INTRODUCTION

1 Leading ideas in phonology

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The aim of this handbook is to provide an up-to-date history of phonology, written by phonologists, from the earliest examples of phonological thinking that we can reconstruct through the rise of phonology as a field in the twentieth century and up to the present time. We believe that this handbook is particularly timely in the current period when phonological theory has been developing in different directions that appear to lack a common set of core ideas. An exploration of the history of phonology from various viewpoints could provide some much needed perspective on where phonology has been, and throw some light on where it is going. While the various chapters inevitably devote attention to the diversity and unique aspects of individual theories and schools of thought, they also demonstrate the continuity of fundamental ideas that have shaped the history of phonology. We believe it is important, as in any field of science, to study the development of the ideas and theories that inform the current state of our field. We hope that this volume will stimulate further work in what has been a relatively understudied area.

1.1 Previous histories of phonology

There have been several works that discuss central concepts, different schools, and the historical development of phonological thinking. In the past half-century, some authors have surveyed the rise of such central notions as the phoneme (Jones 1967, Krámský 1974), neutralization (Davidsen-Nielsen 1978, Akamatsu 1988), and morphophonemics (Kilbury 1976). Dinnsen

(1979), with chapters written by different authors, is a review of alternative approaches in the early generative era. Two comprehensive histories of phonology from the late nineteenth century to the last quarter of the twentieth century are Fischer-Jørgensen (1975/1995) and Anderson (1985). Fischer-Jørgensen devotes separate chapters to theories and schools up to and including early generative phonology, with a special interest in how the theories compare with respect to a number of issues. Anderson (1985) presents theories and schools in the light of how they dealt with representations and rules (derivations). Goldsmith & Laks (2019), both phonologists, offer an ambitious account of developments in linguistic theory with a focus on phonology, placing them in the broader context, as they argue one must, of psychology, philosophy, and mathematics. All these publications are of great value, deserving a prominent place in a bibliography of the history of phonology.

In addition to the publications mentioned, there are chapters about phonology in single-authored books on the history of linguistics (e.g. Robins 1967) or in handbooks of the history of linguistics (van der Hulst 2013) or of specific subareas of phonology (Murray 2015). *The Oxford handbook of historical phonology* (Honeybone & Salmons 2015) has many chapters that deal in whole or in part with topics in the history of phonology. Also, many other articles in journals or chapters in single-authored or edited volumes on phonology devote partial or extensive attention to the historical development of specific aspects of phonology, such as typology (van der Hulst 2017), constraints (Lacharité & Paradis 1993, van der Hulst 2011), contrast (Dresher 2015, 2016), or specific theories, especially generative phonology (van der Hulst 2004, Scheer 2011). Notable in this regard is issue 34(1-2) of *Folia Linguistica Historica* devoted to the history of phonology (with an introduction by Goldsmith & Laks 2000). In fact, it is fair to say that during the last twenty years or so there has been an increased interest in the history of our field, which is

why we believe that it is time to capture the insights that have been gained in a single multi-authored handbook.

1.2 Plan of the volume

The volume is divided into five parts. Part I, **Early insights in phonology**, begins with writing systems, for reasons we elaborate on in the next section, and has chapters devoted to traditions of phonological thought that go back to antiquity: the Sanskrit tradition of Pāṇini; the East Asian traditions (Chinese, Japanese, and Korean); the medieval Arabic grammatical tradition; and the Greco-Roman tradition. These great intellectual traditions form the foundation of later thinking, and continue to enrich phonological theory to this day. We conclude Part I with two chapters that form a bridge to modern phonology: one on theories of phonological phrasing from the eighteenth to the twentieth centuries, and one on the contributions to phonology of nineteenth century historical linguistics.

Part II takes up what we call **The founders of phonology**, the important schools and individuals of the late nineteenth and first half of the twentieth centuries who shaped phonology as an organized scientific field. These chapters are arranged in roughly chronological order, and discuss the Kazan School, Saussure, the Prague School, the London School, and the American schools associated with Boas, Sapir, and Bloomfield. We conclude this section with a chapter on the pioneers of sign language phonology, an important strand in the tapestry of phonological thought.

Part III continues with **Mid-20th century developments in phonology**. The first three chapters discuss phonology in the Soviet Union, Northern and Western Europe, and North America, respectively. These are followed by a chapter on developments leading up to

generative grammar. The section culminates in a chapter on Chomsky and Halle's *The sound pattern of English* (*SPE*). While there have been other very influential and foundational publications in the history of phonology, in our history *SPE* is a major landmark that closes one era and begins another.

Part IV is therefore titled **Phonology after *SPE***, reflecting our view that subsequent phonological theory had to respond in one way or another to that work, either taking it further or reacting against it. The first three chapters in this section—on derivations, representations, and phonology-morphology interaction—discuss developments that were considered to be extensions of the *SPE* theory, even when they departed, sometimes radically, from it. The next two chapters discuss two theories, Dependency Phonology and Government Phonology, that came to be perceived as competitors to mainstream generative phonology. Constraint-and-repair approaches to phonology, which put an emphasis on constraints in addition to rules, were overshadowed by Optimality Theory, which posited that constraint ranking is the sole mechanism, and which took over *SPE*'s role as the lingua franca of phonological theory, notwithstanding the existence of competing traditions. This part ends with a chapter on the study of variation, which has had a complex relation to generative grammar, and which forms a bridge to the final part.

Part V, **New methods and approaches**, is not organized by theoretical school, but rather takes up methods and approaches that became more prominent in the latter part of the twentieth century and have continued to be so in the twenty-first. The section begins with a review of attempts to provide phonetic explanations for phonological phenomena, a project that dates back to the beginnings of phonology but which takes on new forms in this period. The other chapters in this part deal with areas that rely on the development of computer technology, large databases and corpora, and sophisticated statistical techniques: these are the chapters on corpora and

phonological analysis, probabilistic phonology, the computational modelling of phonology, and models of phonological learning. The volume concludes with a chapter on the evolution of phonology.

In the rest of this chapter we will discuss how the leading ideas that characterize contemporary phonology emerged and developed in the history of our field, with reference to the individual chapters. We refer to them using the authors' surnames in SMALL CAPITALS.

1.3 Leading ideas in phonology

1.3.1 Part I: Early insights in phonology

The central insight that distinguishes a phonological approach to the expression side of language from phonetics is that sounds that are *different* can count as *the same* at some level of linguistic analysis, and, hence by inference, in the minds of language users. We will call this insight *the phonemic principle* (Swadesh 1934; van der Hulst 2013), and the first explicit statements of this insight in the nineteenth century are usually taken to mark the birth of phonology as a field.[1] However, the idea is much older, and is to some degree implicit in the invention of writing systems. According to SPROAT, 'all full writing systems … must represent sound even if very imperfectly, and thus the history of phonology really begins with the history of writing.' No

[1] Swadesh (1934) formulates the phonemic principle as follows: 'The phonemic principle is that there are in each language a limited number of elemental types of speech sounds, called phonemes, peculiar to that language; that all sounds produced in the employment of the given language are referable to its set of phonemes; that only its own phonemes are at all significant in the given language.'

phonographic writing system is designed to capture the full array of phonetic properties of words or whole utterances. A system that is limited to a finite set of symbols that has to be applied in a broadly consistent way will naturally tend to choose symbols that, however imperfectly, represent phonologically contrastive units, and thus manifests an implicit version of the phonemic principle.

While the thinking that went into the invention of the earliest writing systems is lost to us, we have records of several ancient traditions of phonological analysis of considerable sophistication. KIPARSKY writes that Pāṇini's grammatical analysis of Sanskrit (approximately 500 BCE) 'is the most complete generative grammar of any language yet written, and a source of many of the key ideas in Western linguistics in the last two centuries'. Therefore, the history that this handbook covers begins at its highest point, with a work that has never been surpassed. The Sanskrit tradition distinguished phonetic treatises, which were meant to encode the pronunciation of the Vedic texts and which classified sounds by a unified set of phonetic categories, from phonological analysis; the latter referred to phonetic categories, but imposed its own classification of them based on the way sounds pattern in the phonology. With its emphasis on empirical coverage and economy of statement, Pāṇini's grammar remains an inspiration and source of phonological ideas to this day.

DUANMU & KUBOZONO discuss phonological issues that have concerned Chinese, Japanese, and Korean linguists from ancient times to the present day. They observe that, though it may seem paradoxical, the very poor representation of phonology in Chinese orthography did not hinder phonological research, but rather encouraged its early flourishing, 'precisely owing to the need to annotate pronunciation, however arduous the task'. In the first millennium BCE Chinese linguists collected and catalogued regional speech; rhyming books began to appear in the first

millennium CE, and started a tradition of organizing syllables according to similarities in their constituents and tones. The earliest records of studies on Japanese sound structure are of a more recent date. Documents and dictionaries compiled by Buddhist scholars (of which the most famous date from around 1100 CE) include tonal descriptions that are valuable sources of data for the study of the development of pitch accent systems in varieties of Japanese. The theoretical concept of the mora is closely related to the katakana and hiragana syllabaries (both based on Chinese characters). The primary focus of the Korean section is the remarkable Hangul writing system, designed in 1446. Invented *de novo* under the influence of Sanskrit Devanāgarī script, it symbolizes the articulation of sounds in a systematic manner.

BOHAS & LOWENSTAMM discuss the rich tradition of grammatical analysis that developed in the Arab world from the 8th to the 14th centuries. Their focus is the *taṣrīf*, the grammatical component which hosts phonology. They argue that the Arab grammarians' analysis of the morphology and phonology of the verbal system of Classical Arabic can be recast in strikingly contemporary terms. Starting with the root-and-pattern morphological structure of Arabic, which provided the 'underlying' representations, the Arab grammarians took a derivational approach to word formation and inflection, with phonological operations interleaved, eventually arriving at representations of the surface realization of forms. Like Pāṇini, they paid attention to detail, applying rigorous, formal analysis to achieve comprehensive coverage of the language data in ways that anticipated fundamental insights of modern linguistic theories.

According to SEN, 'The most important legacy of the Greco-Roman tradition is the appreciation of language science as an independent discipline requiring its own terminology, principles, and techniques'. He details how the Greco-Roman tradition, which paid attention to both literary language and vernaculars, and combined practical grammar writing with scientific

analysis, formed the basis of medieval and later linguistics in Europe and further east, with its early recognition of practically every grammatical distinction that has persisted throughout linguistic history into modern times. Though writings on phonology were not typically separated from articulation, orthography, metrics, and morphology, they show awareness of natural classes of sounds and what would later be called allophonic variation—the fact that certain 'letters' (i.e. sounds) have different values in different positions. Other contributions of the ancient western grammarians include studies of accentuation, syllable structure and weight, phonological processes, morphophonological alternations, and abstract underlying bases.

LAHIRI & PLANK trace the history of the scholarly study of prosodic grouping. They first review Joshua Steel's 1775/1779 account of the melodic and rhythmic structure of English speech, which starts a tradition continued in the late nineteenth and early twentieth centuries by Henry Sweet in England and Eduard Sievers and Franz Saran in Germany. While differing in terminology and the number of domains they distinguish, all share the recognition of what later came to be known, after the British phonetician David Abercrombie, as the 'Abercrombian foot', which consists of a stressed syllable followed by unstressed syllables up to the next stressed syllable. They contrast this tradition, which sees prosodic structure as largely independent from syntactic structure and being driven by rhythmic factors, with the later twentieth century approach in which phonological structure above the word reflects the surface syntactic structure, albeit one that can be modified by rhythmic factors.

SALMONS surveys selected 19th century developments in historical and comparative linguistics as they helped foreshadow or lay the foundations for major strands of modern phonological theory. He writes that when we consider 'contemporary theorizing about abstract structures of speech sounds, the echoes of the 19th century are loud and constant'. He shows how

19th century historical linguistic scholarship led to crucial insights and initiated debates that have endured to the present. Topics given special consideration are the relation between phonetics and phonology, the notions of system and contrast, representations and abstractness, and how to account for regularity and variation.

1.3.2 Part II: The founders of phonology

As impressive as the achievements of the early traditions in Part I are, they each worked on one language, or group of dialects, and did not aim at a universal theory of phonology. The 19th century saw a transition to a search for universal principles of sound change, and this emphasis on general principles came to characterize the various schools that we call the founders of phonology. Whereas the traditions in Part I developed independently of one another, the schools in Part II all built on the foundations of 19th century historical linguistics, and shared certain basic concepts.

RADWAŃSKA-WILLIAMS shows how much of what we consider to be modern phonology is prefigured in the works of Jan Baudouin de Courtenay (1845-1929) and his student Mikołaj Kruszewski (1851-1887), the key members of the Kazan Linguistic Circle. Kruszewski's brief monograph *On sound alternation* (1881) offers an astonishingly insightful and explicit discussion of issues that have continued to be central in phonological theories and debates—in particular, the question as to whether and how different kinds of phonological generalization need to be distinguished. In *An attempt at a theory of phonetic alternations* (1895), Baudouin further developed the classification of alternations, and redefined the phoneme as 'the psychological equivalent of a speech sound'. As the author states, Baudouin and Kruszewski's theorizing about the relationship between synchrony and diachrony and between phonetics,

phonology, and morphology was ‘the Kazan School’s enduring inspiration for the subsequent worldwide development of phonology’.

Ferdinand de Saussure (1857–1913) was a founder of the modern orientation in linguistic theory, which focuses on the analysis of language as a synchronic system of contrasting units. JOSEPH shows how he influenced modern phonology, first with his *Memoir on the primitive system of vowels in the Indo-European languages* (1879), and, more widely with his posthumous *Course in general linguistics* (1916). Both of these works undertake to analyse a language as a synchronic system: the earlier one by reconstructing part of the sound system of Proto-Indo-European, and the later one extending its scope to languages generally. The chapter traces Saussure’s phonological thinking and discusses certain widespread misunderstandings of his work. While the historical linguists realized that individual sounds form part of a system, it was Saussure who put the system first. He thereby laid the ground for ‘structural linguistics’ which has characterized all major theories of phonology to the present day, and ultimately for structuralism as an intellectual movement beyond linguistics which has influenced sociology, anthropology, and other disciplines that study human cognition and behaviour.

From our current perspective, the Prague School, discussed by BATTISTELLA, was the most influential in setting the future course of phonological theory. The primary representatives of this school, Nikolai Trubetzkoy (1890–1938) and Roman Jakobson (1896–1982), drew on the work of Baudouin, Kruszewski, and Saussure to address the nature of phonological elements, alternations, and the structure of phonological systems. Their debut at the First International Congress of Linguists in 1928 in The Hague marked an important milestone in the evolution of the concept of the phoneme and of phonological structure. The Prague School was characterized by the pursuit of scientific rigor and the quest for a general theory of language. Its writings

promoted and developed a 'functional' perspective which views sounds as elements of a functional system of oppositions (contrasts). Trubetzkoy's *Principles of phonology* (1939) is a highlight of 20th century phonology and the point of departure for later work.

As described by BATTANER MORO & OGDEN, the British linguist John R. Firth (1890–1960) developed a unique functionalist approach to language and linguistics at the School of Oriental and African Studies (SOAS), London, from 1937 to his death. The 'London School' refers to the group of Firth's colleagues and disciples at SOAS who developed Firthian Prosodic Analysis (FPA) on the basis of Firth's thinking. A characteristic of this approach that was unique at the time was the separation of properties of the sound stream that extend over multiple phonological units. The identification of these 'prosodies' broke with strict segmentalism, that is, the absolute vertical slicing of the speech signal into linearly sequenced segments. This idea re-emerged later in American linguistics in various guises, notably in Autosegmental Phonology. Another distinguishing property of FPA is that it is polysystemic: 'that is, it establishes multiple systems of contrast which hold at different places in phonological structure, and does not assert any necessary identity of elements in different systems.' For example, consonants in syllable-initial and syllable-final positions can belong to different systems if they show different patterns of contrast. This idea also lives on, for example in Dependency Theory. Another contribution of this school was its attention to African and Asian languages.

SILVERSTEIN describes how phonological theory in North America was reoriented from a historical to a synchronic structural perspective by three great figures: Franz Boas (1858–1942), Edward Sapir (1884–1939), and Leonard Bloomfield (1887–1949). Though all had training in philologically based comparative Germanics, all three specialized in fieldwork on the 'exotic' languages of North America. Countering evolutionary and racist notions that languages of so-

called primitive peoples had no fixed sounds, Boas demonstrated that every language has a phonological system of categories of sound. Silverstein observes that the *Handbook of American Indian languages* (1911), 'organized by Boas to illustrate the wide typological diversity of the continent's indigenous languages, was as well a major enterprise for recruiting scholars to fieldwork-based empirical investigation of typologically interesting languages.' Sapir was 'the awe-inspiring 20th century virtuoso of anthropological linguistic fieldwork'. As summed up in his ground-breaking article, *Sound patterns in language* (1925), his detailed accounts of Takelma and of Southern Paiute contained fundamental insights into the importance of studying sounds as points in a pattern, and of an 'emic', as opposed to an 'etic', perspective. Bloomfield systematized and codified descriptive phonological theory, and became 'an authoritative voice in the new empirical descriptivism, the most significant apical figure in American linguistic theory until Noam Chomsky'.

The chapter by VAN DER HULST on the (early) history of sign language phonology covers a development which stands largely apart from the other chapters in this volume; nevertheless, it has come to be recognized that the study of sign language expands our view of what phonology is about. An early pioneer was Roch-Ambroise Auguste Bébian (1825), who developed a notational system which allows signs to be segmented into smaller, meaningless parts. In the twentieth century, La Mont West (1960) and William Stokoe (1960) applied structuralist linguistic methods of analysis to sign language. Stokoe's seminal work, inspired by Trager & Smith (1951), is commonly acknowledged as the first publication to claim that signs can be analyzed into meaningless simultaneously organized elements; West's unpublished dissertation, in some ways ahead of its time, remains little known, unfortunately. The work of Ursula Bellugi and Edward Klima (1973) subsequently added much to bring sign language to the attention of

linguists. Van der Hulst then reviews the impact on sign phonology of the transition from American structuralist linguistics to generative approaches. Sign phonology entered a new era with the rise of sequential structure and various strands of research that broke with Stokoe's conception of the sign as a simultaneous bundle of properties. By showing that spoken and signed languages share design properties in their phonology that are independent of the phonetics of each modality, these researchers have enlarged our conception of phonology and merit a place among its founders.

1.3.3 Part III: Mid-20th century developments in phonology

The chapters in Part III show how the various kinds of structural phonology discussed in Part II developed in particular directions in the Soviet Union, Europe, and North America in the mid-20th century. Despite their common interest in universal principles, each school was influenced by the particular languages their proponents worked on, as was the case with the traditions discussed in Part I.

IOSAD considers the development of phonological theory in the Soviet Union, both within the context of its origins in the intellectual atmosphere of late 19th and early 20th century linguistics in Russia, and in the light of its later separation into two different frameworks, known as the 'Moscow' and 'Leningrad' (St Petersburg) schools. The former originated with Filipp Fortunatov (1848–1914) and emphasized a 'formalist' approach; the Leningrad phonologists were heirs, at least rhetorically, to the 'psychological' approach of Baudouin. Nevertheless, the author writes that 'phonology in the Soviet Union can be seen as a coherent, independent sibling of the better known European and American varieties of structuralism', notably the Prague School, and both schools share important similarities in how they address issues of phonological

analysis. It is demonstrated that many of the analytical choices and controversies were shaped in a significant way by the properties of the phonological grammar of Russian, with which both schools were preoccupied.

BASBØLL focuses on the phonological implications of the general theory of language, called Glossematics, forged by the Danish linguists Louis Hjelmslev (1899–1965) and Hans Jørgen Uldall (1907–1957). 'Glossematics takes as its point of departure the dual nature of all things linguistic': the parallel structure of the expression plane and the content plane. Glossematics emphasized paradigmatic and syntagmatic relations rather than phonetic analysis, and this led to an interest in scrutinizing phonotactics and prosody in systematic and original ways, areas to which scholars from the glossematic milieu contributed important studies. The approach was influenced by the properties of Danish, in particular the Danish *stød*, 'the central crux in Danish phonology, morphophonology, and prosodic morphology'. There are certain affinities with the theory of Firth, who appears to have been influenced by the early writings of Hjelmslev and Uldall. The chapter further describes the impact of Glossematics on the strong Danish tradition of structuralist dialect descriptions and on phonological descriptions of French, where André Martinet (1908–1999) played a key role.

As described by LADD, from the early 1940s to the early 1960s American phonology, led by Bernard Bloch (1907–1965), George Trager (1906–1992), and Charles Hockett (1916–2000), was remarkably monolithic, notwithstanding the important heterodox work of scholars such as Kenneth Pike (1912–2000) and Zellig Harris (1909-1992). Its practitioners (the 'post-Bloomfieldians') nominally followed Bloomfield, but in practice departed from his views in several respects. First, contrary to Bloomfield's explicit view, they assumed the reality of a narrow phonetic transcription (what Chomsky would later call 'systematic phonetics'). Second,

they accepted a strong version of what Hockett called ‘duality of patterning’ (similar in spirit if not to the letter of Hjemslev’s duality perspective), according to which individual utterances are simultaneously arrangements of phonemes and arrangements of meaningful units; this led to their insistence—contrary to Bloomfield’s practice—that phonemic analysis had to be carried out without ‘mixing levels’; that is, without any reference to grammatical and lexical categories. Separation of levels in turn led to the requirement of a ‘biunique’ relation between phonemes and allophones. Though these principles made it difficult to deal with morphophonological regularities, ‘The architects of the theory did not regard these consequences as flaws’ but ‘as evidence of the insight afforded by rigorous adherence to the logic of the theory’.

As in many other fields, the United States became the centre of gravity of linguistic theory following the Second World War, partly due to the movement of scientists from Europe to America. DRESHER & HALL discuss key figures in the 1950s and 1960s whose work led to the theory of generative phonology. They show how generative phonology developed in part from the collaboration of Roman Jakobson and his student Morris Halle, continuing the Prague School approach by elaborating and modifying earlier ideas concerning distinctive features and relating them to mathematical models from the then-new field of information theory. Another source was the formalization of American structuralist phonology by Zellig Harris and the critique of that theory by his student, Noam Chomsky. These sources merged in the collaboration of Chomsky and Halle and their critiques of prevailing notions of what they called the ‘taxonomic’ phoneme and the strict separation of levels. The emerging synthesis both built on and diverged from earlier ideas. According to the authors, ‘What was novel about Chomsky and Halle’s critique was that they took issue with the scientific and psychological assumptions that underpinned taxonomic

phonemics' and proposed to replace the modest procedural goals of phonological theory by more ambitious scientific goals.

Part III concludes with a chapter devoted to Chomsky & Halle's *SPE* (1968). KENSTOWICZ writes that it is 'the first detailed exposition of the generative model of phonology and linguistics. With its reliance on ordered rewrite rules, it is no exaggeration to say that *SPE* revolutionized the field of phonology'. The key innovation in this landmark study was to treat phonology as the realizational component of a generative grammar that aims to characterize the tacit knowledge of an idealized native speaker in terms of a system of ordered rules defined over sound sequences represented as distinctive feature matrices. The chapter reviews *SPE*'s analysis of English word stress and morphophonological vowel alternations as well as the general distinctive feature system it employs. A theory of markedness, designed to take account of the intrinsic content of the features, is introduced toward the end of *SPE* to remedy what Chomsky & Halle characterize as the 'overly formal' approach of the rest of the book. Kenstowicz concludes with a consideration of the special climate that nurtured the development of the generative approach and the contributions of Chomsky and Halle's first generation of students.

1.3.4 Part IV: Phonology after *SPE*

The first set of issues that arose following the publication of *SPE* concerned phonological derivations, perhaps the most characteristic aspect of the *SPE* theory. Though it had precedents in the morphophonology of American structuralists (not to mention the work of Pāṇini and the medieval Arab grammarians), making the derivation the main mechanism of the theory distinguished generative phonology from other contemporary approaches. KENSTOWICZ & KISSEBERTH frame their discussion in terms of a series of questions: Can any limitations be

placed on the disparity between the underlying and surface phonetic representations? Should phonological rules be distinguished in terms of phonetic versus morphological function and motivation? How do rules interact (what sort of rule orders are permitted), and what kinds of information do they have access to? Is there a role for output targets? In addition to ordered rewrite rules, should the grammar include characterizations of the inventory of elements and structures at underlying, intermediate, or surface structure? If so, what is the relation between the rewrite rules and these structures? The abstractness controversy (first raised by Paul Kiparsky's 1968 paper 'How abstract is phonology?') and other debates in phonological theory turned on these questions; new answers to them gave rise to the theories of Natural Phonology (Stampe 1973; Donegan & Stampe 1979), Natural Generative Phonology (Vennemann 1974a, b; Hooper 1976), and later, Lexical Phonology and Morphology (Kiparsky 1982, 1985), and contained the seeds of constraint-based theories that came to the fore in the following decades. The authors observe that these issues continue to be revisited in the light of new methods and theoretical orientations.

While *SPE* was a sharp departure from American structuralism in some respects, notably in the centrality of derivations, KISSEBERTH writes that it carried over the earlier American structuralist notion that phonological representations consist of linear sequences of distinctive features divided by boundaries. During the 1970s and 1980s, attention turned from derivational to representational issues: 'The earlier preoccupation with the form of rules and how these rules derived the correct surface forms from input forms was almost entirely superseded by proposing representations that allowed (as much as possible) for universal principles to interact with these representations to yield outputs'. Phonological representations were radically reimagined as complex multi-linear, (partially) independent, (sometimes) hierarchically arranged structures.

Autosegmental Phonology (Goldsmith 1976), originally proposed to account for the special properties of tone, provided a conceptual framework that was extended to the representation of syllables, stress, distinctive features, and the internal phonological structure of words and sentences. A number of these proposals, which did not find a place in the *SPE* theory, had been prefigured by earlier non-generative theories.

Broadly speaking, derivations and representations are the two ways for morpho-syntax to bear on phonology, and the tension between these types of accounts is explored by SCHEER in his chapter on the impact of morpho-syntactic information on phonology in generative theories. The derivational path was introduced by Chomsky et al. (1956: 75) and was successively known as the transformational cycle, the phonological cycle, cyclic derivation, and, more recently, as derivation by phase. Representational accounts insert objects into the linear string that is submitted to phonological computation: juncture phonemes in their earliest incarnation, then boundary symbols in *SPE*, then prosodic domains in the early 1980s. Since that time, the two channels have been associated with specific theories: Lexical Phonology and Morphology and its Optimality Theoretic descendants on the derivational side, and Prosodic Phonology (Selkirk 1981 [1978]; Nespor & Vogel 1986) on the representational side. Another major issue is whether the phonology can refer directly to morpho-syntactic information, or whether such information is invisible to the phonology and must be translated into phonological vocabulary before the phonology can refer to it. The chapter traces the complex history of these approaches in generative phonology.

Several theories that reacted to *SPE* emphasized the representational side of phonology. One that anticipated some generative-internal developments is Dependency Phonology (DP; Anderson & Jones 1974 [1972], 1977; Anderson & Ewen 1987). STAUN writes, ‘As the founders

and principal followers of DP are based in Britain, Holland, France, and Denmark, this theory of phonological representation and subsequent developments is strongly rooted in a European tradition of linguistics, in particular indebted not only to the work of Firth (1948), Abercrombie (1967), and Catford (1977), but also to the work of the proponents of Glossematics (Hjelmslev 1943)'. Dependency Phonology extends the dependency formalism originally used to account for syntactic structure to segmental internal structure, syllables, and larger supra-segmental structures. It proposes an alternative interpretation of the internal structure of phonological segments, replacing binary features with a restricted number of monovalent primes.

Arising in the 1980s, Government Phonology (GP) also minimizes the derivational aspect of phonology in favour of enriched representations. RITTER writes that GP tried to restore the parallelism between phonology and syntax that existed in the early days of generative grammar in order to yield a unified cognitive approach to both components; under the influence of the Government-Binding syntax of the time (Chomsky 1981), GP proposed a system of fixed principles in conjunction with language-specific parameters, which together operate on representations in terms of minimal computation. GP rejected phonological rules, rule ordering, and binary features in favour of a small inventory of unary elements which could enter into dependency relations (similar to those of Dependency Phonology). The chapter shows that as the theory evolved, it departed further from other contemporary approaches to phonology, for example in the replacement of the syllable constituent by pairs of onset-rhyme sequences and doing away with the machinery of resyllabification, the revocation of a division between phonological and phonetic representations, and the elimination of constraints that are grounded in phonetics or physical properties, or more generally in functional motives of perception and production.

CALABRESE begins his chapter on constraint-and-repair theories by observing that a phonological rule—the main formal device of the *SPE* theory—can be decomposed into two parts: a configuration that needs to be changed (the structural description) and a prescription as to what to do to it (the structural change). These two parts can be separated: the structural description can be reformulated as a negative constraint that states that a certain configuration is illicit, without prescribing how to fix or remove it. A further operation—a repair—is used to do that. Constraints, in the form of morpheme structure conditions, were already present in the *SPE* model, but starting in the 1980s, a series of papers by Rajendra Singh, Carole Paradis, and Andrea Calabrese proposed versions of theories that put the constraint-and-repair mechanism at the centre of phonological theory. The theories differed in how the repairs are implemented: for Singh and Paradis, by universal automatic processes (reminiscent of Natural Phonology); for Calabrese, by rules, which are retained and work together with constraints. All these models were derivational, transforming an underlying representation into a surface representation by steps, as in classical generative phonology.

A theme that recurs in all the chapters in this section is dissatisfaction with the *SPE* focus on rules, or derivations, or both. Both rules and derivations were rejected in spectacular fashion in Alan Prince and Paul Smolensky's (1993) *Optimality Theory: Constraint interaction in generative grammar*. VAN OOSTENDORP writes that Optimality Theory (OT) became immensely popular very quickly, and represented the greatest revolution in phonological theory since *SPE*, supplanting it as the new phonological lingua franca. In place of an underlying form undergoing a series of ordered rules in a step-by-step derivation, Prince & Smolensky posited that all possible outputs for a given input are evaluated in parallel against a set of universal constraints. In a departure from most previous theories that incorporated constraints, OT constraints can

conflict and are thus violable; which constraints prevail is determined by language-specific ranking of the constraints. Like the *SPE* theory, OT has given rise to many variations, including Stratal OT, Harmonic Serialism, and a number of stochastic versions that aim to account for variation. Van Oostendorp concludes that some feel that OT is losing the position it has held for the past 25 years as the dominant framework of phonology, as basic issues about 'what the stuff of phonology really is' continue to be contentious; however, no successor has become apparent in a field that is becoming increasingly diverse.

The final chapter in this section takes us back to the origins of generative phonology and, earlier than that, to the early 20th century split between diachronic and synchronic phonology. FRUEHWALD writes that the study of phonological variation 'has followed a largely parallel history to the development of generative phonology'. Like generative phonology, contemporary variationist research can be said to date to 1968, to Uriel Weinreich, William Labov, & Marvin I. Herzog's seminal article, 'Empirical foundations for a theory of language change'. With its roots in dialect study and debates within historical linguistics, this article brings us back full circle to the study of language change and how it connects to the synchronic state of the language. Contrary to *SPE*, which abstracts away from variation and takes the idiolect of an idealized native speaker as its object, Weinreich, Labov, & Herzog argue that language is a social object characterized by orderly heterogeneity. How this variation should be accounted for, and the status of variable rules and their relation to mainstream phonology, have been matters of considerable debate. Nevertheless, Labov's demonstration that phonological change can be studied in real time has given rise to a major research enterprise that has developed, at times in opposition to and at times in concert with, the research program of generative phonology.

1.3.5 Part V: New methods and approaches

The methods and approaches in this section are not actually 'new'; some have a fairly lengthy history. However, they have taken on new forms due to their reliance on developments in fields such as computer technology, computational modelling, and statistical analysis. The first chapter in Part V reviews the history of phonetic explanations of phonological patterns from the 1920s to the present. KINGSTON starts with the observation that 'The phonological content of spoken messages is conveyed phonetically from the speaker to the listener, which suggests that phonological patterns may be explained phonetically'. Nevertheless, he concludes, 'There is no consensus in the field regarding the proper relationship between phonology and phonetics, and thus no consensus regarding whether and how phonological patterns can be explained phonetically.' His chapter takes us through the changing relationship between phonetics and phonology, starting with the 1920s–1940s, when phonologists attempting to define the phoneme emphasized the independence of phonology from phonetics. In the second half of the 20th century distinctive features came to the fore, which raised new questions about this relation that remain unresolved: To what extent are phonological features grounded in phonetics? Are the correlates of features primarily acoustic or articulatory? More generally, how much of phonology can be explained by phonetic principles? The tension between the substantive and formal aspects of speech sounds has been a fundamental theme in the history of phonology.

In her chapter on corpora and phonological analysis, HALL observes that there are many different definitions of 'corpus phonology'. In the widest sense, a corpus can be defined as any collection of linguistic data; in this sense, all empirical phonology from Pāṇini on has drawn on some sort of corpus, however strictly delimited. More commonly, the term is associated with work that involves answering a research question using pre-existing data of an appropriate type:

depending on how strict the criteria are for establishing a corpus, corpus phonology can become a research paradigm in opposition to other approaches to phonology. Hall writes, 'The critical view that Chomsky and other generativists took toward corpora helps explain the feeling of novelty of corpus linguistics' in the 1980s. Advances in computational storage capacity, processing power, and analytical tools have all contributed to the feasibility of corpus linguistics; the availability of large, accessible corpora of naturalistic data facilitate investigations of frequency and probability in phonology.

Probabilistic phonology is the subject of the chapter by PIERREHUMBERT, who reviews the history of the claim that statistics play a central role in the cognitive system that allows individuals to acquire and use a phonological system; in particular, that 'the phonological grammar is acquired by a process of statistical inference over linguistic events of different frequencies, and furthermore the resulting mental representations incorporate probabilities in some manner.' The idea that phonology is probabilistic goes back to Pāṇini, and the classic distinction between accidental and systematic gaps in the lexicon is implicitly probabilistic. However, this idea took on new vigour with the development of information theory by Shannon (1948), a work that influenced North American phonology in the 1950s. Research using these tools has both demonstrated the importance of probabilities in phonology, and identified cognitive and social factors that cause deviations between what people experience and what they produce.

CHANDLEE & JARDINE write that the computational modelling of phonology is almost as old as generative phonology itself. Their review focuses on finite-state modelling, which, like generative grammar, has roots in automata theory. For much of its history, computational modelling has tended to follow the phonological theory of the time, being designed in turn to model derivational rules, autosegmental representations, and the constraint systems of Optimality

Theory. However, ‘computational modelling has evolved from practical implementations of phonological theories to an active part of phonological theory’. They discuss two strands of research that have informed phonological theory: stochastic learning from corpus data and gradient acceptability judgements, and the study of the computational nature of phonological patterns.

Computational modelling has had close connections to learnability theory. HEINZ & RAWSKI trace learnability as a research subject back to the ‘cognitive revolution’ of the 1950s which, spurred by advances in the theory of computation, transformed linguistics and psychology. They write, ‘This marriage of many fields produced two new twin disciplines, not identical, yet not completely distinct: Artificial Intelligence and Cognitive Science. Language was crucial to the development of both.’ Despite the centrality of linguistic issues to computer science, they observe that the history of learnability has been mostly one-sided, with many ideas from computational learning models imported into phonology, but rarely the converse. Their belief is that phonology provides a concrete, knowledge-rich domain in which solutions to learnability problems can be developed and studied, and that phonologists are in a position to actively contribute to the science of learning.

The final chapter in our volume is on phonology and evolution. DE BOER writes that in the context of language, evolution can refer both to the biological evolution of the human ability for language (i.e. the origins of language in the species) as well as to the cultural evolution of languages (language change). Interest in these topics can be traced back to the earliest writings on language, bringing us back to the traditions surveyed in Part I, and on through figures such as Dante in the 14th century to the 18th and 19th century historical linguists. Contemporary thinking about evolution began with the accounts of the origin of species by Charles Darwin and Alfred

Russel Wallace in 1858; in his *The descent of man* (1871), Darwin considered the formation of species and languages to be 'curiously parallel'. De Boer then reviews the century-long debate on the evolution of the vocal tract, before turning to some reasons the evolutionary perspective was eclipsed for much of the 20th century. It is making a comeback in the early 21st century, however, and more recent work looks at how evolutionary theory can help to understand how phonological structure emerges and changes. Like the other topics in this section, the evolution of phonology can be tackled anew in the light of modern developments, in this case in the study of genetics and evolution, as well as advances in phonetics and phonology.

1.4 Conclusion

In this concluding section we wish to make a few general observations about the history of phonology that emerge from this handbook. As is apparent from our brief survey of the volume, the history of phonology does not follow a straight line, or show a monotonic development toward ever more successful theories. Rather, we find certain themes and tensions that recur in different guises over the years; some of these are:

- language as a property of an individual speaker versus language as a social object;
- derivations versus representations as the main mechanism of phonology;
- an aesthetic of 'holism' (van der Hulst and Ritter 2000), whereby phonology is characterized by one predominant type of device, versus modularity, whereby phonology is a collection of diverse subtheories geared to particular phenomena;
- a view of sounds as successive segments or feature bundles versus sounds as participating in 'prosodies' that may extend over stretches of speech;

- an understanding of phonological primes as features with two (or more) values versus unary (single-valued) elements that are either present or absent.
- phonological primes as grounded in the phonetics of perception and production versus formal cognitive entities with their own organizing principles;
- phonological universals versus the idiosyncrasies of particular languages;
- phonology as sharing certain principles with syntax versus phonology as being fundamentally different from syntax.

These oppositions are not mutually exclusive: thus, language is a property of an individual speaker *as well* as a social object; a theory of phonology requires *both* a theory of representations and some notion of derivation (that is, a mapping between a lexically stored form and a perceived or produced utterance); and so on. In most cases, the question is not whether both sides of a dichotomy (say, representations or derivations) are needed; the challenge is to know which phenomena should be assigned to one or the other. Perhaps this is why these tensions have never been resolved: theories that come down strongly on one side or another often have to make some accommodations to the other side. The difficulty of arriving at a proper balance may account for the relative lack of continuity that we find in the history of phonology. Fundamental debates are rarely decided in a conclusive manner; rather, interest in certain topics wanes and attention shifts to other issues. Because there are few matters in phonology that we can declare to be settled, there is a certain value in being open to ideas that have been discarded: in a different context, they may reveal new potential.

Nevertheless, one notion that recurs throughout the history of phonology is what we have called the phonemic principle, the idea that sounds that are different can count as the same at some level of linguistic analysis. Of course, there has been much disagreement as to how exactly

to define and implement this principle—what levels of analysis it should apply to, and what conditions should be put on them—but a rejection of a particular definition of the phoneme does not amount to rejection of the phonemic principle itself (Dresher 2011; van der Hulst 2013).

The pervasiveness of the phonemic principle, its presence from the earliest times, appears to vindicate the claim by Sapir (1949 [1933]) that 'the phonemic attitude is more basic, psychologically speaking, than the more strictly phonetic one': 'In the physical world the naïve speaker and hearer actualize and are sensitive to sounds, but what they feel themselves to be pronouncing and hearing are "phonemes."'

Finally, we recognize that every history reflects the preoccupations of those who write it. The chapters in this volume inevitably represent the interests of the authors; the choice and arrangement of the chapters are those of the editors. Limitations of space prevent us from including many topics and perspectives that merit inclusion in a history of phonology, and it is our hope that they will find a place in a future volume.

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