian with respect to the resetting of the context-sensitive parameter supplying [+back] for low vowels. In Hungarian it is assumed that this featural parameter is reset once [back] and [low] are both available. At that point /ɛ/ will be added to the system, and the specification of [back] will be restructured. This parameter is not reset in Spanish, a low front vowel is not part of the inventory, and restructuring does not occur. Restructuring is not predicted to occur at all in the acquisition of Spanish, since no marked featural parameters are required.

6.2.2.2 CU Account

In the CU account of the stages of acquisition of Spanish vowels, I again assume that the RRC can be interpreted as a predictor of acquisitional markedness. Assuming that the child has phonetic representations for the 5 vowels of Hungarian, the child's initial contrastive specification of these vowels, as constrained by the R-rules in (4.26) is given in (6.21)\(^{10}\).

(6.21) Initial Spanish Vowel System - CU

\[
\begin{array}{cccccc}
\text{high} & + & - & - & + \\
\text{low} & & + & - \\
\text{back} & - & - & + & + \\
\end{array}
\]
This is identical to the contrastive specifications assumed for the adult system of Spanish (see (3.72)). Following the assumptions for the CU acquisition of Spanish given in 4.3.2.2, there are no featural parameters for the child to reset in order to achieve the adult system.

Given the order of feature availability in (6.6) and the specifications in (6.21) we predict that no vowels will be acquired when only the features [low] and [back] are available to the child, since only /a/ is marked with one of those features, and the only vowel that is marked [-low] is also [-high]. When [high] becomes available, we predict that /i/, /e/ and /u/ will be added to the system, and will contrast with /a/. The final vowel to be added to the system will be /o/, since it has the most feature specifications.

This account then predicts the sequence of stages shown in (6.22).

(6.22) a. a e i u

   c. a e i u o

While the first stage does contain 4 vowels, as does the initial stage in (6.18), the CU account predicts that /u/ will be a member of this early stage, while the attested stages in (6.18) demonstrate that it is not. The CU account also predicts that /o/ will be the last vowel acquired, while the attested stages demonstrate that it is part of the initial inventory.
It then appears that the CU theory is incapable of accounting for the attested stages of development in Spanish, as well as in Hungarian.

6.3 Substitution Patterns

In 5.2 the substitution patterns used by Hungarian and Spanish children are examined. These substitutions are classed as either paradigmatic substitutions or syntagmatic substitutions. Paradigmatic substitutions occur when the unmarked setting of a phonological parameter applies in a child's speech when the language being acquired requires the marked setting. Syntagmatic substitutions occur when a phonological rule of Spread operates across a child's word form to fill in unspecified feature values. Such a process supplies the surface values for a skeletal slot which is underlingly unspecified. The Hungarian and Spanish results demonstrate that the most frequent type of paradigmatic substitution is the use of a simple vowel in the child's form for a complex vowel in the adult form. It is also shown that the syntagmatic substitutions that occur in the two different languages are remarkably similar, although the trigger mechanisms are somewhat different.

The parametric theories of RU and CU make very similar predictions concerning the types of substitution errors that will occur in the speech of children acquiring Hungarian and Spanish. These predictions are outlined in 4.3. In 6.3.1 and 6.3.2 I look at the substitution patterns that occur in the
acquisition data, and show the RU theory is better able to explain several of these patterns than the CU theory of acquisition. In looking at syntagmatic substitutions in 6.3.1 I first look at the similarities that exist between the syntagmatic substitutions used in the two languages under investigation, and then I look at the differences. In 6.3.2 I examine the paradigmatic substitution patterns that occur in both Hungarian and Spanish.

6.3.1 Syntagmatic Substitutions
6.3.1.1 Cross-linguistic Similarities

In 5.2 it is shown that CV and V Spread are used by children acquiring both Hungarian and Spanish. Of a total of 3 children acquiring Spanish, all 3 make use of CV Spread, while there is evidence for V Spread only in Claudio's speech. Of a total of 4 Hungarian children, there is evidence that 2 make use of CV Spread and 3 make use of V Spread. Since the number of lexical types per child are fairly small, it is possible that the child produced additional forms, not reported in the published articles, which would show the operation of these rules. Both types of Spreading are used more often by both Hungarian and Spanish speaking children at Time 1 than at Time 2.

What is interesting about the occurrence of CV and V Spread in the Spanish and Hungarian acquisition data is that Spanish does not have a productive spreading or assimilation process. Contrary to the assumptions that are usually made
about parametric rules, the unmarked option of this rule can be assumed to be ON (or application), rather than OFF (or non-application, see 2.1.3 and 4.3).

An alternative conception of why we find Spreading occurring at such an early age even when the language being learned does not require such a rule, is that its appearance can be attributed to the effects of the Satisfaction Condition, given earlier in (4.12) and repeated here in (6.23).

(6.23) Satisfaction Condition (McCarthy and Prince 1986: 6)

All elements in a template are obligatorily satisfied.

I assume, as discussed in 4.2.3, that children's initial word shapes are provided by a set of templates to which melodic information must be mapped. If a child is unable to provide melodic information for all elements in the template, and the condition in (6.23) is assumed to be a part of UG, then the child will be forced to provide specifications for unspecified segments. If we assume that only the operations of Insert, Delink and Spread (given in (4.11)) are available phonological operations, then only Spread would be able to provide featural representations for an underlingly unfilled segment. Insert would require that the child add a feature, and if the child is having difficulty supplying features for templatic elements, this option seems unlikely. Delinking would only serve to diminish the featural content of the representation
even further.

If we conceive of Spread in early phonological development as a rule which is initially ON, and then later has to be turned to OFF in languages such as Spanish, then we must assume that there positive evidence will tell the child that such a rule does not function in their language. It is difficult to conceive of what positive evidence of this sort would look like. It is much easier to conceive of a rule of Spread as simply dropping out of the child's repertoire of operations once the entire phonological inventory of the language has been acquired. Spread might then have to be relearned (or reset to the marked ON option in the parametric account) if it is required as a phonological rule in that language.

This conception of Spread enables us to explain how the child can go from a rule which spreads all vocalic features, so that all vowels in a word become identical, to one which spreads only a single feature (as in the case of Back or Round Harmony in Hungarian). It also allows us to explain why Spread (i.e. reduplicated child forms) appear to decrease in the speech of all children over time, even when the language being learned may require a spreading rule.

It is an interesting fact that the vocalic features which are spread in the data from children acquiring Hungarian and Spanish always seem to be the Dorsal features. In the Hungarian forms which undergo CV and V Spread in (5.23), only the vowels /a/, /i/, /o/ and /ɛ/, which do not require the
specification of [round] are spread. In Spanish the vowels which spread are /a/, /o/ and /e/. This may suggest that it is the Dorsal Node which is being spread. Consistent with that is the fact that a Dorsal consonant never seems to intervene between the target and trigger of the spreading process. The principles of spreading would suggest that a consonant specified as Dorsal should block spreading of the Dorsal Node. Within the theory of RU it would be possible to assume that in many cases a rule of Spread manipulates only a single feature value rather than an entire node (except that this will not account for the spreading of /a/ once the context-sensitive rule predicting [+back] on [+low] vowels has been reset), however, this predicts that we then have several seemingly unrelated spreading processes, rather than one unified rule.

6.3.1.2 Cross-linguistic Differences

The major difference that is found with regard to syntagmatic substitutions in Hungarian and Spanish relates to the conditions under which these substitutions are realized. In Hungarian Spread occurs, as predicted in 4.2.3, either when a target sound is not in the child's phonological inventory at that time, or when some complexity exists in the target. For example, T.A. at Time 1 used the form [magna] for magnó, where the features of the initial vowel are spread to the second vowel slot, at a time when the long vowel /ő/ was not in his repertoire. In Laci's form [appa:] for hoppá the vowel
specifications of the final vowel in the target are spread to the initial vowel in the child's form. Although /o/ is one of the sounds in Laci's phonological repertoire at the time this form was used, both the target and Laci's form contain geminate consonants. It is possible that the representation of the geminate is an added complexity in the child's form, and as a result Laci is only able to provide distinct vowel features for a single vowel.

In contrast, there is no evidence that Spanish children use syntagmatic substitutions to provide features for vowels not yet in their repertoire. Syntagmatic substitutions appear to arise in this language only to provide surface specifications for an unstressed vowel. In the majority of the forms shown in (5.37) both vowels in the child forms surface with the feature specifications of the stressed vowel in the adult target. In 5.2.2.1 I have speculated that Spanish children at the age studied here have not yet determined how stress functions in their language, and stress must be lexically marked. This underlying representation of stress makes the child's representation more complex, and as a result the child is able to supply feature specifications only for the stressed vowel. Unstressed vowels will receive their surface specifications through the operation of Spread, or as will be shown in 6.4.2, through the operation of redundancy rules.
6.3.2 Paradigmatic Substitutions

Paradigmatic substitutions are predicted by both the CU and RU theories to occur when the universal unmarked parameter setting operates in the child's system in a language which requires a marked parameter setting. Both theories predict that simple vowels will be substituted for complex vowels, based on the unmarked setting of the Complex N parameter, as discussed in 4.2.2.3. Both theories predict that in Hungarian [a] will initially be substituted for /ε/, and that [i] and [e] will initially be substituted for /ʊ/ and /ø/, based on the context-sensitive redundancy rules that must be reset in these languages. In Spanish both theories predict that there will be no paradigmatic substitutions that relate to context-sensitive featural parameters, since there are no context-sensitive rules which require resetting in this language (given the assumption discussed in 6.2.1.1 regarding the marked value of [high] in the RU theory).

6.3.2.1 Hungarian

The most common type of paradigmatic substitution process found in Hungarian is the collapsing of short and long vowels\(^{11}\). This type of substitution accounts for almost one-half of the mismatches that occur between adult and child forms in both sessions (i.e. throughout the child's second year). As discussed in 6.1.2 long vowels appear to be acquired in a gradual fashion, rather than all at once. At Time 1 (i.e. in the first half of the second year) the
composite inventory for Hungarian contains only the long vowel /A/, while at Time 2 (i.e. in the second half of the second year) the vowel /é/ has also been acquired. It has been suggested that this gradual acquisition can be attributed to the learning mechanism, and is not necessarily evidence against the parametric model of acquisition.

The productive paradigmatic substitutions that are found to occur in Hungarian that do not relate to the long/short vowel distinction are the substitution of [o] for /u/, and the substitution of [a] for /e/. The latter substitution is predicted by both the RU and CU theories, because the universal redundancy rules provide [+back] as the redundant value of low vowels.

Neither theory predicts the substitution of [o] for /u/, however, given the theory of feature availability discussed in 6.1.3 and the initial representation of Hungarian vowels provided by the theory of RU (shown in (6.12)) it is possible to find an explanation for such a pattern. The order of feature availability in (6.6) tells us that the feature [back] becomes available to a child before [high], and the RU representation of vowels specifies /o/ as [+back] and /u/ as [+back] and [+high]. It is therefore conceivable that before [high] enters the child's system, the vowel [o] may be used to replace target /u/.

There is no comparable explanation to be found within the initial representation of vowels given by the theory of CU. In (6.15) it is shown that /u/ is initially specified as
[+high] and [+back], while /o/ is specified as [-high], [-low] and [+back]. Given a theory of feature availability where features become specified in the order given in (6.6) there would be no reason to suspect that [o] might act as a replacement for /u/. /u/ requires one additional feature specification, and both require the availability of the features [high] and [back].

6.3.2.2 Spanish

It is shown in (5.31) that the replacement of a simple vowel for a diphthong in the adult target accounts for approximately one-third of all the mismatches found in the Spanish data. Even by the second half of the second year diphthongs are not part of children's phonological inventories, although some children are beginning to attempt them at this later time (see (5.29)). It may be that complex vowels are later acquisitions in Spanish than in Hungarian because their surface realization is controlled not only by the Complex N parameter, but also by phonological rules such as High-Glide Formation (see 3.2). In Hungarian the two skeletal slots that form long vowels share a single set of feature specifications, so once the child has learned the appropriate set of feature specifications and has reset the Complex N parameter, the vowels will begin to be used productively. Acquisition of complex vowels in Spanish requires one extra step.

Although neither parametric theory predicts that
paradigmatic substitutions will occur that do not relate to
the Complex N parameter, it is shown in 5.2.2.2 that Spanish-
speaking children sometimes replace /a/ by [e]. Given the RU
representation of Spanish vowels in (6.19) this substitution
finds a ready explanation. If the child neglects to provide
feature specifications for a vowel, then that vowel will
surface as [e]. [e] is the most common substitute for all the
vowels of Spanish, although this pattern is only frequent
enough to call productive for /a/\textsuperscript{12}. If we look at the CU
initial specification of Spanish vowels in (6.21), again there
appears to be no reason to assume that [e] might ever occur in
place of /a/. /a/ is marked as [+low], while /e/ is [-high]
and [-back], and while it may be possible to explain the
substitution of [a] for /e/ before [high] and [back] become
available, we would never expect the opposite to occur.
Again, then, the RU theory of acquisition appears to be the
better account of these acquisition facts.

6.4 Rules

As was discussed in 4.1.2 most research into the
acquisition of phonological rules has centered around the
child's own rules, rather than on the rules that the child
must acquire to achieve the adult phonological system. This
is in part due to the fact that a coherent theory of
autosegmental rules is a relatively new development, and to
the fact that acquisition researchers have only recently begun
to view the child's phonological system as a possible adult
grammars. As a consequence, little is known about the relationships that exist between children's phonological rules and the rules of adult phonological systems. In this section I will examine the acquisition data from Spanish and Hungarian to determine if there is evidence for the rules of the adult language as outlined in Chapter 3. The two underspecification acquisition theories assume roughly the same sets of rules for both languages, although the rule mechanisms differ in certain crucial ways that will be important in accounting for the data.

6.4.1 Hungarian

In Chapter 3 analyses of the vocalic system of Hungarian are presented within the frameworks of RU and CU. The phonological rules assumed to be present in Hungarian by both theories are given in (6.24).

(6.24) Parametric Phonological Rules of Hungarian

a. Back Harmony (BH)
b. Round Harmony (RH)
c. Epenthetic Vowel Specification (CU only)
d. Low Front Vowel Formation

Back Harmony and Round Harmony are both spreading rules, while Low Front Vowel Formation changes a front mid unrounded vowel into a low vowel. Each of these rules are parametric rules in the sense discussed in Chapters 3 and 4, however, Round Harmony and Low Front Vowel Formation have relatively complex
I hypothesize in 6.3.1.1 that the Spread rule that is in evidence in these children's early forms may be totally independent of the rules of Back and Round Harmony and may disappear from the child's system before Back and Round Harmony are acquired. If this is true then we might expect that multisyllabic forms that do not undergo Place Spread or Copy will contain vowels that violate the restrictions of Back or Round Harmony, and this is not the case. In an examination of the multisyllabic forms which contain differentiated vowels, there are no apparent violations of Back Harmony at either Time 1 or 2. Back vowels follow back vowels, front rounded vowels follow front rounded vowels, and either set may co-occur with /e/ and /i/. There do not appear to be any cases of the vowels /e/ and /i/ being changed into back unrounded vowels, and while there are one or two cases of /e/ and /i/ being changed into a back [o] or front [ʊ], these substitutions are by no means systematic.

It may be then that a rule of Back Harmony cooccurs with a Spread rule which accounts for CV and V Spread. The Spread rule which accounts for CV and V Spread will gradually drop out of usage as the child learns the correct feature specifications of the language, and at the same time the rule of Back Harmony increases in usage, as the child gets better at providing the underlying specifications for vowels.

Round Harmony is shown in Chapter 3 to be a less general rule than Back Harmony. This rule spreads the marked feature
value(s) of [round] only to short mid vowels. In the RU account it is assumed that Round Harmony spreads [-round], the universally redundant feature value. For this to be feasible, the child must reset the context-free parameter for [round] to the marked option, suggesting that Round Harmony will be a late acquisition ([round] is also the last feature make available to the child, according to (6.6)). In the small number of child forms which contain final suffixes only one was found that violates Round Harmony restrictions. This form is [tʃuʃuˈlek] from T.A. (target = [tʃuʃuˈłök]), which would be impossible if a rule of Round Harmony spread [+round] rightwards. Because there are so few child forms with suffixes I do not believe there is sufficient evidence to prove that a rule of Round Harmony does or does not exist.

A process of Epenthesis in Hungarian inserts a vowel which is realized as [ø], [o] or [ɛ] to break up impermissible consonant clusters. The rule can apply root-internally or between morphemes, and I assume it applies automatically as a result of the syllabification algorithms of the language. The child forms which contain additional vowels not present in the target are given in (6.25).
In each of these forms an extra vowel appears word-finally so that the child's syllable structure is (C)V(C)(C)V. There are no examples of extra word-final vowels in the data for Jolán or T.A. at Time 1. In 6 of the 8 examples in (6.25) the quality of the final vowel appears to be determined through Spread, and therefore it does not seem likely that a rule of Epenthetic Vowel Specification, such as that proposed in CU, is functioning in the speech of these children.

One possible interpretation of the forms in (6.25) is that the final vowel slots are inserted by a rule of Epenthesis, but I believe a better explanation is that they are the result of mapping the features of a consonant-final adult target to a CVCV template. In (6.26) the number and proportion of vowel-final and consonant-final phonetic types are given for each Hungarian child at two times.
At Time 1 in both T.A. and Jolán's speech approximately 70% of all forms are vowel-final and 30% are consonant-final. Laci did not produce any consonant-final forms at all at this time. By Time 2 T.A. had increased his proportion of consonant-final forms by almost 10% and M. produced a larger proportion of consonant-final than vowel-final forms.

The fact that Hungarian children initially use such a large number of CV and CVCV syllable structures even when this is not the preferred syllable structure of the language (see discussion of the syllable shapes of Hungarian in 5.1.2.2) suggests that the shape of these early words is provided by UG. In 4.1.2.4 I hypothesize that UG supplies a set of word templates which provide the initial word shapes that children
use. The figures in (6.26) suggest that by the second half of the second year Hungarian children are using these universal templates less and less, and have learned to produce more consonant-final forms. If this is true then the final vowels in the child forms in (6.25) are best explained as mismatches between universal templates and adult targets, and not as examples of Epenthesis.

The final adult rule of Hungarian given in (6.24) is Low Front Vowel Formation. This rule adds [+low] to a vowel which is front, mid and unrounded when one is derived through Back Harmony or Round Harmony. In the published Hungarian data [ɛ] is written orthographically as e, and I have chosen to interpret all instances of e as phonetic [ɛ]. I therefore have no evidence as to whether Low Front Vowel Formation exists in the speech of these children.

6.4.2 Spanish

The phonological rules which are proposed by the theories of RU and CU to account for the vocalic system of Spanish are discussed in detail in 3.2. These rules are given in (6.27).

(6.27) Parametric Phonological Rules of Spanish

a. Unstressed N Reduction
b. Vowel Delinking
c. High-Glide Formation
d. Final Vowel Lowering
e. Reassociation of [+high] (CU only)
Unstressed N Reduction and Vowel Deletion are both rules which delete a skeletal slot associated with a nucleus, if it is not stressed. Vowel Delinking is a cyclic lexical rule which delinks the skeletal slot of a vowel when it is immediately followed by another vowel. High-Glide Formation adds the feature [+high] to the non-head member of a branching stressed nucleus. Final Vowel Lowering changes a high vowel to a mid vowel when it is word-final and unstressed. Reassociation of [+high] is a rule required only in the CU analysis which reassociates the [+high] feature of a vowel delinked by Vowel Delinking.

The rule of Unstressed N Reduction (6.27a) is intricately tied to the representation of diphthongs in Spanish. I assume, following Harris (1985), that falling diphthongs in Spanish are underlyingly represented as two skeletal slots, both which may have their own sets of vocalic features. Unstressed N Reduction is the rule which deletes the non-head member of the diphthong if it does not receive stress, and therefore accounts for the simple vowel alternants of vowels which can surface either as a diphthong or as a simple vowel.

The composite phonological inventories for Spanish children at Times 1 and 2 in (5.28) and (5.30) demonstrate that diphthongs are not being used productively at either session. Both Florencia and Ignacio are beginning to attempt diphthongs, but these are not systematic even at Time 2. Examples of diphthong reductions are shown in (6.28).
Target diphthongs are generally produced as a simple vowel with the same vocalic features as the head member of the diphthong. It would therefore appear that Spanish children, like Hungarian children, are only able to map vocalic features to a single skeletal slot. This suggests that the child's representations of *cielo* and *cuarto* will be as in (6.29).

(6.29)  

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In each form the child will have distinct representations for the two vowels, but because the Complex N parameter is set at the unmarked universal option, each vowel will be represented as a single skeletal slot. Spanish children will have to learn, on the basis of positive evidence, that the language permits nuclei to branch and dominate two skeletal slots. Diphthong reductions can then be explained in a parallel fashion to Hungarian long/short vowel confusions -- they are paradigmatic substitutions which occur because a universal parameter setting is present in the child's phonology when the adult language requires the marked parameter setting. Given that diphthongs are not productive for 2 children at Time 2 and that a paradigmatic substitution accounts for the diphthong reductions, it is unlikely that a rule of Unstressed Vowel Reduction is part of the child's early phonological system.

Once a Spanish child has acquired the ability to represent vowels as two slots, the rule of High-Glide Formation (6.27c) must be acquired before the two slots will be realized correctly. In 3.2 I have assumed that High-glide Formation is a specific rule of Spanish, rather than a universal convention, as is proposed in Harris (1985). If High-glide Formation is in fact a rule that must be learned, then we might expect to find children having some difficulty with diphthongs between the time that they are able to represent branching nuclei and the time that diphthongs are
correctly produced. This does not appear to be the case. Underlying diphthongs seem to have only two possible realizations in the speech of children acquiring Spanish: they are realized as simple vowels (as in (6.30)), or as the correct diphthongs. This evidence suggests that High-glide Formation may in fact be a property of Universal Grammar (as Harris suggests) rather than a rule specific to the phonology of Spanish.

The rule of Vowel Delinking (6.27b) is a cyclic rule which only applies when two vowels are contiguous because of morphological concatenation. There is very little evidence in the Spanish data that children at this early age are systematically combining inflectional morphemes and roots. At Time 2 there are several examples of verb roots with indicative endings, but these are not frequent enough to indicate that children are adding suffixes productively. If children do not yet have a sense of how to perform morphological operations, then they will certainly not be able to order rules within the lexical component.

Given that we looked at Hungarian child forms which contain an extra vowel slot than the target, it would be interesting to do the same for Spanish. The forms in (6.30) are examples of child forms that are vowel-initial when the adult target is consonant-initial.
(6.30) Child  Adult Lexical Type  Child.form
Claudio  dulce  eBi  eBle
        kolumpio  eBje
        libro  eBle
        toalla  eja
        lece  ese
        huevo  oBo
Florencia  gracias  ata
            zanajoria  aoja

In all but the final 3 forms the vowel which occurs word-initially is [e], although that the initial vowel in the target is [e] only in the case of lece.

The forms in (6.30) can be analyzed as CVCV forms that have features mapped only to the final syllable. In a form such as [eBi] Spread has not taken place to fill in unspecified feature values, and the initial vowel is realized as [e]. In forms such as [oBo] and [ata] Spread provides the feature specifications of the initial vowel.

This data is interesting when examined in conjunction with the earlier findings on paradigmatic substitution patterns and exceptions to V Spread. In 6.3.1 I point out that the trigger of Spread in Spanish is generally the stressed vowel, with the exception of two forms in which the stressed vowel is [e] ([poxo] 'espEjo' and [oBo] 'huEvo'). If /e/ is a vowel which underlyingly has no features in Spanish,
If /e/ is specified in this fashion there is no reason to expect that it should be the most frequent substitute, nor that it will occur in certain vowel-initial phonetic forms. The forms in (6.30) can be analyzed as forms which have two distinct vowel representations, but this would not explain why the initial vowel in these forms is always [e] or a copy of the final vowel.

The final rule which is assumed by both the RU and CU theories is Final Vowel Lowering (6.27e) which lowers a high unstressed final vowel to a mid vowel. The evidence for the presence of this rule will come mainly from morphemes which have a vowel that alternates between a high or mid vowel, depending upon its position in the word. There are several examples in the Spanish data of children's forms which contain a final high vowel when the adult target does not (e.g. [eBi] 'dulce', [kai] 'cual', [nani] 'media'), suggesting that Final Vowel Lowering is not present in children's systems at these early ages. I suggest that such a rule is more likely to be acquired later, when the child is actively beginning to combine morphemes, and begins to pay attention to the processes that occur when morphemes are combined (the same is true for Vowel Delinking).

Reassociation of [+high] (6.27f) is a rule that is necessary only in the CU analysis of Spanish. This rule reassociates a floating [+high] feature after the vowel slot has been deleted by Vowel Delinking. As stated above, there is no evidence for a rule of Vowel Deletion at the early ages.
studied here, and I assume then that a rule of Reassociation of [+high] is also not possible. Rules such as these are probably better studied at a later point in acquisition, when morphological forms can be manipulated for the child.

6.5 **Summary**

The acquisition data show that the initial phonological inventories of both Spanish and Hungarian children are smaller than predicted by either the RU or CU acquisition theories. The evidence points to the gradual development of a phonological inventory beginning with the vowels /a/, /e/, /o/ (and /ɛ/ in Hungarian). The next vowel to be added to this system is /i/, and the last vowel to be added to a symmetrical 5 vowel inventory is /u/. In Hungarian /ʊ/ and /ø/ are the last vowels acquired.

To account for the discrepancy between the inventories predicted by a parametric theory of acquisition and the attested data I have proposed a theory of feature availability, which specifies the order in which features become part of the child's phonological system. This is a universal order that will hold for all children. In addition to prescribing the order of features, this theory of feature availability will help to make predictions about the order in which context-sensitive featural parameters are reset. The evidence from Hungarian demonstrates that the context-sensitive rule which makes reference to the features [low] and [back] will be reset once the features [low] and [back] are
made available to the child, and before the feature [high] enters the child's system. The resetting of this rule will allow the low front vowel /ɛ/ to become a part of the child's phonological system. The context-sensitive rules which involves the feature [round] can only be reset after [round] is made available.

The acquisition theory based on the theory of RU is able to predict the early inventories of Hungarian and Spanish, assuming the components of UG in (6.31).

(6.31) a. a theory of default (universal redundancy) rules
    b. a theory of feature availability which says that features become available in the order [low]/[back], [high] and then [round]
    c. the MRC interpreted as a predictor of acquisitional markedness.

The theory of default rules dictates the universally predictable feature values, and these rules may initially override the child's specification of segments. If the language requires a marked context-sensitive parameter setting, the effect of the child initially using the unmarked setting will be that certain distinct segments or classes of segments will be merged in the child's early system. Once a feature is made available for the child to use productively, the child will add all segments specified by that feature to the inventory.

The MRC is the principle of UG which says that segments
with the fewest number of feature specifications will be added to the child's repertoire first, and can only be used in conjunction with a theory which indicates the order in which features will become part of the child's system. Once all segments specified by a given feature have been added to the inventory a context-sensitive default specification relating to that feature will be reset at the OFF option, if resetting is required by the language-specific grammar. Parameter resetting will force the feature specifications in the existing inventory to be restructured.

The three aspects of the RU theory given in (6.31) allow the RU theory to correctly account for the development of the vocalic inventories in Hungarian and Spanish. The underlying feature specifications required by the theory of Radical Underspecification explain why /a/, /e/ and /o/ are the first vowels acquired, why /i/ is acquired only after the mid and low vowels, why /u/ is acquired after /o/, and why /ü/ and /ö/ are the last vowels to be acquired in Hungarian. The predictions made by the RU theory also suggest that in the acquisition of Hungarian children will have to reset the context-free parameter for [round]. There is no evidence in the Hungarian acquisition data that this parameter had been reset at either Time 1 or Time 2, and no evidence for a rule of Round Harmony by age 2;014.

Even paired with a theory of feature availability or with the RRC (the Restricted Redundancy Condition), the contrastive specifications required by the theory of CU cannot explain the
attested order of acquisition in either Spanish or Hungarian. In a contrastive system the vowel /o/ will be marked with the features [low], [back] and [high], while /u/ should be marked only for the features [high] and [back]. We would then predict that /o/ should be acquired later than /u/, when the opposite order of acquisition is attested in both languages.

A second discrepancy between the predicted and attested systems relates to complex vowels. Both parametric acquisition theories predict that the acquisition of complex vowels is a function of the setting of the Complex N parameter, and once a child acquiring Spanish or Hungarian resets this parameter to the marked option complex vowels should immediately be used for all vowels that feature specifications exist for. This did not prove to be the case in either language (the evidence is less clear in Spanish where complex vowels were just entering the child's system in the second half of the second year). Acquisition of complex vowels appears to be a gradual process, which is similar to the acquisition of simple vowels. I have suggested that the parametric view of acquisition can be maintained if we assume that once a parameter is reset, the learning mechanisms will integrate the new parameter setting in a gradual fashion.

The data from syntagmatic substitution patterns suggest that Spread is a rule which functions in child forms to fill in the quality of a target vowel when it is left unspecified in the underlying representation. While it might be possible to assume that the universally unmarked setting of these rules
is ON, I have chosen to account for the spreading facts by assuming that Spread is an operation provided by UG, and that it is forced to apply in the child's system because of the Satisfaction Condition. It is therefore not necessary to assume that this rule is 'unlearned' on the basis of positive evidence.

The spreading evidence from both languages shows that the operation of this type of Spread does not consistently apply in a specific direction. Directionality is determined solely by which vowel or syllable in the word is left unspecified. In Spanish the vocalic trigger of Spread is generally stressed, while this is not the case in Hungarian. It is hypothesized that this difference may be due to the different roles that stress plays in these languages -- in Hungarian stress is assigned by a very regular rule, while in Spanish stress is a complex process which requires the knowledge of which roots and suffixes are exceptional to certain stress rules. Until a Spanish child can productively represent complex vowels and has determined the appropriate stress patterns of the language, stress on vowels will be lexically indicated. The underlying representation of stress may complicate the Spanish child's underlying representations enough that underlying feature values are supplied only for stressed vowels.

Two productive paradigmatic substitution patterns are found in the Hungarian data -- the substitution of /e/ with [a] and the substitution of /u/ with [a]. The first is
predicted by both theories of underspecification, since it is the result of the universal default rule predicting [+back] for low vowels. The second substitution pattern is not predicted by either theory, but it is possible to explain this pattern given the specifications of /a/ and /u/ required by RU. The contrastive feature specifications of /a/ and /u/ do not lead to any insights into why this particular substitution pattern occurs. Both the RU and CU acquisition theories also predict that [i] should serve as a substitute for /ã/ and [e] should serve as a substitute for /ð/, but neither of these patterns are found in the acquisition data.

Although no paradigmatic substitution patterns are predicted by either theory for Spanish, it is found that [e] has certain idiosyncratic properties in the early phonological systems of children acquiring this language. These are given in (6.32).

(6.32) a. [e] is the most frequent substitute
   b. [e] appears initially in certain VCV child forms where the adult target is consonant-initial
   c. forms containing stressed [e] appear to be exceptions to V Spread.

There is no obvious way to relate these 3 characteristics in the theory based on CU. In RU, on the other hand, these properties can be explained by the fact that /e/ is the totally unspecified vowel of the language. A vowel will surface as [e] if for some reason it is underlyingly
unspecified and Spread does not operate in the word form. In CVCV forms where the initial syllable is entirely unspecified and Spread does not take place, the word will be realized as a VCV form with [e] as the initial vowel. If the stressed vowel has no underlying feature specifications it will not be able to act as a trigger of Spread. If Spread applies in such a form, the only possible vowel that can spread is the unstressed one.

Based on the analyses given in Chapter 3 both variants of the acquisition theory predict that 3 phonological rules will be a part of the adult phonology of Hungarian. I have hypothesized that Spread that operates early in children's speech is a distinct rule from Back and Round Harmony. The child will initially spread all Dorsal features to a totally unspecified target vowel, and this rule will gradually disappear as the child acquires greater skill at representing vocalic features. The fact that Hungarian children, even at this young age, do not violate Back Harmony restrictions suggests that a rule of Back Harmony may begin to operate very early. I have essentially ignored the rule of Low Front Vowel Lowering in Hungarian, because of the confusions that exist in Hungarian between the orthography and the sources of [ε].

Based on the analysis of Spanish in 3.2 the RU analysis posited 4 rules for the adult phonology and the CU analysis 5. Three of the RU rules and 4 of the CU rules affect diphthongs, and the evidence suggests that in general Spanish children at
this early age do not productively use diphthongs, nor any of the rules that affect them. The diphthongs that were used suggest that once a complex vowel can be represented, the correct features will be associated to that vowel. This is taken as evidence that High-Glide Formation may a very unmarked rule. The rule of Vowel Delinking is a cyclic rule deleting vowels only between morphemes, and there is no evidence of its use in Spanish-speaking children's early productions.

These results point to several areas where a closer study of the acquisition data is required. I have assumed that children map feature specifications to templates which provide their initial word structures and that templates exist as the unmarked option of a parameter. In some languages the marked setting of the parameter will be required in the adult language. I have not looked at how mapping to a template proceeds, when features are mapped to initial or final syllables (or vowels), or when templates cease to restrict children's word shapes. In a related area, I have not attempted to determine when a child will use a paradigmatic substitution, and when a syntagmatic substitution. These are obvious areas for future research.

6.6 Implications

The primary focus of this study has been the comparison of two variants of a parametric acquisition theory, based on the opposing theories of Radical and Contrastive
Underspecification. In this chapter acquisition data on normal phonological development in Spanish and Hungarian has been examined, and tested against the predictions these theories make for the acquisition of vowels in these languages. While it has been shown that neither theory can account for all the data, the RU theory provides a superior account of the aspects of the data in (6.33).

(6.33)

a. the RU theory (in conjunction with a theory of feature availability and an acquisitional interpretation of the MRC) is able to predict the development of both the Hungarian and Spanish vocalic inventories.

b. a radically underspecified system of Hungarian explains why /a/ is sometimes used as a substitute for /u/.

c. the RU theory of underspecification predicts that /e/ is a totally unspecified vowel in Spanish. This account of Spanish /e/ explains why it is the most frequent substitute used by these children, why the initial vowel in children's vowel-initial forms is always [e], and why stressed /e/ behaves exceptionally in forms that undergo V Spread.

These results have certain implications both for phonological theory in general and for a theory of acquisition. These will be outlined in the following sections.
6.6.1 Implications for Phonological Theory

There has been much cross-linguistic research into the empirical validity of the competing theories of RU and CU (e.g. Mester and Ito 1989, Abaglo and Archangeli 1989, Davis 1989). The fact that the RU acquisition theory is able to explain the development of the phonological inventories of Hungarian and Spanish while the CU theory is not suggests that RU provides the best account of how underlying phonological systems are specified and how they develop. Given the most basic principle of RU -- the MRC -- children will use only non-redundant features and feature values in their initial phonological representations, and only non-redundant information will be represented in adult phonological systems.

The RU acquisition theory predicts that two types of featural parameters will require resetting in Hungarian -- context-sensitive redundancy rules and the context-free redundancy rule for [round]. The acquisition data from Hungarian show that by 2;0 children have reset the context-sensitive parameters, and have acquired the short vowel inventory of the adult language, but there is no evidence that they have reset the context-free rule for [round] or that they are using a rule of Round Harmony. These facts suggest that context-sensitive parameters are reset early, while context-free parameters, if reset at all, are switched much later.

One serious inadequacy of both parametric acquisition theories is that they predict that at the initial stages of phonological acquisition, children's inventories will be fully
developed, except where the rules of UG provide context-sensitive parameters that are not part of the language-particular system. To account for the attested systems I have hypothesized that an acquisition theory must be enriched by a theory of feature availability, which will supply features one at a time for integration into the child's phonological system. I believe it is essential to assume that at a phonetic level, features are provided innately, but they are only made available for systematic phonological manipulation one at a time in a fixed order.

Evidence was found in the acquisition data presented in this chapter for a rule of Spread, even in children's systems before 1;6. These rules are found in both Hungarian and Spanish, even though there is no evidence in the phonology of adult Spanish for either rule. This suggests that Spread is a parametric rule whose unmarked setting is ON, or that this is the only operation available to a child to fill in unspecified feature values. If we assume that the operation of Spread in young children's speech represents the most unmarked form of the rule parameters, then these parameters must be revised to take into account the following:
(6.34) a. the unmarked setting of a directionality parameter should reflect the fact that Spread may operate either L → R or R → L.

b. the unmarked setting of Spread when it applies to a vocalic segment is the Dorsal Node, or the highest node that will allow vocalic spreading to take place across consonants.

6.6.2 Implications for a Theory of Phonological Acquisition

The results given in this chapter show that a parametric theory of acquisition based on the RU theory of underspecification provides a feasible account of many aspects of phonological acquisition in both Hungarian and Spanish. Assuming that the context-sensitive rules provided by UG are part of the child's first phonological system helps to explain why their phonological inventories develop as they do. A simplified schema of an RU acquisition model, with certain revisions based on the acquisition findings, is given in (6.35).
I have provided only a simplified version of the parametric aspects of this model. Four specific types of parameters are shown in (6.35): phonological rule parameters, featural parameters (default rules), the Complex N parameter, and template parameters.

The featural parameters are the set of redundancy rules given in (6.11), and these will provide children with the
initial set of hypotheses concerning the underlying specifications for the vowels of their language. The model in (6.35) also contains a Complex N parameter, which will allow for complex vowels as a marked option, and a set of templatic parameters, which will provide the structure for children's early words. The principles in (6.35) are the same as in the earlier model given in (2.43), with the addition of Feature Availability. While it may be possible that Feature Availability is a parameterizable principle of UG, I prefer to believe that the order of feature availability is universally inviolable. The acquisition data suggest that the learning mechanism in (6.35) should be a mechanism which allows for gradual acquisition once parameters are reset, rather than one that assumes instantaneous learning.

There are several aspects of the acquisition data presented in Chapters 5 and 6 that remain rather mysterious. One is the conditions under which Spread takes place in Hungarian and Spanish. In Spanish it is fairly clear that the trigger vowel in both processes is always the stressed one (unless it is /e/), while it is just as clear that stress does not play a role in determining triggers in Hungarian. The only explanation that I have to offer for this phenomenon is that stress plays a very different role in the two languages. In Hungarian stress is assigned by a very simple rule that stresses the initial syllable in words of any length. In Spanish, on the other hand, certain roots and affixes are exceptional with regard to the stress rules. If children are
not able to determine the complex stress patterns at this early age, then the stress patterns of the language would be appear to be totally random, and would have to be marked lexically.

A second aspect of the data that remains puzzling is the fact that several aspects of acquisition do not appear to be an all-or-nothing event, as is suggested by the parametric theory. Once a parameter is reset to the marked option during the course of language acquisition, the parametric theory predicts the new structure or rule should be immediately acquired in all contexts. This view of acquisition is not supported by previous acquisition evidence, nor is it supported by the results presented here. In attempting to account for this characteristic of acquisition I have simply assumed that the learning mechanisms (i.e. the parameter-switching device) is a more complicated mechanism than learnability theory assumes, and that it is responsible for these gradual patterns of phonological rules and segments.

I believe these acquisition data provide striking evidence that children's and adults' phonological systems are closely related. Acquisition in both Spanish and Hungarian appears to be directed by many of the same constraints and rules as exist in the adult systems.

Several aspects of the acquisition data discussed here provide evidence that UG provides the child with a set of templates that will help shape their first words. Children's initial words are mostly CV if monosyllabic and CVCV if
multisyllabic. Children acquiring a language such as Hungarian, where words are predominantly consonant-final, soon learn that the template supplied by UG does not fit the preferred syllable shape of the language, at which point final-consonants become much more frequent. Evidence from forms that undergo Spread suggest that sometimes when the child is dealing with a CVCV template, they have only enough information to represent a single syllable. In this case a principle such as the Satisfaction Condition (McCarthy and Prince 1986) will initiate a phonological rule to fill in the feature specifications of the remaining syllable or segment.

The Jakobsonian theory of acquisition (Jakobson 1941/68, Jakobson and Halle 1956) assumes that children's early phonological systems are constructed around the notion of contrast. Although the notion of contrast is not formally built into the theory of RU, the development of children's inventories shown in 6.2 shows that contrast is an important aspect of this early development. Jakobson's discussions of contrast are based on pairs of individual segments, although the primitives of the theory itself are distinctive features. If vocalic (and consonantal) features are made available to a child one at a time in a given order, then children's initial inventories will develop around featural contrasts.

Two out of three of Jakobson's predictions for vowels given in (4.1) are supported by the Hungarian and Spanish acquisition data. In Hungarian the front rounded vowels are acquired after front unrounded vowels, and in both languages
it appears to be the case that the contrast between /i/ and /e/ is acquired before the contrast between /u/ and /o/. I have assumed that the vowels /ɛ/ and /e/ enter the child's system at the same time in Hungarian, so there is no particular evidence bearing on whether or not the contrast between /a/ and /e/ is acquired before the contrast between /a/ and a low front vowel. As shown in (6.3), Jakobson and Halle (1956) predict that the first three vowels may be /a/, /i/ and /u/ or /a/, /e/ and /o/. The acquisition data from Hungarian and Spanish demonstrate that, at least in these languages, only the latter scenario is possible, with /i/ and /u/ being later acquisitions than /a/.

In closing, I would like to add that the analyses of early phonological acquisition in Hungarian and Spanish presented in this thesis are really only a beginning. Those aspects of this data that I have examined here -- the sequence of stages in the acquisition of vocalic inventories and the types of substitution errors that occur in the child forms -- reveal several pressing areas for future research. How and when does Spread operate in children's early word forms? How do children represent stress initially in a language such as Spanish? What is it that makes children underspecify word forms in certain cases and not in others? And perhaps most importantly, what are the exact set of word templates provided by UG, and how are feature specifications mapped to them? These and many other questions must be asked, and I believe
answers will be forthcoming given the type of model argued for in this thesis.
Notes to Chapter 6

1 This type of substitution is referred to as a paradigmatic substitution, and is discussed in 4.1.2 and 4.2.

2 The composites for Hungarian are given in (5.13) and (5.15) for Times 1 and 2, and those for Spanish are given in (5.25) and (5.23).

3 The low and mid front unrounded vowels in Hungarian will be addressed in 6.1.3.

4 Calabrese's theory also makes two predictions that are not borne out in the acquisition data from Hungarian and Spanish. First, Calabrese's theory predicts that the first vowel system will contain 3 vowels, while the data suggest that the initial system contains only /a/. Secondly, his theory predicts that the initial vowel system will contain /a/, /i/ and /u/, while the Spanish and Hungarian data show that when a 3 vowel inventory is achieved, it will contain the vowels /a/, /e/ and /o/.

5 These are given in (5.13) and (5.15).

6 The symbols [ü] and [ø] are used in this chapter rather than IPA symbols because these are the orthographic symbols used for non-low front unrounded vowels in Hungarian.

7 I believe an added piece of evidence to support this decision comes from the analyses of Hungarian and Spanish in Chapter 3. It seems strange that an identical marked parameter setting is required in two totally unrelated languages, and it would make much more sense to assume that both languages make use of the unmarked context-free parameter setting for [high].

8 This RU account of acquisition does not predict whether /o/ will be acquired first, or whether the context-sensitive rule [+low] --> [+back] will be reset first. This suggests that there may be some individual variation in the ordering of these two acquisitions.

9 It is entirely possible that /ɛ/ is acquired before /o/, although the RU theory predicts /ɛ/ will be acquired after /e/.

10 This system is given earlier in (4.32).

11 In a majority of cases Hungarian children produce long vowels as short ones, although there are examples of long vowels being used as substitutes for short vowels.
12 In Chapter 5 I use an arbitrary criteria of 3 occurrences of a substitution before it is considered productive.

13 Diphthongs cannot contain two [+high] feature matrices. See Harris (1983) for more details on this restriction.

14 This fact does not argue against the RU acquisition theory, since this parameter could very well be reset at a later time.
References


Mohanan, K.P. 1983. The structure of the melody. Unpublished manuscript, MIT.


