The consequences of Optimization for Underspecification

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1 Introduction

This paper[*] argues for a theory in which underlying representation is determined solely by optimization with respect to the grammar, not by imposing any type of constraints directly on underlying representation. This approach has important consequences for underspecification, changing the way in which this and other properties of underlying structure are deployed. In particular, I show that an optimization approach, couched within Optimality Theory (Prince and Smolensky 1993), results in the use of underspecification only when there are alternant surface forms all of which are predictable from context or grammatical defaults.

2 Background

We begin with a definition of underspecification[1]:

(1) UNDERSPECIFICATION: the state of affairs in which a segment which surfaces with some phonological material M is not specified for M in the input to some phonological level.

In most discussions of underspecification, M is featural (as observed by Archangeli 1988), and the level is initial, although in reality metrical structure and intermediate levels of representation are equally relevant. In this paper I will, for convenience, restrict myself to discussing underspecification in underlying representation, but I will consider material other than features.

Underspecification has been controversial since its earliest existence, drawing fire early from Stanley 1967 and more recently from Mohanan 1991, McCarthy and Taub 1992, Smolensky 1993, Steriade 1994, and others. Aside from Stanley, to whom I'll turn later on, virtually all objections to underspecification have actually been objections to various principles designed to regulate the distribution of this alluring device. Though there is considerable variation in their exact details, proposed principles of underspecification fall into three (often overlapping) clusters:

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[1] Defining underspecification in this way actually eliminates the kind of underspecification discussed by Stanley 1967, in which morphemes may be underspecified underlyingly but, through the application of redundancy rules, are fully specified in the input to the first application of phonological rules.

(2) •**Markedness** (universal, language-specific, or contextual); unmarked material is underspecified (e.g. Kiparsky 1982, Pulleyblank 1983, Kiparsky 1993)
•**Redundancy**; redundant feature values (determined on the basis of the segment inventory) are underspecified (e.g. Clements 1987, Steriade 1987, Christdas 1988, Mester and Itô 1989)
•**Predictability**: predictable material is underspecified (e.g. Ringen 1975, Kiparsky 1982, 1993; Archangeli 1984, Pulleyblank 1988, Archangeli and Pulleyblank 1989)

Critics of underspecification have pointed out that there are counterexamples to each of these principles, and that as a result underspecification lacks principled deployment in linguistic analyses (McCarthy and Taub 1992, Smolensky 1993, Steriade 1994). Unfortunately, however, such criticisms sometimes fail to clearly decouple the situation of underspecification from the tainted principles intended to govern it, leading to the implicit, sometimes explicit, conclusion that underspecification is equally untenable. Thus Smolensky 1993 and McCarthy 1994 have claimed it to be a virtue of Optimality Theory (Prince and Smolensky 1993) that underspecification is unnecessary in the analysis of various phenomena — for example, transparency effects and neutralization — once thought to require it.

In this paper I concur with critics of underspecification that principles of the type in (2) do not belong in phonological theory. However, I also argue that underspecification is necessary, even in Optimality Theory, and that it cannot simply be withdrawn from the phonologist's toolbox in order to avoid the difficult issue of figuring out its distribution.

One general flaw that binds the principles in (20) together is the regulation of underspecification in a grammar-blind fashion without regard for the alternations in a language. I propose a new theory in which underspecification, and for that manner all aspects of underlying form, are distributed so as to optimize input-ouput mappings in grammar. The only motivation for underspecification is to capture alternations in the optimal way.

3 The necessity of underspecification and full specification

We begin with a demonstration that a contrast between underspecification and its opposite, full specification, is necessary to the pure description of certain alternations[2]. From this it will follow that principles of the kind in (2) are impossible to maintain. The relevant data involve three-way contrasts in a single feature, phenomena which are marginalized in much phonological work but which ought to play a central role in grammar construction.

3.1 Voicing alternations in Turkish (Inkelas and Orgun 1994)

Root-final plosives in Turkish exhibit three different types of behavior (Inkelas and Orgun 1994; see also Kaisse 1986, Rice 1990). Some, as illustrated in (3a), alternate between being voiceless in coda position and voiced in onset position. Others, as in (3b), are consistently voiceless. Still others, as in (3c), are consistently voiced.

[2] I believe this same point is made in the 1993 dissertation of Michael Broe, which I have not yet obtained a copy of. The ternary use of a binary-valued feature has also been proposed by Clements 1976, Archangeli and Pulleyblank 1992, and many others, though such proposals have often been criticized; see section 6 for discussion.

(3) a. Alternating root-final plosive:

kanat	‘wing’	kanad-ɨ	‘wing-Acc’
kanat-lar	‘wing-pl’	kanad-ɨm	‘wing-1sg.poss’

b. Nonalternating voiceless plosive:

sanat	‘art’	sanat-ɨ	‘art-Acc’
sanat-lar	‘art-pl’	sanat-ɨm	‘art-1sg.poss’

c. Nonalternating voiced plosive:

etüd	‘etude’	etüd-ü	‘etude-Acc’
etüd-ler	‘etude-pl’	etüd-üm	‘etude-1sg.poss’

This is a genuine three-way contrast and requires the contrastive use of underspecification, as shown in (4). The root-final plosive in (3a) is unspecified for [voice], while those illustrated in (b) and (c) are prespecified as voiceless and voiced, respectively.

(4) Underlying representations:

/kanaD/	Ø
/sanat/	[–voiced]
/etüd/	[+voiced]

Coda and onset voice specifications are assigned in a purely structure-filling manner, affecting only underspecified representations (Inkelas and Orgun 1994).

3.2 Vowel harmony in Turkish

Turkish vowel harmony (see Clements and Sezer 1982) provides a similar example. The plural suffix in (5), like many others in Turkish, displays the well-known front-back harmony, surfacing as back following a root whose final vowel is back (a) and otherwise as front (b):

(5)

a.		b.	
at-lar	‘horse-pl’	ek-ler	‘affix-pl’
kadɨn-lar	‘woman-pl’	etüd-ler	‘etude-pl’
čoǰuk-lar	‘child-pl’	filim-ler	‘film-pl’

In contrast to the alternating plural suffix vowel, however, both nonalternating front and back suffix vowels exist as well. /-ken/, in (6a), surfaces with a front vowel in the context of both back (i) and front (ii) roots; similarly, the second vowel in the progressive suffix in (6b) surfaces as /o/, a back vowel, regardless of what root it attaches to. (Note that the first vowel in this same suffix *does* alternate, precluding any level-ordered or other morphological account of the lack of harmony.)

(6)

a. Nonalternating front suffix vowel			b. Nonalternating back suffix vowel		
i.	at-ken	‘horse-while.being’	i.	at-ɨyor	‘throw-progressive’
ii.	ek-ken	‘affix-while.being’	ii.	gel-iyor	‘come-progressive’

Here again, a three-way contrast requires the use of underlying underspecification (7) to distinguish the suffix vowels in (5) and (6):

(7) Underlying representations: /-lEr/ Ø
/-ken/ [–back]
/-Iyor/ [+back]

To interact properly with these representations to derive the correct surface forms, vowel harmony must be a purely structure-filling alternation (as in Clements and Sezer 1982).

3.3 Tonal assimilation in Margi

Our final example of a three-way contrasts comes from tonal alternations in Margi (Pulleyblank 1986). The suffixes in (8) assume in tone to the root they combine with, whether L(ow) (a) or H(igh) (b):

(8)	a.	ghà + na	→ [ghànà]	'to shoot away'	p. 104
		tá + na	→ [táná]	'to cook and put aside'	p. 105
	b.	tsá + ri	→ [tsárí]	'to knock at'	p. 124
		nə̀ + ri	→ [nə̀rì]	'to tell a person'	p. 124

Similarly, the alternating roots in (9) assume whatever value for tone is specified on the suffixes that they combine with[3]:

(9)	a.	məl + iá	→ [mə́liá]	'to make (ready)'	p. 72, 124
		ŋal + bá	→ [ŋálbá]	'to bite a hole'	p. 72, 89
	b.	hər + ɗà	→ [hə̀ɗà]	'bring me'	p. 72, 124
		skə + ɗà	→ [skə̀ɗà]	'wait for me'	p. 73

These alternating morphemes contrast with fixed-tone morphemes (including the roots in (8) and the suffixes in (9)), as is clearly shown by the following examples in which each morpheme retains its own tone:

(10)

Fixed	H suffix		L suffix	
H root	tá + bá	'to cook all' (p. 124)	ná + ɗà	'give me' (p. 199)
L root	dzà'ù + bá	'to pound well' (p. 196)	ptsà + 'yà	'roast us' (p. 124)

Once again, a three-way contrast (alternating vs. fixed L vs. fixed H) can be captured only if underspecification is used contrastively to identify the alternating morphemes:

(11) Underlying representations: /məl/ Ø
/nə̀/ H
/ghà/ L

As analyzed by Pulleyblank 1986, tone spreading is a purely structure-filling alternation.

[3] Pulleyblank doesn't actually cite the same root combining with both H and L suffixes; nor, as far as I can tell, does Hoffman 1963, his data source. However, Hoffmann is quite clear about the existence of alternating roots.

3.4 The inadequacy of “exception” features in such cases

What the three forgoing examples all show is that underspecification is determined by *alternations*. No grammar-blind principles can therefore be adequate.

Before proceeding to outline a theory of underspecification that permits the contrasts in Turkish and Margi to be captured, however, it is necessary to dispense with an analytical device that undermines any debate over underlying representation. This is the use of exception features in rule-based theories or their counterparts in constraint-based theories.

Consider the contrast between /kanat/ and /etüd/, two of the examples from (3), presented again in (12). One alternative approach to contrasts like this has been to assign both final plosives the same underlying representation, say /d/, marking /etüd/, the morpheme with a nonalternating /d/, as an exception to the rule of Coda Devoicing:

(12) Exception feature (rule theory)

“Regular” grammar contains Coda Devoicing rule: $\begin{bmatrix}\text{–son}\\ \text{–cont}\end{bmatrix} \rightarrow$ [–voice] / __ $]_\sigma$

UR: /kanad/
/etüd/[–Coda Devoicing]

Works employing rule exception features include Lees 1961, Lightner 1965, Chomsky and Halle 1968, Harris 1969, Saciuk 1969, Kisseberth 1970, Kiparsky 1973, Schane 1973, Zonneveld 1978, Ringen 1978; Mohanan 1982; Halle and Vergnaud 1987, and many others.

This type of approach transcends rule theory, however. Its translation into Optimality Theory, for example, takes the form of morpheme-specific constraint reranking (Kisseberth 1993, Kirchner 1993, Pater 1994). (13) shows that, again, the alternating final plosive of the roots in (3a) and (3c) can be given the same underlying representation, /d/, as long as /etüd/ is associated with a special constraint ranking to protect its /d/ from devoicing. On the assumption that in the “regular”, devoicing grammar, the constraint responsible for coda devoicing outranks the constraint responsible for parsing underlying [+voice] features, exceptional forms such as /etüd/ must require the opposite ranking, such that underlying [+voice] survives on the surface:

(13) Constraint reranking (Optimality Theory)

Regular, devoicing grammar: NO-VOICED-CODA >> PARSE[VOICE]

UR: /kanad/
/etüd/[PARSE[VOICE] >> NO-VOICED-CODA]

Both approaches ((12) and (13)) are equivalent to assigning the two roots to different grammars (Inkelas, Orgun and Zoll 1994). Multiplication of grammars of course reduces the number of phonological contrasts needed underlyingly. The problem is that it reduces them too far. For example, we could assign a nonalternating root-final /t/ an underlying representation of /d/, making it equivalent underlyingly with the roots in (13) — as long as it is associated with yet a third grammar in which *all* plosives must devoice:

(14) UR: /kanad/$_{\text{[Grammar A]}}$ where Grammar A devoices coda plosives...
/etüd/$_{\text{[Grammar B]}}$ ...Grammar B devoices *no* plosives...
UR: /sanad/$_{\text{[Grammar C]}}$ ...and Grammar C devoices *all* plosives

Grammar multiplication ultimately makes phonological underlying representation entirely unnecessary, a scenario in which it is impossible to discuss underspecification at all. I will, therefore, proceed on the assumption that rule features or their equivalents are off-limits (Inkelas, Orgun, and Zoll 1994). Underlying representation *has* to matter, underspecification *is* necessary to capture three-way contrasts, and grammar-blind principles of underspecification cannot be right.

3.5 The inherently unprincipled nature of underspecification

We have now concluded that we need a device, underspecification, which is governed by no known principles. In section 4 I make a proposal to restore underspecification to principled status. The claim is that underspecification, and, for that matter, all aspects of underlying structure, should be determined solely by Lexicon Optimization and not by any constraints holding directly on underlying form.

4 The inherently principled nature of underspecification

Lexicon Optimization, developed by Prince and Smolensky 1993 for Optimality Theory, is a principle which, given the surface form of a morpheme and knowledge of the grammar, selects the optimal underlying representation for that morpheme:

(15) Lexicon Optimization (Prince and Smolensky 1993:192):

> "Suppose that several different inputs I_1, I_2, ..., I_n when parsed by a grammar G lead to corresponding outputs O_1, O_2, ..., O_n, all of which are realized as the same phonetic form Φ — these inputs are all *phonetically equivalent* with respect to G. Now one of these outputs must be the most harmonic, by virtue of incurring the least significant violation marks: suppose this optimal one is labelled O_k. Then the learner should choose, as the underlying form for Φ, the input I_k."

Lexicon Optimization may be paraphrased as follows: of all possible underlying representations that could generate the attested phonetic form of a given morpheme, that particular underlying representation is chosen whose mapping to phonetic form incurs the fewest violations of highly ranked grammatical constraints.

As stated, the principle in (15) deals only with morphemes with a single phonetic realization. The present paper is, of course, also concerned with morphemes that have more than one surface alternant; thus in (16) I offer a restatement of Lexicon Optimization which takes alternation into account.

(16) Alternation-sensitive restatement of Lexicon Optimization:

> Given a grammar G and a set S = {S_1, S_2, ... S_i} of surface phonetic forms for a morpheme M, suppose that there is a set of inputs I = {I_1, I_2, ... I_j}, each of whose members has a set

of surface realizations equivalent to S. There is some $I_i \in I$ such that the mapping between I_i and the members of S is the most harmonic with respect to G, i.e. incurs the fewest marks for the highest ranked constraints. The learner should choose I_i as the underlying representation for M.

In other words, given a set S of surface forms for a morpheme M, assume that there is a set of inputs each of whose members has a set of surface realizations equivalent to S. There is some input whose mapping to surface forms is the most harmonic. The learner chooses that input as the underlying representation of M.

(17) illustrates Lexicon Optimization at work in a toy grammar. In this Lexicon Optimization tableau, recognizable by the "LO" insignia in the upper left corner, row sets (a) and (b) contrast two underlying representations for a morpheme whose surface alternants are [ta] and [ta:]. (This language lengthens vowels in unsuffixed roots to satisfy a bimoraic minimality condition.) In the tableau, input candidate (a) wins because its mapping to surface forms incurs less serious violations than that of candidate (b).

(17)

LO			example context	PARSE-μ	INSERT-μ
☞a.	/ta/	[ta]	ta-loŋ		
		[ta:]	ta:		*
b.	/ta:/	[ta]	ta-loŋ	*!	
		[ta:]	ta:		

In what follows, I apply Lexicon Optimization in a range of typologically selected examples to illustrate that it selects underspecification in some contexts and not in others. A preview of the results is shown in (18). The cells of interest are bolded. The significant conclusion to be reached is that underspecification is used only for alternating structure:

(18)

	Predictable	Unpredictable
Alternating	underspecification (§4.1)	full specification
Nonalternating	full specifiation (§4.2)	full specification

This novel, utilitarian result will be demonstrated by looking, in section 4.1, at alternating predictable structure, and, in section 4.2, at nonalternating predictable structure. (The use of full underlying specification for nonpredictable structure has never been challenged, and I will not discuss it further in the paper.)

4.1 Alternating structure, all alternants predictable: underspecification

We turn first to alternating structure of the entirely predictable sort.

4.1.1 Yoruba ATR harmony

As described by Pulleyblank 1988 and Archangeli and Pulleyblank 1989, Yoruba exhibits regressive harmony of the feature [Advanced Tongue Root] (ATR). The Yoruba vowel inventory is given in (19) (Archangeli and Pulleyblank 1989:174):

(19)

	i	e	ẹ	a	ọ	o	u
high	+	–	–	–	–	–	+
low	–	–	–	+	–	–	–
back	–	–	–	+	+	+	+
ATR	+	+	–	–	–	+	+

The data in (20) show ATR harmony in action. It applies from right to left, spreading the initial ATR specification of the root onto the prefix (a,b) (Archangeli and Pulleyblank 1989:188)[4]:

(20)	a.	ọ-de	'hunter'	(de	'hunt')	[A&P1989:188]
		ẹ́-rọ	'machine'	(rọ	'fabricate')	
	b.	ò-kú	'corpse of person'	(kú	'die')	
		è-rò	'a thought'	(rò	'think')	

ATR harmony is potentially structure-changing, as shown in (21a,b), where the first stem in a compound loses its own inherent ATR specification and takes on that of the second member:

(21)	a.	ọmọ	+	idan	→	omidan	*ọmidan	[A&P:189]
		'child'		'virgin'		'Miss'		
		àwọ̀	+	ejò	→	àwò ejò		[Pulleyblank 1988:238]
		'color'		'snake'		'color of a snake'		
	b.	ògbó	+	ẹni	→	ọ̀gbẹ́ni	*ògbẹ́ni	[A&P:190]
		'old'		'person'		'sir'		
		owó	+	ọmọ	→	owọ́ ọmọ		[Pulleyblank 1988:238]
		'money'		'child'		'child's money'		

From these data we know that the grammar of Yoruba is capable of deleting either value of [ATR] when needed to satisfy the needs of vowel harmony. The relevant constraint ranking is as follows:

(22) Feature-changing harmony: VOWEL.HARMONY >> PARSE[ATR VALUES]

The question at hand is, what is the underlying representation of the prefix vowels in (20)? The three logical possibilities for the prefix /o- ~ọ-/ are stated below:

(23) /o/ [+ATR]
/ọ/ [–ATR]
/O/ Ø

[4] As Archangeli and Pulleyblank observe (crediting Bamgboṣe 1986, who in turn apparently cites Owolabi 1981), there are certain exceptional roots which begin with [+ATR] high vowels but condition [–ATR] harmony on the prefix. Archangeli and Pulleyblank plausibly suggest that such roots are preceded in underlying representation by a floating [–ATR] feature which links to a prefix, if any.

Because ATR harmony is potentially feature-changing (22), all three possibilities will work. Only Lexicon Optimization can tell us which is optimal. The Lexicon Optimization tableau in (24) compares the possibilities in (23). Both of the fully specified candidate inputs in (a) and (b) incur PARSE violations. Only the underspecified input in (c) violates no relevant constraints, and this candidate wins. Lexicon Optimization has opted for underspecification[5].

(24)

LO			example context	PARSE[+ATR]	PARSE[ATR]
a.	/o/	o	o-ku 'corpse'	*!	*
		ọ	ọ-de 'hunter'	*!	*
b.	/ọ/	o	o-ku		*!
		ọ	ọ-de		*!
☞c.	/O/	o	o-ku		
		ọ	ọ-de		

An assumption I make, reflected in this tableau, is that markedness is encoded by grammatical constraints of the type proposed by Kiparsky 1994 (as opposed, e.g. to the constraints proposed in Prince and Smolensky 1993 or Smolensky 1993[6]). According to Kiparsky, each constraint (PARSE, FILL, SPREAD, etc.) has at least two versions: one holding generally over structure of a particular type (segments, vowels, place feature, etc.) and one (or more) holding specifically of the marked structure of that type.

(25) Capturing markedness in grammar (Kiparsky 1994):

CONSTRAINT$_i$[specific structure], CONSTRAINT$_i$[general structure]

e.g. PARSE[PLACE], PARSE[LABIAL], PARSE[DORSAL] (but not: PARSE[CORONAL])
PARSE[–HIGH], PARSE[HIGH] (but not: PARSE[+HIGH])

Thus in (25) we find PARSE[+ATR] — the specific constraint — and PARSE[ATR] — the marked constraint. No constraint refer to unmarked feature values, an important feature of Kiparsky's system. This will play a role later on.

4.1.2 Round harmony in Warlpiri

[5] Steriade 1994, who otherwise does not advocate the underspecification of binary-valued features, alludes to cases such as this on p. 53, suggesting that in the case of segments for which a given underlying feature or features could never surface, those features "are not underlyingly underspecified; rather, they are *unlearnable*, whether or not they are specified. They are unlearnable because they will never be in a position to manifest their existence."

But since the only way for an unlearnable feature specification to be underlyingly present is for it to be innate — an impossible conclusion if signs are arbitrary — it must be the case that unlearnable feature values *are* underlyingly underspecified.

[6] Prince and Smolensky 1993 and Smolensky 1993 assume a theory of markedness in which each feature value (whether marked or unmarked) is prohibited by a separate constraint (e.g *CORONAL, *LABIAL). The ranking of these constraints (e.g. *LABIAL >> *CORONAL) indicates which is the more marked. As Kiparsky 1994 observes, however, this approach cannot account for cases in which unmarked values delete in favor of marked ones.)

In Yoruba, the vowel harmony data totally determined the (relevant part of) the grammar, and Lexicon Optimization was therefore itself deterministic. But what happens when the data allow grammatical ambiguity? This case is illustrated by Warlpiri, whose progressive roundness harmony is illustrated by the forms in (26) (Nash 1986:86):

(26) kurdu-kurlu-rlu-lku-ju-lu ‘child-Prop-Erg-then-me-they’
maliki-kirli-rli-lki-ji-li ‘dog-Prop-Erg-then-me-they’

The alternating suffixes in (26) surface with /u/ when preceded by /u/ in the root, and with /i/ when preceded by /i/. They always attach to a base which determines their surface form. There are no nonalternating /u/ or /i/ vowels with which these alternating suffix vowels contrast (Nash does discuss one or two verbal suffixes which are fixed /i/ or /u/, but these apparently do not appear in the same morphological environments as the alternating suffixes in (26)).

Based on these data alone, we do not know whether harmony is potentially structure-changing, as assumed by Nash 1986 (27a), or purely structure-filling, as proposed by Kiparsky 1988 (27b):

(27) a. Structure-changing: VOWEL.HARMONY >> PARSE[+RD], PARSE[RD]
b. Purely structure-filling: PARSE[+RD], PARSE[RD] >> VOWEL.HARMONY

If the grammar is purely structure-filling, then we have no choice as the the underlying representation of the alternating suffix vowels in (26); they must be underlyingly underspecified. But if the grammar is structure-changing, then we have a choice: the suffix vowels could be underlyingly /i/, /u/, or unspecified. In this case we have the same situation as in Yoruba, and Lexicon Optimization will achieve the same result: underspecification.

(28) Underlying representation for alternating suffixes in (26), e.g. /-kirli~ -kurlu/: /-kIrlI/

(by Lexicon Optimization given (27a); by descriptive adequacy given (27b))

The situation changes, however, when (29) is taken into account. Roots whose final vowel is /a/ condition [+round] harmony on suffix vowels:

(29) minija-kurlu-rlu-lku-ju-lu ‘cat-Prop-Erg-then-me-they’ [Nash 1986:86]

This feature value cannot result from spreading. It is either inserted or underlyingly present.

The grammar is even less determinate now, and the underlying representations of the suffixes are again in limbo. The Lexicon Optimization tableau in (30) compares an underspecified underlying suffix, in (c), to fully specified [–round] and [+round] candidate inputs in (a) and (b). Without knowing the relative ranking of PARSE and FILL, it is impossible to determine which candidate underlying representation is optimal for the Proprietive suffix:

(30)

LO			example context	PARSE[+RD]	PARSE[RD]	FILL
💣 a.	/-kirli/	kirli	maliki-kirli		*	
		kurlu	kurdu-kurlu		*	
		kurlu	minija-kurlu		*	*

b.	/-kurlu/	kirli	maliki-kirli	*	*	
		kurlu	kurdu-kurlu	*	*	
		kurlu	minija-kurlu			
c.	/-kIrlI/	kirli	maliki-kirli			
		kurlu	kurdu-kurlu			
		kurlu	minija-kurlu			*

We know candidate (c) outperforms candidate (a), because their respective violation marks are in a subset relation, but the choice between (b) and (c) is up in the air. If FILL is ranked high, then /-kurlu/ is optimal, as it requires no insertion of [+round] following an /a/-final root. If PARSE is ranked high, however, then the underspecified input /-kIrlI/ is optimal, as no feature deletion is required.

(31) a. If FILL >> PARSE, /kurlu/ is optimal underlying representation
b. If PARSE >> FILL, /kIrlI/ is optimal underlying representation

Lexicon Optimization is indeterminate because the grammar is indeterminate. This is where we must appeal to a second principle, which I'll term Grammar Optimization. The idea, due to Kiparsky 1993 (in a non-Optimality framework), is that the best grammar is the most transparent, i.e. deletes the least. In Optimality terms, this translates to saying that, all else being equal, PARSE outranks FILL.

(32) GRAMMAR OPTIMIZATION: The optimal grammar is the most transparent, i.e. the one in which alternations are maximally structure-filling (Kiparsky 1993). In terms of Optimality Theory, this means that PARSE is ranked as high as possible.

GRAMMAR OPTIMIZATION enables us to choose between the two grammars in (31). Grammar (b), in which PARSE is ranked highest, is more optimal than Grammar (a).

As can be seen by glancing back to the tableau in (30), this ranking will induce Lexicon Optimization to pick input candidate (c). The underspecified input, /–kIrlI/, is the only one not to violate what we now know to be the higly ranked PARSE constraint.

Lexicon Optimization, here aided by Grammar Optimization, once again has opted for underspecification in the case of predictable alternating structure.

4.1.3 Turkish glide-vowel-Ø alternations

Optimization is not restricted to the determination of feature values. The Turkish data in (33)-(34) show that it can lead to the underspecification of entire segments. In (33) we see a number of suffixes whose surface forms differ in the presence or absence of an initial vowel. (34) shows suffixes whose surface forms differ in the presence or absence of an initial glide. In both cases the alternations can be understood in terms of syllable structure; the alternating vowel in (33) provides a needed nucleus when the stem ends in a consonant, and the alternating glide in (34) provides a needed onset when the stem ends in a vowel.

(33) Vowel-Ø alternations

		After C-final base: VC			After V-final base: C	
i.	a.	bɨrak-ɨr	'leave-Aorist'	b.	anla-r	'understand-Aorist'
		süpür-ür	'sweep-Aorist		ye-r	'eat-Aorist''
ii.	a.	bul-un	'find-Passive'	b.	anla-n	'understand-Passive'
		bil-in	'know-Passive'		ye-n	'eat-Passive'
iii.	a.	kitab-ɨm	'book-1sg.poss'	b.	elma-m	'apple-1sg.poss'
		öküz-üm	'ox-1sg.poss'		cizme-m	'boot-1sg.poss'
iv.	a.	kitab-ɨn	'book-2sg.poss'	b.	elma-n	'apple-2sg.poss'
		dümen-in	'rudder-2sg.poss'		köprü-n	'bridge-2sg.poss'

(34) Glide-Ø alternations

		After C-final base: VC			After V-final base: GVC	
i.	a.	dön-en	'turn-relative'	b.	söyle-yen	'say-relative'
		kac-an	'escape-relative'		uyu-yan	'sleep-relative'
ii.	a.	dön-eǰek	'turn-future'	b.	söyle-yeǰek	'say-future'
		kac-aǰak	'escape-future'		uyu-yaǰak	'sleep-future'
iii.	a.	dön-üš	'turn-gerund'	b.	söyle-yiš	'say-gerund'
		kac-ɨš	'escape-gerund'		uyu-yuš	'sleep-gerund'
iv.	a.	kitab-a	'book-Dative'	b.	elma-ya	'apple-Dative'
		dümen-e	'rudder-Dative'		köprü-ye	'bridge-Dative'

There is little consensus in the literature on Turkish as to how these alternations are to be analyzed[7]. Two possibilities at the logical extremes are sketched in (35). The first posits minimal underlying forms and insertion across the board; the second assumes maximal underlying forms and posits deletion.

(35) a. INSERTION GRAMMAR: (Vowel epenthesis into clusters; glide epenthesis into hiatus (in derived environments))

Grammar: PARSE >> NO.CLUSTER, NO.HIATUS >> FILL
Underlying representations: For V~Ø, /Ø/; For G~Ø, /Ø/

b. DELETION GRAMMAR: (vowel deletion in hiatus; glide deletion in CG clusters (in derived environments))

Grammar: FILL >> NO.CLUSTER, NO.HIATUS >> PARSE
Underlying representations: For V~Ø, /V/; For G~Ø, /G/

Although either the insertion or the deletion grammar would work, Grammar Optimization judges the former to be superior, since PARSE is higher ranked. Given this grammar, it is clear that

[7] Lees 1961 and Itô and Hankamer 1989 opt for deletion in general, while Lewis 1967 tends to favor epenthesis analyses; Underhill 1976 opts for underlying V-initial suffixes with morphologically sensitive glide epenthesis in (34).

the underlying forms of the alternating suffixes are underspecified for the alternating segment. Once again we have opted for underspecification.

4.1.4 Consonantal morphemes

Much the same conclusion obtains for predictable, alternating metrical structure. Consider the Armenian verb roots in (36), the three consonantal roots in the language (see e.g. Samuelian 1989):

(36)	a. /k/	‘come’	b.	/l-ats-ék/	‘cry (pl.)!’
	/d/	‘give’		/l-ál/	‘to cry’
	/l/	‘cry’		/l-ats-adz-é-m/	‘cry-ext-ppl-TV-1sg (=I have cried)’

Like all verb roots in Armenian, these are bound, always joining with a vowel-initial suffix. Armenian lacks syllabic consonants, so these roots never head a syllable. For that matter, they are often not even in a stress foot, as Armenian has fixed final stress and highly suffixing verbal morphology.

Faced with the logical alternatives, namely prespecification vs. underspecification of metrical structure on these roots, Lexicon Optimization confirms the intuition doubtless held by most phonologists that consonantal roots should *not* be specified underlyingly for metrical structure. As (37) shows, any underlying syllable or foot nodes would invariably be deleted; the optimal underlying form for the root /k/ ‘come’ is the underspecified one in (b). Only this candidate incurs no violations of PARSE.

(37)

LO			example context	PARSE
a.	F | σ | /k/	F | σ /|\ [kV...]	F | σ /|\ kal	*! (F, σ)
☞b.	/k/	F | σ /|\ [kV...]	F | σ /|\ kal	

(The constraint against incorporation of a consonant into onset position of the syllable headed by the following suffix vowel isn’t mentioned here, since both inputs would violate it equally).

A similar point can be made for consonantal suffixes. (38) shows that the first person singular possessive suffix in Turkish can surface as an onset or a coda (and, for that matter, inside or outside of the stressed syllable):

(38)	el.má-m	‘apple-1sg.poss’	Coda
	el.ma.-m-ɨ́	‘apple-1sg.poss-Accusative’	Onset
	má.sa-m.-dan	‘table-1sg.poss-Ablative’	Coda
	má.sa.-m-a	‘table-1sg.poss-Dative’	Onset

Here, too, the intuitively natural analysis is for the possessive suffix to be underlyingly just the segment /m/, devoid of syllable or foot structure (which would simply get deleted in the grammar). This is exactly what Lexicon Optimization predicts.

In summary, Lexicon Optimization causes the underspecification of structure that is both predictable and alternating. When either condition is not met, however, Lexicon Optimization leads to the opposite scenario: full underlying specification.

4.2 Nonalternating, predictable structure

All of the examples we have just seen involved bound, alternating morphemes. In this section, we turn our attention to nonalternating structure.

4.2.1 Unmarked segments

The tableau in (39) illustrates a morpheme which always surfaces as [ti] in a language where Coronal is the unmarked value for C(onsonantal) Place, [–] the unmarked value for [voice], and [+high, –back] the unmarked specifications for V(ocalic) Place.

(39)

LO			INSERT[C-PLACE]	INSERT[VOICE]	INSERT[V-PLACE]
☞a.	/ti/	[ti]			
b.	/Ti/	[ti]	*	*	
c.	/TI/	[ti]	*	*	*

This morpheme is chock-full of predictable, unmarked feature values. But look what Lexicon Optimization predicts: full underlying specification! This is because any underspecified candidates simply incur gratuitous violations of FILL, the constraint against insertion of features.

4.2.2 Unmarked skeletal or moraic structure

This general point is foreshadowed in Prince and Smolensky 1993, who discuss the hypothetical case in (40) in a language in which syllables are always CV in shape and where vowels are therefore predictable from the number of consonants (p. 193). Prince and Smolensky show that Lexicon Optimization will nonetheless result in the prespecification of vowels (the winning candidate input in (c)):

(40)

LO			INSERT-V
a.	/CCC/	[CVCVCV]	*!**
b.	/CVCC/	[CVCVCV]	*!
☞c.	/CVCVCV/	[CVCVCV]	

A similar result is obtained for moraic structure. (41) shows data from Hausa, in which vowel length is contrastive (data from Newman and Newman 1977):

(41)	μ μ	μμ μμ	μμ μ	μ μμ
	| |	\/ \/	\/ |	| \/
	mace	m a t a	g a ta	gad o
	‘woman’	‘women’	‘three days hence’	‘bed’

While it is uncontroversial that unpredictable vowel length must be prespecified, it is of some interest that Lexicon Optimization will cause even short vowels — whose mora count is predictable — to be prespecified as well. This supports the original proposal of Hyman 1985 for the prespecification of moras on vowels.

Exactly parallel results extend to syllable structure and even stress, where nonalternating.

4.3 Summary: Archiphonemic Underspecification

In general, whether the predictable structure is featural, as in (39), skeletal, as in (40), or moraic, as in (41), the same result will obtain: if it doesn’t alternate, Lexicon Optimization will cause it to be prespecified[8]. This crucial difference between alternating and nonalternating structure is what distinguishes the current approach from past approaches.

In placing so much emphasis on neutralization, the present approach recaptures in part the insight behind the original Prague school archiphoneme (Jakobson 1929; Trubetzkoy 1929, 1936; Martinet 1936; see Akamatsu 1988). There are, of course, a number of differences, not the least of which being the broad conceptual issue of the status of the phoneme. A number of practical differences between classical archiphonemes and the proposed underspecified representations are summarized below:

(42) a. In the present proposal, underspecification is restricted to segments involved in alternations, while the archiphoneme was used for positional neutralization even if no alternations occurred
b. There is no extrinsic limit on the degree of underspecification, whereas the use of the archiphoneme was typically restricted to bilateral oppositions
c. There is no requirement that segments underspecified to different degrees have distinct phonetic realizations, whereas different archiphonemes must differ phonetically.

Despite these differences, however, I will dub my approach Archiphonemic Underspecification in honor of its noted forebears.

5 Advantages of Archiphonemic Underspecification

Archiphonemic Underspecification has a number of advantages over past theories of underspecification, beyond the issue of descriptive adequacy in three-way contrasts discussed earlier.

[8] A natural question is whether even allophonic, “low-level” nonalternating structure, such as aspiration in English, should be prespecified. I have no answer at present other than to observe that there might be some general, inviolable constraint against the presence of such information in the lexical (or other similarly well-defined) component of grammar.

5.1 Solves notorious prelinking problems

The first is the notorious problem of redundancy in the prespecification of stress or tone on exceptional words.

(43) contrasts two words in Turkish, a language with regular final stress (Lees 1961, Lewis 1967, Underhill 1976, Kaisse 1985, Poser 1984, Barker 1989, Idsardi 1992, Hayes (in press), Inkelas 1994). *babá* 'father' is well-behaved; stress appears at the end of the word in all suffixed forms shown here. *mása* 'table', however, is a well-known counterexample to the final stress rule, retaining initial stress in all contexts:

(43) a.

	-Plural	-Plural-Acc	gloss
mása	mása-lar	mása-lar-ɨ	'table'
babá	baba-lár	baba-lar-ɨ́	'father'

b.

```
 (x  .)
  σ  σ
  |  |
  μ  μ
  /\ /\
/masa/     /baba/
```

One past approach has been to prespecify a stress foot on stress foot on *mása*, as shown in (44b), thus overriding the assignment of final stress to regular, underspecified morphemes such as *babá* (Inkelas 1994).

But this kind of prespecification was always an embarrassment; prespecifying a stress foot on *masa* entailed the prespecification of otherwise predictable mora and syllable structure as well. Thus, as (43b) shows, in past theories *baba* and *masa* would contrast underlyingly in their specification for syllable structure even though both are CVCV strings and differ only in stress.

The same problem occurs with tone. Leben pointed out in 1973 that the prespecification of tone in languages where the syllable is the tone-bearing unit is a problem because it requires the underlying presence of predictable syllable structure:

(44) "If syllables were allowed to bear features, they would be the only feature-bearing units whose extension was completely predictable by an algorithm referring to other phonological units." [Leben 1973:192]

This sort of issue entirely disappears under Archiphonemic Underspecification, however. Since the syllable structure of *masa* and *baba* never alternates, and since vowels unfailingly form syllable peaks, this structure will be prespecified in any case. Its underlying presence as a bearer of exceptional stress feet or tones is no longer an embarrassment.

5.2 Solves notorious tone melody problems

A second advantage to Archiphonemic Underspecification is that it encounters no difficulty in representing tonal melodies in languages like Kukuya (45), in which H, HL, LH and LHL melodies are contrastive (as in Mende (Leben 1978), Margi (Pulleyblank 1986), and many other languages).

(45) Tone melodies in Kukuya (Hyman 1987 (based on Paulian 1974)):

L	(kɪ̀)-bàlàgà	‘to change route’
H	(mà)-bálágá	‘fence’
LH	mʷàrə̀gɪ́	‘younger brother’
HL	(kɪ̀)-káràgà	‘to be entangled’
LHL	(ndÈ)-kàlə́gɪ̀	‘he turns around’

In a theory forcing universally unmarked feature values, in this case L, to be underspecified, tone melody contrasts would incorrectly be neutralized. Past theories had to proliferate tone features or introduce otherwise unneeded tonal nodes to capture the simple contrasts in (45) (e.g. Pulleyblank 1986, Inkelas 1987, Hyman and Pulleyblank 1987). Archiphonemic Underspecification is, however, unimpeded by extrinsic constraints on what may be prespecified, and can represent the melodies in their entirety in underlying representation.

5.3 Markedness reflected in, but not forced on, lexicon

A third virtue of Archiphonemic Underspecification is that, due to its versatility, it can handle both those cases in which lexical representation reflects markedness and those in which it does not. An important result of past markedness theories of underspecification is that they predict which segments will be inert, weak, or epenthetic. Pulleyblank 1988, for example, accounts for such behavior on the part of /i/ in Yoruba by underspecifying /i/, the unmarked vowel, for all features underlyingly. Can Archiphonemic Underspecification derive this same result?

5.3.1 Yoruba

Consider the Yoruba data in (46) (Pulleyblank 1988:238-239). Vowel sequences arising in possessive constructions exhibit regressive assimilation such that the first vowel takes on the ATR and other feature specifications of the second (a):

(46)	a.	owó + adé	→	owá adé	‘Ade’s money’
		owé + ọmọ	→	owẹ́ ẹmo	‘wine money’
	b.	ará + ìlú		*arí ìlú	‘townsman’
		ẹrù + igi		*ẹrì igi	‘bundle of wood’

If, however, the second vowel in the sequence is /i/ (b), no assimilation occurs. Pulleyblank attributes the inertness of /i/ to its lack of underlying specification: with no features to spread, /i/ is incapable of affecting an adjacent vowel.

Viewed from the perspective of Archiphonemic Underspecification, however, it is unnecessary to stipulate in advance that /i/ is underspecified. Given the type of grammar we have been developing, /i/ *must* be underspecified for the phenomenon in (46) even to be described.

According to Kiparsky’s theory of markedness, no constraint may single out unmarked feature values. As shown in (47), the only possible spreading options are (a,b) to spread all features or (c) to spread only unmarked feature values. (In (47), AGREE is the constraint requiring assimilation.)

(47) a. AGREE > SPREAD[FEATURE VALUES], SPREAD[MARKED FEATURE VALUES]
all feature values will spread
b. SPREAD[FEATURE VALUES] >> AGREE, SPREAD[MARKED FEATURE VALUES]
no feature values will spread
c. SPREAD[MARKED FEATURE VALUES] >> AGREE >> SPREAD[FEATURE VALUES]
only unmarked feature values will spread

No constraint ranking enables only marked feature values to spread. But that looks like what is going on in (46). Therefore it must be the case that /i/ lacks feature values altogether, thus having none to spread in the first place.

Through the markedness theory of Kiparsky 1994, we thus achieve Pulleyblank's result without having to stipulate in advance that /i/ is underspecified. Descriptive adequacy forces underspecification, as it did in the three-way contrasts discussed earlier. The lexicon reflects the markedness constraints in the grammar.

A second phenomenon from Yoruba supports underspecification of unmarked feature values in a different way. Consider the data in (48), in which vowel sequences arising through morpheme combination are simplified by the deletion of the first vowel in the sequence (a):

(48)	a.	oní + ẹmu	→	ẹlẹmu	'palm-wine seller'	[Pulleyblank 1988:242]
		ra + ọ̀gẹ̀dẹ̀	→	rọ̀gẹ̀dẹ̀	'buy bananas'	
	b.	ní + oko	→	lóko	'at the farm'	
		wo + ilẹ̀	→	wolẹ̀	'look at the ground'	

If, however, either vowel in the sequence is /i/, as in (48b), /i/ deletes regardless of its position. According to Pulleyblank, this follows from the a priori assumption that /i/, the unmarked vowel, is undergly unspecified for vowel features. As shown in (49), this enables Pulleyblank to treat deletion as uniform at the skeletal level, with the features of the deleted V slot reassociating to the empty slot of /i/ when possible:

(49) Pulleyblank 1988:243: V → Ø / __ V

CV VCV → C$\boxed{\text{V}}$VCV (48b)
| |+ | | → | ǂ / | |
wo lè → w o l ẹ̀

Without extrinsic constraints on underlying representation, of course, the underspecification stipulation is unavailable. But we *can* derive Pulleyblank's result through Lexicon Optimization. The constraints in (50) account for the deletion patterns in (48). *VV, ranked above PARSE, mandates vowel deletion; PARSE[MARKED FEATURE VALUES] mandates that /i/ is a better deletion target than a more marked vowel would be; KEEP V2 states that (all else being equal), the second vowel in the sequence is retained.

(50) *VV >> PARSE[FEATURE VALUES], PARSE[MARKED FEATURE VALUES]
PARSE[MARKED FEATURE VALUES] >> KEEP-V2

As (51) and (52) show, this grammar achieves the right result regardless of whether /i/ is fully specified for features underlyingly (as in (51)) or completely underspecified for features underlyingly (52)):

(51)

	/wo + ilẹ̀ /	*VV	PARSE[MARKED FEATURE VALUES]	PARSE[FEATURE VALUES]	KEEP-V2
☞a.	wolẹ̀			* (i)	* (i)
b.	wilẹ̀		*! (o)	* (o)	
c.	woilẹ̀	*! (oi)			

(52)

	/wo + Ilẹ̀ /	*VV	PARSE[MARKED FEATURE VALUES]	PARSE[FEATURE VALUES]	KEEP-V2
☞a.	wolẹ̀				* (i)
b.	wilẹ̀		*! (o)	* (o)	
c.	woilẹ̀	*! (oi)			

Lexicon Optimization, invoked to adjudicate between these two equally adequate inputs, will choose the underspecified one (52) because it requires less gratuitous feature deletion in the grammar. Thus we achieve Pulleyblank's representational result — but we *derive* underspecification, instead of assuming it in advance.

5.3.2 Japanese

Of course, unmarked feature values are not always underspecified. We've seen several such cases already in the paper, and another is cogently made by Itô, Mester and Padgett 1993, who propose the prespecification of redundant, unmarked voicing on nasals in Japanese.

As shown in (53), initial obstruents voice in the second members of Japanese compounds (a) unless, as in (b), a voiced consonant already occurs in theword (Itô and Mester 1986). As shown in (a), nasal consonants do not count for this purpose, and are presumably underspecified for [voice] when the alternation takes place:

(53) Rendaku voicing (Itô and Mester 1986):

a. ori + kami → origami 'paper folding'
b. ore + kugi *oregugi 'broken nail'

However, as Itô, Mester and Padgett 1993 show, obstruents which are voiced due to obligatory assimilation to a preceding nasal, as in (54a), do count for the purpose of blocking Rendaku voicing (b).

(54) a. kam + te → kande 'chewing'
kaŋgae * kaŋkae 'thought'
b. širooto + kaNgae *širootogaŋgae 'layman's idea'

As Itô, Mester and Padgett 1993 observe, this can be accounted for only if those nasals that precede obstruents *are* specified redundantly for [+voice] when the Rendaku alternations take place. This requires the following constraints (Itô, Mester and Padgett 1993):

(55) a. LICENSE[FEAT] ([+voice] must be linked to an obstruent root node)
b. NASVOI (If a root node dominates [+nasal] it also dominates [+voice])
c. *SPREAD[FEAT], PARSE[FEAT], *INSERT[FEAT]

Using Lexicon Optimization to derive optimal inputs given this grammar, Itô, Mester and Padgett 1993 propose the underlying representations in (56).

(56)

Segment, in morpheme-internal environment	underlying representation	specified for [voice]?
Nasal-obstruent cluster:	n t \/ [+vd]	yes
Voiced obstruent:	t | [+vd]	yes
Nasal (not preceding obstruent):	n	no
Vowel:	a	no

Exactly in the spirit of the present paper, underspecification distinguishes the nasals which participate in alternations from those which do not.

To summarize, in Archiphonemic Underspecification the lexicon reflects the grammar. If, as we have been assuming, markedness is encoded in grammar, then the lexicon will reflect markedness. But it will reflect it only weakly, when alternations permit. Crucially, it is clear that markedness and predictability are *not* predictors of underspecification.

5.4 Requires no constraints to hold expressly on underlying representation

A final virtue of Archiphonemic Underspecification is that it requires no constraints to be imposed directly on underlying representation. In avoiding such constraints it overcomes certain technical difficulties encountered by theories that attempt to impose them. In (57)-(59) we consider two such proposals[9], both couched within Optimality Theory (for purposes of comparison to each other and to the rest of this paper).

The first approach assumes that lexical entries which are not appropriately specified (according to some arbitrary constraint(s) on input which I'll abbreviate as "PROPER.SPEC(INPUT))" simply fail to be parsed.

[9] A third possibility would be to assume, following Stanley 1967, that the "dictionary entries" of underlying representation are related by the grammar to a "morpheme level"; the mapping between the two levels ensures that representations at the latter are properly specified (whether fully specified, as Stanley 1967 assumed, or underspecified, is negotiable). Underspecification theory would be a type of morpheme structure constraint, and comes in for the same critcisms that other morpheme structure constraints do. For example, there would be no explanation for asymmetries between bound and free morphemes (Kiparsky 1982, Inkelas 1990), or for the so-called "duplication" effects (Kenstowicz and Kisseberth 1977, Kiparsky 1982).

(57) Possibility #1: Grammar ensures that improperly specified inputs cannot be used (even if the means exist to repair them in the grammar)

PROPER.SPEC(INPUT) >> M-PARSE

Only morphemes that satisfy PROPER.SPEC avoid the null parse (Prince and Smolensky 1993:48) and manage to surface.

While this solution works, it is counter to the spirit of Optimality Theory, in which underlying ill-formedness is repaired (to the maximum extent possible, by the grammar, rather than rejected outright. The use of the null parse that would be required here differs from the use to which the null parse is put in Prince and Smolensky 1993, where, in a discussion of minimal stem size in Latin, Prince and Smolensky show that there are certain potential inputs to which the grammar would be intrinsically incapable of assigning a well-formed output. In (57), however, there is no question that an appropriate output could be assigned to an improperly specified input. The constraint ranking simply stipulates that this is not to be done.

A second possible implementation of constraints on underlying representation is suggested by Prince and Smolensky 1993, who propose the *SPEC constraint in (58):

(58) *SPEC: Underlying material must be absent. (Prince and Smolensky 1993:196)

The function of this constraint, which is ranked sufficiently low never to result in the null parse or affect derivations, is simply to induce Lexicon Optimization to produce appropriate specified lexical entries. This is sketched in more general terms in (59), where *SPEC is replaced by the more neutral PROPER.SPEC(INPUT):

(59) Possibility #2: PROPER.SPEC simply induces Lexicon Optimization to produce appropriately specified lexical entries to begin with

M-PARSE >> PROPER.SPEC(INPUT)

The problem with this approach, as well as with that in (57), is that it simply stipulates an arbitrary solution to the problem we are trying to understand. The linguist, not the data, determines the contents of PROPER.SPEC. No predictions are made; the hypothesis cannot be tested.

In Archiphonemic Underspecification, which rejects any such PROPER.SPEC constraints, the *data*, and the grammar arrived at on the basis of that data, determine underlying form. It achieves principled underlying representation while avoiding unfalsifiable constraints like PROPER.SPEC altogether, a desirable result.

6 Implications of Archiphonemic Underspecification

In this final section I touch on some broader implications of Archiphonemic Underspecification.

6.1 Some arguments for cyclicity disappear

The first implication is that it is no longer as easy to base arguments for cyclicity on affixal sensitivity to derived phonological structure on the base. In the past, affixal selection for such predictable properties as stress or syllable structure has been taken as evidence for for phonology-morphology interleaving (e.g. Kiparsky 1982, Hargus 1993, Booij and Lieber 1993, Booij 1994). If, however, the structure in question is nonalternating, then Archiphonemic Underspecification will result in its being prespecified; reference to it by morphology does not require the cycle at all. (Of course, there is still abundant evidence for cyclicity; this particular kind will simply have to be reevaluated.)

6.2 Ternarity can no longer be taboo

A second implication is that we will have to overcome the fear of ternarity that has dogged phonologists since Stanley 1967. Kiparsky, for example, is careful to point out that his (1982) theory of underspecification does not permit the dreaded ternary use of a binary feature:

(60) "If we are to allow unspecified feature values in the lexicon, then it becomes incumbent upon us to answer the well-known objections of Stanley (1967) against that procedure. We shall do this by stipulating that no feature can appear marked both + and – in the same environment in the lexicon." [Kiparsky 1982:168]

The analyses proposed in section 3 of this paper would have been anathema to Stanley 1967, whose objections to underspecification are still widely cited. However, they pose no problem for Archiphonemic Underspecification. I contend here that Stanley's conclusions are based on premises which no longer hold (see Ringen 1975, Archangeli 1988, Archangeli and Pulleyblank 1992, and Broe 1993 for similar argumentation and conclusions.)

The first such premise is stated in (61):

(61) Premise #1: underspecification is used solely to eliminate morpheme-internal redundancies.

This premise entails that the ternary use of a binary-valued feature is illicit. Consider the configuration in (62), which which segments differ only in their relative specification — or lack thereof — for a single feature:

(62)	* Segment #1	Segment #2	Segment #3
	[+F]	[–F]	[ØF]
	...	...	...

As Stanley observes, this configuration makes no sense given the premise in (61). If one or another feature value of [F] is redundant, as it must be given the existence of Segment #3, then either Segment #1 or Segment #2 is redundantly specified, in violation of (61).

Of course, as we have seen in this paper, underspecification has uses beyond that in (61). If underspecification is used to distinguish potentially alternating segments from systematically nonalternating ones, then the configuration in (62) is perfectly legitimate.

The second premise is stated in (63):

(63) Premise #2: the grammar evaluation metric counts the number of features mentioned in rules; in the best grammar, the fewest features are mentioned.

This premise entails that underspecification causes grammars to fare better in terms of the evaluation metric (since [Ø] is an invisible feature value); because this sort of simplification is specious, Stanley argued, it should not be used.

But not all theories evaluate grammars by feature-counting. In particular, Optimality Theory *could* not; since constraints are universal, all grammars would rate identically. A theory which rejects Premise #2 is not bound by its entailment.

In conclusion, although Stanley's argumentation is internally consistent, his conclusions are inapplicable to contemporary phonological theory, which rejects the premises from which those conclusions are derived. There is simply no good methodological or theoretical reason to avoid the ternary use of a binary features, or underspecification in general.

6.3 Privativity can't be motivated as an alternative to underspecification

Steriade 1994 has recently argued that many cases which might be analyzed in terms of underspecification of one particular value of a binary-valued feature are better analyzed in terms of privative features. Indeed, there have been a number of recent proposals to split binary-valued features into privative features, each instantiating a single value of the original feature:

(64)	Lombardi 1990:	[±continuant] → {Cont, Stop}	
	Lombardi 1991:	[±voice] → {Voice, Aspiration}	*(for sonorants only)*
	Steriade 1994:	[±Advanced Tongue Root] → {Advanced Tongue Root, Retracted Tongue Root}	

Steriade 1994 has proposed that such expansion be limited to binary phonological features each of whose values represents a distinct deviation from the neutral state. But what if we were to ignore Steriade's caution and convert all binary-valued features into pairs of privative features? Suppose, for example, that we were to split [Voice] into two features, Voiced and Voiceless. Would this actually save us from having to posit a three-way contrast for the feature [Voice] in Turkish?

(65)	[±voice] → {Voiced, Voiceless}	/t/ in /sanat/:	Voiceless
		/d/ in /etüd/:	Voiced
		/D/ in /kanaD/:	—

The answer is, of course, no. As (66) shows, the distribution of Voiceless is exactly identical to the distribution of [–voiced]; the distribution of Voiced is exactly identical to that of [+voice].

(66) Distribution of [+voice], [–voice] = distribution of Voiced, Voiceless respectively
Distribution of [Øvoice] = distribution of absence of {Voiced, Voiceless}
Phonetic interpretatation of [+voice], [–voice] = that of Voiced, Voiceless respectively
Underspecification for [voice] = underspecification for {Voiced, Voiceless}

Any conceptual issues of underspecification arising in the original, binary feature system arise in the privative system as well. We simply find ourselves speaking with different terms: instead of asking whether a segment is underspecified for a given feature, we ask if it is underspecified for a given family of features, at least one of which the segment surfaces with. Even with (65), we will still need to know which segments are specified for the Voice family and which ones are not. Privativity is no panacea for the true problem of underspecification. Steriade's wise caution should be heeded.

In summary, the proposed theory is perfectly compatible with truly privative features, although it is true that once lexical exceptions (including the data in section 3) are included in the database from which the feature system is deduced, as this paper contends that they should be (see also Inkelas, Orgun and Zoll 1994), many apparent cases of privativity may disappear. In any case, the hypothetical possibility of trivially redefining a binary-valued feature as two privative ones has no bearing on the fundamental issue of underspecification.

6.4 The role of underlying representation in explanation

Since the earliest days of generative grammar, underlying representation has been saddled with the task of explaining alternations and surface forms. A final implication of adopting Archiphonemic Underspecification is that it will no longer be possible to say that underlying representation "explains" phonological phenomena, as Chomsky and Halle (1968:234) said of the abstract underlying velar fricative which they posited in the underlying representation of certain morphemes of English:

(67) "The same [velar fricative] device might be used to explain various other exceptions to trisyllabic laxing, as in the boldface positions of *n**i**ghtingale* and *m**i**ghtily*. Furthermore, we can use it to explain alternations such as *resign-resignation* ..." [Chomsky and Halle 1968:234]

It should by now be clear that since underlying representations are derived, they cannot themselves be the source of explanation. Rather, in Archiphonemic Underspecification the burden of explanation lies unambiguously with the *grammar*, whose intersection with phonetic form determines underlying form. In the case of the velar fricative in English, this conclusion is probably welcome. In other cases, it may require some rethinking.

7 Summary of paper

I would like to close with a quotation from an illuminating paper on underspecification by Steriade (1994) who, in a discussion critiquing "opportunistic" approaches to underspecification, said:

(68) "One hopes...that any discrepancies in feature specification between lexical and surface structure follow from general principles, not descriptive convenience." [Steriade 1994:3]

In this paper I have argued that underspecification is necessary for descriptive adequacy, that grammar (and alternation)-blind principles of underspecification cannot be maintained, that those segments with predictable surface alternants are underspecified, and that Optimization is the best available strategy for determining underlying representation. It may be convenient, but it is also principled.

8 Selected references

Akamatsu, Tsutomu. 1988. The theory of neutralization and the archiphoneme in functional phonology. Amsterdam Studies in the Theory and History of Linguistic Science, series IV: Current Issues in Linguistic Theory, Amsterdam: John Benjamins Publishing Co.

Archangeli, Diana. 1984. Underspecification in Yawelmani phonology and morphology. Doctoral dissertation, Massachusetts Institute of Technology. Published in 1988 by Garland.

Archangeli, Diana. 1985. Underspecification in underlying representation. In G. Youmans (ed.), In memory of Roman Jakobson: papers from the 1984 Mid-America Linguistics Conference. Columbia, MO: Linguistic Area Program. 3-15.

Archangeli, Diana. 1988. Aspects of underspecification theory. Phonology 5:183-207.

Archangeli, Diana and Douglas Pulleyblank. 1989. Yoruba vowel harmony. Linguistic Inquiry 20:173-218.

Archangeli, Diana and Douglas Pulleyblank. 1992. Grounded phonology. To be published by MIT Press.

Bamgboṣe, A. 1986. Yoruba: a language in transition. J. F. Ọdunjọ Memorial Lectures Series 1. Lagos, Nigeria.

Barker, Christopher. 1989. Extrametricality, the cycle, and Turkish word stress. In J. Itô and J. Runner (eds.), Phonology at Santa Cruz. 1. UC Santa Cruz: Syntax Research Center. 1-33.

Booij, Geert. 1994. Lexical Phonology: a review. In R. Wiese (ed.), Theorie des Lexicons 56: Recent Developments in Lexical Phonology. Heinrich Heine Universität, Düsseldorf. 3-29.

Booij, Geert and Rochelle Lieber. 1993. On the simultaneity of morphological and prosodic structure. In S. Hargus and E. Kaisse (eds.), Phonetics and Phonology 4: Studies in Lexical Phonology. San Diego: Academic Press. 23-44.

Chomsky, Noam and Morris Halle. 1968. The sound pattern of English. New York: Harper and Row.

Christdas, Prathima. 1988. The phonology and morphology of Tamil. Doctoral dissertation, Cornell University.

Clements, George N. 1976. Neutral vowels in Hungarian vowel harmony: an autosegmental interpretation. Proceedings of NELS 7.

Clements, George N. 1987. Towards a substantive theory of feature specification. Symposium on Segment Structure. University of California, Los Angeles.

Clements, George N. and Engin Sezer. 1982. Vowel and consonant disharmony in Turkish. In H. v. d. Hulst and N. Smith (eds.), The structure of phonological representations. Part II. Dordrecht: Foris. 213-255.

Halle, Morris and Michael Kenstowicz. 1991. The Free Element Condition and cyclic versus noncyclic stress. Linguistic Inquiry 22:457-501.

Halle, Morris and Jean-Roger Vergnaud. 1987. An essay on stress. Cambridge, MA: MIT Press.

Hammond, Michael. 1989. Lexical stresses in Macedonian and Polish. Phonology 6:19-38.

Hargus, Sharon. 1993. Modeling the phonology-morphology interface. In S. Hargus and E. Kaisse (eds.), Phonetics and phonology 4: studies in Lexical Phonology. San Diego: Academic Press. 45-74.

Harris, James. 1969. Spanish phonology. Cambridge, MA: MIT Press.

Hayes, Bruce. in press. Metrical theory: principles and case studies. Chicago: University of Chicago Press.

Hayes, Bruce. 1981. A metrical theory of stress rules. Bloomington: Indiana University Linguistics Club.

Hoffmann, Carl. 1963. A grammar of the Margi language. London: Oxford University Press.

Hyman, Larry. 1985. A theory of phonological weight. Dordrecht: Foris.

Hyman, Larry M. 1987. Prosodic domains in Kukuya. Natural Language and Linguistic Theory 5:311-333.

Hyman, Larry M. and Douglas Pulleyblank. 1987. On feature copying: parameters of tone rules. In L. M. Hyman and C. N. Li (eds.), Language, speech and mind: studies in honor of Victoria A. Fromkin. Croom Helm Ltd. Publishers.

Idsardi, William. 1992. Unpublished dissertation. Massachusetts Institute of Technology.

Inkelas, Sharon. 1987. Tone feature geometry. In J. Blevins and J. Carter (eds.), Proceedings of the Northeastern Linguistics Society 18. 223-237.

Inkelas, Sharon. 1990. Prosodic constituency in the lexicon. New York: Garland.

Inkelas, Sharon. 1994. Exceptional stress-attracting suffixes in Turkish: representations vs. the grammar. To appear in R. Kager (ed), Proceedings of a Workshop on Prosodic Morphology. Mouton.
Inkelas, Sharon and Young-mee Yu Cho. 1993. Inalterability as prespecification. Language 69:529-74.
Inkelas, Sharon and Orhan Orgun. 1993. Turkish coda devoicing: a prosodic constraint on extrametricality. LSA annual meeting. Los Angeles, CA.
Inkelas, Sharon and Orhan Orgun. 1994. Level economy, derived environment effects and the treatment of exceptions. In R. Wiese (ed.), Proceedings of a workshop on recent developments in Lexical Phonology. Düsseldorf: Heinrich-Heine Universität.
Inkelas, Sharon, Orhan Orgun and Cheryl Zoll. 1994. Subregularities as cogrammars: the theoretical status of nonproductive patterns in grammar. Unpublished manuscript. University of California, Berkeley.
Itô, Junko. 1990. Prosodic minimality in Japanese. In M. Ziolkowski et al. (eds.), Papers from the 26th Regional Meeting of the Chicago Linguistics Society. Volume 2: the Parasession on the Syllable in Phonetics and Phonology. Chicago: Chicago Linguistics Society. 213-239.
Itô, Junko and Jorge Hankamer. 1989. Notes on monosyllabism in Turkish. In J. Itô and J. Runner (eds.), Phonology at Santa Cruz. 1. Syntax Research Center, University of California, Santa Cruz. 61-69.
Itô, Junko and Armin Mester. 1986. The phonology of voicing in Japanese: theoretical consequences for morphological accessibility. Linguistic Inquiry 17:49-73.
Itô, Junko, Armin Mester and Jaye Padgett. 1993. Licensing and redundancy: Underspecification in Optimality Theory. LRC-93-07. UC Santa Cruz.
Jakobson, Roman. 1929. Remarques sur l'évolution phonologique du russe comparée avec celle des autres langues slaves (=Travaux du Cercle Linguistique de Prague 2). Prague: Jednota C‡eskoslovensk´ych Matematiku(a Fysiku(.
Kaisse, Ellen. 1985. Some theoretical consequences of stress rules in Turkish. In W. Eilfort, P. Kroeber et al. (eds.), Papers from the general session of the Twenty-first regional meeting. Chicago: Chicago Linguistics Society. 199-209.
Kaisse, Ellen. 1986. Locating Turkish devoicing. In M. Dalrymple et al. (eds), The Proceedings of the Fifth West Coast Conference on Formal Linguistics. Stanford, CA: Stanford Linguistics Association. 119-128.
Kenstowicz, Michael and Charles Kisseberth. 1977. Topics in phonological theory. New York: Academic Press.
Kiparsky, Paul. 1973. Phonological representations: abstractness, opacity and global rules. In O. Fujimura (ed.), Three dimensions in linguistic theory. Tokyo: TEC. 56-86.
Kiparsky, Paul. 1982. Lexical morphology and phonology. In I.-S. Yang (ed.), Linguistics in the morning calm. Linguistics Society of Korea, Seoul: Hanshin. 3-91.
Kiparsky, Paul. 1988. Vowel harmony as delinking. Unpublished manuscript. Stanford University.
Kiparsky, Paul. 1993. Blocking in non-derived environments. In S. Hargus and E. Kaisse (eds.), Phonetics and Phonology 4: Studies in Lexical Phonology. San Diego: Academic Press.
Kiparsky, Paul. 1994. Remarks on markedness. Trilateral Phonology Weekend II. University of California, Santa Cruz.
Kirchner, Robert. 1993. Turkish vowel disharmony in Optimality Theory. Rutgers Optimality Workshop 1. Rutgers University.
Kisseberth, Charles. 1970. The treatment of exceptions. Papers in Linguistics 2:44-58.
Kisseberth, Charles. 1993. Optimal domains: a theory of Bantu tone. A case study from Isixhosa. Rutgers Optimality Workshop 1. Rutgers University.
Leben, William R. 1973. Suprasegmental phonology. Outstanding dissertations in linguistics, New York: Garland.
Leben, William R. 1978. The representation of tone. In V. A. Fromkin (ed.), Tone: a linguistic survey. New York: Academic Press. 177-219.
Lees, Robert. 1961. The phonology of Modern Standard Turkish. Indiana University Publications Uralic and Altaic Series, Vol. 6. Indiana University Publications.
Lewis, Geoffrey. 1967. Turkish grammar. Oxford: Oxford University Press.

Lightner, Theodore. 1965. On the description of vowel and consonant harmony. Word 21:244-250.

Lombardi, Linda. 1990. The nonlinear organization of the affricate. Natural Language and Linguistic Theory 8:

Lombardi, Linda. 1991. Laryngeal features and laryngeal neutralization. Amherst, MA: GLSA Publications.

Martinet, André. 1936. Neutralisation et archiphonème. Travaux du Cercle Linguistique de Prague 6:46-57.

McCarthy, John. 1994. On coronal “transparency”. Trilateral Phonology Weekend II. Stanford University.

McCarthy, John and Alison Taub. 1992. Review of Paradis and Prunet 1991. Phonology 9:363-70.

Mester, Armin and Junko Itô. 1989. Feature predictability and underspecification: palatal prosody in Japanese mimetics. Language 65:258-93.

Mohanan, K. P. 1982. Lexical phonology. Doctoral dissertation, Massachusetts Institute of Technology.

Mohanan, K. P. 1991. On the bases of radical underspecification. Natural Language and Linguistic Theory 9:285-326.

Nash, David. 1986. Topics in Warlpiri Grammar. New York: Garland.

Newman, Paul and Roxana Ma Newman. 1977. Modern Hausa-English Dictionary. Ibadan: University Press Limited.

Owolabi, D. K. o. 1981. Pedagogical description of derived nouns in Yoruba. Unpublished manuscript. University of Ibadan.

Pater, Joe. 1994. Against the underlying specification of an ‘exceptional’ English stress pattern. Proceedings of the Conference on Contrast. University of Toronto.

Paulian, Christiane. 1974. Le Kukuya: langue teke du Congo. Paris: S.E.L.A.F.

Poser, William J. 1984. The phonetics and phonology of tone and intonation in Japanese. Doctoral dissertation, Massachusetts Institute of Technology.

Poser, William J. 1989. The metrical foot in Diyari. Phonology 6:117-48.

Prince, Alan. 1985. Improving tree theory. In M. Niopokuj et al. (eds.), Proceedings of the Eleventh Annual Meeting of the Berkeley Linguistics Society. Berkeley, CA: Berkeley Linguistics Society.

Prince, Alan and Paul Smolensky. 1993. Optimality theory: constraint interaction in generative grammar. Unpublished manuscript. Rutgers University and the University of Boulder, Colorado.

Pulleyblank, Douglas. 1983. Tone in Lexical Phonology. Doctoral dissertation. Massachusetts Institute of Technology.

Pulleyblank, Douglas. 1986. Tone in Lexical Phonology. Dordrecht: Reidel.

Pulleyblank, Douglas. 1988. Feature hierarchy and Tiv vowels. Phonology 5:299-326.

Ringen, Catherine. 1978. Another view of the theoretical implications of Hungarian vowel harmony. Linguistic Inquiry 9:105-115.

Ringen, Catherine. 1975. Vowel harmony: theoretical implications. Outstanding Dissertations in Linguistics Series, New York: Garland.

Saciuk, Bohdan. 1969. The stratal division of the lexicon. Papers in Linguistics 1:464-532.

Samuelian, Thomas J. 1989. A course in Modern Western Armenian. New York: Armenian National Education Committee.

Schane, Sanford. 1973. The treatment of phonological exceptions: the evidence from French. In B. Kachru et al. (eds.), Issues in linguistics. Urbana: University of Illinois Press. 822-835.

Smolensky, Paul. 1993. Harmony, markedness and phonological activity. Rutgers Optimality Workshop 1. Rutgers University.

Stanley, Richard. 1967. Redundancy rules in phonology. Language 43:393-436.

Steriade, Donca. 1987. Redundant values. Proceedings of the regional meeting of the Chicago Linguistics Society.

Steriade, Donca. 1994. Underspecification and markedness. In J. Goldsmith (ed.), A handbook of phonological theory. Blackwell.

Trubetzkoy, Nicolai Sergeyevic. 1929. Polabische Studien. Sitzungsberichte der Akademie der Wissenschaften in Wien, Philosophisch-historische Klasse, Bund 211, Abhandlung 4, Wien/Leipzig: Hölder-Pichler-Tempsky A.-G.

Trubetzkoy, Nicolai Sergeyevic. 1936. Essai d'une théorie des oppositions phonologiques. Journal de psychologie normale et pathologique 33:5-18.
Underhill, Robert. 1976. Turkish grammar. Cambridge, MA: MIT Press.
Zonneveld, Wim. 1978. A formal theory of exceptions in generative phonology. Lisse: Peter de Ridder.