

The Syllable in Optimality Theory

Edited by

CAROLINE FÉRY

University of Potsdam, Germany

RUBEN VAN DE VIJVER

University of Potsdam, Germany



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Overview

Caroline Féry and Ruben van de Vijver

The syllable has (nearly) always played a central role in phonological theory, but with the recent advent of Optimality Theory (OT), its role has become crucial. The first papers on OT, as well as numerous papers written since, are based on the syllable. It is no exaggeration to say that syllabification has played a pivotal role in establishing OT and, in turn, that OT has contributed to our understanding of the role of the syllable, since many issues concerning this prosodic constituent have been reconsidered in the light of this theory (McCarthy and Prince 1993, Prince and Smolensky 1993). The present book provides insights into the syllable and into OT in three respects. First, it underlines the continuing interest in the syllable. Second, it shows that OT is capable of providing answers to old issues that have been problematic in procedural analyses, as well as shedding light on new issues and giving fresh perspectives. Third, the syllable helps reveal and solve problems within OT. Several aspects of syllabification have proved hard to solve within OT and have forced phonologists to come up with original solutions.

The first section of this introduction gives an overview of the three issues just mentioned. Since it is impossible to give a detailed account of all the numerous aspects of the syllable that phonologists are concerned with, we focus on the points that we consider as central in the volume. In the second section, we concentrate on the individual chapters and offer summaries of their contents.

1.1. The Central Role of the Syllable in Phonology

In the seventies, several phonologists, such as Vennemann (1974), Hooper (1976), and Kahn (1976), proposed including the syllable as a prosodic unit in generative phonological theory. The relevance of the syllable for linguistic theory has increased ever since. The syllable is connected with both segmental

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and suprasegmental levels. It allows a succinct formulation of many phonological generalizations (see Blevins 1995 for a summary of the role played by the syllable in phonological theory). Let us briefly illustrate these observations.

The connection with segments is apparent in various processes, such as the well-known glottalization of voiceless stops in the coda of English syllables or the aspiration of the same voiceless stops in the onset of (stressed) syllables. The first [t] in the English word *Atlanta* is glottalized; [p] in *applause* is aspirated. In both words stress is on the second syllable. Words may start with [pl], such as in *play*, but no word starts with [tl]. An intuitive way to describe the distribution of the glottalization and aspiration of stops is to say that syllable-initial stops are aspirated while syllable-final stops are glottalized. The consonant cluster [pl] in *applause* is syllable-initial, while [t] in *Atlanta* is syllable-final. It is much more difficult to formulate the distribution of aspiration and glottalization if no reference is made to the syllable. The distribution of aspiration must be expressed by a statement along the following lines: before stressed vowels voiceless stops are aspirated if they are word-initial or are part of a possible word-initial consonant cluster.

At higher prosodic levels, syllable shape determines which syllables are most likely to be stressed in many languages: heavy syllables are more prone to be stressed than light ones. In Latin, for example, stress is on the penultimate syllable if it contains a long vowel (*amīcus* ‘friend’) or a closed syllable (*agēnda* ‘things that have to be done’). If the penultimate syllable has a short vowel, stress is on the antepenultimate syllable (*Cícero* name). Both long vowels and closed syllables have a branching rhyme and differ in this respect from syllables with just a short vowel in their nuclei. Syllables with a branching rhyme are called heavy and those with a nonbranching rhyme are light. Thus, the stress distribution can be stated in the following terms: stress is on the penultimate syllable if it is heavy; otherwise it is on the antepenultimate syllable. Again, a formulation of the distribution of stress without the aid of the syllable would fail to point out the structural equality of syllables with long vowels and closed syllables in Latin.

To sum up, the syllable allows the formulation of generalizations both at the segmental level and at higher prosodic levels, which are awkward to express without referring to this constituent. Of primary concern for the goals of this book, however, is the way OT can be used to account for different aspects of syllabification and, conversely, how different aspects of syllabification tell us more about OT.

1.1.1 How OT Sheds Light on the Syllable

With the recent rise of OT, the theoretical emphasis has shifted away from representations and toward constraints and their interactions. One of the main

insights of OT is that markedness generalizations, as expressed in the form of constraints on surface forms, are part of phonological theory in the most direct way. These constraints are grounded in phonetics: they are justified by general considerations of acoustics or articulation. These constraints conflict with faithfulness constraints. An example is hiatus avoidance. Hiatus is the phonetic result of the immediate adjacency of vocalic syllable peaks. In languages that resolve hiatus, resolution can be attained by different means, such as insertion of a consonant between the two vowels, glide formation, deletion of one of the vowels with or without compensatory lengthening, and so on. OT assumes that a constraint against hiatus (*HIATUS) is part of Universal Grammar and thus that such a constraint is part of the grammar of every language. However, the way in which individual languages choose to resolve hiatus depends on the ranking of this markedness constraint with respect to faithfulness constraints. Languages that do not resolve hiatus have high-ranking faithfulness constraints on the vowels involved in the hiatus, whereas languages that eliminate hiatus rank the relevant faithfulness constraints lower than the constraint against hiatus. In other words, typological variation is the direct consequence of the interaction of constraints. The result of different interactions can be summed up with the help of (a simplified account of) three languages. In Hawaiian, hiatus is freely allowed; in German and French, it is not or at least not in all morphosyntactic and/or prosodic environments. In Hawaiian, the markedness constraint *HIATUS is ranked below all other constraints; in German and French, *HIATUS is high ranking. In German, hiatus is resolved by inserting a glottal stop as the onset of the second syllable (*Beamte* ‘civil servant’ is realized as [bəʔamtə]), whereas in French, the first vowel of a two-vowel sequence is deleted in a Det + N context (*le amour* ‘the love’ is [lamur]). In terms of constraint interaction, the difference between the three languages is expressed in the following way. In Hawaiian, *HIATUS is ranked below constraints prohibiting consonant epenthesis (called DEP(C)) and vowel deletion (MAX(V)), as in (1a). In German, where a consonant is inserted to avoid hiatus, both MAX(V) and *HIATUS are higher ranking than DEP(C), as shown in (1b). Hiatus must be avoided, but vowels may not be deleted. In French, hiatus is avoided as well, but in this language it is better to delete a vowel than to epenthesize a consonant. This is expressed by ranking both DEP(C) and *HIATUS above MAX(V), as in (1c).

- (1) a. Ranking in Hawaiian: hiatus is allowed.
 MAX(V), DEP(C) >> *HIATUS
 b. Ranking in German: hiatus is avoided by inserting a consonant.
 MAX(V), *HIATUS >> DEP(C)
 c. Ranking in French: hiatus is avoided by deleting a vowel.
 DEP(C), *HIATUS >> MAX(V)

In the older derivational approach to phonology, hiatus resolution takes the form of (ordered) rules whose common purpose is not deducible from the rules themselves. This hidden common goal of different kinds of processes has been called “the conspiracy of the rules” by Kenstowicz and Kisseberth (1977). Compare the rules in (2), which have the effect that a glottal stop is inserted between two vowels (in German) or that a vowel is deleted (in French). From the format of the rules, it must be interpreted as a coincidence that vowel deletion in one language and consonant epenthesis in another both lead to the elimination of hiatus.

- (2) Derivational rules
- a. Consonant epenthesis (German)
 $\emptyset _ C / V _ V$
 - b. Vowel deletion (French)
 $V _ \emptyset / _ V$

Although both rules result in the avoidance of a sequence of two heterosyllabic vowels, this outcome is not immediately apparent from the rules themselves. The target, avoidance of hiatus, is not mentioned in the rules, whereas in OT it is a direct component of the constraints.

Syllable typology can also be elegantly accounted for in OT. It has been repeatedly observed that all languages have syllables of the form CV but not necessarily other forms (Jakobson 1962, Prince and Smolensky 1993, Blevins 1995), which follows from certain typological generalizations. First, if a language has syllables without onsets (V), it also has syllables with onsets (CV). Second, if a language has closed syllables (CVC), it also has open ones (CV). Furthermore, if a language has syllables with complex onsets (CCV), it also has CV syllables. And finally, if a language has syllables with complex codas (CVCC), it also has CVC syllables and therefore also CV ones. These generalizations can be accounted for by constraint interaction between markedness and faithfulness constraints. The markedness constraint ONSET requires that syllables have onsets, and NoCODA prohibits codas. Faithfulness constraints, such as the ones used for hiatus, state that underlying material must be parsed as such. As shown, there are at least two kinds of faithfulness constraints, one against epenthesis (DEP) and one against deletion (MAX). These two constraints are joined together here under the cover term FAITH. Consider several rankings standing for different types of languages in (3)–(5). In the first Tableau 1 in (3) the markedness constraints dominate the faithfulness constraints. Whatever the input, if the constraints are ranked as shown, the language allows only the most unmarked CV syllables to emerge as optimal.

(3) Tableau 1: ONSET, NoCODA >> FAITH (No epenthesis, no deletion)

/cv/	ONSET	NoCODA	FAITH
☞ CV CVC V	*!	*!	* *
/cvc/			
☞ CV CVC V	*!	*!	* *
/v/			
☞ CV CVC V	*!	*!	* *
/vc/			
☞ CV CVC V	*!	*!	* * *

If FAITH is ranked above NoCODA but below ONSET, as in (4), the language has the syllable types that win in this tableau. The ranking in (4) allows both CV and CVC syllables.

(4) Tableau 2: ONSET >> FAITH >> NoCODA

/cv/	ONSET	FAITH	NoCODA
☞ CV CVC V	*!	*! *	*
/cvc/			
CV ☞ CVC V	*!	*! *	*
/v/			
☞ CV CVC V	*!	* *	*!
/vc/			
CV ☞ CVC V	*!	**! * *	

In (5) the consequences of the ranking FAITH >> ONSET >> NoCODA are illustrated. This ranking allows the syllable types CV, CVC, V, and VC.

(5) Tableau 3: FAITH >> ONSET >> NoCODA

/cv/	FAITH	ONSET	NoCODA
☞ CV			
CVC	*!		*
V	*!	*	
/cvc/			
CV	*!		
☞ CVC			*
V	*!*	*	
/v/			
CV	*!		
CVC	*!*		*
☞ V		*	
/vc/			
CV	*!*		
CVC	*!		*
V	*!	*	
☞ VC		*	*

The tableaux in (3)–(5) illustrate that all languages, irrespective of their constraint ranking, allow CV syllables. More complex types of syllables, in contrast, are only allowed in some constraint rankings.

The ability of OT to explain typological patterns as a result of the interaction of markedness and faithfulness constraints is the core of the theory, and it is to a great extent responsible for its success.

1.1.2 How the Syllable Sheds Light on OT

As mentioned in section 1.1, syllable structure has played a prominent role in the conception and development of OT, not only because it can neatly illustrate simple factorial typologies, but also because it involves different interacting modules, such as segments, sonority, moras, syllabification, edges, and stress.

There are, however, cases in which constraints on surface structure do not seem to make the right predictions. For example, certain types of alternations involving syllable structure are not recoverable from surface forms alone but seem to need an intermediate form between input and output to which both

are in some sense more faithful than they are to each other. Such cases have been called “opaque” by Kiparsky (1973). Opacity is illustrated here with palatalization of [s] in Swabian, an Alemannic Germanic dialect spoken in the southwest of Germany. In Swabian, [s] and [ʃ] are distinctive, as can be observed in the pair *vermi[ʃ]en* ~ *vermi[s]en* ‘to mix ~ to miss’. However, when coronal [s] is followed by an obstruent, it is palatalized to [ʃ], as shown in (6), and thus becomes indistinguishable from underlying [ʃ].

- | | | | |
|-----|---------------------------|------------|-----------------|
| (6) | Palatalization in Swabian | | Standard German |
| | Konstanz | Kon[ʃ]tanz | name of a city |
| | Aspekt | A[ʃ]pekt | ‘aspect’ |
| | | | Kon[s]tanz |
| | | | A[s]pekt |

In addition to palatalization, Swabian has a process of word-final obstruent cluster simplification, illustrated in (7). In contrast, the standard Northern pronunciation involves a nonpalatalized [s] and complete realization of the cluster.

- | | | | |
|-----|---------|-------|-----------------|
| (7) | Swabian | | Standard German |
| | bist | bi[ʃ] | ‘are, 2 sg.’ |
| | | | bi[s]t |

In the Swabian examples in (7), [s] is palatalized, although the reason for the palatalization is not present on the surface. The more transparent candidate *[bis] is expected, since in standard OT this candidate is always more faithful to the input [bist] than [biʃ]. [biʃ] incurs a violation of a faithfulness constraint called IDENT(anterior), requiring featural identity between input and [bis] output that does not have.

Opaque interactions such as these have proved difficult to express in OT. Certain generalizations are not statable in terms of the usual surface constraints, simply because these generalizations are not surface true. The success of OT in other areas, however, forces phonologists to find a solution to this problem. To make a definition of opacity possible, it needs to be established whether all known cases of opacity are due to the same kind of effects. Another important question is whether opacity always necessitates the assumption of a so-called sympathetic candidate that is neither the input nor the output (see the different proposals by McCarthy [this volume] and Ito and Mester [this volume]). Thus the opacity problem is an example of how the syllable can shed light on issues pertaining to OT, or, viewed less parochially, pertaining to the phonological system.

1.2. Overview of the Content

This volume is further organized into the following parts: part two deals with syllable structure and prosodic structure, part three concerns semisyllables and edges of syllables, part four focuses on segmental alternations, and part

five considers the interface between phonetics and phonology. Even though most of the chapters touch upon several of these issues and thus could justifiably be included in several parts of the book, we have assigned every chapter to a part based on its main focus.

1.2.1 Syllable Structure and Prosodic Structure

Part two groups together the chapters dealing with syllabic and prosodic structure. Several issues are raised in this section: the relation between the structure of the syllable and its position in the foot, the role of syllable weight in morphology, the role of syllables in a language that has traditionally been described as a mora language, and the relation between sonority and weight at various levels of the *prosodic hierarchy*.

In his chapter “Sympathy, Cumulativity, and the Duke-of-York Gambit,” John McCarthy deals with syllables, phonological opacity, and the intersection of these two topics. He focuses on a problem in the syllabic and metrical phonology of Bedouin Arabic. According to traditional analyses, a stressed vowel deletes, its stress shifts to a following vowel, and then the deleted vowel is replaced: $?ákalat \rightarrow ?kálat \rightarrow ?akálat$. This is a Duke-of-York derivation in the sense of Pullum (1976), because it contains an $A \rightarrow B \rightarrow A$ mapping. McCarthy presents a reanalysis of Bedouin Arabic in OT terms, eliminating the Duke-of-York derivation by making crucial use of the *semi-syllable*, a concept also used by many other contributors to this book.

One part of the analysis of Bedouin Arabic involves an opaque alternation, which McCarthy proposes to treat using Sympathy Theory (McCarthy 1998). In Sympathy Theory, a particular failed output candidate exercises an indirect influence over the actual output form. Sympathy can accommodate the opaque alternation in Bedouin Arabic, but it raises a broader typological question: is it possible to eliminate Duke-of-York derivations entirely? McCarthy suggests that it is, if the indirect influence of the sympathetic candidate over the output is reckoned in terms of shared unfaithful mappings, which he calls “cumulativity.” At the conclusion of his chapter, McCarthy returns once again to the topic of the syllable, showing that, if cumulativity is correct, there cannot be constraints demanding faithfulness to syllable affiliation. This, he argues, is how OT must construe the familiar observation that syllable structure is never contrastive.

Stuart Davis’s “The Controversy over Geminales and Syllable Weight” focuses on the relation between geminates and weight and gives a positive answer to the recurrent question as to whether geminates are underlyingly moraic (see the chapters by van Oostendorp and by van de Vijver in this volume, which also come to the conclusion that consonant length can be specified underlyingly). Davis’s chapter illustrates how OT allows new analyses of

old problems by giving an elegant analysis of the formation of the inanimate plural in Sinhala. Davis shows that, although much discussed in the phonological literature, it is a moot question whether the singular of the Sinhala inanimate noun is derived from the plural or the plural is derived from the singular. The difference between the singular and the plural is determined by the constraint hierarchy of the language. Moreover, he shows that constraint ranking can provide answers to questions about representations, in particular, whether geminates are represented moraically or nonmoraically. He also explains that Leti and Ngalakan, which have been used in the literature to argue against the moraicity of geminates, do not, in fact, present serious counterevidence: the patterning of word-initial clusters in Leti motivates the view that word-initial geminates can be partly extraprosodic, and the Ngalakan stress data do not really bear on the issue of the underlying moraicity of geminates.

Haruo Kubozono's "The Syllable as a Unit of Prosodic Organization in Japanese" shows that even in a so-called moraic language like Japanese, the syllable is an indispensable prosodic constituent. His argument for the syllable is based on preferred foot structures. In a whole series of word formations, there is a tendency toward the trochaic feet HL and HH, and an avoidance of LH and LL forms. The word formations that Kubozono discusses are based on the syllable and not on the mora. Evidence for his analysis comes from phenomena like word accent, babies' language or motherese, loanword truncation, *zuzuya-go* (a secret language used by Japanese jazz musicians), and chanting phrases used by Japanese baseball fans when cheering for their favorite players.

The last chapter in part two, Draga Zec's "Prosodic Weight," proposes that weight is a property of prosodic constituents in general. The syllable, the foot, and possibly the prosodic word all impose their own minimal sonority thresholds. She proposes that SONORITY is a family of constraints that govern the sonority relations within the prosodic hierarchy. SONORITY interacts with the family of FAITHFULNESS constraints. Three case studies provide evidence for positing a sonority threshold constraint external to the syllable. To give one example here, in English, syllables with *l* or a nasal in the nucleus (CL(C)) exhibit a highly restricted distribution: CL and CLC syllables are never stressed, nor are there any monosyllabic CLC words or disyllabic CLCL words. In contrast, [r] in the nucleus (CR(C)) has the same distribution as a full vowel. Thus, English prohibits syllabic liquids and nasals as heads of feet.

An interesting conclusion of this chapter is that prosodic heads have their own phonotactic requirements, and it can be hypothesized that nonheads may have different phonotactic requirements. In this way, Zec's contribution can be linked to several other chapters in this volume, namely, those of Cho and King, Féry, Green, Kiparsky, and Wiltshire, which all deal with segments that

cannot be syllabified straightforwardly. These segments are usually analyzed as syllables without moras or, alternatively, as moras without syllables. Apparently, that a constituent is the head of a higher prosodic level determines much of its phonotactics; however, the absence of a head also seems to be relevant for the phonotactics.

To sum up, the chapters in part two touch upon several aspects of weight. They illustrate that syllable structure and other prosodic structures are closely intertwined.

1.2.2 Nonmoraic Syllables and Syllable Edges

Part three of this book centers around the best characterization of edges of words and syllables. It has been assumed that whatever sequence is allowed to begin or end a syllable is also allowed to begin or end a word. Although this is usually accepted (but see Wiltshire, this volume), the reverse is not true. Words can begin or end in longer sequences than syllables.

The common perspective of this section is that the Strict Layer Hypothesis (SLH) can be violated, but in keeping with the economy property of OT it can be violated only minimally. The SLH requires that each unit of the prosodic hierarchy, shown in (8), dominates a unit at the immediately lower level.

(8) Prosodic hierarchy

Prosodic word

|

Foot

|

Syllable

|

Mora

All four chapters in this section reject the strong interpretation of the SLH, which says that the prosodic hierarchy is nonrecursive (a node at level n should not dominate another node at level n) and exhaustive (each constituent of level $n - 1$ is exhaustively dominated by a node of level n). This has been replaced by a view in which NONRECURSIVITY and EXHAUSTIVITY are violable constraints, like the other principles of phonology (see Selkirk 1995). In a weak interpretation of the SLH it would be possible, for example, to attach a mora directly to a foot or a prosodic word. In agreement with the principle of economy of OT, violations are kept to a minimum. The violations of EXHAUSTIVITY considered here involve semisyllables in three of the five chapters; the authors of this section conclude that only syllables that are not prosodic heads and that lack a head themselves can violate the SLH.

The first chapter of part three is Paul Kiparsky's "Syllables and Moras in Arabic," which deals with a number of topics (semisyllables, initial geminates, superheavy syllables) as part of a larger issue: the status of moras that are unaffiliated with syllables. Also, it is a defense of Lexical Phonology against parallelism. In Lexical Phonology, phonology and morphology are organized serially; for example, all phrase-level phonology applies after all lexical phonology. In more radical versions of OT, the whole phonology applies simultaneously. Kiparsky argues that such a view is incompatible with the facts of stress and syllabification in Arabic.

Kiparsky discusses syllabification in various dialects of Arabic and claims that they differ in whether they license semisyllables, which are unsyllabifiable consonants he analyzes as moras adjoined to the prosodic word. This licensing of unsyllabified consonants by moras can take place at the lexical level or at the postlexical level, which makes a strictly parallel version of OT unlikely. Three types of dialects syllabify their final consonant in different ways. First, the so-called C-dialects freely allow semisyllables both at the word level and postlexically, as exemplified by [yíkt**t**bu] 'they write' from Maltese (the boldfaced [t] is the semisyllable). Second, the so-called VC-dialects allow semisyllables at the word level only. Postlexically semisyllables are not allowed, and epenthesis takes place at the phrase level to make the relevant consonant part of a syllable. Compare [yíkitbu] 'they write' from Upper Egyptian, with epenthetic [i] preceding the potential semisyllable. Third, in the so-called CV-dialects, no semisyllables are allowed at any level of the prosodic hierarchy, and lexical epenthesis takes place to make syllabification of a stray consonant possible. An example from this third type of dialect is [yíkt**t**ibu] 'they write' from Cairo Egyptian, with epenthetic [i] following the potential semisyllable. The three dialects thus differ in two respects: in the constraint ranking and in the level at which semisyllables are allowed.

Young-mee Yu Cho and Tracy Holloway King's "Semisyllables and Universal Syllabification" introduces semisyllables in the phonology of Georgian, Polish, and Bella Coola to account for apparent violations of the sonority hierarchy. According to Cho and King, semisyllables have the following properties: they have no nucleus, no coda, and no stress/accent/tone, and they are found only at the edge of a morpheme. Cho and King show that the interaction of faithfulness constraints, such as DEP and MAX, with certain markedness constraints, such as the one requiring all syllables to contain a mora, can account for the variation found among languages in the admission of semisyllables. Principles like the Sonority Sequencing Principle and Exhaustive Syllabification are then assumed to be universal. However, contrary to Kiparsky, they define semisyllables as typically nonmoraic. Kiparsky conceives of semisyllables as moras adjoined to prosodic words, while Cho and

King assume they are segments adjoined to syllable nodes without an intervening mora. Semisyllables in their analysis, too, violate the SLH.

In “Onsets and Nonmoraic Syllables in German,” Caroline Féry also argues for semisyllables, sharing a nonmoraic view with Cho and King. Her study of German shows that consonants added to heavy syllables at the edges of words, which are sometimes analyzed as a third mora, are best analyzed as the onsets of nonmoraic semisyllables. Maximal bimoraicity can then be guaranteed, and the unmarked foot pattern of German, the syllabic trochee, can be extended to the class of words traditionally analyzed as having superheavy final syllables. Féry’s chapter presents an analysis of onsets in German and shows that, while feet and prosodic words require an onset, nonmoraic syllables try to get rid of their onsets, at least if ambisyllabic segments are not considered to be onsets. Laryngeals, which are consonants with low sonority, are never pronounced as the onsets of semisyllables, even though [h] (but not [ʔ]) is present in the input. Another segment that can be analyzed in this way is the dorsal nasal [ŋ], an allophone of the sequence [ng], which is chosen as the realization when no onset is required. In sum, the higher the prosodic constituent, the stronger the requirement for the presence of an onset. Some consonants, like the laryngeals, are realized only when they begin such a high prosodic constituent.

Antony Dubach Green’s “Extrasyllabic Consonants and Onset Well-Formedness” focuses on onsets. In line with the other authors of this section, he observes that not all consonants are straightforwardly assigned a position within a syllable. Green argues that each level of the prosodic hierarchy determines which onset clusters, if any, it tolerates. In Munster Irish, for example, higher prosodic levels tolerate more onset clusters than lower levels do. The consonants that cannot be licitly incorporated into a syllable are attached directly to higher-level structure. To account for the facts, he proposes a universally ranked set of constraints against specific onset clusters. Constraints against onset clusters with falling sonority are ranked above those against onset clusters with shallow-rising sonority, which in turn are ranked above those against onset clusters with steep-rising sonority. Recognizing that languages may differ, the Syllable Contact Law (SCL) is invoked. The SCL states that in a sequence A\$B, where A and B are consonants and \$ is a syllable boundary, B should be less sonorous than A. In OT, this is conceived of as a violable constraint. This constraint can be ranked with respect to the onset constraints, thus yielding the ranking determines the differences between languages.

In this chapter, too, extrasyllabic consonants violate the SLH.

The last chapter of this part, “Beyond Codas: Word and Phrase-Final Alignment,” by Caroline Wiltshire, considers the syllabification of final consonants. Wiltshire observes that words and phrases can end in segments that

cannot be syllabified without violating the Sonority Sequencing Principle. Unsyllabified consonants do not add weight to the syllable. Word and phrase-final edges can impose additional restrictions beyond those imposed on syllable-final segments, so that the full typology of the right side of the syllable need not always be the same as the typology of the right side of the word. She proposes to account for these facts with the help of alignment constraints, such as *ALIGN-R(word,C)*, *ALIGN-R(word,V)*, *ALIGN-R(phrase,C)*, and *ALIGN-R(phrase,V)*. Like the other authors in this section, she allows edge segments to violate the SLH. Such violations are seen in languages like Kamaiurá and Cairene Arabic, which allow additional segments that do not fit into the canonical coda positions of these languages.

In part three, then, issues raised in part two are pursued further. The prosodic hierarchy can be minimally violated, in the sense that constituents can “skip” a level. The precise nature of the constituents that violate the prosodic hierarchy, however, still needs further study, mostly of a typological nature. At this point it is hard to decide what the prosodic structure of the semisyllable looks like. Is it a mora without a syllable, as in the analysis of Kiparsky, or is it a syllable without a mora, as in the analyses of Cho and King and Féry? The final decision will have to be made on the basis of empirical considerations. Some of the properties shared by all segments that have been called semisyllables, not only by the authors of this volume but also by other phonologists, are mentioned by Cho and King (this volume) (and also by Kiparsky [this volume]): semisyllables are usually toneless or have a limited tonal contrast; they have a restricted segmental inventory; they can have a lower sonority than the nucleus of a plain syllable, or, conversely, they can be subject to a minimum sonority requirement; they have simpler syllable shapes; and they generally occur at word edges.

One property that might be decisive for the final analysis of these consonants has to do with their influence on the metrical structure. Semisyllables that appear to make a syllable heavy and those that do not might have different representations.

1.2.3 Segmental Properties of Syllables

Part four of this volume consists of four chapters dealing with the relation between syllable structure and segment quality. Ito and Mester argue that opacity is a fact of phonological life and illustrate this with data from German. They maintain that opacity may arise in only one particular instance of constraint conjunction: when faithfulness constraints are conjoined with markedness constraints. Van Oostendorp and van de Vijver in their respective chapters examine facts from Dutch, in particular the role of the head of the syllable (the nucleus) in determining properties of the shape of the syl-

lable. Morelli examines the quality of obstruent clusters at syllable edges and shows that in this position sonority can be turned off. Although all the chapters in this part concentrate on segmental quality, they do so in different ways.

The first chapter, Junko Ito and Armin Mester's "On the Sources of Opacity in OT: Coda Processes in German," is a discussion of opacity in German codas. In Northern German, the final stop in *wenig* [ve:niç] 'few', with an input /g/, is spirantized, while there is no spirantization with *Derrick* name [dɛrik] (*[dɛriç]), with an input /k/. An input /k/ always emerges unchanged. In *wenige* [ve:nigə] 'few pl.', /g/ remains a voiced stop as well. Descriptively, it seems that /g/ in *wenig* is devoiced because it is syllable-final and subject to Final Devoicing and that the spirantization crucially only affects a devoiced segment. It does not affect segments that are already voiceless in the input, such as the final [k] of [dɛrik]. To account for the opaque context of spirantization, Ito and Mester invoke an optimality-theoretic strategy called "Local Conjunction of Constraints" (Smolensky 1995). In their proposal, markedness constraints, such as the constraint against voiced dorsal segments in the coda of a syllable, are crucially conjoined with faithfulness constraints. The difference between [ve:niç] and [dɛrik] amounts to the fact that the final segment in *wenig* violates a high-ranking constraint conjoining markedness and faithfulness constraints, whereas the final segment of *Derrick* does not. It is the conjunction of faithfulness and markedness constraints that makes it possible to distinguish formally between underlying and derived segments. In the case of spirantization, there is a constraint against voiced codas, which forces the final /g/ in *wenig* to devoice. Ito and Mester's solution amounts to the postulation of a constraint conjoining a markedness constraint against codas, another against dorsal plosives, and a faithfulness constraint requiring identity of [voice] in input and output. This final constraint is violated by a dorsal plosive coda segment that has a voice specification different from its input. The candidate [ve:nik] violates this constraint, but the candidate [dɛrik] does not. To test the predictions made by their analysis, they study final devoicing, postnasal g-deletion, velar spirantization, dorsal fricative assimilation, and r-vocalization, both in Standard German and in the Northern dialect.

Marc van Oostendorp's "Ambisyllabicity and Fricative Voicing in West Germanic Dialects" deals with the relationship between the feature [voice] in fricatives and syllable structure. Van Oostendorp discusses facts from Frisian, Thurgovian German, Roermond Dutch, and Standard Dutch and concludes that the feature [voice] is not contrastive in fricatives in the first three languages and is only marginally so in the last one. Whether a fricative is voiced or not depends on whether it is underlyingly short or long (monosyllabic or ambisyllabic). Van Oostendorp's key assumption is that a consonant occurring between two vowels can be affiliated to syllable structure in

two ways: either it belongs only to the onset of the following syllable, in which case it is voiced, or, alternatively, it is ambisyllabic, belonging both to the coda of the preceding syllable and to the onset of the following syllable. In the latter case, it is voiceless. This paper thus argues for underlying syllable structure (or at least for the existence of underlying geminates) and against underlying specification of voice. The voicing facts are a consequence of the length of the fricative. Another major point is that OT, including the Richness of the Base Hypothesis, can successfully account for the variation we find between dialects.

In van Oostendorp's chapter, as well as in the one by van de Vijver (discussed next), it is the length of a segment that is underlying, and particular phonotactic constraints on length make sure that long segments are always syllabified in a certain way. Ambisyllabicity is then just a consequence of segmental length.

The third chapter of this part, "The CiV-Generalization in Dutch: What *Petunia*, *Mafia*, and *Sovjet* Tell Us about Dutch Syllable Structure" by Ruben van de Vijver, deals with the relation between the structure of the syllable and the quality of the vowel. A vowel preceding a CiV-sequence is usually tense (or long), although it may also be lax (or short). The *i* is usually realized as a vowel, although it is realized as a glide in a few cases. These two facts are related, and they are accounted for by appealing to vowel markedness. Lax vowels are argued to be marked and tense vowels, unmarked. Following the logic of OT, if a vowel is not somehow forced to be lax, it will be tense. This has immediate consequences for the following consonant, since tense vowels occur only in open syllables. The following consonant will therefore be an onset. Complex onsets of the form *Cj* are avoided in Dutch, and, again, if nothing forces the creation of such a complex onset, the *i* will surface as a vowel. In this way segments determine the structure of syllables (*petunia*). The reverse situation, in which syllable structure determines vowel quality, is seen when a consonant occupies a coda position and an onset position simultaneously. The vowel in the syllable preceding this ambisyllabic segment is in a closed syllable and must therefore be lax, but the *i* following the consonant will still be a vowel, since it is preceded by an onset. In this case, the prosodic structure of the word determines the quality of its vowels (*mafia*). Finally, a vowel can be forced to be lax by faithfulness constraints, in which case the following consonant must be a coda. The *i* is therefore not preceded by an onset and is realized as a glide (*sovjet*).

This chapter illustrates the way in which segment structure relates to syllable structure and vice versa.

Finally, Frida Morelli's "The Relative Harmony of /s + Stop/ Onsets: Obstruent Clusters and the Sonority Sequencing Principle" argues against the view that s + stop clusters are ill-formed onset clusters because of their

violation of the Sonority Sequencing Principle and different phonological behavior in comparison to other onset clusters. She argues that within obstruent clusters a system of markedness constraints, which is sonority independent, evaluates the relative harmony of the different types of obstruent clusters. Within her system, *s* + stop clusters are the most harmonic obstruent clusters. She argues that because these clusters are unmarked within their own dimension, rather than being marked with respect to the Sonority Sequencing Principle, it is easy to explain why they frequently occur across languages.

Going deeper into the substance of the syllable structure, the chapters in part four look at segments, the ingredients of the syllable, and show that not all melodies can be associated with all syllable positions but that the choice between allophones is determined by position.

1.2.4 How Concrete Is Phonotactics?

One motivation for the introduction of syllables into phonological theory is the claim that certain regularities in the sequential distribution of segments (phonotactics) are best stated as syllable-based constraints. Part five of this book includes a chapter questioning this claim. Blevins argues that string-based phonotactics are primary in phonological systems and that syllabifications and syllable-based constraints are secondary properties defined with respect to these phonotactics. She bases her arguments on phonetic explanations underlying broad typological generalizations about feature-based phonotactics, on the occurrence of near-identical phonotactics in languages with distinct syllable structures, and on the variability of native speaker syllabification judgments in many languages. The major finding of this contribution is that the majority of phonotactic constraints are best stated as feature-sensitive, string-based constraints independent of syllable structure.

Juliette Blevins's contribution, "The Independent Nature of Phonotactic Constraints: An Alternative to Syllable-Based Approaches," presents evidence for string-based phonotactics in the cross-linguistic distribution of laryngeal features, place features, manner features, and consonant clusters. In many cases, syllable-based constraints are shown to be inadequate. Furthermore, the string-based phonotactic constraints proposed are shown to stem from well-understood cases of phonetic sound change. Though the phonetic bases of string-based phonotactics may no longer be transparent due to phonologization, in the majority of cases, they remain surface true and reflect the "unmarked" sound pattern. Blevins suggests that, where surface true, these string-based phonotactics should be encoded in terms of language-specific inviolable constraints. With this encoding, OT will move closer to establishing a theory of phonotactic markedness.

In this discussion of the content of the chapters we have identified several issues that still need to be clarified, even though there is also much that is already understood. This book testifies to the crucial role that the syllable still plays in the phonological debate.

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