Rule-based generative historical phonology

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1. *Introduction*

This chapter presents an account of historical phonology in terms of classical generative phonology (Chomsky & Halle 1968; Kiparsky 1965; 1982; King 1969). Generative phonology can contribute to our understanding of diachronic developments because it allows us to view them in richer terms than the traditional two categories of 'sound change' and 'analogy'. In generative phonology, underlying phonological forms that are stored in the lexicon are operated on by a series of ordered rules that derive surface phonetic forms. Any aspect of the phonological grammar is liable to be implicated in a particular change: rules may be added, lost, modified, or reordered, and underlying representations may be restructured. While some phonological changes may originate from outside influences (from other dialects or languages), generative grammar traces many phonological changes to the process of language acquisition. Learners acquire grammars, not just surface forms, and grammars are not transmitted directly from one generation to the next; rather, every learner must construct the grammar anew, based on the available evidence. We might expect that changes in the ambient data available to successive generations of learners will cause them to acquire grammars that differ in some respects from those of previous generations. In this way, diachrony becomes relevant to learnability, and is a source of evidence concerning the cognitive principles that govern language acquisition.

Sections 2 to 4 relate the change in perspective from the nineteenth century Neogrammarian approach to sound change, understood as applying to surface forms, to a

generative approach, in which change affects grammars, not just surface forms. I also show how generative phonology's focus on rules is able to resolve the structuralist Saussurian problem of the separation between diachronic change and synchronic systems. These points are illustrated with a series of examples from Old and Middle English that show how a generative perspective can shed new light on developments that are otherwise difficult to explain. Section 5 presents examples that show how synchronic patterns influence change, and the close relationship between learnability and certain types of phonological change is discussed in section 6.

Departing a bit from the theory of Chomsky and Halle (1968), section 7 shows how one could incorporate into generative theory the structuralist notion that sound change can be sensitive to contrastive patterns of the phonological system. Section 8 is a brief conclusion.

2. *Neogrammarian diachronic linguistics*

As is discussed elsewhere in this Handbook, the great achievement of nineteenth century historical linguistics was arriving at the discovery that sound changes are regular (see in this volume Bermúdez-Otero; Murray; and Phillips). This discovery allowed for the refinement of the comparative method and put historical reconstruction, as well as linguistic theory in general, on a much sounder basis. Nevertheless, nineteenth century theory, culminating in the work of the Neogrammarians, had certain limitations.

The first limitation was caused by the overwhelmingly diachronic orientation of Neogrammarian theory. Though nineteenth century linguists achieved unprecedented levels of precision by following the evolution of each sound in great detail, this approach

was unable to capture synchronic relations that might hold between sounds at various stages of their development. The shortcomings of this 'atomistic' approach were revealed by the structuralists, who, following Saussure (1972 [1916]), put the main emphasis on a language as a synchronic system whose parts are interconnected.[1]

A second limitation is the Neogrammarian emphasis on surface changes. Their assumption, a natural one in the absence of an articulated notion of a synchronic grammar, is that a sound at a given time is represented the way it sounds; when this sound changes, the older sound is replaced by the newer one, and any further changes relate only to the newer version, not to the older one. For example, the early West Germanic stressed *a is believed to have undergone the following changes on its way to Mercian Old English when it stood before a back vowel in the following syllable:

[1] See Murray (this volume) for a more nuanced discussion of nineteenth century linguistics. Murray shows that Saussure's notion of a synchronic sound system was already being advanced in the nineteenth century, notably by Sievers (1876), and that later linguists sometimes exaggerated the degree to which the Neogrammarian approach was focused on individual sound changes viewed in isolation.

(1) Development of West Germanic stressed *a before a back vowel[2]

a.	Early West Germanic	*a	*haƀuc	*fatas
b.	Anglo-Frisian Brightening	*æ	*hæƀuc	*fætas
c.	*a*-Restoration	a	hafuc	fatas
d.	Second Fronting	æ	*hæfuc	*fætas
e.	Back Mutation	æə	hæəfuc	fæətas
	Mercian *Vespasian Psalter*	<ea>	<heafuc>	<featas>
	Gloss[3]		'hawk N S'	'vats N P'

From the point of view of the phonetics of these sounds (as far as we can reliably reconstruct them), the sequence of changes shown in (1) amount to the successive changes of *a* > *æ* > *a* > *æ* > *æə*. Apart from the suspicious-looking reversals, this account misses any connections that these changes might have had with other changes taking place in this dialect, as well as any role that the grammar may have played in influencing the changes themselves.

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[2] Forms in angle brackets < > are orthographic. I assume that the spellings <ea> and <eo> represent phonologically short diphthongs pronounced roughly [æə] and [eə], respectively, and that these diphthongs are allophones of the short vowel phonemes /æ/ and /e/, respectively; see Hogg (1992) and Minkova and Lass (both, this volume) for discussion of various interpretations of these digraphs.

[3] Abbreviations used in glosses are: S = singular; P = plural; N = nominative; A = accusative; G = genitive; D = dative; M = masculine; F = feminine; N = neuter.

3. *Structuralism and diachrony*

Saussure's strict distinction between synchrony and diachrony brought in the notion of (synchronic) grammar as a system whose parts hang together. A basic structuralist notion is the phoneme: determining if two sounds belong to the same or two different phonemes requires a synchronic perspective. Further, a phonemic perspective allows us to distinguish between the contrastive value of a phoneme, conventionally indicated by slash brackets / /, and its phonetic implementation, indicated by square brackets [ ]. Hogg (1992) provides a number of interesting illustrations of instances where his Neogrammarian predecessors have been unable to give a satisfactory account of developments in Old English because they lacked a phonemic perspective (see also Salmons & Honeybone, this volume).

One example concerns the prehistory of early Old English long *æ:*. Since the corresponding vowel in Proto-Germanic is assumed to have also been *æ:, Wright & Wright (1925) had proposed that *æ:* simply persisted into the Old English period. Against this view is historical and comparative evidence which appears to show that it was a back vowel, *a:, in West Germanic. The version of events accepted by most other writers therefore posits, as in (2), that Proto-Germanic *æ: retracted to *a: in West Germanic, then fronted again to *æ: in Old English when not before a nasal.[4]

(2) Development of Proto-Germanic stressed *æ:: Pre-phonemic account

Proto-Germanic	*æ:
West Germanic	*a:
Anglo-Frisian Brightening	*æ:

[4] I follow Hogg's account (1992), but see Purnell & Raimy (this volume) for another view.

Hogg (1992: 61–3) considers not just the phonetic value of this vowel, but also its phonemic status at each stage of the language. This approach results in the richer picture shown in (3). He assumes, as in the traditional account, that this phoneme was a contrastively front vowel in early Proto-Germanic (3a).

(3) Development of Proto-Germanic stressed *æ: in phonemic perspective

a. Early Proto-Germanic long vowel system

/i:/	/u:/	There is a contrast between /æ:/
/e:/	/o:/	and /ɑ:/. / æ:/ is phonologically and
/æ:/ = [æ:]	/ɑ:/	phonetically front.

b. Later Proto-Germanic long vowel system

/i:/	/u:/	/ɑ:/ merged with /o:/. / æ:/ shifts
/e:/	/o:/	phonemically to /a:/, but remains
/a:/ = [æ:]		phonetically front [æ:].

c. Early West Germanic long vowel system

As in (b). The low vowel is contrastively neutral as to front/back status and can develop in some dialects as a central or back vowel.

d. Early Old English

/i:/	/u:/	A new phoneme /ɑ:/ develops. [æ:]
/e:/	/o:/	is reinterpreted as belonging with
/æ:/ = [æ:]	/ɑ:/	the front vowels.

Due to some changes in Proto-Germanic, notably the merger of /ɑ:/ with /o:/, /æ:/ was left as the only low vowel phoneme (3b). Hogg proposes that this vowel was contrastively neutral with respect to the front/back dimension; therefore, it can be

represented as /a:/, whatever its precise phonetic character. Since it could act neutrally with respect to backness (3c), it appeared to earlier writers as though it were a back vowel in early West Germanic. Hogg suggests that this phoneme may have nevertheless been phonetically front throughout in the dialects that developed into Old English. At a later period (3d), the development of a contrasting back low vowel (from the monophthongization of older */ai/ which merged with retracted /a:/ before nasals) created a backness contrast which led to a reanalysis of the original low vowel to a contrastively front vowel /æ:/. Hence, the alleged shift of Proto-Germanic *æ: to West Germanic *a: and then back to *æ:* in Old English and Old Frisian emerges as an artefact of a non-phonemic theory.

Hogg (1992: 77f.) suggests that the short low vowel in (1) developed in parallel to the long low vowel. As with the long vowels, there was only one short low vowel phoneme in early West Germanic; like the long low vowel, */a/ was neutral with respect to the front/back dimension, though it appears to have had a more back pronunciation than /a:/. In parallel with the long low vowel, it became contrastively front, i.e. */æ/, in early Old English (1b). Thus, a phonemic perspective allows for a simpler sequence of development and allows us to see the relationship between the changes in the long and short low vowel.

Though the introduction of a synchronic structuralist perspective allowed for richer explanations of phonological developments, Kiparsky (1965) demonstrated that, in a classical structuralist theory where phonemes are defined only in terms of contrast, problems arise in the description of dialects and successive diachronic stages. Strictly speaking, the phonemic systems of closely related dialects become incommensurable if

they differ in the number of phonemes they have (cf. Moulton 1960). This is because, in an approach that considers only the number of contrasts a phoneme enters into, a /t/ that contrasts with two other coronal stops (say, /d/ and /t^h/ cannot be compared with a /t/ that contrasts with only one other coronal stop, say /d/.

Kiparsky's argument draws on developments in the various dialects descending from Proto-Armenian, as shown in (4). He proposed that the current situation can most plausibly be attributed to three sound changes that spread through different geographic regions (5).

(4) Armenian dialects (Kiparsky 1965)

Old Armenian	th	t	d	*Contrasts*	*Sound changes*
East Central	th	t	dh	2	Aspiration
West Central	th	d	dh	2	Voicing, aspiration
Northern	th	t	d	2	———
Eastern	th	t	t	1	Devoicing
Western	th	d	d	1	Voicing
Northwestern	th	d	th	1	Voicing, aspiration
Southern	th	d	t	2	Voicing, devoicing

(5) Armenian sound changes (Kiparsky 1965)

a. Aspiration: /d/ aspirates to [dh] (or [th]) in the Central and Northwestern dialects.

b. Voicing: /t/ voices to [d] in the Western, West Central, Northwestern, and Southern dialects.

c. Devoicing: /d/ devoices to [t] in the Eastern and Southern dialects.

Kiparsky (1965) points out that these sound changes spread from one dialect to another, regardless of how many contrasts they contained. If we were to classify the dialects in terms of oppositions, we would arrive at meaningless groupings for explaining any synchronic or diachronic facts. He writes (1965: 17): "An incidental feature of the present example is that it highlights the pointlessness of a structural dialectology that...distinguishes dialects according to points of structural difference rather than according to the innovations through which they diverged...If in the present example we were to divide the dialects into those with two stop series and those with three, we would be linking together dialects that have nothing to do with each other and separating dialects that are closely related."

This is not to say that the number of contrasts plays no role in diachrony; we saw earlier that attention to the number of contrasts in the low vowels is important in understanding the nature of some of the changes they underwent, and this point will become central in section 7. However, Kiparsky showed that attention only to number of contrasts can impede a proper understanding of language change.[5]

4. *Generative phonology*

In the structuralist phonemic theory exemplified above by Hogg's analysis of the development of the low vowels from Proto-Germanic to Old English, a sound has two representations: a phonetic representation that approximates its pronunciation, and a phonemic representation that represents its contrastive value within the phonological

[5] See Keyser (1963) for another early discussion of how traditional dialectology could benefit from a generative perspective.

system. In the theory of generative phonology (Chomsky & Halle 1968), the phonemic representation is identified with the underlying, or lexical, representation of a sound, and the phonetic representation is its surface realization.[6] Mediating between the underlying and surface representations is a set of partially ordered phonological rules that convert the underlying forms into surface forms.

The notion of a grammar as a set of ordered rules presents a more explicit account of what it means to say that a grammar is a system. At the same time, it allows diachronic changes to interact with the synchronic system because both are expressed in terms of rules. Thus, the Armenian sound changes in (5) can be viewed not just as diachronic events, but as three rules that entered the synchronic grammars of the various Armenian dialects. It does not therefore follow that the synchronic set of rules in a grammar will merely mimic a series of historical sound changes. As Chomsky & Halle (1968: 249f.) observed, some rules of grammar may faithfully reflect a sound change that was introduced into the grammar centuries before, but this is the case only if successive generations of learners continue to acquire a grammar containing that rule. Where the data no longer provide learners with the requisite evidence, a rule will not be preserved intact in the grammar, but may be acquired in an altered form; or else the underlying representation will be changed and the rule will disappear from the grammar.[7] Moreover,

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[6] The number and nature of the levels in phonological theory have been the subject of much discussion and a major point of contention between different theories; see Dresher (2005; 2011) for historical overviews, and Bermúdez-Otero and Kiparsky (both this volume) for a more articulated set of levels.

[7] In the case of Eastern Armenian, we could imagine an initial stage in which speakers would have acquired lexical items with Old Armenian /d/, and subsequently introduced a rule devoicing this /d/ to [t]. For these

the grammar may change in other ways, with the result that it will fail to accurately reflect the history of the language.

Some of these notions can be illustrated by looking at the sequence of Old English sound changes introduced in (1) above. The change of early West Germanic stressed *a to early Old English *æ (Anglo-Frisian Brightening) is not easily recoverable in the synchronic grammar of early Old English, because this rule applied to all or most stressed *a.[8] That is, once words like *haƀuc 'hawk' and *fat 'vat' have been changed to *hæƀuc and *fæt, respectively, learners of the new grammar would have no reason to reconstruct the older /a/ in the lexical representations of these words; rather, these representations would be restructured as in (6), where (6a) represents the stage prior to the change, (6b) represents the period of the change in which speakers still represent the underlying form with /a/ and apply a rule to change it to [æ], and (6c) represents a subsequent stage in which learners acquire the [a] directly as /a/. The rule from (6b) is no longer needed, and is not part of this or subsequent grammars.

(6) Restructuring of underlying forms

a. Before Anglo-Frisian Brightening

Underlying	/haƀuc/	/fat/
Surface	[haƀuc]	[fat]

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speakers the change of *d* to *t* would exist as a rule of their grammar. But learners in the next generation who hear this sound as [t] would need synchronic evidence to continue deriving these [t] from /d/, rather than simply acquiring them with the underlying form /t/, just like [t] from Old Armenian /t/.

[8] See Hogg (1992: 80–82) for discussion of whether this change applied to all stressed *a, or was blocked in certain environments.

b. During Anglo-Frisian Brightening

Underlying	/haƀuc/	/fat/
A-F Brightening	hæƀuc	fæt
Surface	[hæƀuc]	[fæt]

c. After Anglo-Frisian Brightening

Underlying	/hæƀuc/	/fæt/
Surface	[hæƀuc]	[fæt]

The next change listed in (1c), *a*-Restoration, had a different effect on the grammar. In this change, stressed /æ/ became [a] when preceding a single consonant followed by a back vowel. In classical generative grammar, this change can be represented as the rule in (7), where the formalism A → B / C ____ D is read 'A changes to B when preceded by C and followed by D'. For this discussion I assume that sounds are composed of distinctive features, more or less as proposed by Chomsky & Halle (1968).[9]

(7) *a*-Restoration

$$\underset{[+\text{stressed}]}{\text{æ}} \rightarrow [+\text{back}] \; / \; _____ \; \text{C} \quad \underset{[+\text{back}]}{\text{V}}$$

This rule created alternations in many words, such as /fæt/, where the stressed vowel appeared as [æ] in forms where no back vowel followed, and as [a] where a back vowel followed. In such words it is clear that the stressed vowel is [æ] except in the specialized contexts where it is [a], suggesting that the basic vowel remains /æ/. Since

[9] See Purnell & Raimy (this volume) for a somewhat different approach to distinctive features; see also section 7 below.

surface [a] is easily derivable by rule (7) even in words where it does not alternate with [æ], as in *hafuc*, I assume that such forms also retain underlying /æ/.[10] Thus, sound changes can persist in grammars as synchronic rules if they create conditions whereby learners can still recover the underlying forms of the pre-sound change grammar. The effect of *a*-Restoration on several words in the grammar is shown in (8).

(8) Effect of *a*-Restoration on the grammar

a. Before *a*-Restoration

Underlying	/fæt/	/fæt + um/	/hæfuc/	/hæfuc + e/
Surface	[fæt]	[fætum]	[hæfuc]	[hæfuce]
Gloss	'vat N S'	'vats D P'	'hawk N S'	'hawks G S'

b. After *a*-Restoration

Underlying	/fæt/	/fæt + um/	/hæfuc/	/hæfuc + e/
a-Restoration	—	fatum	hafuc	hafuce
Surface	[fæt]	[fatum]	[hafuc]	[hafuce]

a-Restoration was not the only rule in Mercian Old English that backed /æ/ to [a]: another such rule is Retraction (9), which applies before *w* and back *l* (*l* that is followed by a consonant or a back vowel). Like *a*-Restoration, Retraction sometimes creates

[10] There were, and continue to be, differing views as to how 'abstract' underlying forms could be relative to surface forms (e.g., Nathan & Donegan, this volume, take a different approach; see Scheer, this volume, for discussion). Various constraints on underlying forms have been proposed that would require non-alternating [a] to be derived from /a/. It is an empirical question as to how this issue should be settled. Diachronic change is a valuable source of evidence bearing on this issue, and I have argued (Dresher 1985) that the changes we are considering support the general analysis advanced here.

alternations, as in *hwæl ~ hwalas* ‘whale ~ whales’; more usually, however, it does not, as in *ald* ‘old’, which has inflected forms *aldum, alde, aldra, aldran,* etc., all of which meet the conditions for the rule to apply. Sample forms are shown in (10).

(9) Retraction

$$\begin{bmatrix} \text{æ} \\ \text{+stressed} \end{bmatrix} \rightarrow \text{[+back]} \; / \; _____ \begin{bmatrix} \text{+sonorant} \\ \text{+back} \end{bmatrix}$$

(10) Grammar with Retraction and *a*-Restoration

Underlying	/æld/	/hwæl + as/	/fæt + um/	/hæfuc/
Retraction	ald	hwalas	—	—
a-Restoration	—	—	fatum	hafuc
Surface	[ald]	[hwalas]	[fatum]	[hafuc]
Gloss	‘old’	‘whales N P’	‘vats D P’	‘hawk N S’

Not all sound changes correspond to restructuring of underlying forms or to rules that are added to the grammar. In Mercian Old English there was a change known as Second Fronting (1d) which changed [a] back to [æ] in the *a*-Restoration contexts. That a rule would simply reverse a previous rule is only one of the suspicious characteristics of Second Fronting. The change is a strange sort of dissimilation whereby a back vowel becomes front before a following back vowel. Moreover, Second Fronting does not affect any *a* that are created by Retraction. The confluence of these facts suggests that Second Fronting was not a sound change in the sense of the addition of a new rule, but rather is the result of the loss of the rule of *a*-Restoration (Dresher 1980; 1985), as shown in (11).

(11) Second Fronting as the loss of *a*-Restoration

Underlying	/æld/	/hwæl + as/	/fæt + um/	/hæfuc/
Retraction	ald	hwalas	—	—
a-Restoration	—	—	L O S T	
Surface	[ald]	[hwalas]	[fætum]	[hæfuc]
Gloss	'old'	'whales N P'	'vats D P'	'hawk N S'

In the *Vespasian Psalter* (*Ps(A),* Kuhn 1965), the surface forms of the words that had formerly undergone *a*-Restoration are not as shown in (11), however. These forms had undergone a further rule called Back Mutation (12), whereby a schwa-like vowel is added to a stressed short front vowel when it precedes a single consonant followed by a back vowel. With *a*-Restoration gone from the grammar, Back Mutation can apply to /æ/, as shown in (13).

(12) Back Mutation

$$\emptyset \rightarrow \text{ə} \,/\, \begin{bmatrix} \text{V} \\ \text{–back} \\ \text{–long} \\ \text{+stressed} \end{bmatrix} \text{____} \; \text{C} \begin{bmatrix} \text{V} \\ \text{+back} \end{bmatrix}$$

(13) Back Mutation as rule addition

Underlying	/fæt + um/	/hæfuc/	/wer + as/	/hefun/
a-Restoration	L O S T		—	—
Back Mutation	fæətum	hæəfuc	weəras	heəfun
Orthography	< featum >	< heafuc >	< weoras >	< heofun >
Gloss	'vats D P'	'hawk N S'	'men N P'	'heaven N S'

Although *a*-Restoration is not evident from *Ps(A)*, we know that it had applied in the Mercian dialect because of the evidence of the early *Épinal Glossary* (EpGl) and

Corpus Glossary (CorpGl). These glossaries show a variety of spellings that appear to reflect the relative age of the rules that produced them (Toon 1983). For the short low stressed vowel, EpGl has spellings in <a>, <æ>, and <ea>, reflecting *a*-Restoration, the loss of that rule, and Back Mutation, respectively. (On the interpretation of English vowel orthography, see Minkova and Lass, both this volume.) Moreover, Back Mutation is more frequently recorded with <ea> than with <eo>, suggesting that the rule began with the low vowel and then spread to the other front vowels. The spellings thus reflect the series of stages in the evolution of EpGl shown in (14).

(14) *Épinal Glossary* dialect: historical evolution (Dresher 1985: 241)

a. *a*-Restoration is added

Underlying	/fæt + u/	/wer + as/
a-Restoration	fatu	—
Orthography	< fatu >	< weras >

b. *a*-Restoration is lost

Underlying	/fæt + u/	/wer + as/
Orthography	< fætu >	< weras >

c. Back Mutation begins in the low vowels

Underlying	/fæt + u/	/wer + as/
Back Mutation of *æ*	fæətu	—
Orthography	< featu >	< weras >

d. Back Mutation generalizes to the non-low vowels

Underlying	/fæt + u/	/wer + as/
Back Mutation	fæətu	weəras
Orthography	< featu >	< weoras >

In CorpGl, compiled a few years later, the spellings occur in different proportions. Most striking is the absence of spellings representing a stage after the loss of Second fronting but before the introduction of Back Mutation (corresponding to (14b) in EpGl). Rather, it appears that <a> went directly to <ea> without passing through <æ>. On the assumption that Second Fronting was a conventional sound change, this development is problematic, since Back Mutation applies to front vowels, and could not affect [a]. On the rule loss analysis, however, this development is what we would expect if Back Mutation arrived in the CorpGl dialect before Second Fronting was lost. In support of this chronology we observe that the Back Mutation of *e* and *i* is relatively advanced in that dialect, being represented two thirds of the time, next to one third unmutated spellings. By contrast, the ratio in the low vowels is two thirds <a> next to one third <ea>, consistent with the notion that Back Mutation entered the dialect prior to the loss of Second Fronting. The latter would have blocked Back Mutation in the low vowels, as shown in the chronology in (15).

(15) *Corpus Glossary* dialect: historical evolution (Dresher 1985: 242)

a. *a*-Restoration is added: as in (14a)

b. Back Mutation is added

Underlying	/fæt + u/	/wer + as/
a-Restoration	fatu	—
Back Mutation	—	weəras
Orthography	< fatu >	< weoras >

c. *a*-Restoration is lost

Underlying	/fæt + u/	/wer + as/
Back Mutation	fæətu	weəras
Orthography	< featu >	< weoras >

A generative rule-based analysis of the changes in the stressed low vowels of Mercian Old English thus gives us a richer account than the surface-based sequence shown in (1). A crucial ingredient of the generative analysis is the interplay between sound changes and the synchronic grammar. In some cases a change results in reanalysis of underlying forms, in other cases it leaves the underlying forms as they were but persists in the form of a synchronic rule.

The above account does not explain why the changes in question occurred. Traditional Neogrammarian theory makes a distinction between sound change and analogy. Whereas analogy is understood as being influenced by the grammar, sound change is assumed to arise from extragrammatical causes, influenced by articulatory, perceptual, and sociolinguistic factors. In generative terms, sound change corresponds either to restructuring of underlying forms (if the change leaves the previous underlying forms unlearnable), or to the addition of a rule to the end of the phonology. Analogy corresponds to other sorts of changes, such as the addition of a rule to the middle of the

grammar (rule insertion, King 1969; 1973), or to the loss or reordering of rules.[11] As the example of Second Fronting shows, however, the line between sound change and grammar change (i.e., between rule addition and rule loss) may not be easy to detect. Also, we cannot rule out grammatical influences even in the case of apparently simple sound changes. It has been observed, for example, that the rules of *a*-Restoration and Back Mutation appear to be variants of a single process of adding a back element to a stressed vowel under influence of a following back vowel, and that both of these processes appear to be part of a more general pattern whereby features are transferred from an unstressed vowel to the stressed vowel (Colman & Anderson 1983; Dresher 1990; 1993). Such patterns suggest the presence of an overarching grammatical principle that could be influencing these changes.

In the following section I look at another set of changes that at first appear to be sound changes but that turn out to be analogy, broadly speaking. They illustrate other ways in which the grammar influences diachronic change.

5. *How synchronic grammar influences diachronic developments*

In the light of contemporary approaches that again emphasize surface forms, or seek the explanation of synchronic patterns in diachrony, it is worth showing the enduring value of the fundamental generative notion that change is something that affects synchronic grammars, and that synchronic patterns in turn can influence change. Language learners acquiring lexical items must do so using the evidence available to them. An exclusively

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[11] For critiques of traditional notions of analogy and arguments for a generative approach see Kiparsky (1965; 1982) and Lahiri (2000), and Fertig and Kiparsky (both, this volume).

'vertical' diachronic perspective, focusing on individual sound changes, is liable to miss any 'horizontal' effects caused by the way seemingly unrelated items interact in the course of acquisition. The next example is intended to show the intricate synchronic interaction of different aspects of the grammar in what looks like a simple set of historical changes. It also supports the synchronic analysis presented above in (13).

Early Old English inherited a group of disyllabic noun stems, such as the reconstructed forms shown in (16a) and (16b). In (16a) we know that the *y* in *yfel*, from earlier *ubil, arises from the umlaut of /u/ due to an *i* in the following syllable, which was itself lowered in Old English to *e*. In (16b) the diphthong is caused by Back Mutation (12); the back vowel in the following syllable remains overt in *steaðul* but is reduced to *e* in *heofen* and in inflected forms of both words.

(16) Reconstructed early Mercian Old English

a.	yfel	yfeles	micel	miceles
	'evil N S M'	'evil G S M'	'much N S M'	'much G S M'
b.	steaðul	steaðelas	heofen	heofenes
	'foundation A S'	'foundation A P'	'heaven N S'	'heaven G S'
c.	weter	wetres	fugul	fugles
	'water N S'	'water G S'	'bird N S'	'bird G S'

In addition, Old English also inherited a group of noun stems ending in sonorant consonants that were originally monosyllabic, examples of which are shown in (16c). When followed by vowel-initial inflections, such as in *wetres* and *fugles*, the original CVCC form of the stems surfaces; when uninflected, or followed by a consonant-initial inflection, an epenthetic vowel is inserted whose nature is partially determined by the

stressed vowel: it is *e* following a front vowel, and *u* following a back vowel. The height asymmetry between the front *e* and back *u* is due to the same rule of *i*-Lowering that must have applied in *yfel*.

The diachronic steps leading to the forms in (16) are summarized in (17):

(17) Diachronic changes from pre-Old English to early Mercian Old English

pre-OE	ubil	ubil+es	stæðul	stæðul+es	wætr	wætr+es
i-Umlaut	ybil	ybiles	—	—	—	—
Epenthesis	—	—	—	—	wætir	—
i-Lowering	ybel	ybeles	—	—	wæter	—
Back Mutation	—	—	stæəðul	stæəðules	—	—
V-Reduction	—	—	—	stæəðeles	—	—
early OE	<yfel>	<yfeles>	<steaðul>	<steaðeles>	<weter>	<wetres>

What about the synchronic phonology of this stage of early Old English? In the view of generative phonology, we must suppose that learners, in their acquisition of the sound patterns produced by these historical changes, attempt to account for them synchronically. This does not mean, however, that learners simply reconstruct the sequence in (17) as a synchronic grammar. Synchronic sound patterns are not just a record of the past. Though phonologies sometimes display a certain 'inertia' where a series of changes piles up resulting in unnatural-looking synchronic alternations, often we see 'adjustments' of various kinds that give evidence bearing on the grammar. In the Mercian Old English dialect of *Ps(A)*, for example, we find that words of the type (16a) systematically alternate as in (18a), taking on the pattern of (16c).

(18) *Vespasian Psalter* dialect

a.	yfel	yfles	micel	micles
b.	steaðul	steaðeles	heofen	heofenes
c.	weter	wetres	fugul	fugles

Two questions arise: what does the change consist of, and why does it apply to the words in (a) but not in (b)? As to the nature of the change, one might think that it amounts to the syncope of a medial vowel. But Dresher (1985) shows that there is no general rule syncopating a vowel after a short stressed syllable in this dialect. Rather, the change amounts to a reanalysis of the lexical forms of the morphemes in (a) from disyllables to monosyllables, as in (c).

Next, why did this reanalysis come about? Evidently, learners hearing uninflected forms like *micel* and *weter* had no way to tell, without hearing the inflected forms, whether these would inflect as *miceles, weteres,* or as *micles, wetres*. Put another way, learners hearing the uninflected forms could not be sure if the second vowel is underlying or epenthetic. One might suppose that exposure to thousands of examples would suffice to settle the matter, but evidently this was not the case. As Lahiri & Dresher (1983–84) argue, learners do not always take advantage of the full array of data that may be available to them. In this case, it appears that where the uninflected form was ambiguous, learners erred in favour of monosyllabic forms of type (c).

But why didn't the same reanalysis affect the forms in (b), with short diphthongs? If forms like *steaðul* and *heofen* had been reanalyzed to have underlying diphthongs, their status would be the same as the words in (a), and their immunity to reanalysis would be mysterious. Dresher (1985) argues rather that short diphthongs are not underlying in the

Ps(A) dialect: every occurrence of a short diphthong can be attributed to a synchronic rule accessible to language learners. It follows, then, that the presence of the short diphthongs in words of type (b) serve as evidence to learners that the second vowel is underlying: in these words, there is no other source for the diphthong.

Therefore, this analysis explains why the forms in (b) were not reanalyzed like the forms in (a). Note that the synchronic analysis proposed in Dresher (1985) does not simply recapitulate the diachronic sequence in (17): some reanalysis has occurred. The second vowel *yfel* is reanalyzed as epenthetic, despite the presence of the front rounded vowel *y*. I have argued that, though a rule of *i*-Mutation persists in the *Ps(A)* dialect, not all cases of *y* can be derived, the rule in some cases having become too opaque to recover. Therefore, /y/ is an underlying phoneme in this dialect, and its presence is not sufficient to show that a following vowel is underlying.[12]

The sort of merger that occurred in Mercian did not happen only once. Moving a few hundred years forward, we have documentary records of the descendant of the Mercian dialect, called the Middle English AB dialect by Tolkien (1929). At some point the short diphthongs merged back with monophthongs. We expect, then, that the descendants of the forms we have been looking at would look as in (19): the old diphthongs (a) should have trisyllabic inflected forms, and the old monophthongs would have disyllabic inflected forms (b).

(19) Reconstructed early Middle English (Old AB dialect)

a.	stæðel	stæðeles	heofen	heofenes
b.	weter	wetres	muchel	muchle

[12] See Kiparsky (this volume) on the role of *i*-Mutation in the creation of new phonemes.

Again, this is not what we find. The two classes, now lacking any further distinguishing elements to keep them apart, again merge, this time in the other direction: the second vowel is restored, even to words that never had one, as shown in (20).

(20) Middle English (AB dialect)

a.	heouene D S	'heaven'	cf. *Ps(A)* heofene
b.	fuheles P	'birds'	cf. *Ps(A)* fuglas
c.	muchel, muchele	'much'	cf. *Ps(A)* micel, micle
d.	water, watere	'water'	cf. *Ps(A)* weter, wetre

It is hard to see how one can account for these developments without a synchronic grammar similar to the one I have argued for. In this case, the diachronic changes give us evidence bearing on the choice of synchronic grammar, and illuminate the sort of principles language learners use to acquire grammars. In turn, the diachronic changes cannot be properly understood in the absence of a synchronic analysis.

6. *Change and learnability*

The above example reveals the close connection between language change and learnability (see Foulkes & Vihman, this volume). Children are not directly given the grammars of their parents; rather, they must recreate the grammar given input from the ambient language. If the language children hear is exactly the same as the one their parents heard when they were children, we would expect the children's grammar to be essentially the same as that of their parents. But more usually the language children hear is somewhat different from the one their parents heard. Even without assuming dramatic changes, languages are constantly changing in minor ways, such as, for example, a

change in the proportion of certain words or phrases compared to others. In many cases such minor variances do not cause fundamental differences in the grammar acquired, but in some cases the differences may be enough to cause language learners to come to different conclusions about the grammar than their parents, causing a change in the grammar that may itself trigger further changes.

Therefore, without claiming that all language change originates in acquisition, it appears inescapable that certain types of changes do. In this section I consider a case where a simple sound change appears to have made the grammar unrecoverable to learners. The result was a fundamental change in lexical representations and the loss of quantity alternations in Present Day English singular ~ plural pairs. Thus, if the phonology had been learnable, the vowel alternation in *staff ~ staves* would have been the regular pattern for many English nouns.[13]

In traditional accounts, which I basically follow, with a few elaborations, Middle English had a rule of Open Syllable Lengthening (OSL), which lengthened stressed vowels in open syllables (21) (Prokosch 1939: 140); Luick 1964).[14] It interacted with Trisyllabic Shortening (TSS), which shortened a stressed vowel when followed by two unstressed syllables (22) (Wright & Wright 1925; Lahiri & Fikkert 1999).

(21) Open Syllable Lengthening (OSL)

A short stressed vowel in an open syllable must be long.

(22) Trisyllabic Shortening (TSS)

A long stressed vowel followed by two unstressed syllables must be short.

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[13] This section is based on work with Aditi Lahiri, particularly Lahiri & Dresher (1999).

[14] See Scheer (this volume) on open syllable lengthening in various languages.

As has long been observed, and as underlined particularly by Minkova (1982), there is considerable variation in the Present Day English length of vowels that should have undergone these rules. Thus, looking only at disyllabic stems, we find outcomes as in (23). The length of the vowel in Old English does not predict the length in Present Day English.

(23) Old English and Present Day English vowel lengths

	OE	*Length*	*PDE*	*Length*
a.	sadol	short	saddle	short
b.	cradol	short	cradle	long
c.	beofor	short	beaver	long
d.	dēofol	long	devil	short
e.	bēacen	long	beacon	long

Minkova (1982) observes that the only class of nouns in which Open Syllable Lengthening appears to have taken place reliably is in nouns which had once ended in schwa, such as *talə* 'tale'. The coincidence of lengthening with the loss of schwa led her to propose that lengthening was due not to Open Syllable Lengthening, but to Compensatory Lengthening.[15] However, this does not account for the fact that lengthening occurred in many disyllabic nouns which did not lose a schwa, as in (23b, c).

Ritt (1994; 2004) proposes that lengthening occurred in probabilistic fashion, subject to influences as in (24).

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[15] Versions of this account have since been presented by Lass (1985), Minkova (1985), Hayes (1989), Kim (1993), and Bermúdez-Otero (1998).

(24) Probabilistic vowel lengthening (Ritt 1994)

The probability of vowel lengthening was proportional to a. the (degree of) stress on it; b. its backness; c. coda sonority;

and inversely proportional to a. its height; b. syllable weight; c. the overall weight of the weak syllables in the foot.

The probability of vowel shortening is inversely proportional to the probability of lengthening.

The problem with this sort of analysis is that it does not take account of one simple yet inescapable fact about English singular ~ plural noun pairs: with the exception of *staff ~ staves*, and some irregular nouns like *child ~ children*, English nouns do not exhibit any length alternations between singular and plural. This despite the fact that many such nouns would have been expected to show such an alternation, because in Old and Middle English plurals typically had one more syllable than their corresponding singular. Thus, according to traditional accounts, the expected outcomes for some common noun classes should have been as in (25).

(25) Predicted effects of OSL and TSS on Old English noun classes

		Stem	*OE*	*Rule*	*Expected*	*Gloss*
a.	N S	open σ	talu	OSL	ta:lu	‘tale’
	N P	open σ	tala	OSL	ta:la	‘tales’
b.	N S	closed σ	hwæl	—	hwæl	‘whale’
	N P	open σ	hwalas	OSL	hwa:las	‘whales’
c.	N S	open 2 σ	beofor	OSL	be:ofor	‘beaver’
	N P	open 3 σ	beoferas	TSS	beoferas	‘beavers’

d.	N S	open 2 σ	dēofol	OSL	deːofol	‘devil’
	N P	open 3 σ	dēofelas	TSS	deofelas	‘devils’

In the forms in (25a) the stressed short vowel occurred consistently in an open syllable: nouns in this class indeed consistently appear in PDE with long vowels, as Minkova (1982) observes. Every other class is expected to have had a length alternation: not only is this not the regular case, it does not happen at all! Therefore, it is futile to consider only whether a short vowel or a long vowel is better adapted for, say, the context of *god* ‘god N S’: one must also consider the environment of the vowel in *godes* ‘god G S’, in which the preferences come out differently. Similarly for *bever* and *beveres* and *dēofol* and *dēofelas*. No matter how much one context may favour a short vowel and the other one a long vowel, the fact is that we are going to get only one answer for each pair.

Why did this happen? The unstressed inflected vowels in (25) became schwas which were subsequently deleted. Lahiri & Dresher (1999: 698) propose that the loss of schwas in the inflected forms created a hopelessly opaque alternation pattern, as shown in (26).

(26) Expected singular-plural pairs in Middle English

a. Before loss of schwa

Singular	Plural
stōn	stōnes
bōdi	bodies
god	gōdes
bēver	beveres

b. After loss of vowel

Singular	Plural
stōn	stōns
bōdi	bodis
god	gōds
bēver	bevers

What was a well-behaved and perfectly ordinary length alternation before the loss of the inflectional schwa becomes chaotic and mysterious after: sometimes the addition of plural /s/ leaves the vowel length unchanged; other times it shortens a long vowel; still other times it lengthens a short vowel. In this type of unrecoverable opacity, we expect some sort of major breakdown of the system, which is exactly what we get. Evidently, learners could not make sense of these alternations and gave them up completely. Where all forms of a morpheme had a consistently long or short vowel, that is the vowel that remained. Where there was variation, it appears from the word counts that learners picked one or the other with almost equal odds. It is hard to see any other explanation of the total destruction of what had been a pervasive set of alternations. A further benefit of this account is that we have no reason to suppose that the phonological processes that caused the lengthenings and shortenings were themselves variable or had a statistical character. Variability entered the picture after the breakdown of the old grammar.

Once again, this account crucially relies on a certain model of how language learners react to the language data they are exposed to. It would not have been beyond the cognitive powers of late Middle English speakers to simply commit to memory the pattern of short and long vowels bequeathed to them by the previous generations, no matter how opaque. If synchronic grammars are simply the result of the operation of historical evolutionary processes, then why didn't Middle English speakers simply live with these alternations? We could say it was because they were maladaptive, not user-friendly, evolutionary dead ends, or a dysfunctional meme-complex. But if we ask why this is so, we must find the answers not in history, but in Universal Grammar.

7. *Change and contrast*

In this section I consider ways that generative grammar can incorporate notions of contrast into phonological change. I deviate somewhat from an 'orthodox' interpretation of generative phonology, because Chomsky and Halle (1968) did not assign a special status to contrastive features as opposed to redundant ones. However, once one makes this distinction it follows naturally that the effects of contrast should turn up in change. Indeed, the insight that phonological change may involve a reorganization of the contrasts of a language goes back to Jakobson (1931), who wrote: 'Once a phonological change has taken place, the following questions must be asked: What exactly has been modified within the phonological system?... has the structure of individual oppositions [i.e., contrasts/BED] been transformed? Or in other words, has the place of a specific opposition been changed…?' In this section I propose an answer to Jakobson's questions in a generative grammar that assigns a special role to contrastive features.

In some sense, contrast is inherent in a phonemic analysis, as exemplified in section 3. Recall that Hogg (1992: 61) proposes that, in the West Germanic dialects from which Old English developed, '*/æ:/ is the only low long vowel and there is no front/back contrast in operation. From the structural point of view, therefore, the vowel as it develops in WGmc may be considered to be neutral in this last respect, that is, */a:/.' In terms of distinctive features, this suggests that */a:/ (and its corresponding short low vowel, */a/) should not be specified as being either [+back] or [–back].

This kind of contrastive underspecification was not incorporated into the theory of Chomsky & Halle (1968), though it was prominent in earlier theories of phonology. To translate Hogg's insight into an explicit theory, we can borrow an idea from Jakobson

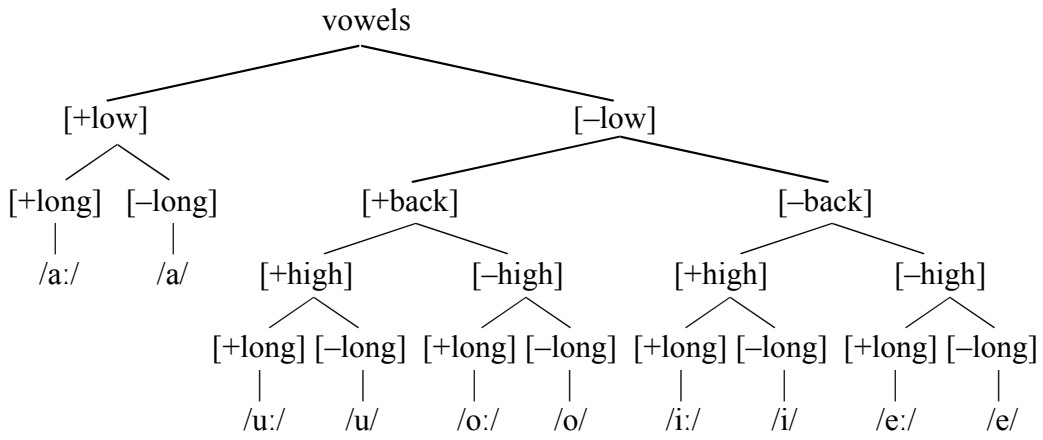
and his collaborators (Jakobson, Fant & Halle 1952, Jakobson & Halle 1956), namely: contrastive specifications are assigned by ordering the features into a contrastive hierarchy (Dresher 2009; Purnell & Raimy, this volume), and dividing the inventory by each successive feature in turn until all phonemes have been uniquely distinguished. On the assumption that active features are contrastive (the Contrastivist Hypothesis, Hall 2007), phonological activity can serve as a heuristic to ordering the features.

One way of ordering the features so that the low vowels have no specification for the front/back dimension is proposed by Purnell & Raimy (this volume). For the features used in section 4, their hierarchy would look as in (27), where the ordering of the features is [low] > [back] > [high] > [long].[16] In addition to the low vowels lacking any contrastive features beyond [low] and [long], the feature [round] does not appear at all in this hierarchy, even though the non-low back vowels are phonetically round; rather, the contrast between the non-low vowels is made by the feature [back] (or possibly [front], as in their account). Purnell & Raimy observe that the omission of [round] is supported by Lass's (1994) observation that rounding is non-distinctive in West Germanic. The fact that the non-low back vowels are nevertheless phonetically round can be attributed to phonetic enhancement (Stevens, Keyser & Kawasaki 1986; Stevens & Keyser 1989):

[16] The tree in (27) differs from Purnell & Raimy's in several respects. I omit their dimensions and list only terminal features. With respect to the latter, I use [low] instead of [RTR], and [back] instead of [front], and I include a length feature in the tree for completeness. Also, I assume binary features rather than privative ones, though there may well be markedness asymmetries between the positive and negative values.

rounding a non-low back vowel enhances its backness and makes the contrast more salient.[17]

(27) Contrastive hierarchy for West Germanic vowels



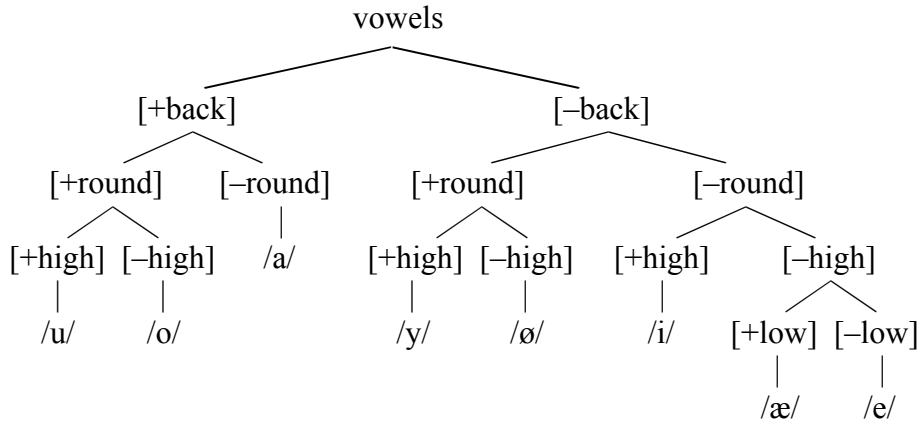
The contrastive specifications in (27) account for phonological generalizations about West Germanic that would be missed by a theory that requires that every phoneme be specified for every distinctive feature that might apply. As West Germanic evolved into Old English, the grammar changed not just in the rules and underlying representations, but also in the system of contrastive specifications. Even phonemes that do not appear to change overtly may come to have different contrastive features.

In Old English a new contrast developed between front /æ(:)/ and back /a(:)/, and, as Purnell & Raimy observe, rounding became phonologically active, hence, by hypothesis, contrastive, as shown by the development of new phonemes /y/ and /ø/ from the *i*-Mutation of /u/ and /o/, respectively. A possible contrastive feature hierarchy for

[17] See Hall 2011 for a lucid discussion of how enhancement operates on contrastive feature specifications.

Old English is shown in (28), where the features are ordered [back] > [round] > [high] > [low] > [long] (the contrast between long and short vowels is not shown).[18]

(28) Contrastive hierarchy for Old English vowels



In phonetic terms, the vowels /a/, /u/, /o/, /e/, and /i/ do not appear to change from West Germanic to Old English; however, the representation of each of these vowels has changed, some significantly. These changes in representation correspond to different patterns of phonological activity.

As with every other aspect of the grammar, it is an empirical question whether the feature hierarchy in (28) is correct, in the sense that the assigned feature specifications correspond to observed phonological activity, and sort vowels into the required classes. Though we cannot pursue this analysis here (but see Purnell & Raimy, this volume), there is mounting evidence that contrast shift is an important type of phonological change.[19]

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[18] The main difference between this feature hierarchy and Purnell & Raimy's, beside those already noted, is that [back] is ordered ahead of [round]. Evidence for this ordering is provided by Mercian Back Mutation, which requires /a/ to be contrastively [+back] (or [–front]).

[19] Other analyses that exploit the contrastive hierarchy in accounting for diachronic change include: Zhang (1996) and Dresher and Zhang (2005) on Manchu; Barrie (2003) on Cantonese; Rohany Rahbar (2008) on

8. *Conclusion*

This chapter has sketched how rule-based generative phonology accounts for various types of phonological change. It has also argued for the continuing relevance of a number of fundamental principles. First, it is basic to the generative approach that phonological change, though visible in surface forms, is the result of a change in the grammars of speakers. The relationship between an observed change and the associated changes in grammar is not obvious, however: similar-looking changes may have different consequences for the grammar.

Second, the above analyses support the idea that some typical changes in grammar originate in the course of acquisition, when learners arrive at grammars that are different from that of their parents due to differences in the input data from that which shaped the grammar of their parents. This is not to say that all changes result from acquisition, but an important class of changes do.

It follows that considerations of learnability are central to diachrony as well as to acquisition. Some changes leave lexical representations and previous rules relatively undisturbed, in the sense that they are still learnable by speakers acquiring the new grammar. Other changes, however, make previous representations or rules of grammar

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Persian; Dresher (2009: 215–225) on East Slavic; Compton & Dresher (2011) on Inuit; Gardner (2012), Roeder & Gardner (2012), and Purnell & Raimy (2013) on North American English vowel shifts; and large-scale studies by Harvey (2012) on Ob-Ugric (Khanty and Mansi), Ko (2010, 2011, 2012) on Korean, Mongolic, and Tungusic, and Oxford (2012a, b) on Algonquian.

difficult or impossible to learn, with sometimes far-reaching consequences to the grammar.

Central to the approach taken here is the notion that synchronic patterns and principles of learnability (aka Universal Grammar) influence the types of changes that language can undergo, and not the other way around; that is, it is not the case that there are universals of change that cause synchronic grammars to be the way they are. To the extent that there are diachronic universals, their source must be sought in properties of learners.

Finally, departing somewhat from classical generative grammar, but incorporating earlier Prague School ideas, I assume that considerations of contrast are important in accounting for synchronic patterns, because only contrastive features can trigger phonological processes. It follows that contrastive features will also affect the outcome of diachronic change, and that contrast may itself be the target of some diachronic changes, in that contrasts may be lost or gained, or old contrasts may be reinterpreted.

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