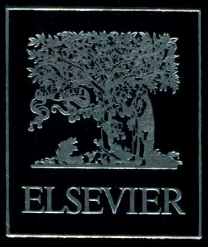

VOLUME FIVE

ENCYCLOPEDIA OF LANGUAGE & LINGUISTICS

SECOND EDITION

EDITOR-IN-CHIEF
KEITH BROWN

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GUIDE TO USE OF THE ENCYCLOPEDIA

Structure of the Encyclopedia

The material in the Encyclopedia is arranged as a series of articles in alphabetical order. To help you realize the full potential of the material in the Encyclopedia we have provided several features to help you find the topic of your choice: an Alphabetical list of Articles, a Subject Classification, Cross-References and a Subject Index.

1. Alphabetical List of Articles

Your first point of reference will probably be the alphabetical list of articles. It provides a full alphabetical listing of all articles in the order they appear within the work. This list appears at the front of each volume, and will provide you with both the volume number and the page number of the article.

Alternatively, you may choose to browse through the work using the alphabetical order of the articles as your guide. To assist you in identifying your location within the Encyclopedia, a running head line indicates the current article.

You will also find 'dummy entries' for certain languages for which alternative language names exist within the alphabetical list of articles and body text.

For example, if you were attempting to locate material on the *Apalachee* language via the contents list, you would find the following:

Apalachee *See* Muskogean Languages.

The dummy entry directs you to the *Muskogean Languages* article.

If you were trying to locate the material by browsing through the text and you looked up *Apalachee,* you would find the following information provided in the dummy entry:

Apalachee *See:* Muskogean Languages.

2. Subject Classification

The subject classification is intended for use as a thematic guide to the contents of the Encyclopedia. It is divided by subject areas into 36 sections; most sections are further subdivided where appropriate. The sections and subdivisions appear alphabetically, as do the articles within each section. For quick reference, a list of the section headings and subheadings is provided at the start of the subject classification.

Every article in the encyclopedia is listed under at least one section, and a large number are also listed under one or more additional relevant sections. Biographical entries are an exception to this policy; they are listed only under biographies. Except for a very few cases, repeat entries have been avoided within sections, and a given

article will appear only in the most appropriate subdivisions. Again, biographical entries are the main exception, with many linguists appearing in several subdivisions within biographies.

As explained in the introduction to the Encyclopedia, practical considerations necessitate that, of living linguists, only the older generation receive biographical entries. Those for members of the Encyclopedia's Honorary Editorial Advisory Board and Executive Editorial Board appear separately in Volume 1 and are not listed in the classified list of entries.

3. Cross-References

All of the articles in the Encyclopedia have been extensively cross-referenced. The cross-references, which appear at the end of each article, serve three different functions. For example, at the end of *Norwegian* article, cross-references are used:

1. to indicate if a topic is discussed in greater detail elsewhere

> Norwegian
> *See also:* Aasen, Ivar Andreas (1813–1896); Danish; Inflection and Derivation; Language/Dialect Contact; Language and Dialect: Linguistic Varieties; Morphological Typology; Norway: Language Situation; Norse and Icelandic; Scandinavian Lexicography; Subjects and the Extended Projection Principle; Swedish.

2. to draw the reader's attention to parallel discussions in other articles

> Norwegian
> *See also:* Aasen, Ivar Andreas (1813–1896); Danish; Inflection and Derivation; Language/Dialect Contact; Language and Dialect: Linguistic Varieties; Morphological Typology, Norway: Language Situation; Norse and Icelandic; Scandinavian Lexicography; Subjects and the Extended Projection Principle; Swedish.

3. to indicate material that broadens the discussion

> Norwegian
> *See also:* Aasen, Ivar Andreas (1813–1896); Danish; Inflection and Derivation; Language/Dialect Contact; Language and Dialect: Linguistic Varieties; Morphological Typology; Norway: Language Situation; Norse and Icelandic; Scandinavian Lexicography; Subjects and the Extended Projection Principle; Swedish.

4. Subject Index

The index provides you with the page number where the material is located, and the index entries differentiate between material that is an entire article, part of an article, or data presented in a figure or table. Detailed notes are provided on the opening page of the index.

Other End Matter

In addition to the articles that form the main body of the Encyclopedia, there are 176 Ethnologue maps; a full list of contributors with contributor names, affiliations, and article titles; a List of Languages, and a Glossary. All of these appear in the last volume of the Encyclopedia.

ALPHABETICAL LIST OF ARTICLES
VOLUME 5

Note: Readers are urged to use the comprehensive name and subject indexes and the Classified List of Entries extensively, since the contents presented here represent only the broad framework of the *Encyclopedia.*

Generative Phonology

M Kenstowicz, Massachusetts Institute of Technology, Cambridge, MA, USA

Noam Chomsky and Morris Halle founded the Generative School of Phonology in the late 1950s. It's basic premises are that phonological structure reflects the linguistic competence of the individual native speaker to compute a phonetic representation for the potentially infinite number of sentences generated by the syntactic component of the grammar and that this competence can be investigated in a serious scientific fashion. The generative point of view has become dominant in the field of linguistics and has had varying degrees of influence on other cognitive sciences. This entry surveys the development of the generative approach over three 15-year segments and concludes with current research trajectories.

SPE: 1960–1975

The early work of Chomsky and Halle both embraced and rejected various aspects of the two major schools of American Structural Linguistics inaugurated by Edward Sapir (1884–1942) and Leonard Bloomfield (1887–1949). Sapir's 'item and process' model posits an abstract phonological representation that is converted to a phonetic representation by processes that delete, add, and change sounds. Sapir stressed the psychological reality of the representations and processes but did not attempt to formalize them. The Bloomfieldian School adopted an 'item and arrangement' model with an emphasis on explicit procedures of analysis. Their major research goal was to formalize a pretheoretic notion of contrast (e.g., aspiration is contrastive in Korean but not in English) as a level of representation standing between Sapir's phonological (termed 'morphophonemic') and phonetic representations. The Bloomfieldians defined the phoneme as a class of phones (phonetic segments) in complementary distribution. for example, in English the aspirated [p^h] of *pin* and the unaspirated [p] of *spin* are allophones of the phoneme /p/. The allophones are not derived from the phoneme by processes but, rather, stand in a correspondence relation. For each level (phonemic and phonetic), phonotactics state the distribution of the elements composing that level; for example, [p^h] occurs at the onset of a stressed syllable, whereas [p] occurs elsewhere. Among the problems debated in this approach were the observation that [p^h] and [t], as well as [h] and [ŋ], are also in complementary distribution but clearly are not variants of a single phoneme. A requirement that each exponent of a phoneme have a core of defining properties (called the invariance criterion) was entertained. However, as noted by Bloch (1941), invariance prevents the overlapping of two phonemes on the same phone (neutralization), as in the intuitively correct phonemicization of *writer* [rajrər] and *rider* [ra:jrər.] with a /t/ versus /d/ contrast.

Halle (1959, 1962) and especially Chomsky (1964) subjected Bloomfieldian phonemics to a devastating critique. The former noted that Russian voicing assimilation affects both phonemes and allophones. Adherence to the phonemic level would entail splitting the unitary process into two separate rules: a morphophonemic-to-phonemic mapping that merges the phonemes /t/ and /d/ and a phonemic-to-phonetic one that provides a noncontrastive voiced allophone [d^z] for /c/. Chomsky observed that the phonemicization of *writer* versus *rider* as /rajtər/ vs. /rajdər/ violates most of the proposed requirements on a valid phonemicization (invariance, linearity, and biuniqueness). But the mapping follows straightforwardly from two simple ordered rules (**Figure 1**): the introduction of a length distinction before voiced (vs. voiceless) obstruents followed by a rule replacing the dental stops with a flap.

From examples such as these, Chomsky and Halle concluded that there simply is no phonemic level intervening between Sapir's phonological and phonetic representations. Renouncing any direct representation of contrast, they shifted the goal of phonological research to the discovery of the rules that convert the phonological to the phonetic representation and to the development of a general theory of their form and substance. Although rejecting the phonemic level, Chomsky and Halle embraced the Bloomfieldians concern with formal statement – reflected in the adoption of Roman Jakobson's (1896–1982) theory of binary distinctive features. When phonological segments are represented as feature matrices, sound change can be formalized as the modification of a feature coefficient. Features provide a measure of

/rajt/	/rajt+ər/	/rajd/	/rajd+ər/	Phonological representation
—	—	ra:jd	ra:jdər	Length rule
—	rajrər	—	ra:jrər	Flapping rule
[rajt]	[rajrər]	[ra:jd]	[ra:jrər]	Phonetic representation
write	writer	ride	rider	

Figure 1 Derivation of *rider* and *writer*.

phonetic distance and allow a formal study of natural classes in which the plausibility of a rule is reflected in the relative simplicity of its statement. Concern for simplicity and formal statement became a cornerstone of the generative approach.

Chomsky and Halle's landmark study *Sound Pattern of English* (1968) (SPE) is the first systematic exposition of generative phonology. A key feature was to take seriously the notation in terms of which sounds are represented and rules are formulated. SPE's analysis of the English Vowel Shift and Velar Softening illustrate these points well. Alternations among [aj] ≈ [i] (*divine*, *divin-ity*), [ij] ≈ [e] (*serene*, *seren-ity*), and [ej] ≈ [æ] (*profane*, *profan-ity*) pervade English vocabulary. Because the short vowels of *rigid*, *perpetu-al*, and *final* (cf. *rigid-ity*, *perpetu-ity*, *final-ity*) are stable, the long vowel must underlie the [aj] ≈ [i], [ij] ≈ [e], [ej] ≈ [æ] alternations. But the underlying quality of the vowel is reflected in the short variant. Hence, SPE posits underlying /i:/, /e:/, and /æ:/ and two ordered rules. The first rule shortens the vowel before certain suffixes. Any remaining long vowels are diphthongized and then rotate their nuclei by two rules: the first interchanges high and mid /i/ and /e/ by changing [αhigh] to [−αhigh]; the second interchanges mid (derived from high by the first change) and low vowels by changing [αlow] to [−αlow]. Thus, in the derivation of *divine* the high vowel switches places with the mid vowel of *serene* and then with the low vowel of *profane* (**Figure 2**).

This vowel interchange defined a new category of sound change, and SPE devoted a chapter to its documentation in the historical development of English. Although stunning in itself, the analysis of the Vowel Shift allowed linguists to make sense of a variety of consonantal changes as well. For example, /k/ is replaced by /s/ before suffixes beginning with /i/: *critic*, *critic-ism*; *medic*, *medic-ine*. But the trigger in *critic-ise* is a back vowel [aj] at the phonetic surface. However, if Velar Softening applies before Vowel Shift (to /kritik-i:z/), then the latter is not exceptional at all. On the strength of such analytic insights resting on a formally explicit methodology, SPE was universally regarded as a tremendous theoretical and descriptive advance.

/devi:n/	/sere:n/	/profæ:n/	Phonological representation
ij	ej	æj	Diphthongization
ej	ij	—	[αhigh] → [-αhigh]
æj	—	ej	[αlow] → [-αlow]

Figure 2 Derivations of *divine*, *serene*, and *profane*.

The generative methodology in which systematic alternations are derived from a common underlying form by an ordered set of rules was successfully applied to such well-known languages as Russian, Japanese, French, and Spanish by Chomsky and Halle's first generation of graduate students. A critical mass of detailed analyses from the generative perspective accumulated that uncovered numerous problems and research questions – many of them still unresolved. We mention four here.

Paul Kiparsky (1968, 1971) pointed to the excessive abstractness of many analyses adhering to the generative method, raising the question of how a learner could arrive at such rules and representations in the absence of knowledge of their historical antecedents. He suggested that abstract representations are motivated by alternations and that grammars change to states in which the underlying representations can be induced by rules that state generalizations over the surface phonetic representation.

Charles Kisseberth (1970) called attention to various rules in the phonology of Yawelmani that conspire to ensure that the output does not contain three successive consonants. The language lacks roots of this structure; and when stems and suffixes are combined to create CC + C or C + CC sequences, various rules come into play that either delete one of the consonants or insert a vowel. Moreover, another rule elides a vowel in the context VC__CV; it can be understood as a more general V → Ø process that is blocked just in case its output would violate *CCC. With its emphasis on formal connections among rules, the SPE model was unable to express the functional unity among these diverse processes. More generally, it was unclear how to formalize the notion of rules applying or blocking to satisfy a constraint.

David Stampe (1979) emphasized the importance of substantive rather than formal considerations in shaping phonological structure. He tried to make sense of two puzzles in acquisition. Languages such as Catalan, Russian, and German have a process devoicing word-final obstruents. Acquisition studies fail to detect a stage in which the child pronounces final [b, d, g], reflecting incomplete mastery of the rule. Rather, child speech conforms to the process from the outset. More significantly, child language is rife with sound changes that lack any precedent in the mature grammar. The sound substitutions of child phonology are thus hard to understand as immature versions of the rules of adult grammar. According to Stampe, they reflect a set of innate processes that are curtailed in the process of language acquisition so that the child's output matches the ambient language. Stampe also drew a sharp distinction between such natural processes and more phonetically arbitrary

rules such as SPE's Vowel Shift and Velar Softening that state generalizations over limited sets of lexically related words. In his view, phonological processes are what the child brings to the language, whereas phonological rules are what the language's vocabulary brings to the child.

Finally, with its emphasis on rules of sound change, the SPE model has little to say about phonotactics – static constraints on word shape that are unsuited to rules of sound change and seem best treated as conditions on representation that outputs must respect. Kenstowicz and Kisseberth (1976) called attention to the problem that constraints on lexical shape are often duplicated by rules of sound change that can be thought of as bringing the representation in line with the constraint. This point of view was explored by Sommerstein (1974).

Enriched Representations: 1975–1990

The SPE model has a simple representational format: An utterance is a string of feature matrixes punctuated by boundary symbols of various kinds to indicate stem, morpheme, word, and phrase junctures. Rules changing feature structure in a local context are ill suited to the phonology of tone, stress, and length. These suprasegmentals became the object of intensive scrutiny that had a profound effect on how all sounds are represented and manipulated by the rules of grammar.

The tonal languages of Africa proved particularly perplexing. Although phonetically expressed as a vocalic feature, a tone's phonological behavior is largely autonomous from the segmental string. For example, in Mende lexical items belong to a limited number of tonal melodies such as high (*kɔ́* 'war,' *pélé* 'house,' *háwámá* 'waist') or falling (*mbû* 'owl,' *ngílà* 'dog,' *félàmà* 'junction'). The problem is to express the generalization that the falling tone is restricted to monosyllables and breaks into H + L under suffixation (cf. *mbú-mà* 'on owl'). If tone is a segmental feature analogous to [labial] or [nasal], then complicated rules are required to transform [+fall] to [+hi] followed by [−hi]. Also, in tonal languages, when a vowel elides the associated tone typically shifts to an adjacent syllable (cf. Margi (Marghi Central) *kúm-árì* 'meat (DEF)' and *wù* 'tree,' *wǎrì* 'tree (DEF)' from /wù-árì/.

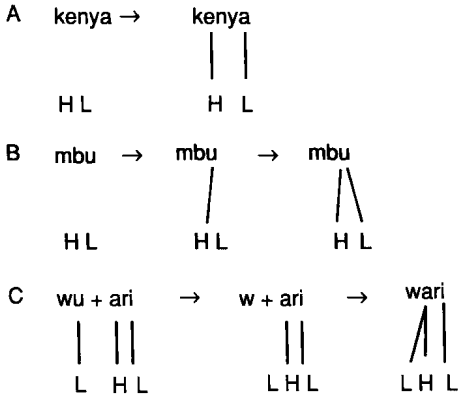

Figure 3 Autosegmental mapping of tones.

Building on the work of Wil Leben, Edwin Williams, and others, John Goldsmith (1976) made a significant breakthrough on this problem by proposing that tonal features be represented on a separate level (tier) associated with, but autonomous from, the segmental tier. Conditions governing a well-formed association of tones and vowels such as one-to-one, left-to-right mapping and no unassociated tones or vowels derive the surface patterns via simple rules operating in local environments (**Figure 3A–B**). And if tones are autonomous then vowels can delete while a tone persists on its own tier and maps to an adjacent syllable to ensure maximal association (**Figure 3C**).

Stress poses similar locality questions. For example, English words with final primary stress such as *Tenness'ee* invert their Weak-Strong contour when followed by a stronger stress: *T'enness'ee W"altz*. If stress is represented as a feature, the final syllable must be demoted in value ([1stress] → [2stress]), while the first is raised ([2stress] → [1stress]). One never finds [nasal] or [back] exhibiting such long-distance complementary changes. Mark Liberman (1975) and Liberman and Prince (1977) made another conceptual advance by seeing stress as the reflection of an abstract property of prominence formalized in terms of a metrical grid in which each syllable is associated with a column of marks indicating its relative prominence in the word or phrase. With this notation, the inversion can be described by a simple rule that slides the top element of the weaker of the two clashing stresses to the next available landing site – the first syllable – to create a rhythmically more balanced contour in which two stronger stresses are separated by a weaker one (**Figure 4**).

Finally, although the 'syllable' was mentioned throughout the analysis of English in SPE, the notion had no formal status in the theory. Various researchers proposed that syllables could be represented by boundary symbols analogous to word junctures in

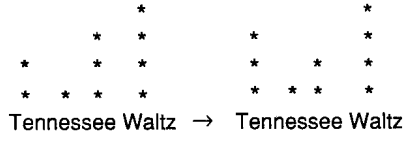

Figure 4 Grid notation for stress inversion.

Table 1 Arabic morphology

/d-r-s/		/ħ–m–l/	
daras-a	'he studied'	ħamal-a	'he carried'
dars-un	'a lesson'	ħiml-un	'a load, cargo'
darraas-un	'student'	ħammaal-un	'porter'
daaris	'studying'	ħaamil	'carrying'

Table 2 Turkish data

Accusative	*Nominative*	*Ablative*	*Gloss*
zamaan-ɨ	zaman	zaman-dan	'time'
hiss-i	his	his-ten	'feeling'
devr-i	devir	devir-den	'transfer'

order to express the frequent conjunction of preconsonantal and word-final position. Adapting insights of Kenneth Pike and Jerzy Kuryłowicz, Elizabeth Selkirk (1982) proposed that the syllable is a constituent with internal structure of onset and rhyme that organizes the individual phonemes. With the syllable given official grammatical status, rules of vocalic epenthesis (Selkirk, 1981) and consonantal deletion (Steriade, 1982) can be formalized as methods to achieve a parsing of segments in accord with limitations on syllable shape, such as the traditional sonority hierarchy.

The ideas that features appear on autosegmental tiers and that an invisible hierarchical structure underlies words and phrases proved especially fruitful. Much of the generative research of the next 15 years involved extending and exploring the consequences of these proposals. We mention a few highlights.

Bruce Hayes (1980, 1985) analyzed the stress contours from a variety of languages with rules that group syllables into iambic (weak-strong) and trochaic (strong-weak) metrical feet in a left-to-right or right-to-left sweep of the word. Metrical stress research suggested that for restricted areas of phonology Chomsky's Principles and Parameters methodology was appropriate. Other influential studies of metrical stress include Prince (1983), Halle and Vergnaud (1987), and Dresher and Kaye (1990).

The notion of phonological features on separate tiers was extended to a variety of problems. John McCarthy (1979) suggested that the notorious root and pattern morphology of Semitic languages such as Arabic could be formalized analogous to the behavior of tones. As illustrated in **Table 1**, derivational relations among words are marked by changes in syllabic structure rather than overt affixation: perfects have the shape CVCVC, nominals CVCC, and agentives CVCCVVC. If the radical consonants [drs] 'study' and [ħml] 'carry' are represented on an autosegmental tier, then the same principles that control tonal structure (left-to-right association and multiple linking) can describe the structure of these words. Biradicals such as [md] 'stretch' seem to spread their second consonants to fill out a CVCVC template (cf. *madadna* 'we stretched') comparable to the extension of the L tone in the HL melody of Mende *félàmà*.

Clements and Keyser (1983) proposed extending the CV representation to all languages so that a greater variety of phonological processes could be expressed in autosegmental terms. For example, long consonants and vowels can be represented as one feature matrix associated with two adjacent CV positions. With this notation, changes in quantity involve the addition or deletion of CV slots. Their study demonstrated how the disparate changes of vowel shortening, consonant degemination, and vowel epenthesis illustrated by the Turkish data in **Table 2** can be formalized as by-products of the organization of segments into CVC syllables (**Figure 5**).

The CV tier and, in particular, the possibility of empty skeletal positions intervening between phonetically adjacent segments was investigated in considerable detail by researchers working under the banner of Government Phonology (see Kaye *et al.*, 1990). For example, whereas the SPE model would posit a rule deleting the medial schwa to account for the V ≈ Ø alternation in French *revenir* [rəvnir] 'to come back' (cf. *revienne* 3 SG. PRES. SUBJUNCTIVE), Government Phonology postulates an empty nucleus [revønir] (Charette, 1990). This approach minimizes the role of rules in favor of constraints on representations – in particular, the distribution of empty elements. The problem was conceived of as parallel to the distribution of empty syntactic elements (traces) in which Chomsky's (1981) notion of proper government was adapted to phonology. More generally, phonological expressions are viewed as sequences of C and V elements organized by syntactic principles based on the concept of government couched within an overarching Principles and Parameters methodology.

Building on observations by Joan Mascaró and K. P. Mohanan, George N. Clements (1985) proposed that features are organized into a hierarchical tree structure, such as in **Figure 6**. This notation allows formal expression of the observation that certain features introduce subdistinctions within the class of other features rather than partitioning the entire set of speech sounds into two groups of comparable status such as [±consonantal]. For example, the feature [anterior] is only relevant for coronal consonants. More important, the feature tree allows one to formalize the observation of recurrent feature sets

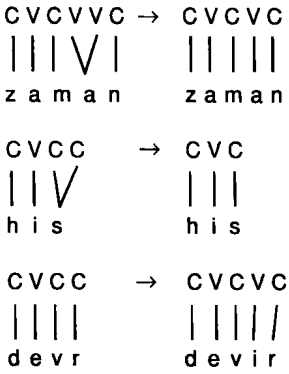

Figure 5 Autosegmental mapping of Turkish data.

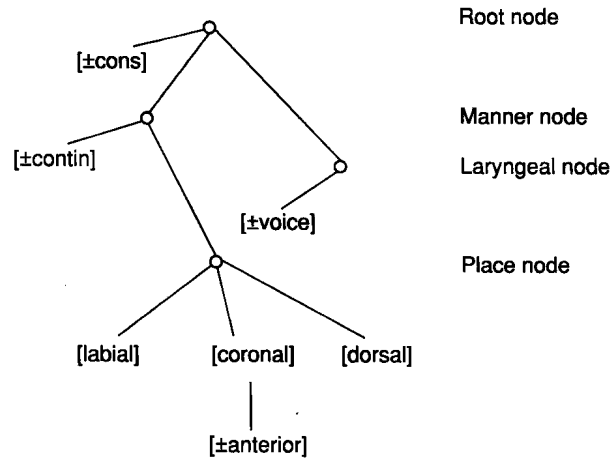

Figure 6 Hierarchical tree structure for features.

in assimilation rules in which, typically, all the subsidiary place features are spread as well.

Also, some sound changes can be treated as deletion and insertion of nodes in the feature tree, for example, debuccalization of $s \rightarrow h$ as the removal of the supraglottal place node, leaving the laryngeal articulator to implement [continuant].

Several other lines of research were inspired by autosegmental-metrical structure. Pierrehumbert (1980) demonstrated that the intonation contours of English can be analyzed as sequences of tones analogous to the melodies found in African languages such as Mende. For example, the rising interrogative contour is composed of a L* pitch accent on the major stressed syllable and a H% boundary tone realized at the end of the intonational phrase. Selkirk (1980, 1986) extended the prosodic hierarchy to include phonological words and phrases so that the domains of sentence-level phonological processes could be defined and studied. McCarthy and Prince (1986/1996) opened up the study of truncatory phenomena such as hypocoristics and reduplication to formal scrutiny. Their Prosodic Morphology hypothesis stated that the templates underlying such structures are not arbitrary sequences of CV slots but rather prosodic categories such as light and heavy syllables and metrical feet whose precise characterization should correspond to how these units function elsewhere in the language. For example, the truncation *Elizabeth — Liz* minimizes the base while respecting the requirements on a freestanding English word – a bimoraic foot. Mokilese prefixal reduplication, seen in *pok-poki* 'beat,' *paa-pa* 'weave,' and *koo-kooko* 'grind coconut,' converges on a heavy syllable (CVC, CVV), whereas in Diyari (Dieri) the CV(C)CV reduplication template underlying *kanku-kanku* 'boy' and *kulku-kulkuɲa* 'jump,' *tjilpa-tjilparku* 'bird (species)' consists of a disyllabic trochaic foot.

Starting with Baudouin de Courtenay in the 19th century, linguists had the impression that phonological rules fall into two broad classes that are exemplified by the English Velar Softening of *electric* ≈ *electric-ity* vs. the flapping of *write* ≈ *wri-writer*. Rules of the first type have exceptions, substitute contrastive segments, and typically apply at the juncture between morphemes. Rules such as flapping tend to be automatic, may introduce allophones, and may apply morpheme internally (cf. *a*[ɾ]*om* vs. *a*[t^{h}]*omic*). In a pair of influential papers, Paul Kiparsky (1982, 1985) developed a Lexical Phonology model of the grammar that formalized this intuition in an especially perspicuous way. Rules of the first type (lexical rules) are placed inside the lexicon and integrated with the morphology to apply after each rule of affixation. As such, lexical rules are inherently cyclic. Adapting Chomsky's notion of the 'strict cycle,' Kiparsky offered an explanation for why lexical rules normally fail to apply morpheme internally in contrast to postlexical rules, which typically introduce allophones regardless of context. Although this approach was initially attractive, problems arose in extending this model to other languages, necessitating complex distinctions among affixes (level-1 vs. level-2). Also the tight connection between morphological and phonological domains on which the model is based is challenged by bracketing mismatches, such as *ungrammaticality* in which the morphology demands the parse [*un*+*grammatical*] + *ity* but the phonology requires *un*+[*grammatical* + *ity*].

Constraint-Based Models: 1990–2005

As more languages were analyzed from the autosegmental and metrical perspectives, recurrent cross-linguistic patterns were discovered, suggesting that a higher level of explanatory adequacy was within reach. The tension between descriptive coverage and theoretical economy came to a head with some

linguists defending the latter at the cost of more elaborate representations and derivations (Jonathan Kaye's 1990 Government Phonology) and others looking to connectionist-inspired modeling of 'soft' universals (John Goldsmith's 1993 Harmonic Phonology) or competing principles that evaluate representations (Luigi Burzio's 1994 analysis of English metrical structure).

Prince and Smolensky (1993) addressed these concerns as well as the unresolved problems from the 1970s with a new model of phonological derivation (Optimality Theory, OT) in which rules are abandoned and the explanatory burden is placed entirely on universal grammar (UG) constraints. Plausible descriptive coverage is ensured by the idea that constraints conflict (echoing Stampe) and that the conflict can be resolved by a strict ranking or prioritization. OT makes it possible to formally express Kisseberth's intuition that inputs are mapped to outputs in order to satisfy a particular objective. And with its basic distinction between faithfulness and markedness constraints, OT formalizes Stampe's intuition that the radical simplifications of child speech reflect innate phonetic biases that must be overcome so that the resultant adult grammar is the residue of these biases. Finally, given that OT constraints shape the output rather than the input, Kenstowicz and Kisseberth's duplication problem is resolved. Most important, the OT model passes the basic test of pairing input with output in an explicit and workable fashion. For these reasons, OT quickly captured the attention of the generative school whose research agenda largely focused on an exploration of its implications for analysis and theory.

The OT model consists of two basic functions. GEN constructs a large (possibly infinite) pool of candidate outputs for any given input, which are then EVALuated by a fixed UG set of conflicting constraints (CON) that sift through the pool of candidates to eliminate all but the correct output. Grammars differ in the ranking of the constraints, which is the major learning task in acquisition. We illustrate with the crosslinguistic treatment of word-final rising sonority clusters, for example, in the stem of *theatr-ic*. English *théa*[tər] inserts a schwa, Canadian French *théâ*[t] deletes the liquid, while European French *théâ*[tr] remains faithful to the input. The relevant constraints appear in (1) and their evaluation of these candidates appears in **Table 3**.

(1) Max-C: Do not delete a consonant.
Dep-V: Do not insert a vowel.
Sonority Sequencing (Son Seq): A sonority peak is a syllable peak.

The grammar of English imposes the ranking Son Seq, Max-C >> Dep-V so that the faithful candidate *thea*[tr] and the truncating *thea*[t] are penalized in comparison to the winning candidate with epenthesis *thea*[tər]. These evaluations are summarized in **Table 4**. Canadian French (*théâ*[t]) demotes the ban on truncation (Son Seq, Dep-V >> Max-C), whereas European French (*théâ*[tr]) demotes the ban on nonsyllabic sonority peaks (Dep-V, Max-C >> Son Seq).

During its initial phase, OT concentrated on recasting the basic insights of prosodic and autosegmental phonology. This research also uncovered cases of top-down and other remote effects (Berber syllabification, Hindi stress, and Malay reduplication), which are handled effortlessly by OT constraints defined over fully formed output structures but which require phonological rules to look ahead of themselves (a formal impossibility in the serial model of SPE). Other achievements include a much more nuanced and elaborated understanding of markedness (structural complexity) that has resulted in typologies with rich implicational hierarchies. The OT model also provides a useful framework for studying phonological development from an initial state in which markedness constraints dominate faithfulness constraints and has fostered the study of learning algorithms (Tesar and Smolensky, 1998).

Because the OT architecture involves a one-step mapping from input to output, it is immediately confronted by the pervasive serialism (e.g., *writer vs. rider or writer-rider*) on which the original SPE model is predicated. OT has chipped away at this problem. Some cases have been attributed to faithfulness to other members of a stem's paradigm. Other researchers have proposed intermediate stages in the input–output mapping that mirror Lexical Phonology's stem and word levels. However, a nagging and

Table 3 Word-Final rising sonority clusters in Optimality Theory

	thea/tr/	*Max-C*	*Dep-V*	*Sonority Sequencing*
English	thea[tər]		*	
Canadian French	thea[t]	*		
Standard French	thea[tr]			*

Table 4 English ranking of word-final rising sonority clusters constraints

thea/tr/	*Max-C*	*Sonority Sequencing*	*Dep-V*
>thea[tər]			*
thea[t]	*!		
thea[tr]		*!	