

Chapter 7

On the Learnability of Abstract Phonology

Bezalel Elan Dresher

The question of learnability is central to linguistic theory, and much work in phonology since Chomsky and Halle's *Sound Pattern of English* (1968) has, quite appropriately, been motivated by a concern with how the rather complex phonological systems proposed there could be acquired. Various constraints on phonological theory have been proposed with the aim of ruling out grammars deemed to be difficult or impossible to learn. On the negative side, this concern with learnability has for the most part been misdirected, for it has been guided by an a prioristic view of the nature of the language faculty. Clearly, any consideration of learnability must take into account what is actually learned—if there is evidence that knowledge of a certain type is attained, it follows that such knowledge must be attainable. Just as obviously, arguments from learnability must be backed up by an empirically supported theory of learnability if they are to have any force. Frequently, however, these two basic prerequisites are not met; rather, language acquisition is taken to conform to some plausible principle, as an axiom, and then constraints are placed on phonological representations to insure conformity with the principle.

In particular, it has been a common assumption of many discussions of learnability in phonology that abstract underlying forms of the *Sound Pattern of English* type are difficult, perhaps impossible to learn.¹ I will argue that in certain cases the abstract analysis is the easiest analysis to learn, given certain assumptions about the acquisition device. I will explore this question with respect to a portion of the phonology of Old English. First, though, I would like to consider the problem on a smaller scale. Although many theories have been considered to posit unlearnable representations, very few analyses in the literature can safely be said to be unlearnable in any obvious way. One such example

Bezalel Elan Dresher

is provided by S
serve to illustrate

Learnable and Un

Saporta (1965) d
dialects, represer

(1)

Spanish Dialects:

Castilian	La
lúnes	lún
lúnes	lún
lápiθ	láp
lápiθes	láp

In the most consi
ing -s after unstre
followed by s, ar

(2)

Spanish Plural R

$$\text{pl} \rightarrow \begin{cases} s / \left[\begin{array}{c} \check{V} \\ \acute{e} \end{array} \right] - \\ \emptyset / \check{V}s - \\ es / \end{cases}$$

A sample gramm

(3)

Castilian:
Underlying
Plural (2)
Surface

This analysis is c
poses no special

In Latin Ame
came s. Now la
which otherwise
plural rule (2) an
rule of Absolute

is provided by Saporta (1965); consideration of his proposals might serve to illustrate some of the points I will be pursuing in more detail.

Learnable and Unlearnable Phonologies

Saporta (1965) discusses singular and plural forms in three Spanish dialects, represented in (1).

(1)

Spanish Dialects:

Castilian	Latin American	South Chile	
lúnes	lúnes	lúnes	'Monday'
lúnes	lúnes	lúnes	'Mondays'
lápiθ	lápís	lápís	'pencil'
lápiθes	lápises	lápís	'pencils'

In the most conservative dialect, Castilian, plurals are formed by adding *-s* after unstressed vowels and stressed *é*, \emptyset after unstressed vowels followed by *s*, and *-es* elsewhere; Saporta formulates the rule as (2).

(2)

Spanish Plural Rule:

$$pl \rightarrow \begin{cases} s / \left\{ \begin{array}{l} \check{V} \\ \acute{e} \end{array} \right\} \text{ —} \\ \emptyset / \check{V}s \text{ —} \\ es / \text{ —} \end{cases}$$

A sample grammar for the Castilian forms is given in (3).

(3)

Castilian:

Underlying	/lúnes + pl/	/lápiθ + pl/
Plural (2)	lúnes + \emptyset	lápiθ + es
Surface	lúnes	lápiθes

This analysis is quite straightforward and, given standard assumptions, poses no special learning difficulties.

In Latin American Spanish a change took place whereby all θ became *s*. Now *lápises* looks like an exception to the old plural rule, which otherwise operates as before. Saporta proposes to keep the plural rule (2) and underlying / θ / in words like *lápiθ* and to add another rule of Absolute Neutralization, as in (4).

(4)

Absolute Neutralization (AN):

 $\theta \rightarrow s$

Sample derivations are given in (5):

(5)

Latin American:

Underlying	/lúnes+pl/	/lápiθ+pl/
Plural (2)	lúnes+∅	lápiθ+es
AN (4)	—	lápís+es
Surface	lúnes	lápises

In this case, the question of learnability is not so straightforward. But before discussing this example further let us consider the South Chile dialect. In this dialect, which represents a more innovative stage of Latin American, it appears that the old plural rule (2) is still working as before, with *lápís* now acting as a regular word that ends in *s*. One might suppose, then, that words such as *lápís* have been restructured in this dialect, yielding the grammar of (6a).

(6)

a. South Chile:

Underlying	/lúnes+pl/	/lápís+pl/
Plural (2)	lúnes+∅	lápís+∅
Surface	lúnes	lápís

Although Saporta considers this solution, he proposes instead to keep underlying /θ/ in *lápís* and to reorder the rules of Plural (2) and Absolute Neutralization (4), as in (6b).

(6)

b. South Chile:

Underlying	/lúnes+pl/	/lápiθ+pl/
AN (4)	—	lápís+pl
Plural (2)	lúnes+∅	lápís+∅
Surface	lúnes	lápís

Saporta argues that (6b) is to be preferred over (6a) because there is independent evidence for underlying /θ/ in other words in this dialect, and because representing *lápís* with underlying /s/ would obscure the relation between this dialect and closely related dialects.

From the point of view of learnability, however, these considerations are irrelevant. For even though other forms in this dialect can be shown

to have underlying /θ/, one must come to know the surface form. Since the surface form is the same in all relevant respects, the two dialects could be distinguished only by the requisite knowledge of the underlying form; as there is no way to capture this information in the grammar of (6b), the grammar of (6a) is preferred. In this instance the two dialects share the same surface form.

Having seen the problem, we return to Saporta's proposal. Whether it requires a reordering of the rules in the dialect there is no problem with *lápís*, so speaking in the grammar of (6a) is captured in the grammar of (6b). This fact is not a problem for the Chile situation.

Two separate arguments are in favor of abstracting the plural rule to construct a theory of learnability. These arguments are obvious ways of capturing the phonologies, and it can be shown that the theory does not expect to capture the surface form—whenever the learnability condition is a riding role.²

For example, in Latin American Spanish she contends that we find that structural descriptions of the American Spanish dialects support this assertion. The entire SD exists

to have underlying /θ/ and even though other dialects may have it in this form, one must ask how a child learning South Chilean Spanish could come to know that *lápiz* ends in /θ/ but *línes* ends in /s/ in underlying form. Since the two words presumably behave identically in all relevant respects, someone ignorant of the history of Spanish or of distant dialects could have no way of distinguishing the two cases. Further, the requisite knowledge could hardly be innate, given standard assumptions; as there is now no possible source for the acquisition of the grammar of (6b), one can conclude that it is unlearnable. Moreover, in this instance there exists a much simpler analysis (6a), which generates the same forms without requiring special assumptions.

Having seen an example of a genuinely unlearnable phonology, let us return to Saporta's analysis of the Latin American dialect (5), and ask whether it requires similar untenable assumptions. Notice that in this dialect there is a difference in outward patterning between *línes* and *lápiz*, so speakers must make some distinction in their representations in the grammar. Although it does not follow that the distinction is captured in the way Saporta proposes as opposed to some other way, this fact is enough to distinguish this case rather sharply from the South Chile situation.

Two separate questions arise: First, can evidence be produced in favor of abstract phonologies like (5)? Second, is it possible to construct a theory that could account for the acquisition of such phonologies? These are two separate issues, although they are related in obvious ways. Thus, if evidence can be provided in support of such phonologies, it follows that it must be possible to acquire them. Or if it can be shown that certain phonologies cannot be acquired, one would not expect to find any good evidence for them. Much of the abstractness controversy has been overtly concerned with the first question—whether there is evidence in favor of abstract grammars—but learnability considerations have played an important, sometimes overriding role.²

For example, Hooper (1976, p. 13) claims that Saporta's analysis of Latin American is not learnable. With respect to rules containing /θ/ she contends that "looking at the rule from the speaker's point of view, we find that such a rule would be impossible to learn because part of its structural description (SD) does not exist on the surface in Latin American Spanish." But no empirical finding is presented to support this assertion. The assumption that a rule cannot be learned unless its entire SD exists on the surface indeed has the effect of ruling out

Saporta's analysis; but it is possible to make other, quite minimal, assumptions that lead to different results.

Suppose, for example, we assume the following:

(7)

- i. Segments are analyzed as complexes of features.
- ii. A learner adopts the most highly valued rules (i.e., rules requiring the fewest features) consistent with, and sometimes even overriding, the available data.³
- iii. Rules formulated in terms of phonetic feature specifications are preferred to rules containing nonphonetic features.

Now we observe that words ending in *s* are of two types—one type forms its plural in $-\emptyset$, the other in *-es*, like words that end in other consonants. In terms of features, *s* is distinguished from other Spanish consonants by the features [+strident, +coronal]; the *s* in *lápiz*, however, acts as if it were not so specified. The smallest change that can be made in the feature specification of *s* to bring it in line with its behavior in pluralization is to change the value of [strident], keeping all else constant. This nonstrident *s* is just \emptyset . Now a rule of $\emptyset \rightarrow s$ is needed to derive the surface forms. A more concrete alternative such as simply marking words like *lápiz* as exceptions to the regular plural rule would be less highly valued, by (7.iii), and so rejected. Abstract alternatives, involving other possible underlying segments, would also be less highly valued, by assumption (7.ii), because the required rules would utilize more features.

It should be emphasized that none of this is offered as support for Saporta's analysis; more evidence is needed to decide that. Rather, this discussion is concerned with the issue of learnability and is intended to demonstrate that it is not difficult to construct a model of acquisition that leads to the acquisition of abstract segments and rules. Moreover, this model rests on assumptions that are fairly well supported on independent grounds. Hardly anyone would deny (7.i); (7.ii) and (7.iii) remain standard assumptions and often are implicit in the work even of those who explicitly deny them—which is not surprising, inasmuch as no cogent alternatives have been presented, to my knowledge.

In what follows I will explore how the principles in (7), supplemented by some others, could lead to the acquisition of a fairly abstract phonology of Old English. I will argue that such a phonology not only can be acquired, given (7), but will be preferred to more concrete alternatives; further, I will argue that a learner would be able to converge on

Bezalel Elan I

these rules s
present some

Hidden *i* in (

Many genera
an underlying
morphologic
surface.⁴ For
of the Class
however, is
evident from
gehēran 'heā

(8)

Class I Weal
Infin.

Indic.

1sing.

2sing.

3sing.

pl.

Subj.

sing.

pl.

Imper.

sing.

pl.

Part.

Evidence
mediately of
lowing princ
underlying /
surface.

The first b
find *freme* b
between the
forms of *hēi*
follows a lig

these rules starting from different parts of the grammar. I will then present some historical evidence that supports the analysis.

Hidden *i* in Old English

Many generative analyses of Old English have posited the existence of an underlying /i/ that plays an important role in the phonological and morphological system, even though this /i/ never appears as such on the surface.⁴ For example, it can be argued that the underlying morphology of the Class I Weak verbs is /stem+i+inflection/. The *i*-extension, however, is never observed in the surface forms of these verbs, as is evident from the sample paradigms of *ġefremman* 'complete' and *ġehēran* 'hear,' given in (8).

(8)

Class I Weak Verbs:

	-fremman		-hēran	
Infīn.	Present	Preterite	Present	Preterite
Indic.				
1sing.	fremmu	fremede	hēru	hērde
2sing.	fremes	fremedes	hēres	hērdes
3sing.	fremeð	fremede	hēreð	hērdes
pl.	fremmað	fremedun	hērað	hērdun
Subj.				
sing.	fremme	fremede	hēre	hērde
pl.	fremmen	fremeden	hēren	hērden
Imper.				
sing.	freme		hēr	
pl.	fremmað		hērað	
Part.	fremmende	fremed	hērende	hēred

Evidence for the underlying *i*-extension exists, though it is not immediately obvious from these forms. However, a language learner following principles (7.i)–(7.iii) would be led rather quickly to posit an underlying /i/ in these forms, even though it does not occur on the surface.

The first bit of evidence involves the imperative singulars, where we find *freme* but *hēr*. Similarly, the preterite forms of *fremman* have an *e* between the stem and the preterite formative *-d-* whereas the preterite forms of *hēran* do not, except in the form *hēred*.⁵ The pattern: an *e* follows a light stem, but not syllable-finally after a heavy stem. One

might conclude that the stem extension was not *i* but *e*, and that this *e* is deleted by a rule that operates in the environment: heavy syllable ____ (CVX)#. Yet, there is much evidence from other forms that *e* does not in general delete in this environment—cf. *worde* in (9). Therefore, either the *e*'s that delete have to be specially marked—a possible though not highly valued solution—or the deleting *e* has a different underlying origin from the nondeleting *e*. As a solution of this nature would lead to a more highly valued grammar than one in which a morphological or arbitrary specification was placed on certain *e*'s, I assume that a language learner would pursue it.

The number of possible solutions of this type is large but, even at this point, partially ordered by the evaluation measure. Thus, since a rule changing one feature is more highly valued than a rule changing two features, the first set of candidates for a segment that becomes *e* would consist of those segments that differ from *e* by only one feature—e.g., *æ*, *i*, *o*, *ê*. I assume, then, that a language learner would consider these possibilities as favored. Next would come segments that differ from *e* by two features, then by three, and so on, down to the exceedingly unlikely candidates, such as *k* and *t*. So while it is no doubt an error to think of a child as diligently and systematically going about testing these various segments in order, the evaluation measure can be thought of as creating a structured solution space that predisposes the learner toward certain hypotheses.

To sum up the problem to here, I have arrived at the following hypotheses:

Hypothesis 1:

The stem extension in the Weak Class I verbs deletes in the environment: heavy syllable ____ (CVX)#.

Hypothesis 2:

This stem extension is a segment that is as close to *e* (not excluding *e* itself) in terms of features as possible.

Consider now the neuter *a*-nouns *scîp* 'ship' and *word* 'word':⁶

(9)

Neuter *a*-Nouns:

	Singular	Plural	Singular	Plural
Nom.	scîp	scîpu	word	word
Acc.	scîp	scîpu	word	word
Gen.	scîpes	scîpa	wordes	worda
Dat.	scîpe	scîpum	worde	wordum

The two nouns
cusative plural
cates a rule de
applies more g
the singulars c

(10)

Disyllabic Ne

Nom.	hê:
Acc.	hê:
Gen.	hê:
Dat.	hê:

These facts ce

(11)

u-Deletion:

[+syll	→ ∅
+high	
+back	

Rule (11), tho
little use to a l
No rule chang
and as we hav
generally dro
tion of the rul

Rule (11), h
be devised, g
target of the r
delete; but th
rule (12) will :

(12)

High Vowel I

[+syll	→ ∅
+high	

Since rule (C
valued rule, b
sis, a languag

The two nouns decline identically except in the nominative and accusative plurals, where we find *scīpu* next to *word*. This pattern indicates a rule deleting *u* word-finally after a heavy stem. That this rule applies more generally, at the end of syllables, is shown by comparing the singulars of the neuter *a*-nouns *hēafud* 'head' and *weorud* 'troop':

(10)

Disyllabic Neuter *a*-Nouns:

Singular

Nom.	<i>hēafud</i>	<i>weorud</i>
Acc.	<i>hēafud</i>	<i>weorud</i>
Gen.	<i>hēafdes</i>	<i>weorudes</i>
Dat.	<i>hēafde</i>	<i>weorude</i>

These facts can be described by a rule such as (11).

(11)

u-Deletion:

$$\left[\begin{array}{l} +\text{syll} \\ +\text{high} \\ +\text{back} \end{array} \right] \rightarrow \emptyset / \text{Heavy syllable ____ (CVX)\#}$$

Rule (11), though operating in the familiar environment, would be of little use to a language learner with respect to the Class I Weak verbs. No rule changing *u* to *e* can be formulated on the basis of these facts, and as we have already noted, *worde*, *hēre*, etc., show that *e* does not generally drop in the environment of (11), precluding any generalization of the rule to *e*.

Rule (11), however, is not the most general rule of deletion that can be devised, given the data to here. The specification [+high] in the target of the rule cannot be deleted, because the *a* of *worda* does not delete; but the specification [+back] has not been needed yet. Thus, rule (12) will account for the same data as rule (11).

(12)

High Vowel Deletion (HVD):

$$\left[\begin{array}{l} +\text{syll} \\ +\text{high} \end{array} \right] \rightarrow \emptyset / \text{Heavy syllable ____ (CVX)\#}$$

Since rule (12) has fewer features than rule (11), it is a more highly valued rule, by the hypothesized evaluation measure. So, by hypothesis, a language learner would posit rule (12) rather than rule (11) in the

interest of arriving at the most highly valued grammar. Now, rule (12), considered in the light of Hypothesis 1, yields Hypothesis 3.

Hypothesis 3:

The Weak Class I stem extension is a high vowel.

As the high vowel that is closest to *e* is *i*, Hypothesis 2 together with Hypothesis 3 yields:

Hypothesis 4:

The Weak Class I stem extension is *i*.

Hypothesis 4 entails the existence of a rule that lowers *i* to *e* in certain environments. Is there any other evidence for such a rule? Again, there is, albeit not in the form of a surface alternation between *i* and *e*.

Consider the paradigms of the masculine nouns *bearu* 'grove' and *here* 'army':

(13)

Masculine Nouns with Stem-final Glides:

	Singular	Plural	Singular	Plural
Nom.	bearu	here	bearwas	hergas
Acc.	bearu	here	bearwas	hergas
Gen.	bearwes	herges	bearwa	herga
Dat.	bearwe	herge	bearwum	hergum

There is an asymmetry between the *u* ~ *w* alternation in *bearu* and the *e* ~ *g* alternation in *here*; for supposed underlying stems /bearw-/, /herg-/, the most straightforward vocalization rule would be (14).

(14)

Vocalization:

[−cons] → [+syll] / . . . — #

Although (14) would correctly convert /bearw/ to *bearu*, it would change /herg/ to *heri*, not *here*. These data lend support to the positing of a rule lowering *i* to *e*, for only by positing such a rule can a general vocalization rule be maintained.

Sample derivations are given in (15).

(15)

Sample Derivations:

	/frem+i/	/hēr+i/	/herg/	/word+u/
Underlying	—	—	heri	—
Vocaliz. (14)	—	—	heri	—
HVD (12)	—	hēr	—	word
<i>i</i> -Lowering	frem+e	—	here	—
Surface	freme	hēr	here	word

Further Evidence

I have argued that it will be led, on the underlying *i*-extension starting from an principle, one w

The principle principle (7.iii), feature specific features. This co that all aspects the phonology. 55 ff.) has called lying systematic tions are organi of some other s Fudge (1967), a of Natural Phon nness condition, netically natura phonological rej ers attempting t

For example, rules involve th ment, that is, a

(16)

Basic Template

$$\begin{bmatrix} a_1F_1 \\ a_2F_2 \\ \vdots \\ a_nF_n \end{bmatrix} \rightarrow [a_j]$$

One can imagin theory. Any su refinement of (of F_j , as well e form of the pri

Further Evidence for Hidden *i*

I have argued that a language learner guided by principles (7.i)–(7.iii) will be led, on the basis of relatively few forms, to the positing of an underlying *i*-extension in the Class I Weak verbs. I will now show that starting from an entirely different set of forms and following a further principle, one would arrive at exactly the same analysis.

The principle involved is not entirely new, but is an extension of principle (7.iii), which states that rules formulated in terms of phonetic feature specifications are preferred to rules containing nonphonetic features. This condition can be stated in a more general form, to require that all aspects of phonetic organization be highly valued throughout the phonology. This property follows from what Postal (1968, pp. 55 ff.) has called the Naturalness condition, the hypothesis that underlying systematic phonemic (often called morphophonemic) representations are organized in terms of phonetic principles rather than in terms of some other set of principles, as held for example by Lamb (1966), Fudge (1967), and Foley (1977), as well as advocates of most versions of Natural Phonology. In the generalized interpretation of the Naturalness condition, rules that are highly valued at the phonetic level (phonetically natural rules) will also be highly valued at other levels of phonological representation and so will be preferred by language learners attempting to construct highly valued grammars.

For example, it is true in general that the most common phonetic rules involve the assimilation of one feature to a feature in its environment, that is, a rule of the form (16).

(16)

Basic Template for Assimilation:

$$\left[\begin{array}{c} a_1F_1 \\ a_2F_2 \\ \vdots \\ a_nF_n \end{array} \right] \rightarrow [a_jF_j] / \begin{array}{l} \text{--- X [a}_j\text{F}_j\text{]} \\ \text{or} \\ \text{[a}_j\text{F}_j\text{] X ---} \end{array}$$

One can imagine several ways of incorporating this statement into the theory. Any such formulation would, moreover, undoubtedly involve a refinement of (16), specifying different values of X for different values of F_j , as well as the effect of contextual features. Whatever the final form of the principle, its incorporation as a principle available to the

language acquisition device has some interesting and surprising consequences, to which I now return.

Consider the present tense paradigm of the Old English verb *eotan* 'eat'.

(17)

Class V Strong Verbs—Present:

	Indic.	Subj.	Imper.	Infin.
1sing.	eotu	ete		eotan
2sing.	ites	ete	et	
3sing.	iteð	ete		
pl.	eotað	eten	eotað	

The stem vowel *e* alternates with *eo* when a back vowel follows. In the 2sing. and 3sing. forms only, the stem vowel appears as *i*. In both cases an *e* follows in the next syllable; but *e* also follows an *e*, as in *ete*, so no surface phonetic generalization about the distribution is immediately apparent.

Given only these data, the theory leads to the following hypotheses: assuming that /e/ becomes *i*, a rule such as (18) can be formulated, where [+R] is a diacritic placed on *e*'s that cause raising:

(18)

Raising:

$$V \rightarrow [+high] / \text{--- } C_0 \underset{[+R]}{e} (= / \text{--- } C_0 \begin{bmatrix} +syll \\ -back \\ -high \\ -low \\ +R \end{bmatrix})$$

An alternative analysis, supposing that /i/ is lowered to *e* except before $\underset{[+R]}{e}$ is not as highly valued because the required rule would be more complex at this stage.

The theory prefers solutions in which rules operate on features specified in terms of phonetic categories over such arbitrary features as [+R] (the Naturalness condition). Can one distinguish between $\underset{[+R]}{e}$ and $\underset{[-R]}{e}$ in purely phonological terms?

(19)

Suppose the language learner wishes to maximize the value of the Raising rule. This could be done by making it conform to a rule of type (16), as in (19):

Bezalel Elan Dre

(19)

Most Highly Va

V → [+high] /

Fitting (18) to (

(20)

Hypothesized I

V → [+high] /

On the basis theory sketched which requires sis in turn calls vert *it + is*, *it + i* on the Class I suffixal *i* and tl

There is mor its preterite by (21), where chi

(21)

Class V Strong Present	Pi
e(o)	e
eotan	et

There is a grou but their prese 'sit,' which has given in (23):

(22)

Class V Strong Present	P
sittan	sc

(19)
Most Highly Valued Raising:

$$V \rightarrow [+high] / \text{---} X \begin{bmatrix} \vdots \\ +high \\ \vdots \end{bmatrix} Y$$

Fitting (18) to (19) produces (20):

(20)
Hypothesized Raising:

$$V \rightarrow [+high] / \text{---} C_0 \begin{bmatrix} +syll \\ -back \\ +high \end{bmatrix} (= / \text{---} C_0 i)$$

On the basis of very little data, a language learner following the theory sketched here would quickly be led in the direction of rule (20), which requires abstract underlying forms /et+is/, /et+ið/; this hypothesis in turn calls for a rule of *i*-Lowering ordered after Raising, to convert *it+is*, *it+ið*, into *ites*, *iteð*. This analysis converges with that based on the Class I weak verbs, which also led to the positing of abstract suffixal *i* and the same rule of *i*-Lowering.

There is more evidence for this analysis. The strong verb *eotan* forms its preterite by changing the stem vowel. The pattern is displayed in (21), where characteristic forms stand for the whole paradigm:

(21)

Class V Strong Verbs—Principal Parts:

Present	Preterite 1	Preterite 2	Participle
e(o)	e	ē	e
eotan	et	ēton	eten

There is a group of verbs which form their preterites according to (21), but their presents look like Weak Class I forms. An example is *sittan* 'sit,' which has the principal parts given in (22); the present forms are given in (23):

(22)

Class V Strong Verbs with Weak Presents:

Present	Preterite 1	Preterite 2	Participle
sittan	set	sēton	seten

(23)

Present Forms of *sittan*:

	Indic.	Subj.	Imper.	Infin.
1sing.	sittu	sitte		sittan
2sing.	sites	sitte	site	
3sing.	siteð	sitte		
pl.	sittað	sitten	sittað	

Note the Imperative singular *site*, as opposed to *et*, suggesting that the present forms of *sittan* are formed by adding an extension that surfaces as *e*. The stem vowel in these forms is *i*; yet, in the other Class V verbs it is *e*. The statement of the rules of Preterite formation would be simpler if all Class V verbs had the same stem vowel. Moreover, the appearance of *i* for *e* is predictable: it occurs before the extension *-e-*, which can be identified with $e_{(+R)}$ — which has been identified as */i/*. In

this way, one again arrives at the conclusion that the Weak Class I stem extension is derived from */i/*.

The assumption that rules of the form (16) are valued highly by language learners supports the present analysis in yet another way, once it is joined with a principle that penalizes certain “unnatural” uses of the alpha-variable notation. The case in question bears on the rule of *i*-Lowering and concerns a rule of vowel epenthesis.

Apparent disyllabic stems such as *weter* ‘water’ and *fugul* ‘bird’ appear as monosyllabic stems in inflected forms: *wetres*, *wetre*, etc., and *fugles*, *fugle*, etc. As there is no general deletion rule in the relevant environment, such forms can be derived from monosyllabic stems */wetr/*, */fugl/* by epenthesis. The epenthesis rule is predictable: it matches the stem vowel in backness, and appears as *u* if back and *e* if front. The Epenthesis rule can be formulated as in (24):

(24)

Epenthesis:

$$\emptyset \rightarrow \begin{bmatrix} +\text{syll} \\ \alpha\text{back} \\ \alpha\text{high} \\ -\text{low} \end{bmatrix} / \begin{bmatrix} +\text{syll} \\ \alpha\text{back} \end{bmatrix} C_0 [-\text{voc}] \text{ — } \begin{bmatrix} -\text{syll} \\ +\text{cons} \\ +\text{son} \end{bmatrix} (\text{CVX})\#$$

There is a difference between the two occurrences of the variable in the specification of the epenthesis rule. In the alpha notation, $[\alpha\text{back}]$ expresses the fact that the backness of the epenthetic vowel matches that of the vowel in its environment, a desirable feature, and

Bezalel Elan D

expected in the backness and way. The asymmetries of the principles. If uses of the alpha variable come more highly valued [+syll, αback .

(25)

i-Lowering:

$$\begin{bmatrix} +\text{syll} \\ -\text{back} \end{bmatrix} \rightarrow [-$$

But (25) is just a special case. Considerations would converge.

External Evidence

I have been arguing that it is possible to construct a grammar of natural language variations. I have been arguing that these *i*'s appear as a result of the action of these highly valued epenthesis rules. This principle in surface form is *it* height. This extension can be viewed as a component of phonology.

I have mentioned in previous discussions of the position of such systems in the case being actually correct and am dealing — th

expected in the light of (16). On the other hand, the correlation between backness and height expressed by [α high] is not significant in the same way. The asymmetry between *e* and *u* does not follow from universal principles. If the theory were made to discriminate between these two uses of the alpha notation, another analysis of epenthesis would become more highly valued—namely, specifying the epenthetic vowel as [+syll, α back, +high], and having a separate rule of *i*-Lowering:

(25)

i-Lowering:

$$\left[\begin{array}{l} +\text{syll} \\ -\text{back} \end{array} \right] \rightarrow [-\text{high}] / \text{ ______ } \\ \text{[-stress]}$$

But (25) is just the rule of *i*-Lowering required by the various other considerations discussed. Thus, a language learner suitably endowed would converge on this rule from different parts of the grammar.

External Evidence for Hidden *i*

I have been arguing that, given certain fairly standard assumptions, it is possible to construct a model of acquisition that leads to the acquisition of a grammar of Old English that contains abstract rules and representations. I have posited underlying *i*'s that never appear at the surface; these *i*'s appear in the rules of *i*-Lowering and *e*-Raising. The interaction of these two rules leads to a surprising consequence of the extended Naturalness condition, according to which assimilation rules are highly valued at every level of the phonology. The result of following this principle in /et+is/ is that once *i*-Lowering has applied, we obtain a surface form *ites*, which manifests a phonetic dissimilation of vowel height. This example illustrates how the Naturalness condition, when viewed as a cognitive principle of phonological organization, can lead to phonologies that are quite abstract and phonetically unnatural.

I have mentioned two separate issues that need to be addressed in discussions of the learnability of abstract phonological systems. The preceding sections were aimed at the second of these issues: namely, whether it is possible to construct a theory that can lead to the acquisition of such systems. It remains to consider the first question: Is there, in the case being examined here, any evidence that my analysis is actually correct? Fortunately the dialect of Old English with which I am dealing—the Mercian dialect—can be traced through several his-

, suggesting that
n extension that
n the other Class
formation would
:l. Moreover, the
he extension -e-,
identified as /i/. In
Weak Class I stem

valued highly by
/et another way,
“unnatural” uses
ears on the rule of

d *fugul* ‘bird’ ap-
, *wetre*, etc., and
le in the relevant
nosyllabic stems
is predictable: it
u if back and *e* if
(24):

CVX)#

of the variable in
e alpha notation,
epenthetic vowel
rable feature, and

torical periods, and the patterns of analogical change that are found do provide evidence for an analysis of the type proposed.⁷

It should be stressed, before embarking on an account of the diachronic developments, that the fact that it was possible to construct an elegant internally consistent analysis, which expresses observed generalizations and which is supported by several independent lines of evidence, all in accord with a set of plausible general principles, is itself *prima facie* evidence for the analysis. Lacking persuasive evidence to the contrary, one would prefer an analysis that best captured observed generalizations, and the burden of proof is on the proponents of "concrete" theories of phonology to construct an analysis without underlying *i*'s that is as well supported synchronically. Of course, it is always possible that the synchronic patterns are somehow misleading: for example, certain generalizations may be only artifacts of historical chance, without significance to phonological theory and, hence, to the language learner.⁸ Again, the usual strategy is to assume that observed patterns in data are significant until it is shown that they are not, especially if they can be accounted for by a theory. But we need not stand only with the synchronic data in this case.

The historical evidence involves developments in the rule of High Vowel Deletion (HVD), rule (12), which deletes a syllable-final high vowel that follows a heavy (H) syllable. In early Old English, HVD operated also in a second environment: when the syllable-final high vowel followed two light (L) syllables (cf. Campbell, 1959, p. 345; Kiparsky and O'Neil, 1976; Keyser and O'Neil, 1980). The early version of this rule is represented schematically as (26):

(26)

Early Old English Vowel Deletion:

$$\left[\begin{array}{l} -\text{cons} \\ +\text{high} \\ -\text{stress} \end{array} \right] \rightarrow \emptyset / \left\{ \begin{array}{l} \text{H} \\ \text{LL} \end{array} \right\} \text{--- (CVX)\#}$$

This rule is responsible for the alternations found in the nominative sing. *hēafud* versus genitive sing. *hēafdes*, nominative pl. *hēaf(u)du*; but nominative sing. *werud* versus genitive sing. *werudes*, nominative pl. *werud* (from /werud+u/). There is little doubt that the environments collapsed by braces originally formed a unified rule.⁹

Later, this rule was made opaque by the introduction of the rule of Epenthesis (24), which made underlying monosyllabic stems like

Bezalel Elan I

/waetr/ 'wate
face. Because
rived disyllab
vowels:

(27)

Underlying
Vowel Deleti
Epenthesis
Phonetic form

(28)

Inflectional F
Stem

/hēafud/
/werud/
/wundr/
/waetr/

Words like
out their par
wundur made
that a final l
also that—e
wundur coul
HL environm
learn correc
and *waetres*
nominative p
abled langua
though there
werud and v
words chang
to create dif

One result
represented
the pattern i
after a heav
syllables, ho
even within
also *hēafud*

/waetr/ 'water' and /wundr/ 'wonder' look like disyllables on the surface. Because Epenthesis was ordered after Vowel Deletion, the derived disyllabic stems did not display the regular pattern of deleted vowels:

(27)

Underlying	/wundr+es/	/wundr+u/	/waetr+es/	/waetr+u/
Vowel Deletion	—	wundr	—	waetr
Epenthesis	—	wundur	—	waetir
Phonetic form	wundres	wundur	waetres	waetir

(28)

Inflectional Patterns (underlying and derived disyllables):

Stem	Nominative sing.	Genitive sing.	Nominative pl.
/hēafud/	hēafud	hēafdes	hēaf(u)du
/werud/	werud	werudes	werud
/wundr/	wundur	wundres	wundur
/waetr/	waetir	waetres	waetir

Words like *hēafud* and *wundur* would have looked the same throughout their paradigms, except for the nominative pl., where forms like *wundur* made Vowel Deletion opaque, since it appears from the surface that a final high vowel was incorrectly deleted following HL. Given also that—except again for the nominative pl.—many words like *wundur* could have been analyzed either as /wundr/ or /wundur/, the HL environment of Vowel Deletion must have become quite hard to learn correctly. By contrast, the alternation exemplified by *werudes* and *waetres* occurred in all inflected forms of such words (except nominative pl.). (In some dialects additional phonological evidence enabled language learners to distinguish the two types of forms.) Although there was some confusion as to which words declined like *werud* and which declined like *waetir*, as is attested by the fact that words changed from one type to the other, the alternation did not seem to create difficulties for the Vowel Deletion rule.

One result of these developments can be seen in the Mercian dialect represented in the *Vespasian Psalter*. After a single stressed syllable, the pattern is as would be expected from rule (26): high vowels drop after a heavy syllable and are retained after a light syllable. After two syllables, however, a fair amount of variation occurs, across stems and even within one stem. Thus, we find the expected *hēafudu* twice, but also *hēafud* five times; the expected *micel* 'much' derived from

/micl+u/ (originally /micil+u/, a form that should also yield *micel*) occurs four times, but the totally unexpected *micelu* occurs eight times. Similarly, the accusative pl. of 'calf' occurs as both *calferu* and *calfur*; the nominative pl. of 'lamb' occurs as *lomberu* as well as *lombur*; *idel* occurs with *idelu*; and so on. (See Drescher, 1978, for details.)

It appears, then, that the original rule of Vowel Deletion (26) has, in the *Vespasian Psalter* dialect, been split into two rules: a rule that applies regularly after H, and another, irregular, rule that applies to the left environment $\acute{V} \dots V \dots _$.

Now one can construct an argument bearing on the abstractness question. To do this, I must consider a bit more closely the environment immediately after a stressed heavy syllable. In the *Vespasian Psalter* dialect, Vowel Deletion occurs exceptionlessly. But this does not mean that the rule in this environment is totally transparent; on the contrary, there occur many apparent exceptions on the surface. Examples are *wītu* 'punishments,' *ermōu* 'misery,' *ældu* 'old age,' and many similar forms, all with a final *u* immediately following a heavy syllable, in apparent violation of (26).

In a concrete theory along the lines of Hooper (1976), these surface violations would be sufficient grounds for ruling out the phonetic formulation of Vowel Deletion after H, as well as after $\acute{V} \dots V$. In such a theory, these two environments would be accorded the same phonological status: since both parts of the rule are opaque (i.e., not surface true), they must both be recast as morphological rules. Now, while the $\acute{V} \dots V _$ part of (26) does indeed show signs of dephonologization in the *Vespasian Psalter*—variants such as *micel*, *micelu* show that it does not apply regularly, and even applies in what is not its original environment—no such variation is found in the short environment. Thus, we find no variant forms like **wīt* or **æld* occurring next to forms such as *micel*, *micelu*, and there is no evidence of the rule applying to new environments, such as after L. But if both parts of the rule are equally opaque, why is one so much more stable than the other?

An answer can be found in the context of a more abstract theory, which permits opaque rules if they contribute to the optimal grammar. It turns out that the morphological classes within which Vowel Deletion after H appears to be violated are also the classes in which two other rules are also contradicted. These rules are Breaking, which changes *a* to *ea* and *e* to *eo* before *rC*, and Retraction, which retracts *a* to *a* before *IC* and *IV* (i.e., before back *l*). Thus *ermōu* and *ældu* are each

[+back]

doubly exceptive Breaking and Retraction. Now, Weak Class I vowels underlying structure apparent lack of which retracts 'lay,' from /æld- by a monophthong /scærp+i+an/ 'Monophthongize sharpen' (cf. *sc* are given in (29)

(29)

Underlying form
Retraction
Breaking
i-Mutation
i-Monophthong
Vowel Deletion
Phonetic form

Notice that the environment H can account for stroke. At the Deletion in the various lines of language learned the rule to be 1

If a concrete considerations ing, *i*-Mutation rule mentioned plays such a role surface. One vowel should collapse eliminated consonants of the form the *Vespasian*.

doubly exceptional, violating not just Vowel Deletion, but the rules of Breaking and Retraction, respectively: compare *earm* 'wretched' and *ald* 'old.' Now, exactly the same cluster of properties occur in the Weak Class I verbs, which in my analysis have been assigned the underlying structure stem+*i*+suffixes. In the Weak Class I verbs, the apparent lack of Retraction can be accounted for by a rule of umlaut, which refronts *a* to *æ* before *i*; this yields forms like *ældan* 'to delay,' from /æld+i+an/. Similarly, the effects of Breaking are undone by a monophthongization rule that is also conditioned by *i*; from /scærp+i+an/ comes /scarp+i+an/ by Breaking, /scerp+i+an/ by Monophthongization, and, following Vowel Deletion, *scerpan* 'to sharpen' (cf. *scearp* 'sharp,' from /scærp/). Other sample derivations are given in (29):

(29)		/witi+u/	/æld+i+u/	/ærm+i+ðu/
Underlying form				
Retraction		—	ald+i+u	—
Breaking		—	—	earm+i+ðu
<i>i</i> -Mutation		—	æld+i+u	—
<i>i</i> -Monophthongization		—	—	erm+i+ðu
Vowel Deletion		wit+u	æld+u	erm+ðu
Phonetic form		witu	ældu	ermðu

Notice that the applications of Vowel Deletion in (29) are all in the environment H _____. By positing an underlying *i* in the forms of (29), I can account for the apparent violations of three different rules with one stroke. At the same time, I can account for the stability of Vowel Deletion in these forms. For although the rule is opaque on the surface, various lines of phonological evidence all converge to indicate to a language learner the presence of an unseen *i* in these forms, enabling the rule to be preserved in a purely phonological form.

If a concrete analysis were correct, on the other hand, none of these considerations should play a role. For the rules of Retraction, Breaking, *i*-Mutation, *i*-Monophthongization, and Vowel Deletion—every rule mentioned in (29)—are all opaque on the surface because *i*, which plays such a central role in this system of rules, never appears at the surface. One would expect that the entire system represented in (29) should collapse, with all the rules becoming morphologized or even eliminated completely. (Note also that alternations within the paradigms of the forms of (29) are lacking.) Yet the system represented in the *Vespasian Psalter* is still extremely regular with respect to all these

rules. In an abstract analysis like that of (29), the difference becomes clear: much more phonological evidence bore on the correct analysis of apparent exceptions to the short environment than on the long environment. So, although both were opaque, only the latter succumbed to nonphonological analogical changes.

More Diachronic Evidence

The external evidence just presented is somewhat indirect: the difference in the historical developments of the two parts of Vowel Deletion calls for an explanation, and one is available in terms of my analysis positing underlying *i* in several different morphological paradigms. On the other hand, it is not clear that an equally satisfactory account is available in terms of an analysis that posits underlying representations closer to the surface forms in these paradigms.

These historical developments do not stand in isolation, however, and additional diachronic evidence, of quite another kind, can be brought to bear. Recall that the apparent violation of Retraction in forms like *ældan* 'delay' was taken to be evidence indicating an underlying *i* which conditioned a rule of *i*-Mutation in this form, refronting *a* to *æ* (cf. (29)). This rule of Retraction was made opaque by such derivations, and minimal pairs existed such as *ældē*, the present subjunctive sing. of *ælden*, from /æld+i+e/, vs. *aldē*, the dative sing. of *ald* 'old,' from /æld+e/. Retraction can be formulated as in (30):

(30)

Retraction:

$$\begin{bmatrix} +\text{syll} \\ +\text{low} \end{bmatrix} \rightarrow [+back] / \begin{matrix} \text{---} \\ [+stress] \end{matrix} \begin{bmatrix} -\text{syll} \\ +\text{son} \\ +\text{back} \end{bmatrix}$$

Given the opacity of Retraction (30), and the fact that alternations between *æ* and *a* are lacking in most paradigms, the theory that rejects underlying *i* will also disallow deriving *ald* from /æld/. Instead, words with stressed *a* in all surface forms will be derived from underlying /a/. But now both *æ* and *a* are possible underlying phonemes, and their distribution is not predicted by synchronic rules of grammar (although, on this view, the patterns following from an abstract analysis still exist as an artifact of earlier historical periods, though without synchronic significance—that is, without psychological reality—for language learners). It follows, then, that the occurrence of *æ* in *ældē* sheds no

light on any unc reasoning, neith and so would all

Is there any choice of the ur from change, thi *Corpus* and *Ep. Vespasian Psalt* of Mercian are front vowels wl backed *æ* to *a* in (31) and (32).

(31)

Back Mutation:

$$\emptyset \rightarrow \text{a} / \begin{bmatrix} +\text{syll} \\ -\text{back} \\ -\text{long} \\ +\text{stre} \end{bmatrix}$$

(32)

a-Restoration:

$$\begin{bmatrix} +\text{syll} \\ +\text{low} \end{bmatrix} \rightarrow [+b]$$

The *a*-Restorat Retraction; *a*-F because Break cian derivation

(33)

Underlying Retraction
a-Restoration
Back Mutatio
Phonetic form

In a concre forms would p in the paradi of *wer* 'man.' underlying ref

light on any underlying *i* that may be hidden in this form. By similar reasoning, neither could any of the rules of (29), for they are all opaque and so would all be ruled out by a theory that disallows such opacity.

Is there any independent evidence, then, that would bear on the choice of the underlying vowel in words like *ald*? There is evidence from change, this time involving a change from the early Mercian of the *Corpus* and *Epinal* glossaries to the later Mercian recorded in the *Vespasian Psalter*. In addition to the rules listed in (29), two other rules of Mercian are relevant: Back Mutation, which diphthongized short front vowels when a back vowel followed, and *a*-Restoration, which backed *æ* to *a* in the same environment. These rules are formulated as (31) and (32).

(31)

Back Mutation:

$$\emptyset \rightarrow a / \left[\begin{array}{l} +\text{syll} \\ -\text{back} \\ -\text{long} \\ +\text{stress} \end{array} \right] \text{ — } \left[-\text{syll} \right] \left[\begin{array}{l} +\text{syll} \\ +\text{back} \end{array} \right]$$

(32)

a-Restoration:

$$\left[\begin{array}{l} +\text{syll} \\ +\text{low} \end{array} \right] \rightarrow [+back] / \text{ — } \left[-\text{syll} \right] \left[\begin{array}{l} +\text{syll} \\ +\text{back} \end{array} \right]$$

[+stress]

The *a*-Restoration rule must be ordered before Back Mutation and after Retraction; *a*-Restoration cannot be part of the same rule as Retraction because Breaking must be ordered between them. Sample early Mercian derivations in terms of an abstract analysis are given in (33).

(33)

Underlying	/æld+∅/	/fæt+e/	/fæt+u/	/wer+a/
Retraction	ald	—	—	—
<i>a</i> -Restoration	—	—	fat+u	—
Back Mutation	—	—	—	wear+a
Phonetic form	ald	fæte	fatu	weora

In a concrete analysis, *ald* would be derived from /ald/; the other forms would presumably be derived as in (33), since *æ* alternates with *a* in the paradigm of *fæt* 'vessel,' and *e* and *eo* alternate in the paradigm of *wer* 'man.' The two types of theories would also provide different underlying representations for words like *hafuc* 'hawk': in my analysis

it would be derived, like *fatu*, from /hæfuc/ by Back Mutation; in a concrete analysis it would have to be derived from /hafuc/, since all forms of this morpheme have the stressed vowel *a*. In terms of such a theory, the change from earlier *hæfuc* to *hafuc* would still be attributed to *a*-Restoration: but once the change had taken place, the underlying form would have had to be restructured as /hafuc/.

Subsequent to the stage of the language represented by the surface forms of (33), a change occurred whereby *fatu* became *featu* (= [fætu] or [fæatu]). I have argued elsewhere (see note 7) that this change is the result of the loss of the rule of *a*-Restoration (32) from the grammar. When one looks at the nonalternating *a*'s, one finds that the *a* in words like *ald* remained, while the *a* in words like *hafuc* became *ea*. The difference between the two types of nonalternating *a* emerges clearly in my analysis but is obscured in a concrete analysis. These facts show that the synchronic generalizations about the distribution of stressed *a* and *æ* were not just a historical artifact but were expressed in the grammars of native speakers.

These results support my analysis of hidden *i* in two ways. First, the fact that Retraction (30) remained in the grammar and applied to *ald* indicates that its apparent violation in *ældan* and other such words was indeed a significant fact, which could be used as evidence by the language learner for an analysis in which *ældan* derived from /æld+i+an/. Second, and more generally, these historical data show that opaque rules are allowed when they contribute to a more explanatory analysis; hence the data support the main lines of the theory of phonology, together with assumptions about learnability, which stands behind this particular analysis.

To sum up, synchronic as well as external diachronic evidence supports the abstract analysis of Old English I have proposed. Moreover, a language learner guided by the formal evaluation measure of Chomsky and Halle (1968), supplemented by substantive principles following from the Naturalness condition, would be able to arrive at this grammar—indeed, would choose it—starting from various different bits of data, despite the fact that the acquired representations are quite abstract relative to the heard phonetic forms. Thus, there is no reason to suppose that theories of phonology that allow such grammars impose, as some have claimed, an intolerable burden on the language acquisition device.

Notes

I would like to thank Keating, and Je

1. Cf. Braine (1974) and Skousen (1974).

2. On the abstract analysis of *fatu*, see Sommer (1974), Sommer (1974) and discussion.

Reference to the abstract analysis of *fatu* for ease of explanation with representations they

3. The notion of 'making the idea of language learner speakers will do into account of significant limitations of acquisition. More depending on factors determine factors. However, the status

4. Cf. Howren Keyser (1975),

5. Other relevant consonant in *-f* in other Class I shown to further cited in note 4

6. Complete pronunciation of the learner must have the forms were

Notes

I would like to thank Robert Bley-Vroman, Norbert Hornstein, Patricia Keating, and Jean-Roger Vergnaud for helpful comments.

1. Cf. Braine (1974), Crothers (1971), Derwing (1973), Hooper (1976), and Skousen (1975), among many others.

2. On the abstractness controversy see Kiparsky (1973a), Schane (1974), Sommerstein (1977, ch. 9), and Dresher (1981) for references and discussion.

Reference to abstract (or concrete) grammars or theories is purely for ease of exposition. It is not theories and grammars which are abstract with respect to surface phonetic forms but the rules and representations they allow.

3. The notion "available data" requires some elaboration. I will be making the idealization that all the data considered are available to the language learner at the same time. The actual grammars constructed by speakers will differ from those predicted by this theory if the data taken into account do not contain certain crucial forms, or if there are significant limitations on restructuring of grammars in the course of acquisition. Moreover, forms may be assigned different weightings, depending on factors such as frequency, markedness, or other principles determined by linguistic theory interacting with developmental factors. However, the existence of such real-time effects does not affect the status of principles (7.i)–(7.iii).

4. Cf. Howren (1967), Wagner (1969), Lass and Anderson (1975), Keyser (1975), and Kiparsky and O'Neil (1976).

5. Other relevant phenomena, such as the gemination of the stem-final consonant in *-fremman* and the palatalization of stem-final consonants in other Class I verbs, will not be discussed here, although they can be shown to further support the proposed analysis. See the references cited in note 4 as well as Dresher (1978) for further discussion.

6. Complete paradigms of nouns and verbs are cited for the convenience of the reader. It is not necessary to suppose that the language learner must have access to complete paradigms; scattered representative forms would serve equally well.

7. See Dresher (1980) for further discussion of the language and the texts, as well as for elaboration of the material discussed here in the section on "More Diachronic Evidence."
8. Skousen (1975) concludes that synchronic evidence is not as "substantive" as other types of evidence; see Dresher (1981) for discussion.
9. Keyser and O'Neil (1980) propose a unified formulation in terms of a metrical approach.

Chapter 7

Comments

Three issues raised, the of particular interest. Tl to the abstractness cont. The second is an interes type presented by Dres phophonemics seems 1 syntactic acquisition. F of "overgeneration" pr child reach generalizat

Learnability Demonstr

Dresher's convincing English can be learned an example of what o phonological analysis, controversy in current

Without the context appear pointless, or t presented, after all, tl tions over others; tha rule; and so on? Dres (at least in this part of correct but only that abstract analyses. Th belief that is thriving that are obviously tr pronunciation") can t is not obviously corre tive views of the acq which embody rules from the surface in ar of acquisition that le

Three issues raised, though not always explicitly, by Dresher's discussion are of particular interest. The first is the importance to linguistic argumentation and to the abstractness controversy of what I shall call a learnability demonstration. The second is an interesting logical feature of learnability demonstrations of the type presented by Dresher: the problem of accounting for the learning of morphophonemics seems to differ significantly from the projection problem in syntactic acquisition. Finally, there is in Dresher's historical discussion a kind of "overgeneration" problem: it seems that the learning theory would have the child reach generalizations that are evidently not achieved.

Learnability Demonstrations

Dresher's convincing demonstration that a certain abstract analysis of Old English can be learned is important for two reasons. Not only does it provide an example of what one hopes will become a paradigm argument type for a phonological analysis, but it makes a valuable contribution to the abstractness controversy in current phonology.

Without the context of this controversy, the learnability demonstration may appear pointless, or the assumptions may appear a priori. What evidence is presented, after all, that the learner selects phonologically based generalizations over others; that there is a template for evaluating a particular type of rule; and so on? Dresher correctly emphasizes, however, that he is not trying (at least in this part of the paper) to show that the learning theory presented is correct but only that it is reasonable and that it can lead to certain sorts of abstract analyses. There is apparently a belief among many phonologists—a belief that is thriving, for all one can tell—that only principles of phonology that are obviously true on the surface ("true generalizations" or "rules of pronunciation") can be acquired by the learner. Dresher shows that this belief is not obviously correct; that it is easy to imagine perfectly reasonable alternative views of the acquisition capacity under which analyses could be acquired which embody rules and underlying distinctions that cannot be directly read from the surface in an obvious way. His burden is to show only that the theory of acquisition that leads to such analyses is not obviously absurd and that it is

equally as reasonable as the a priori assumptions of "concrete" phonology. In this he succeeds.

If all he achieved was to provide an argument that abstract analyses could conceivably be acquired, then the paper would be of no great interest. After all, one need only look at syntax to be overwhelmed with the ability of the human mind to acquire systems of great intricacy, the underlying principles of which by no means jump out at one when one glances at a sample of data.

More interestingly, Dresher provides in his learnability demonstration an example of what could become a paradigm form of argument in favor of an analysis—a form that can in principle lead both to a tighter view of what constitutes a possible phonology and, in conjunction with other sorts of evidence, to a greater understanding of the principles with which the acquisition capacity operates. From this perspective, the proponent of a given analysis has the triple burden of showing, at least in principle, just how a learner, given certain information, might achieve that analysis; then of making explicit the assumptions of learning theory that are necessary to make that achievement possible; and, finally, of showing that these assumptions are neither obviously unreasonable nor in serious conflict with the learnability requirements of other, well-established analyses.

The requirement for a learnability demonstration must not be confused with the much stronger requirement that linguistic theory must provide a discovery procedure that will lead to uniquely correct analyses. A learnability demonstration shows only that the argued solution could have been arrived at, that a path exists from the data to the analysis—a route that can be traversed by a learner equipped only with abilities he may be supposed to possess. Of course there may be (usually is) more than one route, and, more important, there may be more than one achievable solution. It is in this last point that the requirement for a learnability demonstration is most sharply distinguished from the requirement for a discovery procedure. And it is just because of the non-uniqueness of learnable solutions that an evaluation metric is built into Dresher's sketch of the acquisition process.

To see how the requirement of a learning demonstration rules out analyses, one might pursue a bit further the discussion of Saporta's proposal for South Chilean Spanish. Here a learnability demonstration, although it might be possible, would require assumptions about language acquisition that are unacceptable. One way of arriving at Saporta's analysis is of course by the use of factual knowledge of the history and dialectology of Romance, which the learner cannot be expected to possess. This route must therefore be ruled out, as Dresher points out. Another route, not considered by Dresher, is also available. A learning theory might demand that the learner make the maximum number of distinctions phonological theory allows, whether motivated or not, essentially using distinctions "because they are there"—a sort of reverse of Occam's razor. Thus the learner makes distinctions between some *s*'s that are underlying *s*, and some that are underlying *θ*, even though the choice is arbitrary. In this way the learner might at least happen on the analysis proposed.

A slightly less radical proposal might be that once the learner has concluded that a distinction is motivated somewhere in the language, it must be used

wherever possible would require distinction in sil Chilean Spanish are perhaps not convincing evidence imperative set of phonologic

Dresher's learnability demonstration takes various sides of the coin: analysis; each segment. Cor argument for the velar fricative (1968) are also arguments on issues that Dresher prefigures Dresher's arguments for abstract commenting on that the evidence coming to the attention of Maltese phonology of the type

One might say that the learnability demonstration form can be questioned, but sharpening of that some arguments for *English*, or cases serving as principles and Demers (1968)

Given the argument argument nevertheless, evidence should be demonstrated directly on the learner for use have a superficial environment. Using pharyngeal imagine a learnable whereas the

wherever possible—a sort of strong technological imperative. This theory would require the prerequisite step of showing that a strident/nonstrident distinction in sibilants must be learnable on the basis of some available South Chilean Spanish data, even if not for the data in question. These possibilities are perhaps not completely absurd, but they can surely be ruled out unless very convincing evidence is presented in their favor. (Curiously, the technological imperative seems to be a strong influence on the analyses of beginning students of phonological theory; it is thus at least not unimaginable.)

Dresher's learnability demonstration for hidden *i* is a kind of zeroing in: from various sides, bits of evidence seem to converge inexorably on a particular analysis; each bit of evidence is another clue to the underlying identity of a segment. Convergent arguments are not new in phonology: Brame's (1972) argument for Maltese pharyngeals furnishes a paradigm case; the arguments for the velar fricative in *right* in *The Sound Pattern of English* (Chomsky and Halle, 1968) are also of this type; and there are many others. Although convergent arguments are not always cast in terms of learnability demonstrations, the issues that Dresher raises were often implicit in earlier work. In work that prefigures Dresher's in many respects, Brame clearly suggests that his arguments for abstract pharyngeals show that the analysis is learnable. Brame says, commenting on his own argument, that "great pains were taken to demonstrate that the evidence for underlying ζ is in the phonetic data. That is, the child coming to the language-learning situation is capable of inducing ζ on the basis of Maltese phonetics alone" (1972, p. 60). Brame also uses a naturalness condition of the type advocated by Dresher.

One might speculate that any convergent analysis could be converted into a learnability demonstration. Whether analyses not overtly presented in this form can be demonstrated to be learnable in the same way is an interesting question, but one that probably cannot be answered without considerable sharpening of the learnability assumptions of Dresher's theory. It is possible that some analyses would be ruled out. (I have in mind such cases as the arguments for the underlying representation of *spa* in *The Sound Pattern of English*, or cases where an analysis is simply presented, with its own elegance serving as primary argument—for example, the analysis presented by Cathey and Demers (1976). Many of the analyses of Postal, 1968, are also of this sort.)

Given the as yet not fully elaborated learning theory of Dresher, any convergent argument could probably form the basis of a learnability demonstration; nevertheless, a more refined theory could distinguish among them if the evidence should so require. To give just one illustration, the hidden *i* learnability demonstration is compatible with the notion that a distinction must be realized directly on the surface somewhere in the language before it is available to the learner for use in abstract hypotheses. In the case at hand, Old English does have a superficial *ile* distinction; *i* is not always hidden, only in this particular environment. Thus the case of hidden *i* contrasts with the case of the underlying pharyngeals in Brame's Maltese, which are always hidden. One could imagine a learnability theory under which the Old English case might be learnable whereas the Maltese case might not be.

The Logical Problem of Prerequisite Knowledge

The assumptions underlying Dresher's learnability discussion have a fundamentally different logical character from those frequently made in work on learnability in syntax. The projection problem in syntax, as often conceived, is that of determining how—given a fragmentary sample of data and certain assumptions about the learning capacity, available feedback, and the like—the learner can arrive at a knowledge of what the sentences of the language as a whole are. This perspective contrasts sharply with that of Dresher's discussion, where the learner is not faced with discovering what the facts of the morphophonemics are, based on bits and pieces of paradigms; rather, the learner apparently is given complete knowledge of the relevant facts and is required to decide on a systematic representation of them.

The argument for the learnability of hidden *i* is an excellent illustration. From a projection-problem perspective, one might have asked questions such as the following: Having heard miscellaneous verb forms, how does the learner predict in general what the preterite of a given verb might be? How does the learner come up with a way of telling the difference between verbs of the *hēran* type and those of the *fremman* type? Supposing he arrives at a classification system that in fact makes the wrong predictions, what sorts of evidence will lead the learner to abandon it, and is that information generally available? Will the learner progress through "incorrect" stages in the acquisition process? In a discussion of the learnability of morphophonemics such as Dresher's, questions of this sort cannot arise, because the learner is never faced with actually ascertaining what the facts of the morphophonemics are.

Indeed, at the point where the learning demonstration begins, the learner must apparently be assumed to possess a store of prerequisite knowledge. For example, he must have noticed—correctly—that the characteristic distinguishing verbs that behave like *fremman* from those that behave like *hēran* is phonological stem weight, and in this way he predicts the behavior of newly encountered verbs; he knows that the *hēran* types have no *e* in the imperative whereas the *fremman* types do; he has seen that the presence and absence of *e* in the imperative correlates with its presence and absence in the preterite; and so on. Given this sort of knowledge, the learner has, in one sense, learned the morphophonemics already. He is presumed to produce all the forms correctly; his hypotheses run no risk of error. What is there left to "learn"?

In pointing out that discussions of the learnability of morphophonemics like Dresher's seem logically to require this sort of prerequisite knowledge, it is important to emphasize that the problem is not that the learner must somehow be assumed to have access to too much data, to too many or too esoteric forms. Rather, to put the issue in a slightly different way, the learner is required to have already succeeded in figuring out the morphophonemics before the construction of an abstract account can begin. How much data he needed to accomplish that task is not at issue (although it is, in the final analysis, the really interesting question).

Although within Dresher's framework the learning task is not viewed as that of figuring out what the correct forms are, one may still ask in what form the

learner may be ca
that a certain sort

Although Dresh
achieved, yet by c
problem and by se
have laid himself o

An advocate of
that, in order to ac
like the way to pr
concede that he
require that it be s
further suppose th
edge in some form
mar contains info:

1. If a verb has a
matic class.

2. The inflectiona

3. There are cert
verbs have a pret

4. Certain implica
ends in *e*, an *e* fo

Furthermore, we
the grammar has :
form of complex
tries, rules of lex

Now, continue
the prerequisite s
The learner has a
plete and accur
language. Why tl
count—one that
could disconfirm
did in fact aban
change in his bel
abstract phonolo

What is ultim
adoption of a r
learner's efforts t
with his attempt

The Learnability

Since the learnal
an analysis, tho
essential. It is fc
important. Dresf

learner may be capable of systematizing that knowledge. Dresher has shown that a certain sort of abstract phonological system is within reach.

Although Dresher does convincingly show that the abstract analysis can be achieved, yet by divorcing the figuring-out problem from the system-building problem and by seeming to make the former a prerequisite to the latter, he may have laid himself open to an interesting sort of antiabstractionist counterattack.

An advocate of concrete phonology might argue in the following way: Given that, in order to achieve the abstract solution, the learner needs to know things like the way to predict conjugation class from stem weight, and so on, let us concede that he has somehow acquired this knowledge. We will not even require that it be shown how that knowledge might have been attained. Let us further suppose that the language capacity can represent the required knowledge in some form. That is, at what may be called stage I, the learner's grammar contains information of the following sort:

1. If a verb has a certain phonological shape, it belongs to a certain paradigmatic class.
2. The inflectional patterns of the different verb (noun) classes are . . .
3. There are certain partial similarities among paradigms (e.g., all the weak verbs have a preterite in *-d-*).
4. Certain implicational relations hold within a paradigm (e.g., if the imperative ends in *e*, an *e* follows the stem in the preterite).

Furthermore, we are willing, for the sake of argument, to accept the notion that the grammar has a way of representing information of this sort, probably in the form of complex lexical entries and general statements about the form of entries, rules of lexical redundancy.

Now, continues the concrete phonologist, having equipped the learner with the prerequisite stage I grammar, we face a sort of bird-in-the-hand problem. The learner has a completely adequate (concrete) grammar, containing a complete and accurate representation of the paradigmatic alternations of his language. Why then should he abandon it to try for a different, "better" account—one that may not even exist? Note, in particular, there are no data that could disconfirm this stage I grammar. Suppose, nevertheless, that the learner did in fact abandon this concrete grammar. There would be no observable change in his behavior: he could still be producing all the correct forms. The abstract phonologist thus finds himself under a very difficult burden of proof.

What is ultimately required, to avoid attacks of this kind, is the explicit adoption of a more realistic picture of the learning process, in which the learner's efforts to discover what the facts of his language are goes hand in hand with his attempt to set up a systematic account of those facts.

The Learnability of High Vowel Deletion

Since the learnability demonstration cannot provide conclusive evidence that an analysis, though learnable, is in fact learned, other sorts of evidence are essential. It is for this reason that Dresher's historical argument is especially important. Dresher attempts to distinguish two cases of a phonological rule by

learnability. One case must be shown to be learnable, the other case not. In this way he hopes to explain why one part of the rule is stable through time while the other breaks down. He succeeds only partially; for although the "learnable" case is clearly very easy to acquire given his learnability assumptions, the "unlearnable" one looks only slightly more difficult and it is hard to see what limitation in the proposed theory of the acquisition capacity could prevent the learner from attaining it.

In brief, the argument is as follows. High Vowel Deletion operated at one stage in Old English in two environments: after a heavy syllable (the short environment) and after a sequence of two light syllables (the long environment). It happened that Old English evolved so that the environments for these rules were no longer visible. Moreover, the rules that obscured the operation of the HVD were themselves opaque. Since both subrules—the long and the short environment—were now opaque, concrete phonology could not state them: the phenomena they expressed would be memorized quirks in the paradigms of Old English, like many others. Most important, the two subrules cannot be differentiated by learnability: both are absolutely unlearnable on the assumptions of concrete phonology.

In fact there is evidence, presented convincingly by Dresher, that they are differentiated with respect to learnability. HVD after two syllables began to break down, failing to apply when it should, irregularly applying to new environments where it ought not apply. On the other hand, HVD deletion after a heavy syllable was stable: apparently perfectly learned. Dresher puts the question well: "If both are equally opaque, why is one so much more stable than the other?"

What obscures the environment after a heavy syllable is an abstract underlying *i*. What obscures the other (now hard to learn) environment is a rule of epenthesis. Dresher's argument is that because there were various converging lines of evidence on the abstract *i*, which accounts for the apparent irregularity of the heavy syllable case, the abstract *i* was learnable and hence that case of HVD was also learnable.

The task is now to show that, given the assumptions of the learning theory, the other case of HVD cannot be learned. But it is not clear what will stop the learner from arriving at the unlearnable analysis. All that is required is that the learner figure out that it is the epenthetic vowels that are fouling up the environment for HVD. The epenthesis rule itself is extremely natural and expected; it doubtless corresponds closely to what the evaluation metric would specify as the template for most highly valued epenthesis; it may even be a "true generalization." It is difficult to see how the learner could fail to figure it out, given the assumptions of the learning theory presented. Furthermore, the solution that apparently cannot be learned would allow HVD itself to be stated in what is probably its most highly valued "natural" form and, in addition, would allow both cases of HVD to be covered by a single unified rule. Indeed, the fact that one case of HVD is in fact easy to motivate should provide indirect evidence for the other case of HVD, in the same way that *u*-deletion is said to make *i*-deletion easier to learn. Finally, the learner must be prevented from arriving at an analysis that in fact accounts in a general way for all the forms and must

be made to choose irregularities.

Clearly, in order either a far more than that presented than in the cogni

be made to choose an analysis that leaves a range of forms as unexplained irregularities.

Clearly, in order to account for the breakdown of the long case of HVD either a far more restrictive view of the acquisition capacity must be developed than that presented here or the explanation must somehow be sought elsewhere than in the cognitive difficulty of acquisition of the rule.