Phonological Features:
Privative or Equipollent?

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by

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Abstract

Although phonological features have traditionally been considered binary, or equipollent, it has recently been proposed that many features are privative, or single-valued (Steriade 1995). Privative features, rather than representing contrast as plus and minus values of a feature, represent it as the presence or absence of a feature. They can represent a maximally two-way opposition, between [F] and [Ø], whereas equipollent features can treat underspecification as a third option: [+F], [-F], and [Ø]. Since unmarked minus-values of features like [voice] and [nasal] are often observed to be phonologically inactive, privative features have been hailed as theoretically elegant: they explain the inactivity of those values by eliminating them entirely from the theory. However, privative feature theory runs into problems when two values of a feature are needed in representations.

In a case study of Turkish, I show that both [+back] and [-back] are active feature values in the vowel and consonant harmony system, and that an equipollent [back] analysis is superior to one that uses two privative features [front] and [back]. Secondly, investigating the feature [voice], I argue that privative feature theory, by attempting to explain behavioral asymmetries between [+voice] and [-voice], goes too far in banning [-voice], since it is still needed at multiple levels of representation. Three-way contrasts in surface phonetic and phonological behavior of [voice] are described; equipollent [voice] is needed to represent them. Privative [voice] also fails to capture parallel behaviors of [+voice] and [-voice] in assimilation phenomena. These problems follow from the attempt to encode markedness facts into the feature system and generalize privative features to universal status. I conclude that features should be represented as equipollent, and that explanations of markedness lie outside the formal mechanisms of featural representation.

Chapter 1

Privative versus equipollent features

1.1 Introduction

Features are the formal mechanism which phonologists use to describe the sounds of language and explain how they pattern. To illustrate, a well-known pattern in English is the formation of plurals. Native speakers think of the regular plural ending as just "-s," but in reality this ending takes three forms: /-s/, /-z/, and /-ɪz/:

(1) English plurals

cab[z]	cap[s]	catch[ɪz]
bed[z]	bat[s]	bus[ɪz]
dog[z]	dock[s]	dish[ɪz]

The distribution of the three forms is not random. Looking carefully, we see that it depends on the last sound in the root word: if the last sound is /b d g/, the plural is /-z/, and if it is /p t k/, the plural is /-s/. The sounds /b d g/ have in common that they are produced with vocal cord vibration, while in /p t k/, the sounds are produced without voicing. Correspondingly, the "voiced" sounds take the also-voiced ending /-z/, and the "voiceless" sounds take the also-voiceless ending /-s/. Meanwhile, the hissing-type sounds like /s/ and /z/ insert a vowel before the ending.

These patterns can be captured formally by defining the set of voiced sounds as a *natural class*, all of which have the feature [voice]. Instead of listing the sounds that take the /-z/ ending, we can state the generalization that all [+voice] sounds take the [+voice] ending, and make the further generalization that the last sound in a word takes the ending that matches its value for voicing. From this we can predict that a word ending in /n/ will take the /-z/ ending, since we know that /n/ has the feature [+voice]. In addition, the fact that /s/, /z/, and so forth take the /-ɪz/ ending tells us that they have a common property, i.e. form

a natural class, which can be called "strident." In this way a theory of features can permit linguists to analyze phonological patterns in language.

Although distinctive features have long been the building blocks of phonology, there is still widespread debate on some of their basic properties. A fundamental debate in feature theory centers on how to represent phonological contrasts. Traditional generative phonology (e.g. Chomsky and Halle 1968, Kenstowicz and Kisseberth 1979) used plus and minus values on features, representing the contrast between /p/ and /b/ for example as [-voice] versus [+voice]. Recently, however, Lombardi (1991, 1995a), Steriade (1995) and others have proposed that features are privative, or one-valued, and that contrasts are best represented by the presence or absence of the feature in question: /b/ is specified as [voice], whereas /p/ permanently lacks any specification for voicing.

The main motivations for privative features are theoretical elegance and greater explanatory power. An equipollent theory predicts that two values of a feature, both plus and minus, can be active in phonological processes, whereas a privative theory predicts only one active value. For example, it is often claimed (e.g. Ewen and van der Hulst 2001) that minus values of features like [-round] and [-nasal] are completely inert, and never participate in phonological processes such as spreading, blocking, or triggering rules. A privative theory accounts for this in a straightforward way by eliminating formal representation of extraneous values. Equipollent features are claimed to overpredict the range of possible phonological patterns, whereas single-valued features predict a more constrained set of patterns which coincide with those observed cross-linguistically. This idea has been extended into proposals that all phonological patterns can be explained using privative features (Steriade 1995).

However, equipollent features would be preferable just in case it turns out minus-values *are* needed in phonological representations. In this thesis, I will present empirical evidence to show that the features [back] and [voice] are indeed equipollent. For [back], I investigate the system of backness harmony in Turkish, which requires reference to both

[+back] and [-back] in both underlying and surface representations. Reanalyses of the data using privative features either fail because they can only refer to one feature value, or add unprincipled mechanisms that cause privative [front] and [back] to behave exactly like [-back] and [+back].

For [voice], I conclude that phonetic evidence supports the distinct representations of [-voice] and [0 voice], which show categorially different phonetic behavior. Next, I survey languages with a three-way underlying contrast between segments specified for [+voice], [0 voice], and [-voice]. Privative [voice], unable to distinguish between [-voice] and [0 voice], is incapable of representing these attested contrasts at all. Lastly, a typology of assimilation effects shows that [+voice] and [-voice] exhibit parallel phonological behavior. It is shown that a privative [voice] analysis of the data fails to capture the parallelism of the behavior, and must add a host of unprincipled mechanisms to even describe the data.

Thus privative [back] and privative [voice] deliver neither of the expected advantages of theoretical elegance and explanatory power. In some languages, it is true that only one value of a certain feature is active, and a privative-feature analysis is as explanatorily adequate and more theoretically elegant than an equipollent one. When the active value is a marked one, it seems intuitive that the feature's markedness is the cause of its active phonological status. However, the problems arise when privative features are generalized into language universals, and imposed on phenomena that they cannot explain. I conclude that [back] and [voice] (and most likely other features as well) are inherently equipollent, and end with a discussion of whether any universally privative features exist at all.

1.2 Definitions: Univeral versus language-specific privativity

It is necessary to distinguish two related ways of viewing privativity and equipollence: as language-specific properties of features, following Trubetzkoy (1939); or as universal properties of features. For Trubetzkoy, a feature is privative or equipollent depending on its observed behavior within a particular sound system. He argues that since children posit underlying representations based on the data they hear, they will acquire only the active feature values in the course of acquisition; there is no way for them to acquire something that the phonology provides no evidence for. Within the context of a specific language, a privative opposition is one in which only one member of the opposition is phonologically active, and an equipollent opposition is one in which the members are equal (i.e. both are active). A privative opposition is asymmetrical, defined by a "mark" (or a unary feature) that is present on the active member and absent from the inert one.

Trubetzkoy distinguishes the *logical* status of an opposition from its *actual* status. "Actual" refers to the behavior of an opposition within a specific language. "Logical" refers to the inherent status of an opposition, removed from all empirical context. In the absence of independent evidence, all members are logically equal; only in the context of a system can one use observation to determine the opposition's actual status within that system. Thus since the opposition /p b/ is logically equipollent, in some languages it may be actually equipollent as well, but in others it may be actually privative.

Pulleyblank (1995) offers a modern restatement of this bottom-up approach: "Since phonetic work suggests that the goal of full specification is ill-founded, the research strategy based on such retreat [from full specification] must also be reconsidered. An alternative research strategy is to posit only those feature specifications required to establish the oppositions attested in a particular language, filling out such representations with redundant specifications to the extent that there is positive evidence for such."

The opposite of the bottom-up approach is the "top-down" approach: Under a universal feature theory, each feature has the same status for privativity or equipollence in

every language, which is built into UG and the feature geometry. Linguists discover the status of a feature through its cross-linguistically observed behaviors. For example, if there is some language where nasality and orality are both phonologically active, [nasal] is universally equipollent, because UG must allow for that language to exist. If there is no known language where orality is active, we can encode this directly into our theory, thereby increasing its explanatory power, by hypothesizing that [nasal] is privative. Clements and Hume (1995:289) take universal feature theory a step further and imply that perhaps all features are privative, or else they are all equipollent.

My methodology in this thesis is to show cases where a feature behaves as equipollent, and show how analyses assuming universal privativity of the relevant feature fail to explain the data. Therefore, I am not arguing against all analyses that use privative features; in fact, I believe that if phonological patterning does not give evidence of more than one feature value, a child may only acquire one feature value. Rather, my argument against privativity is an argument against the assumption of universal privativity. Correspondingly, my claim that [voice] is equipollent is a claim, based on concrete examples, that [-voice] should be allowed to define a natural class, but *not* that every possible human language has segments specified for [-voice] in its inventory.

1.3 Theoretical aspects of privative features

In this section I will review some of the claimed advantages of having privative features. As stated, one is that they are simpler and more efficient than equipollent features. If privative, two-way oppositions are sufficient to account for the range of attested phenomena, then it is undesirable to have a theory with a three-way distinction (plus, minus, and zero), which would necessitate stipulation to explain the asymmetry between the active plus value and the inert minus value. However, in defining simplicity, one must look beyond the properties of individual features and consider the possibility that simplifying feature representations may result in an overall complication of the phonology. One potential issue

is the proliferation of features. When both values of a feature appear to be necessary, a binary feature such as [ATR] is broken down into two features, [ATR] and [RTR], opening the door for up to twice as many features as existed in the previous equipollent feature theory. In the case of alpha rules, the newly separated features need some way of being formally related to each other (so that a dissimilation rule could change [ATR] to [RTR] but never to [nasal]), which may involve extra stipulations or machinery. In addition, if it is possible to reanalyze the data without creating extra features, the new privative-feature analysis may or may not be more complicated than the old one.

Another claimed advantage is that a privative feature theory parallels physical aspects of articulation (Steriade 1995). A privative feature can be seen as an instruction to an articulator or group of articulators, while absence of a feature can represent the neutral, default state of the articulator. For example, it seems appropriate that [round] would be an instruction to round the lips, whereas, since [-round] may not involve active flattening or widening of the lips, absence of [round] would be the most accurate representation for the unrounded state. Each deviation from a neutral position could be encoded as a single feature. Features could then directly encode markedness facts, since features like [+round] and [+nasal], which involve deviations from the default articulator position, are considered to be marked cross-linguistically. It is often observed that marked values are active, and redundant or unmarked values tend to be inert.

The relationship between phonetic implementation and phonological representation, however, is unclear. Halle (1983) notes that the movements of active articulators "are in many cases controlled by paired sets of agonistic and antagonistic muscles." He describes the feature [nasal] as "implemented by the palatopharyngeus and palatoglossus, which together lower the velum, and the tensor veli palatini and levator veli palatini, which raise it." Secondly, "reversible markedness" is also common, where one value of a feature is marked in one language, but the opposite value is marked in another. In cases where there is no obvious asymmetry between members of an opposition, separate features are often posited

(e.g. [ATR] and [RTR]), but the validity of this approach for a feature such as [round] is questionable.

Crucially, Steriade (1995) divides features into two sets: I will call them "symmetrical" and "asymmetrical." The symmetrical set consists of those features which do not have a clearly marked value. It is perfectly plausible that [+F] might be active in some languages, and [-F] in others. The symmetrical features include [back] and [ATR]. The asymmetrical features, whose positive value is considered to be cross-linguistically marked, include [voice], [round], [nasal], [lateral], and more. For both sets, privative features are claimed to have the advantage of theoretical elegance - there is no reason to have two feature values when just one will do. However, the advantage in explanatory power - the statement that only one value on a parameter is active universally - is only applicable to the asymmetrical set.

In the following chapters, I examine one feature of each set. It is relatively trivial to show that [back] is not universally privative. Already, there is a consensus that [-back] exists and [+back] exists (Goldsmith 1985); the claim of privative [back] is simply a claim that they are never active within the same language. To refute this claim, one must only show an example of a language where both values are active; I argue that this is the clearly the case for Turkish. As for [voice], the claim of privativity is that [-voice] never exists and is never active. To argue against this, I take examples from many different languages to show that the existence of [-voice] is not a fluke that can be attributed to other factors.

1.4 Empirical predictions and admissible evidence

I now turn to empirically testable predictions that can help us distinguish between privative and equipollent feature theories. One difference in the predictions of privative and equipollent feature theories is the number of contrasts that are possible with respect to a given feature. Stanley (1967) observed that equipollent features could represent not just the two-way opposition between [+F] and [-F], but, if underspecification was

allowed, a three-way opposition between [+F], [-F], and [0 F]. A privative feature theory, conversely, predicts only a two-way distinction between the presence and absence of a feature, [F] and [0 F]. Insofar as evidence exists for such ternary oppositions, then, an equipollent feature theory is preferred. For example, Turkish seems to have a three-way underlying distinction for [voice], as discussed by Inkelas and Orgun (1995); the following is reproduced from Reiss (2001):

(2) Turkish voicing alternations

a. Alternating: [Øvoiced]
kanat 'wing' kanat-lar 'wing-pl.' kanad-ım 'wing-1sg.-poss.'

b. Non-alternating voiceless: [-voiced]
sanat 'art' sanat-lar 'art-pl.' sanat-ım 'art-1sg.-poss.'

c. Non-alternating voiced: [+voiced]
etüd 'etude' etüd-ler 'etude-pl.' etüd-üm 'etude-1sg.-poss.'

Because there is a three-way contrast in behavior, a three-way contrast in underlying representation is assumed. As Inkelas and Orgun propose, the data in (2) can be explained by feature-filling processes that insert [+voice] in onset plosives and [-voice] in coda plosives. These rules do not apply to the prespecified plosives in (2b) and (2c), because a feature-filling rule cannot change an already-specified value; it can only insert one where none exists. Equipollent [voice] is satisfactory because it predicts precisely the three-way contrast attested here, where two members of the opposition always have the same value, and the other, having no feature value of its own, acquires one through context-sensitive assignment rules. Conversely, privative [voice] cannot account for these voicing alternations.

The second prediction has to do with the difference in behavior between absent and minus-valued features. Although phonological rules can make reference to both [-F] and [0 F], by hypothesis only minus values can be active in the phonological system. I define an "active" feature in derivational terms as one that spreads, blocks spreading, or resists structure-filling processes. If a feature is simply absent, there is no way for it to block

spreading or resist structure-filling rules, which see an empty slot rather than one already occupied by a minus-valued feature. It is also doubtful within an autosegmental approach that an absent feature can mimic spreading effects by triggering deletion of the relevant feature in neighboring segments; this would seem to overgenerate the range of possible phonological patterns.

In OT it is possible for a zero-valued feature to produce the same effects as autosegmental spreading, through IDENT and AGREE constraints. However, since equipollent [back] is already motivated by the "three-way distinction" type of evidence, there is no reason to account for these effect with privative features. Because the original arguments for privativity came from derivational and autosegmental evidence, not all of them will be directly relevant within the framework of OT (Wetzels and Mascaró 2001).

A third test comes from phonetic evidence, specifically coarticulation. Assuming that a feature encodes some kind of acoustic or articulatory target, a segment unspecified for [round] should show stronger coarticulation effects than one specified for [-round]. The idea is that a [-round] specification will cause a segment to resist rounding at the level of phonetic implementation (Keating 1988). When two segments specified for opposite values of a feature surround a segment unspecified for that feature, we can expect *interpolation*, or a linear transition from one feature value to the other, through the unspecified segment, since lack of specification is assumed to mean lack of a target.

In sum, admissible evidence for equipollent features falls into two categories: three-way contrast (either phonetic or phonological), and parallel phonological behavior of features. I believe that these types of evidence are the most theory-independent, and therefore the most sound. In effect, I am emphasizing surface-observable evidence. This is opposed to other arguments for equipollence which invoke a minus-value to analyze a two-way contrast, and conclude that the feature is equipollent because the minus value is needed for the analysis (e.g. Howe 2000). Even if correct, this type of argument is easily countered by reanalyzing the data, and if there is only a two-way contrast in surface behavior, the

reanalysis may not run into the same problems that a privative reanalysis of three-way contrast does. Therefore it is not as convincing as the three types of evidence surveyed above.

Chapter 2

The feature [back]

2.1 Turkish vowel and consonant harmony

This chapter will test the predictions of Chapter 1, and present several types of evidence supporting equipollent [back] in a case study of Turkish. First, I will show that a three-way distinction is required between [+back], [-back], and underspecified vowels to account for disharmonic vowels in certain suffixes. The same distinction may also be required to capture different behavior among three types of velars, although this is controversial. In addition, two more types of phenomena also illustrate the active spreading of both [+back] and [-back]. Although some of the evidence is slightly weakened within non-spreading Optimality Theoretic models of harmony, the evidence as a whole presents a strong case for the equipollence of [back]. Most data is from Clements and Sezer (1982), henceforth CS.

Turkish has eight vowels. The front vowels, /i ü e ö/, are opposed to the back vowels, /ɨ u a o/. The round vowels are /u ü o ö/, and the unround vowels are /i ɨ e a/. Although Turkish has both backness and roundness harmony, here I will concentrate exclusively on backness harmony. Normally, all the vowels in a word agree in their value for [back], and suffix vowels alternate to match the backness quality of the root word. In rounding harmony, all high vowels agree in rounding with the preceding vowel, regardless of the height of that vowel.

Turkish also contrasts three pairs of front and back consonants. The back consonants are /k g l/, and their fronted, palatal counterparts are /k̟ g̟ l̟/. Normally, velars and laterals match in backness to the tautosyllabic vowel. CS note that consonant harmony is independent of vowel harmony because “disharmonic consonants may appear in regular

harmonic words while harmonic consonants may appear in disharmonic words." Some examples of the normal harmony patterns are given in (3):

(3) Turkish harmony patterns

a. Harmonic roots (van der Hulst and van de Weijer 1991, and CS)

i.

küsülü 'annoyed'	kɨmɨltɨ 'movement'
netice 'result'	oyuncak 'plaything'

ii.

k̟el 'bald'	kol 'arm'
yük̟ 'load'	sik 'often'
va.k̟it 'time'	pa.ti.ka 'path'
nek̟.tar 'nectar'	fark 'difference'

b. Suffix harmony (CS)

	nom. sg.	gen. sg.	nom. pl.	gen. pl.
'rope'	ip	ip-in	ip-l̟er	ip-l̟er-in
'girl'	kɨz	kɨz-ɨn	kɨz-lar	kɨz-lar-ɨn
'village'	k̟öy	k̟öy-ün	k̟öy-l̟er	k̟öy-l̟er-in
'end'	son	son-un	son-lar	son-lar-ɨn

There is some controversy over whether root harmony is an active process in Turkish, or whether it is no longer part of the synchronic phonology (see e.g. Harrison and Kaun 2000). Below, I will suggest that an autosegmental spreading analysis satisfactorily accounts for harmonic words as well as the abundant exceptions. By Occam's razor, there seems to be no need for a separate process of root harmony.

2.2 Disharmony

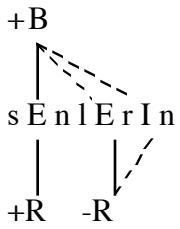
2.2.1 Vowel disharmony

CS cite numerous examples of roots where vowels do not match for backness. Claiming that these roots are well-entrenched in the language and considered by native speakers to be well-formed, they propose a departure from older analyses of Turkish harmony. Instead of positing harmony rules and thinking of ways to deal with the exceptions, CS outline an autosegmental system in which there are no exceptions to the

rules, but rather cases in which the rules do not apply. They accomplish this by defining harmony rules as feature-filling, so that harmony inserts or spreads feature values only to segments which have no specification for that feature.

Feature-filling rules stand in contrast to feature-changing rules, which can assign feature values to already-specified segments, erasing the previous values. If some segments are prespecified for [+back] or [-back], then, backness harmony will fail to apply to those segments, and they will surface as disharmonic. Examples, taken from CS, are given in (4) of how an autosegmental analysis involving prespecification can derive both harmonic and disharmonic patterns, without admitting special "exceptions" to the spreading rules.

(4) a. Harmonic spreading: son-lar-~~i~~n 'end,' gen.pl.

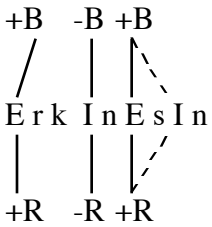


b. Disharmonic root: istakoz 'lobster'

The left-to-right spreading model in (4) predicts that alternating suffix vowels will harmonize backness to the root-final vowel. Without this spreading mechanism, there would be no way to tell which value in a disharmonic root a suffix will harmonize to. This prediction turns out to be correct:

(5) Suffix unspecified for [back]: value filled in by spreading

orkinos-un ‘funny fish,’ gen.sg.



In Turkish, however, not all suffix vowels alternate. There are several classes of invariant or “disharmonic” suffixes, whose vowels do not undergo backness harmony. Suffixes with invariant back vowels, as well as invariant front vowels, both exist.

(6) a. Suffix with vowel specified for [+back]: /-Iyor/ (progressive)

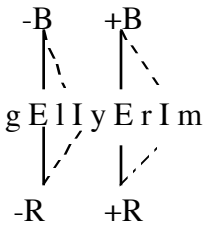
gel-iyor-um ‘I am coming’
kos&-uyor-um ‘I am running’
gül-üyor-um ‘I am laughing’
bak-ıyor-um ‘I am looking’

b. Suffix with vowel specified for [-back]: /-gen/ (noun-forming)

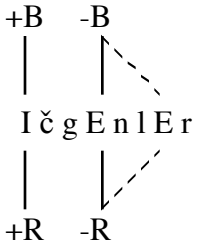
üč-gen-ler ‘triangles’
altı-gen-ler ‘hexagons’
sekiz-gen-ler ‘octagons’
čok-gen-ler ‘polygons’

As shown in (7), CS successfully deal with these in the same manner as disharmonic roots, that is, with prespecification. In addition, (7c) shows that rightward spreading predicts the correct surface form for a suffix with two invariant vowels, one front and one back.

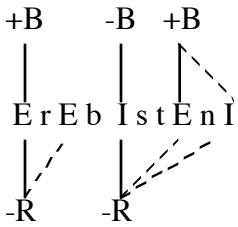
(7) a. ɡe͡l-iyor-um ‘I am coming’



b. üč-ɡen-l͡er ‘triangles’



c. arab-istan-ɨ ‘Arabia,’ acc.

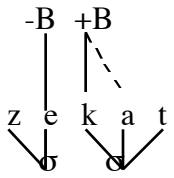


Therefore, to account for the full range of disharmonic suffixes as well as the regular, alternating suffixes, we need to posit a three-way underlying contrast between vowels specified for [+back], those specified for [-back], and those that are unspecified. This is precisely the ternary opposition predicted by an equipollent feature [back]. A privative feature [back] cannot represent more than a two-way opposition.

2.2.2 Consonant disharmony

As stated in 2.1, velar and lateral consonants normally agree in backness with the tautosyllabic vowel. However, there are many instances so-called consonant disharmony involving a front velar or lateral in the same syllable as a back vowel. These consonants are analyzed in (8) as requiring a [-back] prespecification:

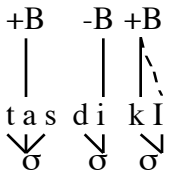
(8) a. Velar disharmony: zek̂at ‘alms’



b. Lateral disharmony: usul̂ ‘system’

In addition, CS describe an idiolect of Turkish where in certain words, an alternating suffix vowel surfaces as back after a velar, even if the root-final vowel is front. These cases call for a prespecified [+back] velar, which spreads its value onto the suffix vowel while blocking propagation of [-back] from the root vowel. This set of words is already considered obsolete by most Turks, who, when asked, produce the form that would be expected with an underspecified velar. However, the fact that there are speakers who produce the form in (9) attests to the fact that at least some dialects of Turkish have three types of velars. The initial motivation for specifying velar in (9) as [+back] is clear: it was borrowed from an Arabic word that originally ended in uvular /q/.

(9) tasdik-ɨ ‘confirmation,’ acc.

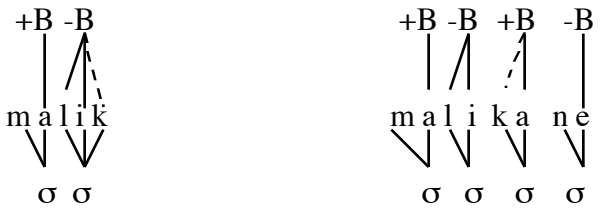


Thus we see an apparent need for a three-way underlying contrast in velars, due to the three-way contrast in their surface behavior as shown in (3aii), (8a), and (9). In 2.2.3, however, I discuss tentative evidence that the velars may not be prespecified as [+back].

So far, two pieces of evidence have been presented for equipollent [back], both arguing from the necessity of a three-way contrast. Now I will address a different prediction: that an equipollent feature will have two active values. The first example uses the disharmonic suffixes illustrated in (7), but approaches them from the angle of seeing which feature values spread. Although we have already motivated equipollent [back] to account for invariant suffixes, we can further show that both [-back] and [+back] spread *rightward* from the suffix to the root under certain conditions. Specifically, CS observe that root-final underspecified laterals are fronted before invariant front suffixes, and underspecified velars surface as back velars immediately before an invariant suffix vowel.

(10) a. asɨl ‘original’ asl̂-ī ‘basic’

b. mālîk̂ ‘owner’ mālîk̂-āne ‘residence’



Since zero-values cannot be active (e.g. spread) in autosegmental phonology, the fact that two contrasting values of backness spread means that the feature [back] must have two possible specifications: it is equipollent.

The second example of both-values-active evidence comes from epenthetic vowels, discussed by Yavas (1980) and Kaun (2000). In initial clusters of the forms /kC/ or /Cl/, a vowel is epenthesized that harmonizes in backness with the velar or lateral, rather than with the following vowel. The velar always surfaces as a back velar, and the lateral is always front. In /kl/ clusters, the velar and epenthetic vowel are [+back], and the lateral is [-back]. Data are from Kaun (2000):

(11) Velar/Lateral Clusters

a. /kC/ clusters: kɨrater, kɨriminal

b. /Cl/ clusters: piɫeyof, fiɫamingo

c. /kl/ clusters: kɨɫiniḵ, kɨɫasiḵ

Yavas accounts for the data by positing that in initial clusters, velars are prespecified as [+back], and laterals are prespecified as [-back]. Epenthetic vowels are underspecified, and receive a [back] value through spreading from the neighboring consonant. Yavas posits that assimilation of [+back] from velars precedes assimilation of [-back] from laterals; the vowel in a /kl/ cluster acquires a [+back] specification first, and is no longer susceptible to the feature-filling process of [-back] spreading from the lateral consonant. In this analysis, both values of [back] spread, which is impossible with privative [back]. Kaun also uses equipollent [back] in her OT analysis of the data.

To summarize, I have just presented a typology of disharmonic suffixes, and epenthetic vowels in Turkish; it appears that any successful analysis of these facts, and perhaps velars as well, will require equipollent [back].

2.2.3 Loanwords and exceptions: some considerations

Many of the disharmonic examples, the ones that eliminate the possibility of privative [back], are loanwords, or otherwise considered exceptional. This raises the concern, as CS put it, that they are "not subject to the otherwise general and productive rules of Turkish" (226) and as such should not be taken to reflect true Turkish phonology. There are several reasons why I believe any satisfactory account of Turkish phonology should be able to account for these exceptions. First of all, disharmonic loanwords are abundant and well-entrenched in the language; CS provide numerous examples and cite a psycholinguistic study (Zimmer 1969) in which speakers of Turkish judged random disharmonic sequences to be as well-formed as harmonic sequences. If disharmonic loanwords could not be accommodated by the native phonology, one would expect that they would have been adopted as harmonic. As it turns out, this is not the case. The most elegant approach is to capture both harmonic and disharmonic patterns through the described mechanism of prespecification and spreading, rather than to posit rules of active root harmony and use ad hoc mechanisms to clean up the exceptions.

Mohanan (1991) criticizes prespecification analyses of exceptions on the grounds that they are unprincipled. However, Inkelas and Cho (1993) offer several reasons to prefer exceptionality by prespecification over approaches such as rule diacritics (which mark a segment as an exception to certain rules). First, morpheme diacritics cannot represent morphemes with one variant vowel and one invariant vowel; if we assume harmony is caused by a feature-filling process of spreading, either prespecification or segment-specific diacritics are necessary. Prespecification functions just like a segment-specific diacritic.

One difference between prespecification and a segment-specific diacritic is that prespecification makes testable predictions about how the exceptional segment will react to other processes in the language. To take the back velars as an example, [+back] specification predicts that the velar will behave like a [+back] segment in all rules and

processes of the language. Unless evidence appears that the segment is an exception only to very specific processes, prespecification is preferable on grounds of elegance. It is already motivated within the language, so there would be no need to posit a whole separate set of formalisms.

As it turns out, the so-called [+back] velars may not behave as [+back] with respect to other rules of Turkish. Sharon Inkelas (personal communication) has mentioned that words like *tasdik* may only take back vowels in the accusative case (tasdikɨ), which are thus frozen, nonproductive forms. Some older speakers of the language, when questioned, used the [+back] ending for the accusative but [-back] endings for all other cases. Further investigation is necessary to establish whether or not most speakers who say *tasdikɨ* consistently treat the /k/ as [+back].

2.3 Prespecification in Optimality Theory

Although many OT analyses are radically different from derivational analyses of the same data, any OT analysis of the Turkish data will need the same prespecified underlying representations as those used above. The equipollent status of [back] is therefore unaffected. The reason for this comes from the fact that many alternations necessitating equipollent [back] are exceptional and therefore unpredictable. Within OT, two main mechanisms are available for dealing with exceptions. The first is constraint rerankings, or cophonologies. Exceptional words are lexically marked as obeying a different constraint ranking than words conforming to the normal pattern.

Here, I follow Inkelas, Orgun, and Zoll (1997) in again suggesting that the second mechanism, prespecification, is preferable. Because prespecification can account for exceptions in a principled way, there is, all other things being equal, no need for constraint rerankings. Prespecification fits into the fabric of OT in the following way: Canonical OT is based on the interaction of well-formedness constraints and faithfulness constraints. Well-formedness constraints ensure that highly marked candidates will not emerge as

optimal, while certain faithfulness constraints ensure that the output bears certain resemblances to the input - so that, for example, all words do not surface as minimally marked sequences like [ta]. Since well-formedness constraints will always prefer the non-exceptional candidate, it must be faithfulness constraints that account for the difference between regular and exceptional words. If we prespecify underlying forms with three different values of [back], a single constraint ranking can produce the three attested types of behavior, since faithfulness constraints can bring about different outputs, when given different inputs.

As mentioned, the predictions made by privative and equipollent feature theories are slightly different in OT than in autosegmental phonology. In 2.2.2, I argued for the equipollence of [back] based on the fact that both values of [back] spread, and hence are both active. In many OT models of harmony, however, a feature does not have to be active in order to exhibit the effects previously attributed to spreading. Specifically, AGREE constraints can require neighboring segments to match in their lack of specification for a feature (Wetzels and Mascaró 2001).

To demonstrate in OT that a feature is equipollent, it seems that a three-way contrast must be shown. Claiming that constraints like AGREE must be formulated with reference to two different feature values is not enough, now that one of these values could be the underspecified one. Since it is possible to model harmony as triggered by underspecified values, one must look for a three-way contrast in spreading behavior, perhaps between two different values that exhibit harmony-triggering effects, and a third value that does not. As for the arguments presented here, the evidence from epenthetic vowels is weakened in OT, but the evidence from disharmonic suffixes remains compelling.

2.4 Critique of privative-feature analyses

2.4.1 Van der Hulst and van de Weijer (1991)

In their account of the Turkish data, van der Hulst and van de Weijer (henceforth HW) model each vowel as a combination of the vowel primitives Low, Front, and Round. These features are privative, so that the low front rounded /ö/ is specified for all three primitives, while the high back unrounded /i/ has no specifications at all. HW claim that root harmony is an active process, positing that frontness and roundness are properties of whole words rather than individual vowels. They hypothesize that in the case of exceptions only, features are linked to specific vowel positions. HW themselves point out that their analysis, as formulated, cannot explain CS's data on disharmonic suffixes and three-way velar contrasts. The analysis fails precisely because it uses privative features: only a two-way distinction is possible, but to explain the data, a three-way contrast, and hence equipollent [back], are necessary.

More specifically, privative [front] fails to account for why the /a/ of invariant suffixes like /-a:ne/ resists harmony. HW concede that it is difficult to explain "without marking this vowel as [+B]." They "tentatively suggest that such suffixes have a compound-like character." Without evidence independently motivating the privative feature system in this analysis, it seems that we should avoid this ad hoc mechanism in favor of the unified explanation offered by equipollent [back]. As for the tasdik-ɨ example, which CS analyze as a [+back] velar spreading its specification to the suffix vowel, they conclude, "These velars, then, are represented with [+B], a possibility which is not an option in the framework outlined above. For the time being, we will mark such cases as simply not triggering vowel harmony."

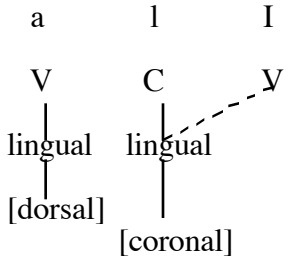
2.4.2 Clements and Hume (1995)

Clements and Hume (1995) propose a new feature geometry in which vowels and consonants share a common set of features. The traditional feature [±back] is redefined as

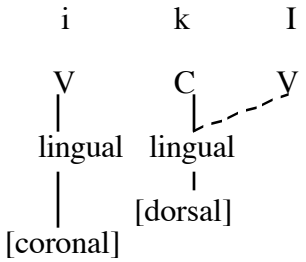
two privative features: [+back] corresponds to [dorsal], and [-back] becomes [coronal]. They are the two sole constituents of a node [lingual], which is motivated by the fact that "both [coronal and dorsal] involve the tongue." CH analyze data from Turkish to show that the new monovalent features can successfully explain rules that had previously been defined on [αback]. Although the analysis works, it only does so because of stipulations that are designed to make the new privative features behave just as the plus and minus values of equipollent [back] do.

Vowel and consonant harmony are defined as spreading of the lingual node. Front harmony is caused by spreading of the feature [coronal], while back harmony involves spreading of [dorsal]. CH focus on cases of consonant disharmony, which they attribute to prespecifications under a V-place node on disharmonic consonants: "Since these features link to the lingual node, which lies on the same tier in consonants and vowels, they will block the propagation of the lingual node from the preceding vowel, and will themselves spread onto the suffix vowel /I/." Their analyses of opaque [-back] and [+back] consonants are as follows:

(12) a. Opaque [-back] sua̱l ‘question’ + /I/ (acc. sg.) --> suā̱l-i



b. Opaque [+back] tasdik ‘confirmation’ + /I/ -> tasdik-i̶



One problem is that when an equipollent feature is reanalyzed as two privative features, the two features must be kept formally related. Otherwise, dissimilation is predicted to be possible not just for the privative pairs [voice]/[voiceless] or [ATR]/[RTR], but also for pairs like [voice]/[RTR] or [voiceless]/[ATR]. With equipollent features, the two values were formally related by virtue of being opposite values for the same feature. Here, CH unify [coronal] and [dorsal] under the lingual node.

The problem is that once [coronal] and [dorsal] are related under the lingual node, additional assumptions are made in the analysis. The main assumption is that [coronal] and [dorsal] are mutually exclusive and can block each other from spreading. The result is that [coronal] and [dorsal] become little more than a notational variant of the equipollent feature [±back]. Normally, privative features are adopted when they make different, more accurate predictions than equipollent features.

This time, however, privative features are adopted for the sake of creating a constriction-based model, so it is unsurprising that care is taken to recreate the workings of an equipollent feature. Although the stipulation that [coronal] and [dorsal] are mutually exclusive just corresponds to the stipulation in binary feature theory that [+back] and [-back] are mutually exclusive, binary feature theory at least makes this an immediate logical contradiction; it is intuitive that a plus and minus value of the same feature should not coexist. With [coronal] and [dorsal], the prohibition can only be explained with recourse to the geometry of the lingual node.

Halle, Vaux, and Wolfe (2000) question the soundness of stipulating V-place nodes for opaque consonants, since consonants with V-place do not seem to be independently motivated. They also claim that the sole function of the lingual node seems to be to create an equipollent relationship between [coronal] and [dorsal], observing that by the "involvement of the tongue" criterion, tongue root features should also be under the lingual node, but phonologically, they group instead with laryngeal features. HVW offer further evidence that coronals and dorsals do not constitute a natural "lingual" class, and they end

by noting that CH do not include the lingual node in the final diagram (p. 292) of their proposed feature geometry. Thus it appears that equipollent [back] is still the best mechanism available to describe backness harmony.

2.5 Summary

In this chapter, I have presented data from Turkish to support two types of arguments in favor of having equipollent rather than privative [back]. I have claimed that Turkish has an underlying three-way backness contrast as well as two active values of [back]; these phenomena are predicted by an equipollent feature theory, but cannot be explained using privative features. The fact that [back] behaves as equipollent in Turkish casts doubt on recent proposals that all features are inherently privative, and I suggest that a successful theory should allow features to behave as either privative or equipollent in individual languages. In so doing I follow Hyman (2002) in observing the merits of "bottom-up" phonological analysis. If a language gives no evidence that front vowels behave as a natural class, it may not be necessary to use [-back] in analyzing that language (Goldsmith 1985). However, because front vowels behave as a natural class in other languages, and both frontness and backness are active in yet others, our theory should be structured in a way that can account for these differences. The need for equipollent [back] is demonstrated in 2.4, where it becomes apparent that any successful privative-feature analysis of Turkish backness harmony will just be a notational variant of the features [+back] and [-back]. Even if different (e.g. constriction-based) features are eventually shown to be superior, they will have an equipollent relationship.

Chapter 3

The feature [voice]

3.1 Overview

Various claims have been made that equipollent [±voice] should be abandoned in favor of privative [voice] (Mester and Ito 1989; Lombardi 1991, 1995; Steriade 1995). Most of these hinge on the idea that [+voice] is the marked member of the voiced/voiceless opposition in obstruents, and that [-voice] is an unmarked default that never manifests itself in phonological processes. Thus, the reasoning goes, [-voice] should not be considered as a real feature value, since it would then have a formal status equivalent to that of [+voice] and would wrongly be predicted to exhibit similar ranges of behavior. In this chapter, I follow Wetzels and Mascaró (2001) in arguing that the opposite is true: [-voice] is an active feature value, is distinct from the underspecified value [0 voice], and must be represented phonologically. Insofar as privative feature theory is an attempt to formally encode markedness into the feature geometry, it is too extreme in the case of [±voice], because "there are many dimensions of markedness, which do not necessarily converge on a single target" (Vaux 2002, following Rice 1999).

I will present several types of evidence to show that privative [voice] cannot be maintained; rather, [voice] is an equipollent feature. Phonetic studies (Dixit 1987) show that [-voice] represents an active acoustic and articulatory target as opposed to a default state. In particular, phonetic evidence from Taiwanese (Hsu 1998) demonstrates that [0 voice] stops behave differently from [-voice] stops, and any analysis that subsumes all voiceless stops under a [0 voice] representation will make incorrect predictions. Secondly, I survey three-way lexical distinctions that require a contrast among segments underlyingly represented as [+voice], [-voice] and [0 voice], and review arguments supporting a prespecification analysis for capturing such contrasts. Lastly, following Wetzels and

Mascaró (2001), I argue that [+voice] and [-voice] show parallel phonological behaviors, which must be accounted for in a unified way. The data presented contradict the common claim that [-voice] is phonologically inactive. Because a privative theory (e.g. Lombardi 1991, 1999) cannot refer to [-voice], it must find alternative analyses which often miss crucial generalizations. I conclude that [voice] is equipollent.

3.2 Phonetic evidence for equipollent [voice]

3.2.1 Articulatory and acoustic definitions of values for [voice]

The privative or equipollent status of the feature [voice] is sometimes argued to follow straightforwardly from its inherent properties. As discussed in chapter 1, Trubetzkoy (1939) defines a privative opposition as a two-way contrast where one member is characterized by a "mark" that is absent from the other. Voicing seems to be a good candidate. Lieberman and Blumstein (1988:112), following Jakobson, Fant, and Halle (1963), point out that "sounds can be either voiced or unvoiced... there is no intermediate state... the larynx can be adjusted either to yield phonation when air begins to flow through it or not to yield phonation." Thus voicing can be defined as the presence or absence of vocal fold vibration, or, along similar lines, it can be defined purely acoustically as the presence or absence of the low-frequency periodic energy caused by such vibration. Under this idea, voicelessness is not characterized by any positive qualities; it is simply the absence of voicing. Privative [voice] captures this idea.

Conversely, Halle (1983) suggests that features can be defined as specific instructions to articulators. Such a definition leads to the idea that [voice] is equipollent: [+voice] is an instruction to close the glottis, while [-voice] is an instruction to spread the glottis. If a privative feature encodes an effortful articulatory deviation in contrast to a neutral, default, unspecified state (Steriade 1995:152), [voice] cannot be privative, because both voicing and voicelessness require active glottal gestures. However, it is an oversimplification to link each feature value with a single type of muscle instruction, since

voicing and voicelessness can be effected through more than one kind of gesture. Adduction and abduction of the vocal folds is the main manner of implementing [voice], but it is also possible to marshall "helping mechanisms," e.g. nasal leak, to achieve the desired voiced or voiceless output where adduction or abduction alone cannot do the job.

In the following discussion, I shall therefore take the position that a feature represents an acoustic target, and the speaker has knowledge of a set of articulatory strategies for achieving the target. This makes sense given that a child acquires language by hearing "sounds, not tongues" (Ohala 1996). The presence of deliberate articulatory gestures is thus an empirically testable diagnostic for the presence or absence of a surface feature value. Both [+F] and [-F] segments should show evidence of active articulations aimed at producing or maintaining some acoustic target encoded by feature [F] throughout the duration of the segment. In the case of [0 F], no active articulatory gesture will be made since there is no acoustic target, and coarticulation or interpolation of neighboring features through the surface-unspecified segment is predicted (Keating 1988). The next section will explore the specific types of articulatory gestures involved in the production of [-voice].

3.2.2 Active versus passive devoicing of stops

Dixit (1987) observes that cross-linguistically, voicing is controlled by the widening and narrowing of the glottis. In general, an adducted (closed or narrowed) glottis results in voicing, whereas an abducted (widened) glottis results in voicelessness. From the laryngeal muscles' point of view, the productions of voicing and voicelessness both require activity, and neither can be considered a "rest" or neutral state with respect to the other.

Dixit examines a variety of mechanisms for the control of voicing and devoicing. It turns out that a number of additional conditions are necessary for voicing even when the vocal folds are adducted - namely, an unobstructed supraglottal vocal tract, and an adequate level of airflow through the vocal tract. The fact that interruption of either of these conditions can cause devoicing implies that there are multiple ways to devoice a stop.

I divide voiceless stops into three categories. First, there is the "normal" case of stops produced by widening of the vocal folds during stop closure. Because the vocal folds are too far apart, vibration cannot occur and voicing ceases quickly. Since an active muscle gesture is implemented to halt voicing, I represent these stops as [-voice]. Secondly, there are voiceless stops which are produced with adducted vocal folds, but where the other conditions necessary for voicing are not present. This is the universal resultant state of affairs during stops: all stop closures obstruct the glottal tract and halt airflow, independently of any gesture to effect voicing or devoicing. Given the compliance (relaxed state) of the tissue surrounding the larynx, and all other things being equal, voicing continues approximately 60 ms into the closure before naturally ceasing (Westbury and Keating 1986). This is called "passive devoicing" because it is simply the byproduct of stop closure, rather than any active attempt to either continue or halt voicing of the stop. Westbury and Keating cite Harms's (1978) observation that "the second /d/ in the phrase *mad dog* often seems to be devoiced, though probably for 'natural' reasons... rather than because of any intentional change in the glottal state." Since there is no articulatory effort made, I will represent these stops as [0 voice], with the prediction that, being acoustically targetless, they will tend to take on the laryngeal posture of neighboring segments and exhibit a context-dependent range of variation in their level of voicing.[1]

There is a third class of voiceless stops: those produced with an closed or nearly closed glottis, but for which voicing ceases almost immediately rather than after the expected 60-80 ms. According to studies cited by Dixit, voiceless stops of this type exist in Hindi, Cantonese, Danish, Fukienese, Icelandic, Mandarin, and Tibetan. Phonetic evidence shows that devoicing in these cases is controlled through "helping mechanisms" independent of the glottis. One such mechanism, used in Cantonese and Fukienese, is glottalization. Another mechanism, proposed by Halle and Stevens (1971) and apparently at work in

[1] Passive devoicing is not inevitable; there are ways to maintain voicing through the stop closure. According to Dixit, some helping mechanisms include slackening of the vocal folds, nasal leak, and expansion of the supraglottal cavity.

Hindi, is stiffening of the vocal folds. Finally, numerous studies are cited in support of high supraglottal pressure as a devoicing mechanism, effected by raising of the larynx by the pharynx muscles. Because there appears to be an acoustic target of voicelessness, as evidenced by articulatory gestures aimed at producing it, I classify these stops as [-voice]. These [-voice] stops are united with the "normal" (glottis-abducting) voiceless stops because of their common acoustic target. This third type is unlikely to occur in a language independently of the normal case; rather, helping mechanisms are a way to preserve the [-voice] target in specific contexts where [-voice] is required but the glottis is in a closed configuration.

The classification of voiceless stops is schematized in (13). Boldface indicates the active articulatory gestures that are responsible for the representation of the class as [-voice].

(13) Representations of voiceless stops

	a. [-voice]	b. [0 voice]	c. [-voice]
Glottis	**open**	closed	closed
Helping mechanisms?	n/a[2]	no	**yes**

Consistent with the prediction of separate [-voice] and [0 voice] classes, Ladefoged and Maddieson (1996:53) note that languages having only voiceless stops appear to divide into two groups. Many Polynesian languages (Hawaiian, Maori, Tongan) produce the stops with active vocal fold widening. Conversely, in many Australian languages, "the stops may be produced with no actual opening required, with vibration ceasing due to lack of efforts to sustain it." In a study of Tiwi, voicing continued in stops about 50 ms into the closure, the amount of time that Westbury and Keating (1986) predict for passive devoicing, which results from a drop in air pressure rather than active laryngeal movements (Anderson and Maddieson 1994). Thus, out of languages that do not contrast voicing in stops, we see a distinction between those that actively devoice their stops through changes of laryngeal

[2] Helping mechanisms may enhance voicelessness, but are not present of necessity.

posture, and languages where the larynx remains in the voicing configuration and devoicing is the natural consequence of stop closure.[3]

3.2.3 Case study: Taiwanese (Hsu 1998)

Taiwanese, as discussed by Hsu (1998), is an example of a language having the predicted three-way phonetic distinction between [+voice], [-voice], and [0 voice]. Taiwanese contrasts word-initial voiced and voiceless obstruents, but has word-final neutralization. Hsu distinguishes between neutralization due to *uniform specification* and neutralization due to *underspecification*, claiming that Taiwanese has the latter. This means that neutralization results in a lack of voicing specification, rather than [-voice] proper: the devoicing of word-final stops is passive, and not the result of active articulatory gestures.

Hsu shows that word-final stops are [0 voice] because they surface with the laryngeal configuration of neighboring segments; passive voicing and passive devoicing alike take place. The word-final stops are opposed to the demonstrably [+voice] and [-voice] word-initial stops, which never show such variation. By hypothesis, word-initial stops are always specified for [±voice], and word-final stops are always underspecified. The data in (14a) show the invariability of the specified stops, while (14b) shows the range of phonetic variability in unspecified stops. The charts in (14) are taken from Hsu (1998:93).

(14) Taiwanese [±voice] and [0 voice] stops

a. Word-initial [±voice]

	voiced	voiceless unasp.
utterance-initially	##ba	##pau
post-V	gɔ#ba	gɔ#pau
post-C	tsaP#ba	tsaP#pau

[3] The voicing underspecification of all Tiwi stops has a parallel in the Marshallese "vertical" vowel system, in which all vowels are demonstrably underspecified for [back] (Choi 1992).

b. Word-final [0 voice]

prepausal:	voiceless and glottalized	tsa^{ʔ}p##
pre-V:	voiced and reduced	tsaβ#aʔ/
pre-$C_{[+voi]}$	largely voiced	tsab#ba, tsab#mi)
pre-$C_{[-voi]}$	largely voiceless	tsap#pau, tsap#p^{h}a

Hsu observes:

> Word-initial closure voicing occurs consistently in all environments, and presumably, helping mechanisms such as nasal leak (Zhang 1983) are implemented, when necessary, to ensure that the appropriate aerodynamic condition for glottal vibration is present. Word-final voicing, on the other hand, occurs *only when*, and *as long as*, the aerodynamic condition appropriate for glottal vibration is naturally present; no helping mechanism such as nasal leak is implemented to ensure glottal vibration, and no inhibiting mechanism such as glottal spreading is implemented to prevent glottal vibration. [emphasis in original]

Hsu's phonetic measurements confirm that the [0 voice] stops are categorially distinct from [-voice] stops. The [0 voice] stops show the predicted 50-60 ms voicing into closure, while in an aerodynamic simulation of [-voice] stops, voicing only lasted 5-7 ms into closure, due to active glottal spreading.

Any privative-feature analysis will fail to capture the Taiwanese facts, because there are two distinct categories of voiceless stops. One is invariably voiceless and needs to be represented by [-voice]; the other is phonetically targetless and must be represented as [0 voice] to account for its observed range of voicing variability (which is context-dependent). Lastly, [+voice] is reserved for representing the invariably voiced stops. The two-way opposition afforded by a privative feature is insufficient to account for the three-way voicing contrast in Taiwanese, while the three values (plus, minus, and zero) of equipollent [voice] fit perfectly.

3.2.4 Residual issues in phonetic underspecification

Even stronger evidence for phonetic underspecification would be a language that had a minimal pair contrasting for [-voice] and [0 voice]. For example, it has been proposed for German (and Polish) that the neutralized stop in *Rad* is passively, not actively devoiced and thus phonetically distinct from the underlyingly voiceless stop in *Rat*, although both are usually transcribed as [rat] (Port and O'Dell 1985, Slowiaczek and Dinnsen 1985). Instead, *Rad* would be represented as [raT] or [rad̥]. According to Lombardi (1995), however, these studies involved reading tasks and were tainted by the influence of orthography; she cites Fourakis and Iverson (1984), whose study showed complete neutralization during a non-reading-based task. Regardless of what the case for German may be, the Taiwanese data demonstrate that perceived neutralization is not reliable, and that phonetic measurements are necessary to ascertain the correct representation of a neutralized segment. In Taiwanese, precise measurements showed the need for an extra feature value which was easily overlooked during crude observation. It remains to be seen how many languages besides Taiwanese exhibit the type of incomplete neutralization characterized by targetlessness and phonetic variability. The ramifications of this for phonological theory are discussed in 3.4.1.1.

3.3 Lexical evidence: Three-way contrasts

This section will present data that show a three-way contrast in phonological behavior with respect to the feature [voice], although presumably only a two-way phonemic contrast exists between voiced and voiceless segments. Following Inkelas (1995) in the paradigm of Archiphonemic Underspecification, I argue that the best analysis of the data requires a three-way contrast among segments underlyingly represented as [+voice], [-voice], and [0 voice]. The underspecified member of the opposition is *not* phonetically underspecified, because it acquires a full (plus or minus) specification on the surface through a feature-filling process. It should be noted that this phonological evidence for

equipollent features is independent of the phonetic evidence presented in 3.2, since it deals with a different type of phenomenon. However, the two types of phenomena are related: since [-voice] is a possible surface feature value, its existence underlyingly might also be expected (contrary to the claim of Lombardi 1996).

As argued in chapters 1 and 2, privative features are unable to capture three-way contrasts in a principled, coherent way. Equipollent features seem necessary to represent a three-way underlying distinction in any theory, derivational or constraint-based, that seeks to explain all three types of observed behavior within a single phonological system.

3.3.1 Turkish

In addition to the three-way backness distinction discussed in chapter 2, I now return to the three-way contrast in Turkish voicing behavior (Inkelas and Orgun 1995, Reiss 2001):

(15) Turkish voicing alternations

a. Alternating: [0 voice]
kanat 'wing' kanat-lar 'wing-pl.' kanad-ım 'wing-1sg.-poss.'

b. Non-alternating voiceless: [-voice]
sanat 'art' sanat-lar 'art-pl.' sanat-ım 'art-1sg.-poss.'

c. Non-alternating voiced: [+voice]
etüd 'etude' etüd-ler 'etude-pl.' etüd-üm 'etude-1sg.-poss.'

In (15a), the coronal stop surfaces as [t] in coda position, and [d] intervocalically. The coronal stop in (15b), on the other hand, is always voiceless [t]. This alternation has been handled in some analyses as coda devoicing, where (15b) is prespecified for [-voice], (15a) is prespecified for [+voice], and the [+voice] delinks in coda position (Kaisse 1986, Rice

1990). However, in (15c), we see an additional case: voiced [d] exhibits the same kind of invariant behavior that [t] does in (15a).

The alternation in (15) can be explained by two feature-filling processes: one inserts [-voice] into codas, and one inserts [+voice] into onsets. Being feature-filling, they only apply to segments that are not already specified, so the coda stops in words like *sanat* and *etüd* retain their underlying values in all syllable positions throughout the paradigm. Inkelas (1995) and Inkelas, Orgun, and Zoll (1997) claim that because of Lexicon Optimization, children posit underlying features that are identical to the surface features (15b,c), except where an alternation gives evidence that the segment is underspecified. In this case, the fact that there are two invariant members and one variant member supports the idea that the operative feature values are indeed [+F], [-F], and [0 F].

The objection may be raised that (15c) is an exceptional pattern, since it is confined to loanwords, and that one should not extend the phonology of "real" Turkish simply to account for something that is not part of "real" Turkish anyway. As argued in 2.2.3, special exception mechanisms such as diacritics and cophonologies are not independently motivated, and it may be difficult for the child to figure out what is an exception and what is not, since the invariant-voiced pattern (15a) is a mirror-image of the invariant-voiceless pattern (15c). Thus it seems sensible to use the already-motivated mechanism of prespecification, which can - and should - be subjected to further tests, since it makes concrete predictions regarding the interaction of prespecified segments with other processes in the languages which refer to the feature value in question. The next section, 3.3.2, deals with a three-way underlying contrast that does not appear to be exceptional.

3.3.2 Île de Groix Breton

According to Krämer (2000), the Breton dialect of the Île de Groix features a three-way contrast among segments underlyingly specified for [+voice], [0 voice], and [-voice]. As illustrated in (16), Breton has word-final voicing neutralization in obstruents. Obstruents can be voiced in onset position only.

(16) Final devoicing in Île de Groix Breton

singular	plural	
a. pout	poudew	'pot'
b. kurt	kurtew	'cour'
c. korf	korvew	'corps'
d. grek	grekew	'cafetière'

In Breton, obstruent clusters agree for voicing. The dialect discussed by Krämer has regressive assimilation of both voice and voicelessness, in addition to progressive assimilation of voicelessness (17). The direction of assimilation appears to be unpredictable.

(17) Cluster assimilation in Île de Groix Breton

i. Regressive assimilation

rok donet	rog donet	'before coming'
rmemes byxej	rmemez byxej	'the same life'

ii. Progressive assimilation

tra nəvaŋk demp	tra nəvaŋk temp	'we don't miss anything'
ərbeis bijãn	ərbeis pijãn	'the little finger'

This unpredictability is further illustrated by the minimal pairs in (18). Given a word beginning with a voiced obstruent, it is not immediately obvious whether that obstruent will

devoice (as a result of progressive assimilation, 18b,c) or spread its voicing to the final segment of the preceding word (regressive assimilation, 18a).

(18) Two kinds of voiced obstruents

a.	unačypaš luggage	+	ba:k boat	unačypažba:k boat-luggage
b.	unačypaš luggage	+	bənak any	unačypašpənak any luggage
c.	urmi:s a month	+	bənak any	urmi:spənak any month

Krämer claims that the direction of assimilation is in fact predictable if we assume that the [b] in [ba:k] has a different underlying specification than the [b] in [bənak]. Since [ba:k] always surfaces with a voiced onset, we may assume that its invariance is caused by an underlying [+voice] specification, which triggers regressive assimilation. Under this analysis, the alternating morpheme in (18b,c) is underspecified; it acquires a [+voice] specification utterance-initially, but surfaces as [-voice] after voiceless segments, by processes which remain to be worked out.

(19) Three-way contrast in onset voicing behavior

a.	/ba:k/	->	[ba:k]	[+voice]
b.	/B´nak/	->	[bənak]/ # __	[0 voice]
	/B´nak/	->	[pənak]/[-V]__	
c.	/pout/	->	[pout]	[-voice]

Regressive assimilation, then, is triggered by underlyingly [+voice] stops, while apparent cases of progressive assimilation occur when C_2 of a C_1C_2 cluster is underlyingly unspecified for [voice]. Because of Breton Final Devoicing, assimilation does not apply to heterosyllabic voiceless-voiceless clusters.

It is unclear from Krämer's discussion whether or not any of the words in (19) are considered exceptional. If not, the Île de Groix dialect of Breton provides even more convincing evidence for representing a three-way underlying distinction by invoking binary features plus underspecification as a third option. Because the representation of exceptionality as prespecification is potentially controversial, equality of distribution of a three-way voicing behavior contrast strengthens the claim that the contrast is represented by different values of a single feature.

3.3.3 Bakairi

Our last example of a three-way underlying contrast comes from Bakairi, a southern Carib language spoken by about 350 people in the state of Mato Grosso in Brazil (Rodrigues 1986). The discussion presented here closely follows the analysis in Wetzels and Mascaró (2001), henceforth WM, whose data are from de Souza (1991, 1995). Bakairi has monosyllabic and polysyllabic roots consisting of V and CV syllables, and an OCP-type effect whereby in many words, obstruents alternate for voicing starting from the first intervocalic obstruent (20a,b,c). In some other words, only voiced consonants appear (20d). Word-initial obstruents are always voiceless (20a,c).[4]

(20) Bakairi voicing alternations

Type I: alternating; first intervocalic C = [+voice]

a.	tɔ**z**e**k**a**d**ɔ	+	- +	'bench'
b.	**ə**d**ə**p**i**g**ɨ**	+	- +	'heat'

Type II: alternating; first intervocalic C = [-voice]

c.	pe**k**ɔ**d**ɔ	-	+	'woman'

Type III: nonalternating; first intervocalic C = [0 voice] (see (21))

d.	a**z**a**g**e	+	+	'two'

[4] WM note that words with more than one occurrence of [-voice] (apart from the initial consonant) are unattested in Bakairi. They suggest that this is due to a cooccurrence restriction on [-voice], but do not provide evidence that it is a synchronically active process rather than simply a surface-true generalization. Mester and Ito (1989) describe Lyman's Law in Japanese, an apparent cooccurrence restriction on [+voice], and claim that the absence of attested restrictions on [-voice] is an argument in favor of privative [voice]. If a cooccurrence restriction does exist in Bakairi, it would refute Mester and Ito's argument.

WM account for the three-way distinction by positing that the first intervocalic obstruent is the only position of voicing contrast, and that three different underlying specifications appear. Types I and II have prespecification for [+voice] and [-voice], respectively. These lexical values then trigger OCP-driven dissimilation from left to right through the rest of the word. Type III, meanwhile, has no lexical voicing specifications, so dissimilation does not apply. Subsequent processes insert [-voice] word-initially and, crucially, [+voice] intervocalically. Insertions (particularly of [+voice]) are feature-filling rather than feature-changing, so in type III words, all intervocalic consonants become voiced since they are underlyingly not specified. In types I and II, this process applies vacuously because all obstruents have already acquired specifications due to the OCP. In (21), capital letters /P T K/ represent underspecified obstruents. Consonants are boldfaced at the stage of the derivation where they acquire specification; OCP triggers are underlined.

(21) Analysis of Bakairi: monomorphemes (WM)

UR	a. /Tɔ**z**eKaTɔ/	b. /Pe**k**ɔTɔ/	c. /aSaKe/
OCP	Tɔz̲e**ka**d̲ɔ	Pek̲ɔ**d**ɔ	---
[- voi]/#__	**t**ɔzekadɔ	**p**ekɔdɔ	---
[+voi]/V_V	---	---	a**z**a**g**e
SR	[tɔzekadɔ]	[pekɔdɔ]	[azage]

It is crucial to show that the processes in (21) are synchronically active in the phonology, since one can easily object at this point that all consonants are lexically specified for [±voice] and no analysis is needed. These phonological processes are necessary because they appear to drive morphemic alternations, as illustrated in (22). (The root-final vowel alternation in (22a) is assumed to be irrelevant for the voicing analysis.)

(22) Analysis of Bakairi: polymorphemic words

a. tɔkɔ 'bow' vs. tɔ-dɔ̲ka-ge 'have a bow'

UR	/T**ɔ**k**ɔ**/	/Tɔ-T**ɔ**k**a**-K**e**/
OCP	---	Tɔ-Tɔ̲k**a**-**g**e
[- voi]/#__	**t**ɔkɔ	**t**ɔ-Tɔka-ge
[+voi]/V_V	---	tɔ-**d**ɔka-ge
SR	[tɔkɔ]	[tɔ-dɔka-ge]

b. n-i̶ge-aki 3-die-past vs. n-i̶ke-agi 3-sleep-past

UR	/n-i̶**g**e-aKi/	/n-i̶**k**e-aKi/
OCP	n-i̶ge-a**k**i	n-i̶̲k̲e-a**g**i
[+voi]/V_V	---	---
SR	[n-i̶ge-aki]	[n-i̶ke-agi]

Because feature-changing rules are potentially too powerful a mechanism, this analysis takes surface voicing alternations as evidence of underspecification combined with feature-filling rules.

The Bakairi argument for equipollent [voice] needs one more piece. Pursuant to my goal of being as theory-independent as possible, a minimal triplet would be the most satisfying way to demonstrate a three-way underlying [voice] contrast. This minimal triplet would look something like (23). I have been unable to find this kind of alternation; further research is necessary to establish its existence (or lack thereof).

(23) Hypothetical minimal triplet

a.	n-i̶ge-aki	3-die-past	(attested)	[+voice]
b.	n-i̶ke-agi	3-sleep-past	(attested)	[- voice]
c.	n-i̶ge-agi	3-???-past	???	[0 voice]

The fact that some voiceless segments - i.e. the ones in initial intervocalic position - fail to alternate, combined with the fact that other segments (e.g., suffix obstruents) do, constitutes a potential argument for separate lexical [-voice] and [0 voice] values. However, in the absence of (23c), we cannot be sure that /k/ in (23b) is [- voice] rather than [0 voice], because in OT it is possible to enforce a wide variety of alternations. For example, one can get the Bakairi pattern with privative [voice] by positing a set of constraints that require faithfulness to [0 voice] specification of root-morpheme consonants, the leftmost intervocalic consonant, etc., to form a *positional faithfulness* account, rather than one based on differences in feature values.

It is perhaps more likely that a minimal triplet will be found among polysyllabic roots, of the type in (21), rather than in monosyllabic roots (22). In monosyllabic roots, as we see in (22), the three-way contrast only manifests itself through triggering or failing to trigger suffix alternations; in the absence of a suffix, only a two-way contrast is apparent. However, a minimal triplet of polysyllabic roots would always present a clear three-way distinction, since the root's final syllables would show the effects of dissimilation (or lack thereof).

In sum, Turkish, Breton, and Bakairi are three unrelated languages which have an observed three-way surface contrast in phonological voicing behavior. The three-way surface contrast is the result of three distinctive underlying representations, which are claimed to be the values [+voice], [-voice], and [0 voice].

3.4 [+voice] and [-voice] in assimilation and neutralization

In this section I will discuss phenomena involving the apparent spreading of [-voice]. Such phenomena are a problem for privative theories which predict the inertness (and therefore nonexistence) of minus values of features. This discussion parallels the attempt in 2.2 to argue for equipollent features by showing that both values are phonologically active.

3.4.1 Assimilation in obstruent clusters: a descriptive typology

In support of privative [voice], Mester and Ito (1989:282) offer a reanalysis of English plural formation, which is often considered to involve spreading of [-voice]. The underlying form of the morpheme is often taken to be /z/, because postvocalically it is ostensibly unaffected by assimilation, and in that environment it surfaces as /z/ (24c).

(24) English plural formation

a.	/dog + z/	---	dog[z]
b.	/cat + z/	(spread of [-voice])	cat[s]
c.	/lunch + z/	(vowel epenthesis)	lunch[ɪz]

Mester and Ito propose that (24b) is not the result of a language-specific rule spreading [-voice], but rather is "triggered by universal syllable well-formedness": syllable-final clusters that disagree for voicing are universally prohibited.

This analysis, applicable only to syllable-final clusters, does not explain cluster assimilation across syllable boundaries. (25) illustrates regressive voicing assimilation of heterosyllabic clusters in three different languages. Yiddish clusters agree for both voicing and voicelessness; Ukrainian for voicing only; and Makkan Arabic for voicelessness only. The existence of languages like Makkan Arabic, which spread voicelessness to the exclusion of voicing, is noteworthy. Such languages have been overlooked by advocates of privative voicing, while Ukrainian has been emphasized because the spreading activity of [+voice] contrasts with the apparent inertness - and thus, some argue, nonexistence - of [-voice]. Kenstowicz (1994) writes that "the monovalent model predicts the absence of languages that would reverse the Ukrainian situation by spreading [-voiced] but not [+voiced]... the fact that such cases are unattested makes monovalent [voice] an attractive hypothesis." In fact, the "anti-Ukrainian" case exists not just in Makkan Arabic, but in

Yorkshire English, Parisian French, and Ya:thê[5] as well, as discussed by Wetzels and Mascaró.

(25) Heterosyllabic cluster assimilation: preliminary typology

Yiddish (+V, -V):

a.	ko[p]	'head'	ko[b].vey.tik	'headache'
b.	vo[g]	'weight	vo[k].soi	'scale'

Ukrainian (+V only):

c.	li[tʃ]ɪ-tɪ	'count'-inf.	li[dʒ]-ba	'count'-nom.fem.
d.	li[ʒ]-ok	'bed'-gen.pl.	li[ʒ]-ko	'bed'-nom.neut.

Makkan Arabic (-V only):

e.	/ʔagsam/	[ʔaksam]	'he made an oath'
f.	/ʔakbar/	[ʔakbar]	'older'

Of course, it is not immediately obvious from (25e,f) that devoicing in Makkan Arabic is due to [-voice] assimilation. Another potential explanation is coda neutralization, whereby all coda obstruents would be required to be voiceless, regardless of the following consonant. However, (26) shows that this is not the case. Makkan has a voicing contrast word-finally, as well as in word-internal codas preceding sonorant onsets. Essentially, devoicing *only* takes place immediately before a voiceless obstruent. One can hardly help concluding that devoicing is triggered by the following voiceless obstruent, since coda-devoicing does not exist independently in the language. Data are from Abu-Mansour (1994, 2000):

[5] WM note that Ya:thê is a "clear example of the reversed Ukrainian situation" because "the spreading element is demonstrably the feature voiceless, not spread glottis, because voiceless obstruents contrast with aspirated ones" (p. 230).

(26) Laryngeal contrasts in coda position in Makkan Arabic

Word-finally:

i.	mar.kab	'boat'
ii.	mat.suus	'hidden'

Word-internally before sonorants:

i.	ǰis.mu	'his body'
ii.	/ib.nu	'his son'

Word-internally before voiced obstruents:

i.	/az.da.har	'he prospered'
ii.	/ak.bar	'older'

But not word-internally before voiceless obstruents:

i.	/mazkuur/	[maskuur]	'mentioned'
ii.	/maktab/	[maktab]	'office'

Clearly, devoicing in (26d) results from the neighboring [-voice] segment, and not from syllable position.

WM argue thoroughly and convincingly that Yiddish, Romanian, and Serbo-Croatian have no independent process of coda devoicing. In these three languages, along with Hungarian (Siptár and Törkenczy 2000), heterosyllabic obstruent clusters agree for voicing; either both members are voiced, or both are voiceless. In a privative theory, only [+voice] can spread, so a separate mechanism is needed to account for the apparent spreading of [-voice]. In Optimality Theory, an AGREE constraint can require obstruent clusters to match for either voicing specification or lack thereof, thus maintaining both privative [voice] and the generalization that the clusters agree for voicing. In an autosegmental theory, however, allowing [0 voice] to trigger deletion of neighboring [voice] features may result in formulation of a too-powerful and unprincipled type of rule - or at least, it seems reasonable to assume that a feature must exist in order to trigger phonological processes. In an autosegmental theory with privative [voice], then, the spreading of both values of [±voice] cannot be captured in a unified way.

The only solution to this is in languages like Makkan Arabic is to attribute apparent spreading of [-voice] to coda devoicing, and claim that word-final, pre-sonorant, and pre-

voiced-obstruent positions (i.e. everywhere except before voiceless obstruents) constitute exceptions, principled or otherwise (Lombardi 1991, 1995, as discussed below). The reason this seems even remotely plausible is that in languages do exist where derived voiceless obstruent clusters need not be attributed to [-voice] spreading. For example in German, coda obstruents are neutralized before voiced and voiceless segments alike by a general process of coda devoicing, so by Occam's razor we need not posit a separate mechanism of [-voice] spreading in German.

(27) German coda devoicing (Rubach 1990)

a.	Rad	[rat]	(word-finally)
b.	Admiral	[atmiral]	(word-internally before sonorant)
c.	Edgar	[etgar]	(word-internally before +V obstruent)
d.	Abteilung	a[pt]eilung	(word-internally before -V obstruent)

Even if there were a process of [-voice] spreading, it would be indistinguishable in these cases from the effect produced by coda devoicing.

3.4.1.1 The representation of neutralization: potential consequences

Or would it? Recall the discussion of active versus passive devoicing in 3.2.2, and the distinction made by Hsu (1998) between neutralization due to *uniform specification* and neutralization due to *underspecification*. Neutralization due to uniform specification would presumably involve delinking of [+voice], followed by insertion of [-voice] (according to what Mester and Ito call the "classical Praguean conception of the relation between neutralization and assimilation"). Neutralization due to underspecification entails delinking only.[6] In a language with neutralization due to underspecification, devoicing would be passive, i.e. [0 voice], and therefore phonetically distinct from a segment to which [-voice] had spread. Here I illustrate a hypothetical language with spreading of

[6] Here I only discuss the type of neutralization that would target only [+voice] segments. This is different from Taiwanese, where all coda obstruents are [0 voice].

[-voice] in heterosyllabic clusters, but passive devoicing word-finally:

(28) /kab.tad/ --> kap.taT
- + - + - - - 0
(transcribed by the casual listener as [kap.tat])

Freely combining each type of neutralization ([-voice] and [0 voice]) with an independent process of assimilation, I predict a partial typology as follows:

(29) Hypothetical sub-typology of laryngeal neutralization

Neutralization due to uniform specification:

a. i. /kab.tad/ [kap.tat]
ii. /kab.dad/ [kap.dat]

Neutralization due to underspecification:

b. With spreading of [-voice]:

i. /kab.tad/ [kap.taT]
ii. /kab.dad/ [kaP.daT]

c. With spreading of [+voice]:

i. /kab.tad/ [kaP.taT]
ii. /kab.dad/ [kab.daT]

d. No spreading:

i. /kab.tad/ [kaP.taT]
ii. /kab.dad/ [kaP.daT]

Specifications for [-voice] would manifest themselves in active devoicing, such as widening of the glottis, which would cause vibration to cease within 2 to 4 pitch periods of stop closure (Dixit 1987). In clusters, an effort to devoice the first stop from the very beginning of closure signals that the [-voice] value has spread leftwards. The phonetically underspecified /P/ in (29ci), which precedes a [-voice] stop, would be predicted to be passively devoiced, having voicing significantly longer into closure. Furthermore, the /P/ in (29cii) would be expected to show a greater amount of voicing, due to coarticulation with the following voiced segment.

One phonological prediction is that any postlexical processes referring to [+voice] or [-voice] segments will affect segments that have acquired feature specifications, whereas underspecified, coarticulated segments would not undergo such processes. Perhaps more promisingly, in a language having contrastive [0 voice] and [-voice] codas (the pattern controversially claimed for German and Polish), the spreading or non-spreading of [-voice] could be tested phonetically:

(30) Given:

a.	/kab/	[kaP]	
b.	/kap/	[kap]	

Test for [-voice] versus [0 voice] in word-internal codas:

c.	/kab.tap.tat/	[kaP.tap.tat]	(no [-voice] spreading)
		or [kap.tap.tat]	([-voice] spreading) ?

The answer can be ascertained by comparing the heterosyllabic clusters in (30c). If the clusters are phonetically identical, we can assume the representations are both [pt]. If voicing into closure is systematically longer in the first syllable coda, we can represent the clusters respectively as [Pt] and [pt].

Otherwise, however, any difference between coarticulation and phonological assimilation may be hard to determine for [0 voice] [-voice] clusters[7]. Hsu (1998) observes that in Taiwanese unaspirated $C_{[0\ voi]}.C_{[-voi]}$ clusters, C_1 has voicing only 25 ms into closure, rather than the 50-60 ms ceteris paribus case predicted by Westbury and Keating (1986). She claims that the reduced voicing time is due not acquisition of a [-voice] value, but to anticipatory coarticulation, i.e. preparation for the actively devoiced C_2. She points out that if C_1 has no [voice] value, spreading of the glottis should start at the beginning of C_1 closure and interpolate through C_1 to C_2, so this slightly reduced voicing time is expected. Thus it seems that any difference between a [-voice] C_1 and a [0 voice] C_1 would consist of extremely small and difficult things to measure, such as rate of glottal opening (quicker for [-voice], slower for [0 voice]). I hypothesize that the poor perceptual

[7] See Flemming's (1997) proposal for a unified treatment of assimilation and coarticulation.

salience of such a distinction (Steriade 1997) is likely to make these types of patterns diachronically unstable, although they may exist.

Given the apparent lack of consensus on the representation of neutralization in such a well-studied language as German, it would be overly speculative at this point to estimate the accuracy of the typology in (29). That is, I know of no language that has been proven to have a contrast between [-voice] and [0 voice] codas. Such a pattern would arise through a neutralization process that delinked [+voice] codas, but left [-voice] codas unaffected. Future phonetic research should shed much light on this issue. It is a crucial question, because the existence of such a language would confirm the existence of the feature value [-voice], and furthermore open the possibility that coda devoicing and regressive assimilation of voicelessness can interact in ways that (to my knowledge) have not been well investigated.

In the meantime, I shall return to the simple cases described above, where both [±voice] values spread in languages which have no independent process of coda devoicing. The table in (31) summarizes the main discussion in this section, based on the traditional typologies. It is normally considered impossible to tell if a language spreads [-voice] in heterosyllabic clusters if that language has coda devoicing, hence the blank cells in the lower right corner of the chart.

(31) Partial typology of assimilation and neutralization (C.C)

	No coda devoicing	Coda devoicing
spread [+voice]	Ukrainian	Dutch
spread [-voice]	Makkan Arabic	(see (X))
spread [±voice]	Yiddish	n/a

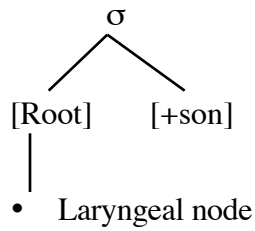
3.4.2 The Laryngeal Constraint (Lombardi 1991, 1995a)

The previous section brought up some potential problems for a privative theory of voicing, namely its inability to treat propagation of [-voice] and [+voice] by the same

mechanism, even though they appear to be parallel processes (31). In a language without an independent process of coda devoicing, a privative autosegmental theory cannot explain apparent [-voice] assimilation in heterosyllabic obstruent clusters. As observed by WM, the theory proposed by Lombardi (1991, 1995a) runs into these problems.[8]

Lombardi creates a typology of laryngeal neutralization based on the Laryngeal Constraint. The Laryngeal Constraint is a positive licensing constraint, stating the positions in which laryngeal features are allowed (as opposed to negative constraints, which state where something is prohibited). Essentially, it states that a language has coda devoicing.

(32) The Laryngeal Constraint (Lombardi 1991, 1995a)



The Laryngeal Constraint licenses a laryngeal node before a tautosyllabic sonorant, i.e. in onset position. In other positions, it is forbidden to have any laryngeal feature specifications at all; underspecification is mandatory. The feature [voice] is a dependent of the laryngeal node. Since in this theory [voice] is privative, voiced obstruents in coda position constitute the major class of Laryngeal Constraint violations. When a voiced obstruent occurs in coda position, deletion of the offending laryngeal node ensues as a "repair" operation, and the unlicensed voiced coda loses its voicing; it becomes neutralized. It is assumed that in the absence of laryngeal features, obstruents default to voiceless, and sonorants surface as voiced.

Languages either have the Laryngeal Constraint, or they do not. This gives us a two-way typology: languages which activate the Laryngeal Constraint and have coda

[8] Lombardi (1995b, 1999) later proposes an OT analysis of laryngeal neutralization, again assuming privative [voice], which I will not discuss here. See Butska (1998) and Wetzels and Mascaró (2001) for arguments that privative [voice] causes this analysis to fail as well, but for different reasons. Butska proposes an OT account incorporating [-voice]; WM suggest that a privative [voice] analysis is possible but undesirable, since [-voice] leads to more elegant explanations and is already motivated lexically.

devoicing, and languages which do not, and thus have a voicing contrast in all coda positions.

To this is added Spreading, which spreads a laryngeal node (voicing) leftward. The Spreading parameter is independent of the Laryngeal Constraint. Since [voice] is privative, only voicing assimilation can take place, never voicelessness assimilation. Now there are four types of languages, illustrated here:

(33) Typology predicted by Laryngeal Constraint and Spreading

a. LC + Spreading: Catalan

i.	me[s]	'month' (cf. me[z]os)
ii.	me[zβ]inent	'next month'

b. LC, no Spreading: German

i.	run[t]	'round' (cf. run[d]e)
ii.	run[tb]au	'rotunda'

c. Spreading, no LC: Ukrainian

i.	pro[z'b]a	'request' (cf. pro[s]ɪtɪ)
ii.	va[z]	'vase' gen.pl.

d. Neither LC nor Spreading: English

The typology in (33) reflects the fact that the Laryngeal Constraint and Spreading are roughly equivalent to the standard autosegmental mechanisms of coda devoicing and [+voice] spreading.

In a theory with equipollent [voice], [-voice] spreading constitutes a third possible mechanism. However, in Lombardi's theory, [-voice] does not exist, so it is here that Lombardi's analysis begins to differ substantively from the traditional one. There are two more types of languages to account for: those where clusters agree for both values of voicing, like Yiddish; and languages like Makkan Arabic where there is propagation of [-voice] but not [+voice].

Polish has word-final devoicing, and heterosyllabic obstruent clusters agree for both values of voicing (Bethin 1984, Lombardi 1991):

(34) Polish laryngeal alternations

Word-final devoicing:

a.	m[o]da	nom.sg.	m[ut]	gen.sg.	'fashion'
b.	s[o]ki	nom.pl.	s[o]k	nom.sg.	'juice'

Agreement for voicing (regressive):

c.	/prośba/	[prośba]	'request'

Agreement for voicelessness (regressive):

d.	/babka/	[bapka]	'grandmother'

Lombardi (1991) classifies Polish as having the Laryngeal Constraint (34a,b) and Spreading (34c). Note that the Laryngeal Constraint explains (34d) as well, since the neutralized segment is in coda position, so there is no need to refer to [-voice]. However, consider the following data from Hungarian (Siptár and Törkenczy 2000):

(35) Hungarian laryngeal alternations

No word-final devoicing:

a.	kút	'well'-noun
b.	kád	'tub'

Agreement for voicing (regressive):

c.	/kút-ban/	[kútban]	'in a well'

Agreement for voicelessness (regressive):

d.	/kád-tól/	[káttól]	'from a tub'

Contrast before sonorants:

e.	láb-nál	'at a foot'
f.	a[st.m]a	'asthma'

Hungarian has Spreading (of voicing), and also a process of devoicing (35d). The Laryngeal Constraint is the only way to enforce devoicing in the theory, but from the word-

final and word-internal contrasts, it seems doubtful that Hungarian devoices codas. For these cases, Lombardi posits a rule of Final Exceptionality. Languages that have the Laryngeal Constraint have access to a further parameter, Final Exceptionality, an "additional positive licensing constraint" which exempts word-final coda consonants from the Laryngeal Constraint. This enables a language to preserve word-final voicing contrast while still neutralizing all word-internal coda obstruents.

(36) Final Exceptionality (Lombardi 1995a:66)

Lar]$_w$

Not only is Final Exceptionality ad hoc, but it also fails to account for the facts. Coda devoicing clearly cannot explain the /b.n/ cluster in (35e). Since /t.m/ is allowed (35f), voice spreading cannot be the cause of /d.m/ either. There are no mechanisms left in the theory. Lombardi's theory, by interpreting [-voice] spreading as coda devoicing, stacks up a host of ad hoc mechanisms - Final Exceptionality, and now needs Exceptionality Before Sonorants (formulated as a process of Fusion of adjacent laryngeal nodes) - just to undo the original assumption. The generalization is that coda devoicing exists nowhere but before a voiceless obstruent. The assertion that all codas are devoiced - except word-finally, before sonorants and (in the case of Makkan Arabic) before voiced obstruents - seems a rather circular way of saying the same thing. Moreover, it misses the crucial generalization that coda obstruents devoice before voiceless obstruents precisely because of voicing agreement, just as with [+voice] spreading. Siptár and Törkenczy observe that the privative-[voice] Laryngeal Constraint can only account for Hungarian if we "loosen [it] to the point that it loses most of its initial appeal."

Thus we see how the inability to refer to [-voice] results in an inelegant analysis which misses not just a basic generalization, but also the typological symmetry between the behavior of [+voice] and [-voice]. In a later paper, Lombardi (1996) concedes that [-voice] is necessary to analyze certain patterns, but maintains that all of these are postlexical, and

therefore [voice] can still be privative in the lexical component. We have seen evidence in 3.2.3 and 3.3 that equipollent [voice] is indeed necessary in the lexical component. Secondly, WM observe that since the Laryngeal Constraint was devised to account for spreading, itself a postlexical phenomenon, the claim that voice is postlexically binary amounts to abandoning nearly all the arguments culled in Lombardi (1991, 1995a) in favor of privative [voice].

3.4.3 On the relationship between markedness and feature values

In the previous sections, I have claimed that [+voice] and [-voice] show parallel behaviors cross-linguistically with respect to spreading. They do not, however, behave in a parallel way with regard to positional neutralization. Coda *de*-voicing is extremely common, yet coda voicing is almost nonexistent.[9] In general, [-voice] is considered the "unmarked" value of the voiced/voiceless opposition: segments neutralize to voicelessness; voiceless stops seem to be simpler and easier to articulate; they are more common cross-linguistically; they are perceptually less salient; and so forth (Rice 1999). Since we want a theory of phonology that predicts precisely the range of possible human languages, it seems that there should be some kind of restriction within the theory to encode this asymmetry between the feature values. Otherwise, the theory seems to only formalize patterns, while lacking real explanatory power.

In an oft-quoted passage from Chapter Nine of *The Sound Pattern of English*, Chomsky and Halle (1968) discuss this intuition:

> The entire discussion of phonology in this book suffers from a fundamental theoretical inadequacy... The problem is that our approach to features, to rules, and to evaluation has been overly formal. Suppose, for example, that were systematically to interchange features... throughout our description of English structure. There is nothing in our account of linguistic theory to indicate that the result would be he description of a system that violates certain principles governing human languages. To the extent that this is true, we have failed to formulate the principles of linguistic theory, of universal grammar, in a satisfactory manner. In particular, we have not made any use of the fact that the features have intrinsic content.

[9] The only case of coda voicing known to me occurs in Lezgian (Haspelmath 1993, Yu 2002), but for historical reasons it appears to be restricted to a certain set of nouns.

Privative features are largely an attempt to formalize this markedness asymmetry. By eliminating an inert feature value from the inventory of representations, the inertness of that feature is encoded directly into the structure of universal feature geometry; it need not be explained by external stipulation.

Kenstowicz (1994:495) observes that Lombardi formulates the Laryngeal Constraint as a parameter that languages can either choose or not choose; "it functions as a 'soft' universal - a configuration of data that is found in many languages. The intuition is that such recurrent but not universal phonotactics have a different status from more arbitrary rules that must be learned." This appears to be the basic driving insight behind privative [voice].

However, we have seen that eliminating [-voice] from the feature inventory creates intractable problems because despite the asymmetry, [-voice] defines a phonologically significant natural class. [-voice] represents an active acoustic target, it is required as an underlying lexical value, and it is active in phonological processes. Privative [voice] is too radical because it takes the feature value that appears less active, and erases it completely, even though it is still needed. Besides the cases discussed above, for example, [-voice] is considered the marked value in sonorant consonants and all vowels.[10] Rice (1999) and Vaux (2002) call traditional notions of markedness into question by showing that markedness criteria do not always point to a single, expected value. This is why privative [voice] appears to work for the most part, but runs into occasional stumbling blocks. The correct account of observed asymmetries should explain why voicelessness is *less* active; it should not stipulate that [-voice] is inactive and then try to explain away the exceptions, especially when the data are symmetrical, as in the typology of [±voice] spreading. It seems that an explanation of asymmetry lies outside the formal structure of phonological representations.

[10] Proponents of privative feature theories (Lombardi 1991) claim that voiceless sonorants are underlyingly aspirated, rather than voiceless.

To return to the Laryngeal Constraint, its problem lies precisely in that it takes for granted a systematic asymmetry in the behavior of voicing and voicelessness, when the data in fact require both [+voice] and [-voice] to be active. On the assumption of privativity, the feature value [-voice] was eliminated and neutralization and assimilation were conflated. As a result, the theory missed the important generalization that in many languages, a voiceless segment caused devoicing of the segment preceding it. Any analysis using privative [voice] with "neutralization and spreading" (e.g. Mester and Ito 1989) is subject to the same problem in languages with no independent process of syllable-final neutralization.

Demonstration of parallel behavior was key. Lombardi (1995b) brings up the topic of regressive and progressive voicing assimilation, which, like assimilation of plus and minus voice, appear to be mirror-image processes whose asymmetry exists only in frequency of cross-linguistic distribution. Upon further examination, though, Lombardi concludes that "all cases [of progressive voicing assimilation] are restricted in some way: either their phonological or their morphological conditions are limited." Here there is a reason for differing analyses of the two phenomena. Because progressive assimilation occurs in a different, more restricted set of environments than regressive assimilation, they cannot be considered parallel behaviors, and the analyses should reflect this fact. However, Lombardi's asymmetrical analysis of laryngeal neutralization comes from the assumption that [voice] is privative, rather than observation of asymmetrical patterns in the data.

Because the Laryngeal Constraint parameter can only explain a few of many types of languages, the theory must jump through hoops to explain "unexpected" cases like Yiddish where assimilation and neutralization are clearly not the same process. Lombardi (1995b) notes the problem: "The result is that languages like Yiddish have a more complex grammar than languages like Polish. However, this additional complexity results from purely theory-internal considerations and does not seem to reflect any true generalization about the naturalness of the two patterns." This appears to make a testable prediction: the voicing pattern of languages like Yiddish should be more difficult to acquire (e.g. acquired

later by children, acquired after a series of erroneous "simpler" patterns). To my knowledge, this prediction has not been substantiated.

Privative features were originally advanced to explain markedness and asymmetry facts. The best whole theory will explain these, while making empirically true predictions. I have shown that equipollent [voice] is necessary to account for the range of phenomena attested in diverse languages. As for the explanatory component, I suggest that it lies outside the architecture of the feature system.

3.5 Summary

In this chapter, three kinds of evidence have been advanced in favor of equipollent [voice]: evidence from phonetics, lexical contrasts, and postlexical phonology.

Phonetically, [+voice] and [-voice] were defined as acoustic targets. In particular, the presence of active articulatory gestures and deliberate devoicing mechanisms, such as glottal spreading or vocal fold stiffening, was taken as evidence for a target represented as [-voice]. Hsu (1998) demonstrated the three-way distinction in Taiwanese between actively voiced stops, actively devoiced stops, and targetless ([0 voice]) stops that passively took on the laryngeal posture of the segments around them. The categorial distinction between [-voice] and [0 voice] showed that [voice] cannot be privative, because without a feature value for voicelessness, there is no way to distinguish the targetfulness of [-voice] from the passive behavior of [0 voice].

Next, lexical contrasts were presented, where in Turkish, Breton, and Bakairi, a three-way surface distinction in phonological behavior was traced to a three-way underlying distinction in specification for the feature [voice]. In Turkish and Breton, nonalternating segments were represented as prespecified for [+voice] or [-voice], while alternating segments were underspecified and acquired surface values through context-dependent feature-filling processes.

Thirdly, a typology of cluster assimilation showed that both [+voice] and [-voice] are active feature values, and exhibit parallel phonological behavior. A privative theory, unable to refer to [-voice], could not model the parallel behaviors in a parallel way, and could not account for the full range of facts without introducing a host of ad hoc mechanisms that effectively undid the original assumptions, and still missed important generalizations.

The three-way phonetic distinction and three-way lexical contrast translate directly into arguments for equipollent [voice] in Optimality Theory. Because OT can require adjacent segments to agree in their lack of specification for voicing, the argument from activity of both feature values does not automatically hold. However, I suggest that the analysis of assimilation should reflect the symmetrical nature of [+voice] and [-voice] behavior, and that [-voice] should be used since it is already well-motivated by the rest of the evidence.

Conclusion

In chapters 2 and 3, I presented evidence that privative [back] and privative [voice] cannot be maintained. Because [back] is a "symmetrical" feature, meaning that the existence of active backness and active frontness is generally accepted, it sufficed to show that both values were active in a single language (Turkish), and to argue that [±back] should not be split up into the privative features [front] and [back]. On the other hand, [voice] is an asymmetrical feature, one where *inherent* privativity is claimed to be the explanation for observed asymmetrical behavior, i.e. activity of just one value.

Now, for a moment, to flip the issue on its head: how would one go about demonstrating that a feature was definitively privative?

Ewen and van der Hulst (2001) note that the equipollent-feature hypothesis is logically unfalsifiable. No matter how many languages are found that have only one active value of [F], it is always possible that some unknown language in a remote part of the world has phonologically active [+F] and [-F], or that such a language once existed but is now extinct, etc.

There is just one type of argument that is possible for the inherent privativity of a feature. Since claiming that [F] is privative amounts to claiming that [-F] is an impossible natural class, it is possible to conjecture that features such as [-labial] encompass too disparate a set of segments, a set that has really has nothing in common. It has been proposed that all Place node features have this property (Pulleyblank 1995; Halle, Vaux, and Wolfe 2000).

Under the criterion of dissimilarity, features like [nasal] and [round] do not qualify for automatic privativity, since nonnasal segments all have orality in common, nonround segments have flattened lips in common, etc. When only a minority of segments in a language is nasal, we fail to recognize the common orality of nonnasals as significant.

However, in a language with a large number - even a majority - of nasal segments in the inventory, the common property of orality could well become phonologically significant.

The natural question is, Why don't these languages appear to exist, or if they do, why are they so rare? Digressing just a bit, I quote Chomsky and Halle (1968):

> Certain apparent linguistic universals may be the result merely of historical accident. For example, if only inhabitants of Tasmania survive a future war, it might be a property of all then existing languages that pitch is not used to differentiate lexical items. Accidental universals of this sort are of no importance for general linguistics, which attempts rather to characterize the range of possible human languages. The significant linguistic universals are those that must be assumed to be available to the child learning language as an a priori, innate endowment.

Rather than historical accident, the rarity of such languages may be due to the *physio-psychological* "accidents" of human speech perception and acquisition. Language inventories, over time, may tend to reduce to easily-acquired sounds, and phonological processes targeting perceptually salient segments may be more easily learned. Thus while speech perception and acquisition fall within the domain of linguistics, they are outside of phonology proper, which presumably prioritizes formalizing the range of possible human languages (Hale and Reiss 1998) over explaining the tendencies of common types of languages, in the case that it is not possible to do both within a unified theory.

This is not a new idea, but I believe it is an important one. The evidence presented here suggests that it is not possible to combine the two goals into one theory, at least not into the architecture of the feature system. Privative features, in particular those proposed on grounds of markedness, fail precisely because they attempt to do this.

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