The contrastive hierarchy in phonology*

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I will show that phonologists have vacillated between two different and incompatible approaches to determining whether a feature is contrastive in any particular phoneme. One approach involves extracting contrastive features from fully-specified minimal pairs. I will show that this approach is provably untenable. A second approach arrives at contrastive specifications by ordering features into a hierarchy, and splitting up the inventory by successive divisions until all phonemes have been distinguished. I will show that this hierarchical approach solves the problems encountered by the minimal-pairs method. Moreover, a hierarchical approach to contrastiveness is implicit in much descriptive phonological practice, and can be found even in the work of theorists who argue against it. Given the centrality of the issue, it is remarkable that it has received almost no attention in the literature. Recovering this missing chapter of phonological theory sheds new light on a number of controversies over contrast in phonology.

0. Introduction

Since Saussure's (1916) famous statement that "*dans la langue il n'y a que des différences*," the notion of contrast has been at the heart of linguistic theory. While it is relatively uncomplicated to determine whether or not two sounds are contrastive in a given language (though see Chomsky 1964), it is another matter to determine whether a given feature is contrastive in any particular situation. I will show that from the beginning phonologists have vacillated between two different and incompatible approaches to determining contrastiveness. Further, one of these approaches is provably untenable. The other is more promising, and in the second half of the talk I will look at some applications of it. Given the centrality of the issue, it is remarkable that it has received almost no attention in the literature. Recovering this missing chapter of phonological theory sheds new light on a number of old and new controversies over contrast in phonology.

*I would like to thank the members of the project on Contrast and Complexity in Phonology in the Department of Linguistics at the University of Toronto for many kinds of help over the years, as well as the students in LIN 1221 in Fall 2001. This research was supported in part by grants 410-96-0842 and 410-99-1309 from the Social Sciences and Humanities Research Council of Canada.

TWPL *Toronto Working Papers in Linguistics* **20**: 47–62

1. Extraction via minimal pairs

One approach to determining contrastiveness is based on a comparison of fully specified minimal pairs. For example, given segments /p b m/ as in (1a) and the binary features [voiced] and [nasal], /p/ and /b/ contrast with respect to [voiced], and /b/ and /m/ contrast with respect to [nasal]. Considering only these specifications to be contrastive, we would specify /p/ as [–voiced], /b/ as [+voiced, –nasal], and /m/ as [+nasal], as in (1b).

(1) French /p b m/ (Martinet 1964: 64)

a. Full specification

	p	b	m
voiced	–	+	+
nasal	–	–	+

b. Features distinguishing minimal pairs

	p	b	m
voiced	–	+	
nasal		–	+

c. Redundancy rules for (b)

[0 voiced] → [+ voiced] [0 nasal] → [–nasal]

These are essentially the contrastive specifications proposed by Martinet (1964: 64) in his discussion of how to contrastively specify the consonants of Standard French. The redundancy rules in (c) then fill in the unspecified features at some point before or during phonetic implementation.

Extraction from fully specified minimal pairs was evidently also used by Trubetzkoy (1969), especially in the first part of his book. For example (68-9), Trubetzkoy writes that in Standard French, *d* and *n* "are the only voiced dental occlusives." This fact is apparent from the fully specified feature values shown in (2a) He observes further that "neither voicing nor occlusion is distinctive for *n*, as neither voiceless nor spirantal *n* occur as independent phonemes." That is, Trubetzkoy understands a feature to be distinctive in a phoneme if there is another phoneme in the language that is identical except for that feature. This notion of contrastiveness is consistent with extraction of minimal pairs based on full specifications. Since there is no voiceless *n*, and no fricative *n*, voicing and occlusion cannot be distinctive in /n/, as shown in (2b), where only specifications that are contrastive in this sense are retained.

Notice in (2b) that with respect to the contrastive features, /d/ and /n/ share only the feature [dental], and this is true also of /t/ and /d/. Thus, these specifications pose a problem for Trubetzkoy's notion of a bilateral opposition, which is an opposition whose members are unique with respect to the set of contrastive features they share. Trubetzkoy believes that both /t/ ~ /d/ and /d/ ~ /n/ form a bilateral opposition in French, though he presents no evidence that this is the case. Thus, he concedes that sometimes noncontrastive features must be considered in assessing if an opposition is bilateral, as shown in (2c), where redundant but necessary features are underlined.

We will see that in later sections of his book Trubetzkoy takes quite a different view of the contrasts in the French consonant system.

(2) Some French consonants, bilateral oppositions (Trubetzkoy 1969: 68-69)

a. Full specifications

	t	d	n	p	b	m	s	z	k	g
voiced	–	+	+	–	+	+	–	+	–	+
continuant	–	–	–	–	–	–	+	+	–	–
place	dnt	dnt	dnt	bil	bil	bil	alv	alv	dor	dor
nasal	–	–	+	–	–	+	–	–	–	–

b. Contrastive specifications via minimal pairs

	t	d	n	p	b	m	s	z	k	g
voiced	–	+		–	+		–	+	–	+
continuant										
place	dnt	dnt	dnt	bil	bil	bil	alv	alv	dor	dor
nasal		–	+		–	+				

c. Determination of bilateral oppositions

Pair	In common	Shared with	Opposition
t ~ n	[dnt]	d	multilateral
t ~ d	[dnt, –nasal]	–	bilateral
d ~ n	[dnt, +voiced, –cont]	–	bilateral
d ~ b	[+voiced, –nasal]	g	multilateral

Jakobson (1949) apparently took a similar approach to specification of the features of Serbo-Croatian. I say "apparently" because he does not state explicitly how he arrived at his specifications, but we can work backwards to infer what the method was. I present his specifications of oral and nasal stops (only features relevant to this example are included). The shaded squares are those that Jakobson leaves unspecified. They are precisely the specifications that do not distinguish between minimal pairs.[1]

(3) Specifications of oral and nasal stops

	t	d	n	p	b	m	ć	đ	ń	k	g
voicing	–	+		–	+		–	+		–	+
nasality		–	+		–	+		–	+		
saturation	–	–	–	–	–	–	+	+	+	+	+
gravity	–	–	–	+	+	+	–	–		+	+

1. An exception is the specification of /m/ as [+saturation]. Since /m n ń/ are the only [+nasal] segments, the features [saturation] and [gravity] are needed only to distinguish between them. /n/ forms a minimal pair with /ń/ based on [saturation], and with /m/ based on [gravity]. As expected, /n/ is specified for both [saturation] and [gravity], and /ń/ is specified for [saturation] but not for [gravity]. By symmetry, /m/ ought to be specified for [gravity] but not for [saturation]. I suspect the specification of /m/ as [+saturation] is simply an error. I will show below that the minimal pairs method is not able to adequately distinguish all members of an inventory in the general case. Therefore, it is not surprising that Jakobson did not, or was not able to, adhere to it in a strict way.

1.1. Algorithm for extraction via minimal pairs

Extraction of contrastive features from full specifications via minimal pairs can be implemented by a formal algorithm. Such an algorithm was proposed by Archangeli (1988). I will call this the Pairwise Algorithm, given in (4):

(4) Pairwise Algorithm (Archangeli 1988)
   a. Fully specify all segments.
   b. Isolate all pairs of segments.
   c. Determine which segment pairs differ by a single feature specification.
   d. Designate such feature specifications as 'contrastive' on the members of that pair.
   e. Once all pairs have been examined and appropriate feature specifications have been marked 'contrastive', delete all unmarked feature specifications on each segment.

An illustration of how this algorithm is supposed to work is given in (5). This is a typical five-vowel system characterized by the features [high], [low], and [back]. According to the Pairwise Algorithm, this five-vowel system, fully specified for these features as in (5a), would be underspecified as in (5b):

(5) Five-vowel system, features [high], [low], [back]

a. Full specifications

	i	e	a	o	u
high	+	–	–	–	+
low	–	–	+	–	–
back	–	–	+	+	+

b. Specifications according to the Pairwise Algorithm

	i	e	a	o	u	Contrasts
high	+	–		–	+	{i, e}; {o, u}
low			+	–		{a, o}
back	–	–		+	+	{i, u}; {e ,o}

1.2. Problems with extraction via minimal pairs

Deriving contrastive features by extraction from full specifications via minimal pairs is unworkable for several reasons. First, it fails to adequately contrast segments that are not minimal pairs. Consider again example (1), French /p b m/. The contrastive specification in (1b) distinguishes /b/ from /p/ on one side and from /m/ on the other; but what about the contrast between /p/ and /m/? /p/ is [–voice] and /m/ is [+nasal]; since these are not privative features but truly binary, we cannot conclude that the absence of a specification is necessarily distinct from a specification. Without running through the redundancy rules that tell us how to fill in missing specifications, we cannot decide if /p/ is distinct from /m/ or not. But then we have failed to arrive at a proper contrastive specification. Thus, the Pairwise Algorithm fails the Distinctness Condition proposed by

Halle (1959), given in (6). Essentially, it says that 0 is not distinct from a plus or minus value in a binary feature system that is not privative. Examples are shown in (7).

(6) Distinctness of phonemes (Halle 1959: 32)

> Segment-type {A} will be said to be *different from* segment-type {B}, if and only if at least one feature which is phonemic in both, has a different value in {A} than in {B}; i.e., plus in the former and minus in the latter, or vice versa.

(7) Examples of distinctness and non-distinctness (Halle 1959: 32)

a. {A} is not "different from" {C}

	{A}	{B}	{C}
Feature 1	+	–	+
Feature 2	0	+	–

b. All three are "different"

	{A}	{B}	{C}
Feature 1	+	–	–
Feature 2	0	+	–

One can argue about whether contrastive specifications ought to meet the Distinctness Condition. (I think they do, but Stanley (1967) is one of a number who disagree.) However, the minimal pairs method faces much more severe problems of adequacy, in that there are common situations in which it fails by any measure to distinguish the members of an inventory. There are two types of cases in which this occurs.

First, the Pairwise Algorithm will fail when there are too many features relative to the number of phonemes in the inventory. In the five-vowel system in (5), the Pairwise Algorithm succeeds in the three-dimensional feature space defined by the features [high], [low], and [back]. But recall that the Pairwise Algorithm starts from *fully specified* specifications; the limitation of the feature space to three features is arbitrary and unjustified. Full phonetic specification implies that the vowels be specified for *all* vowel features, including [round], [ATR], [nasal], and so on. Even adding just one more feature, say [round], causes the Pairwise Algorithm to fail to differentiate the five-vowel system in (5). The results are shown in (8).

(8) Five-vowel system, features [high], [low], [back], [round]

a. Full specifications

	i	e	a	o	u
high	+	–	–	–	+
low	–	–	+	–	–
back	–	–	+	+	+
round	–	–	–	+	+

b. Specifications according to the Pairwise Algorithm

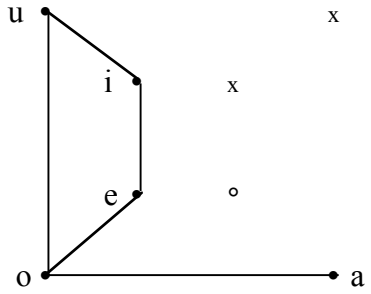
	i	e	a	o	u	Contrasts
high	+	–		–	+	{i, e}; {o, u}
low						
back						
round						

The only minimal pairs are {i, e} and {o, u}; the addition of the fourth feature turns what used to be minimal pairs into segments that are distinguished by more than one feature. The features [back] and [round] are each redundant given the other, but one of them has to be retained. In such cases, the Pairwise Algorithm cannot decide which feature to keep and which to discard. It is not clear, then, that the Pairwise Algorithm and the Minimal Pairs approach that it formalizes can handle even the simplest sound systems, once all features are taken into account.

In these situations, there is a remedy available, and that is to reduce the number of features before employing the Pairwise Algorithm. But then some other mechanism must operate in advance of the Pairwise Algorithm to make the same kinds of decisions. We shall see that when we spell out what this other mechanism is, the Pairwise Algorithm will be shown to be superfluous.

There is another type of case in which the Pairwise Algorithm fails, and this does not involve extra features, but rather the way in which the members of an inventory are dispersed over the space defined by the feature set. That the Pairwise Algorithm gives a contrastive specification at all, whether correct or not, is due to the connectedness of the paths through the space defined by the set of features. We can model the space corresponding to the inventory in (5) and the minimal pair paths through it with a diagram as in (9). An empty circle represents an unoccupied node, and x represents an impossible combination of [+high, +low].

(9) Five-vowel system, features [high], [low], [back]



Archangeli (1988) points out that not every five-vowel system can be assigned a contrastive set of specifications by the Pairwise Algorithm. An example of such an inventory is the vowel system of Maranungku (Tryon 1970). This vowel system is given in (10).

(10) Maranungku, features [high], [low], [back]

a. Full specifications

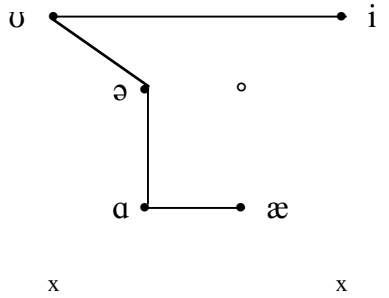
	i	æ	ɑ	ə	ʊ
high	+	–	–	–	+
low	–	+	+	–	–
back	–	–	+	+	+

b. Specifications according to the Pairwise Algorithm

	i	æ	ɑ	ə	ʊ	Contrasts
high				–	+	{ə, ʊ}
low			+	–		{ɑ, ə}
back	–	–	+		+	{i, ʊ}; {æ, ɑ}

In this case, /i/ and /æ/ have the same contrastive specification because they occupy parallel positions in a contrast, as shown graphically in (11), but have no other neighbours that could further differentiate them in terms of this algorithm.

(11) Maranungku, features [high], [low], [back]



Whether or not an inventory has paths that make its members distinguishable by the Pairwise Algorithm is an accidental property, and should not be the basis of a theory of contrastiveness.

2. Specification of contrasts by a hierarchy of features

Another approach to contrastiveness also has roots in the earliest work on contrast phonology. In his discussion of the Polabian vowel system, Trubetzkoy (1969: 102-103) observes that a "certain hierarchy existed" whereby the back ~ front contrast is higher than the rounded ~ unrounded one, the latter being a subclassification of the front vowels. Trubetzkoy's rationale for this analysis is that palatalization in consonants is neutralized before all front vowels (and before "the maximally open vowel *a* which stood outside the classes of timbre." (102)). Also, the oppositions between back and front vowels are constant, but those between rounded and unrounded vowels of the same height are neutralizable (after *v* and *j* to *i* and *ê*). The vowel system, according to Trubetzkoy's contrastive distinctions, is given in (12). The diagram suggests that the feature [back] has wider *scope* than does [rounded].

(12) Polabian (Trubetzkoy 1969: 102-3): [back] > [rounded]

Front		Back
(Unrounded)	Rounded	
i	ü	u
ê	ö	o
e		ɑ
a		

In another example Trubetzkoy observes that Greek has a bilabial stop /p/ and labiodental fricatives /f v/, and a postdental stop /t/ and interdental fricatives /θ ð/. Is the primary contrast one of stop vs. fricative or of place? Trubetzkoy appeals to "parallel" relations between stops and fricatives at different places. In the sibilant and dorsal series (/ts s z/ and /k x ɣ/, respectively), the contrast is unambiguously one of stop vs. fricative, since stops and fricatives occur at exactly the same place of articulation. By parallelism, Trubetzkoy proposes that the same contrast should apply to the ambiguous cases, which leads to the conclusion that the minor place splits are phonologically irrelevant. The picture that emerges is given in (13).

(13) Greek: major place, voicing, occlusion > minor place[2]

	Labial		Apical			Dorsal
	bilabial	labiodental	interdental	postdental	sibilant	dorsal
voiceless stops	p			t	ts	k
voiceless fricatives		f	θ		s	x
voiced fricatives		v	ð		z	ɣ

In French, however, Trubetzkoy argues for a split labial series. "For in the entire French consonant system there is not a single phoneme pair in which the relation spirant : occlusive would occur in its pure form" (126). Indeed, Trubetzkoy follows this analysis to its logical conclusion (n. 93) and disputes that there is an opposition between occlusives and spirants in French, because degree of occlusion cannot be regarded independently of position of articulation. Thus, Greek and French require a different ordering of the continuant feature relative to minor place features.

(14) French obstruents (based on Martinet 1964: 65)[3]

	bilabial	labiodental	apical	alveolar	pre-palatal	dorso-velar
voiceless	p	f	t	s	š	k
voiced	b	v	d	z	ž	g

This analysis is inconsistent with Trubetzkoy's earlier discussion of bilateral oppositions in French. Whereas earlier he assumed that /t/ and /d/ were contrastively occlusive, now we see that [continuant] plays no role at all in the French consonant system, according to Trubetzkoy's later analysis. Moreover, in a hierarchical approach to

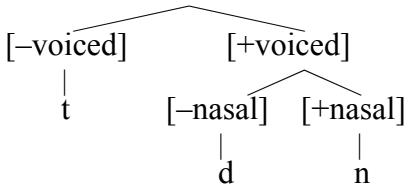
2. I substitute phonetic transcription for Trubetzkoy's Greek letters.

3. As Trubetzkoy does not give a chart, I adapt this one from Martinet (1964), whose analysis is clearly influenced by Trubetzkoy.

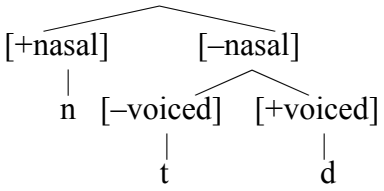
contrastive specification, it is not at all clear that voicing is redundant for /n/. For example, if [voiced] is ordered above [nasal], then the voicing contrast will include in its purview the nasal consonants as well, as shown in (15a). In this ordering, /d/ ~ /n/ participate in a bilateral opposition, but /t/ ~ /d/ do not. On the other hand, the features could be ordered as in (15b), in which case nasals are not specified for voicing, /d/ ~ /n/ do not form a bilateral opposition, but /t/ ~ /d/ do.

(15) French dental obstruents and nasals:

a. [voiced] > [nasal]:
/d/ ~ /n/ bilateral



b. [nasal] > [voiced]:
/t/ ~ /d/ bilateral

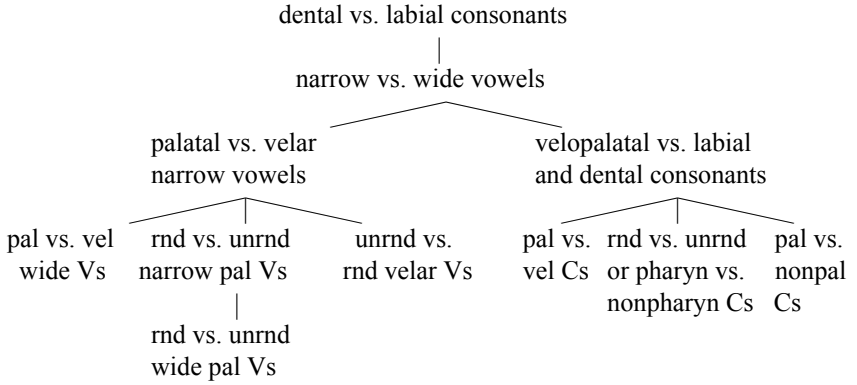


The tree diagrams in (15) show one characteristic of specification by a top-down hierarchy: feature values that are logically redundant, such as [+voiced] for /n/, or [–nasal] for /t/, may still be designated as contrastive, if they are high enough on the hierarchy.

As far as I know, the first person to explicitly argue for the contrastive hierarchy was Roman Jakobson. Even he employed it inconsistently. The hierarchy was given a prominent place in Jakobson and Halle's *Fundamentals of Language* (1956). They refer to this hierarchy as the "dichotomous scale," and adduce "several weighty arguments" in support of this hierarchical approach to feature specification. One argument had to do with information theory, based on work with Colin Cherry. Their second argument involves language acquisition. They suggest that distinctive features are necessarily binary because of the way they are acquired, through a series of "binary fissions." They propose (1956: 41) that the order of these contrastive splits is partially fixed, thereby allowing for certain developmental sequences and ruling out others.

The sequence in (16), for example, concerns oral resonance (primary and secondary place) features.

(16) Predicted acquisition sequences (Jakobson & Halle 1956: 41)



The notion of a developmental sequence of phoneme acquisition did take hold in the field of child language, but had a rockier fate in phonological theory itself.

2.1. The contrastive hierarchy via the Successive Division Algorithm (SDA)

Let us consider a bit more explicitly how contrast might be determined. Our discussion of domains of contrast and the relative scope of features suggests that a natural way of determining contrast is by splitting the inventory by means of successive divisions, governed by an ordering of features. An algorithm corresponding to this idea, which we call the Successive Division Algorithm, is given in (17). The basic idea is that we start by assuming that all sounds form one phoneme. This primordial allophonic soup is divided into two or more sets by whichever distinctive feature is selected first. We keep dividing up the inventory into sets, applying successive features in turn, until every set has only one member. When the algorithm applies to binary features, we call it the Successive Binary Algorithm.

(17) Successive Division Algorithm (SDA)

a. In the initial state, all tokens in inventory I are assumed to be variants of a single member. Set I = S, the set of all members.

b. i) If S is found to have more than one member, proceed to (c).
ii) Otherwise, stop. If a member, M, has not been designated contrastive with respect to a feature, G, then G is *redundant* for M.

c. Select a new *n*-ary feature, F, from the set of distinctive features.[4] F splits members of the input set, S, into *n* sets, $F_1 - F_n$, depending on what value of F is true of each member of S.

d. i) If all but one of $F_1 - F_n$ is empty, then loop back to (c).[5]
ii) Otherwise, F is *contrastive* for all members of S.

e. For each set F_i, loop back to (b), replacing S by F_i.

This algorithm solves the problems encountered by the Pairwise Algorithm:

a) it adequately contrasts all members of an inventory;
b) it is guaranteed to work in all inventories; and
c) it does not have to adopt auxiliary mechanisms for multiple logical redundancies.

2.2. The fall of the contrastive hierarchy

Despite their arguments for it, the contrastive hierarchy was employed inconsistently by Jakobson and Halle in the late 1950s. Perhaps the inconsistency is due to their failure to arrive at a single universal hierarchy that could apply to all the languages they studied. It appeared in the "branching diagrams" of Halle's (1959) *Sound Pattern of Russian*. The use of "branching diagrams" was challenged on various grounds by Stanley (1967).

4. I assume that the set of relevant distinctive features for a particular domain is given by some theory of that domain. By "new" feature I mean one that has not already been tried. Thus, the value of F changes every time this step reapplies. (I assume some mechanism for keeping track of which features have already been tried, but do not specify it here.)

5. That is, if all members of S have the same value of F, then F is not contrastive in this set.

Though the contrastive hierarchy disappeared from generative phonology, the intuition that "there is obviously some kind of hierarchical relationship among the features which must somehow be captured in the theory" (Stanley 1967) continued to haunt generative phonological theory.

Thus, the notion of a hierarchy of features is evident in various forms of markedness theory. Here. too, the emphasis has been on finding a single universal hierarchy, though such a quest has not been entirely successful. The same can be said for feature geometry, which builds a fixed hierarchy directly into representations. Less obviously, underspecification theory also can be shown to assume some notions of a feature hierarchy.

3. Implicit hierarchies in phonological descriptions

With a few notable exceptions, such as the work of Jakobson and Halle, there is almost nothing in the phonological literature on the notion of a contrastive hierarchy. Nevertheless, hierarchies are often implicit in at least a partial way in the practice of phonologists.

One place to see this is in the way tables of segmental inventories are arranged in descriptive grammars. Compare, for example, the tables of Siglitun (18) and Kolokuma Ịjọ (19). I present them as they are given in the sources (with some changes to the phonetic symbols but not to the arrangement). Note in particular the different placements of /l/ and /j/ in these charts. The chart of Ịjọ expresses a hierarchy in which the feature [continuant] has wider scope than such features as [sonorant] and [voiced], and [lateral] has wider scope than [nasal]. The Siglitun chart is not as overtly hierarchical, but it is clear that the feature [lateral] has very narrow scope, confined to making distinctions among apicals, whereas [nasal] is higher in the hierarchy. Apart from the nasals, the other sonorants are not set apart in Siglitun, suggesting that the feature [sonorant] is lower in the hierarchy than in Ịjọ.

(18) Siglitun consonants (Dorais 1990: 70):[6]

	Bilabial	Apical		Velar	Uvular
Stops	p	t		k	q
Voiced fricatives	v	l	j	ɣ	ʀ
Voiceless fricatives		ɬ	s		
Nasals	m	n		ŋ	

6. I have simplified Dorais's *j/dj* and *s/ch* to *j* and *s*, respectively. As he makes clear, these are variants of single phonemes. Dorais does not usually indicate variants in his charts, and in related dialects in which /j/ has similar variants he lists only *j*. Therefore, I keep to the usual practice of representing a phoneme by one symbol.

(19) Consonant phonemes of Kolokuma Ịjọ (Williamson 1965)[7]

	Plosive		Continuant				
			Fricative		Sonorant		
	Vl.	Vd.	Vl.	Vd.	Non-lateral		Lateral
					Oral	Nasal	
Labial	p	b	f	v	w	m	
Alveolar	t	d	s	z	r	n	l
Back	k	g	(h)	(ɣ)	j	ŋ	
Labio-velar	kp	gb					

So pervasive is the hierarchical approach to inventories that we can find it even in the work of those who explicitly argue against it. In *A Manual of Phonology* (1955), C. F. Hockett soberly reviews the different ways of construing the contrasts in the French obstruent system. He observes that place distinctions can make continuancy redundant (the solution favoured by Trubetzkoy and Martinet, shown in (14)); conversely, continuancy can be used to make minor place distinctions redundant (as in the analysis of Greek in (13)). Then he blows his top. He writes that "[b]oth of these decompositions of the French obstruents have the odor of pure game-playing…" (173). He goes on to suggest that it is simply not possible to ever distinguish between features that are "determining," that is, contrastive, and those that are "determined," that is, redundant.

Hockett's conclusion, however, is not consistent with his own practice in the rest of the manual. If we can indeed make no distinctions between "determining" and "determined" features, it would be difficult to assign phonemic symbols to a set of allophones, let alone arrange them into neat schematic diagrams. But this Hockett does in his presentation of types of vowel and consonant systems.

For example, he observes (84) that a 2×2 type of vowel system is widespread. He portrays such a system with the diagram in (20).

(20) A 2×2 vowel system (Hockett 1955: 84)

i	o
e	a

As examples, Hockett cites Rutul, in which the high back vowel is sometimes rounded, sometimes not, depending on environment; Fox and Shawnee, where the low back vowel is usually unrounded, though rounded in certain environments; and a number of other languages. It is particularly interesting that the schematic diagram, for which he cites no specific language, has /o/ rather than /u/, and /e/ rather than /æ/. Hockett adds (84), "we class Fox as a two-by-two system despite the fact that the vowel classed as low back, /a/, is typically lower than that classed as low front, /e/." Though he lists no features, the arrangement in (20) can only mean that backness, not rounding, as well as a single height contrast, are the relevant (determining) ones. In particular, it is not relevant that /o/ may be phonetically lower than /i/, and /a/ lower than /e/; indeed, the choice of

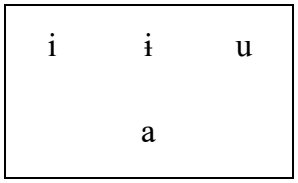
7. I substitute *j* for Williamson's *y*. Williamson notes that Back = palatal, velar or glottal, Vl. = voiceless, and Vd. = voiced. Williamson mentions that some speakers have a marginal phoneme /ɣ/, but she omits it from the table. I have added it because it appears to be no less marginal than /h/, which is included.

these symbols suggests that /o/ and /e/ might be at the same height phonetically, though functioning phonemically at different heights. Thus, the schematization in (20) appears to be specifically chosen to show how the contrastive structure of a vowel system can differ from its surface phonetic appearance.

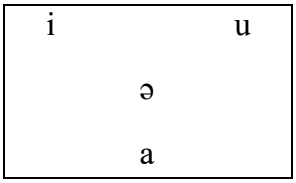
Hockett makes decisions like these throughout his survey of vowel and consonant systems. To take one more example involving vowels, he writes that a 3+1 system "is reported for Amahuaca" (21a), "though the /ɨ/ may be lower than /i u/, placing Amahuaca rather with Ilocano and others" (21b). He observes that in the Filipino languages represented by (21b), /ə/ has fronted variants, and also higher central or back unrounded variants.

(21) Vowel systems: 3+1 vs. 2+1+1 (Hockett 84-5)

a. Amahuaca



b. Ilocano



It is not important, for the purposes of this discussion, whether Amahuaca is as in (21a) or (21b). What is important is that Hockett believes it is meaningful to assign it to one or the other. If there is indeed no way to distinguish between determined and determining features, we could not represent Ilocano as in (21b), since this diagram implies that the determining features of /ə/, for example, are that it is central and mid, even though it has variants that are front and others that are high. Similarly, Amahuaca could not be represented as in (21a) if /ɨ/ is phonetically lower than /i u/ to any extent, because that means making a decision that its centrality is the determining feature and its lower height is the determined feature.

4. Conclusion

I have argued that one common approach to determining contrastive feature specifications is wrong, and that an approach based on ordering of features with respect to their contrast scope is correct. If this approach is correct, it raises anew a number of issues that are quite central to phonological theory. To mention just one, we have to reexamine the question of what redundant features are, and what role they play in the phonology. This topic is the subject of ongoing work in the project on Contrast and Complexity in Phonology at the University of Toronto (http://www.chass.utoronto.ca/~contrast/). Some relevant references are: Avery (1996); Avery and Rice (1989); Balcaen (1998); Barrie (2002); Causley (1999); Dresher (1998a,b); Dresher, Piggott, and Rice (1994); Dyck (1995); Frigeni (2002); Ghini (2001); Hall (1998, 2002); Hirayama (2002); Mercado (2002); Moulton (2002); Rice (1993, 1995, 1997); Rice and Avery (1995); Vilks (2002); Walker (1993); Wu (1994); Zhang (1996); and Zhou (1999).

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