

The Logic of Contrast*

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1. Introduction

Jean-Roger Vergnaud has always advocated formal rigour in linguistic theory as a way of making theoretical notions precise. This is especially needed in phonology where what he has called “recreational diagrams” have sometimes taken the place of formally explicit theoretical underpinnings. I will argue that the history of the notion of contrast in phonology provides a series of illuminating case studies of the dangers of leaving key notions vaguely defined.

Since Saussure it has been a central premise of linguistic theory that contrast is central to understanding the nature of linguistic inventories: an element is defined not only by its substance but by the elements it is in contrast with (“dans la langue il n’y a que des différences”). In phonology contrast is informally understood as applying to phonemes, but at least since the work of Trubetzkoy and Jakobson it has been understood that phonemes are made up of distinctive features, and that the significant oppositions in a language involve features. It is one thing to say that two phonemes, say /z/ and /l/, are in contrast in a given language; it is another thing to determine which particular features are contrastive in these phonemes. Are /z/ and /l/ distinguished by the feature [sonorant], or [lateral], or [continuant], or [strident], or by some or all of these?

As I will show, this question has rarely been asked, let alone answered, in the phonological literature, even in work that would appear to presuppose it. In this paper I will consider a few such examples, drawing on work from widely separated time periods.

Though the terminology and theoretical frameworks may differ, I will try to show that all are hindered by the same problem: the lack of an explicit and adequate means of identifying contrastive and redundant feature values.

2. Two approaches to assigning contrastive feature specifications

2.1. Contrast based on an ordering of features

In the case of phonemes viewed as primitive elements, every phoneme is in contrast with every other one, and there is no further structure to the set. When phonemes are analyzed as complexes of features, however, it is necessary to specify the structure of the contrastive set. I have argued (Dresher 1998, 2002, 2003a, b), following Jakobson, Fant and Halle (1952) and Jakobson and Halle (1956), that contrast must be established by setting up an *ordering*, or *hierarchy*, of features, where the first feature divides an inventory, and successive features divide the subsets in turn until all phonemes have been distinguished. As Vergnaud has put it (p. c.), the logic of contrast is the logic of “given that”: determination of whether or not a feature is contrastive in any particular phoneme depends on what contrastive features have already been specified.

Consider an inventory with the phonemes /p/, /b/, and /m/, and suppose for sake of this example that they are specifiable for the features [voiced] and [nasal].¹ This inventory is given in (1).

(1) A simple inventory

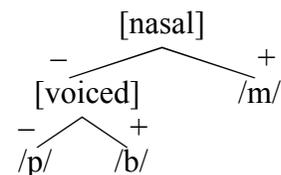
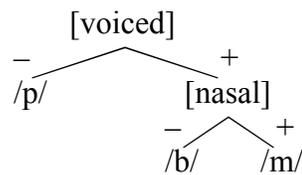
	p	b	m
[voiced]	–	+	+
[nasal]	–	–	+

If [voiced] is ordered ahead of [nasal] (henceforth, [voiced] > [nasal]), then /p/ is contrastively [-voiced] and /b, m/ are contrastively [+voiced]; then the latter two are distinguished by [nasal], which is contrastive only in the [+voiced] set. If, on the other hand, the features are ordered [nasal] > [voiced], then /m/ is contrastively [+nasal] and /p, b/ are contrastively [-nasal]; now, the feature [voiced] only distinguishes between the phonemes in the [-nasal] set. The two orderings can be drawn as in (2).

(2) Two orderings of the features [voiced] and [nasal] applied to /p b m/

a. [voiced] > [nasal]

b. [nasal] > [voiced]



The phonemes in (2a) and (2b) are thus specified for the contrastive features in (3a) and (3b), respectively.

(3) Contrastive specifications derived by (2)

a. [voiced] > [nasal]

b. [nasal] > [voiced]

	p	b	m
[voiced]	-	+	+
[nasal]		-	+

	p	b	m
[voiced]	-	+	
[nasal]	-	-	+

Notice that although the inventories and features in both the (a) and (b) orders are identical, the contrastive specifications differ: in each order, one redundant specification is left out, though it is a different specification in each order. This discrepancy underlines the fact that on this view, contrast must be evaluated relative to an order of features; without an order, the notion remains undefined. Let us call this the Contrastive Hierarchy (CH) approach to determining contrastive feature values.

2.2. Contrast based on logical redundancy

The above procedure for determining contrastive feature specifications is not the only one that has been employed in the linguistic literature, nor is it even the predominant approach. More usually, contrastive specifications have been assigned by removing all the specifications that are *logically redundant*. We can define logical redundancy as in (4).

(4) Logical redundancy

If Φ is the set of feature specifications of a member, M , of an inventory, then the feature specification $[F]$ is *logically redundant* iff it is predictable from the other specifications in Φ .

A feature that is logically redundant is predictable from the other features. In example (1), there are two logically redundant specifications: since /p/ is the only [–voiced] member of the inventory, its feature value [–nasal] is predictable; similarly, the value [+voiced] for /m/ is predictable given [+nasal], since /m/ is the only [+nasal] phoneme. By this reasoning, we arrive at the contrastive specifications in (5); just such specifications are proposed by Martinet (1964:64) for Standard French.

(5) a. Contrastive specifications by removing logically redundant values

	p	b	m
[voiced]	–	+	
[nasal]		–	+

b. Redundancy rules

- i. [–voiced] \rightarrow [–nasal] ii. [+nasal] \rightarrow [+voiced]

Logical redundancy is defined in (4) with reference to specification over the full set of features. For it is only by first specifying all segments for every feature that we can determine which features are redundant. Let us then call this the Full Specification (FS) approach to determining contrastive values.

As demonstrated by Drescher (2002, 2003), this procedure is seriously flawed, because it may not be possible to remove all the logically redundant feature specifications while retaining enough specifications to differentiate the phonemes. To take a simple example, suppose inventory (1) lacked /b/. In an inventory consisting only of /p/ and /m/, the phonemes differ with respect to both the features [voiced] and [nasal]. Therefore, each specification is predictable from the others and every specification is logically redundant in terms of the definition in (4). Obviously, they cannot all be removed. In such cases, the FS procedure for determining contrast fails, and must be supplemented by another procedure. For example, we may decide that [voiced] is a more important feature than [nasal] (or vice-versa); but that is tantamount to ordering them, as in the CH approach.

Such situations arise rather commonly. Consider a familiar inventory with the five vowels /i e a o u/, which have at least the specifications in (6).

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

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

A contrast in the feature [high] is all that distinguishes /i/ from /u/ and /e/ from /o/, therefore these values of [high] are contrastive. The value [–high] of /a/ is predictable from [+low], and so is logically redundant. The same is true of all values of the feature [low]: for the high vowels, [+high] predicts [–low]; all the other vowels are distinguishable without [low], whose value is thus predictable from the features [back] and [round]. In particular, [+back, –round] predicts [+low] (/a/); all other combinations of [back] and [round] predict [–low]. At the same time, each of [back] and [round] is predictable from the other together with the feature [low]: [–low, –back] predicts [–round] and [–low, –round] predicts [–back] (/i e/); [–low, +back] predicts [+round], and [–low, +round] predicts [+back] (/u o/); and [+low] predicts [+back, –round] (/a/).

Therefore, combinations of any two of [low], [back], and [round] make the third feature logically redundant. It follows that they are all logically redundant, but clearly cannot all be omitted. This situation arises as a consequence of trying to determine contrast simultaneously for all features, rather than using the logic of “given that:” feature F is redundant given G, and G is redundant given F, but these logical situations do not apply at the same time.

The particular problem here is that there are too many features for the number of vowels, given their distribution in the feature space. Reducing the number of features to three will allow the FS method to yield a result, but then another theory is needed to decide which feature is dispensable. For example, without the feature [round] in (6), [low] is required to distinguish between /a/ and /o/, and [back] is the only feature that distinguishes between /i e/ and /u o/. Removing the logically redundant features results in the contrastive specifications in (7).²

(7) a. Contrastive specification by FS: features [high], [low], [back] only

	i	e	a	o	u
[high]	+	-		-	+
[low]			+	-	
[back]	-	-		+	+

b. Redundancy rules:

- i. [+low] \rightarrow [-high] iii. [-back] \rightarrow [-low]
 ii. [+high] \rightarrow [-low] iv. [+low] \rightarrow [+back]

Even reducing the number of features will not always give good results for the FS method, depending on the way members of an inventory are dispersed over the space defined by the feature set. An example of such an inventory is the vowel system of Maranungku (Tryon 1970), given in (8).

(8) Maranungku: features [high], [low], [back]

	i	æ	ɑ	ə	ʊ
[high]	+	-	-	-	+
[low]	-	+	+	-	-
[back]	-	-	+	+	+

Removing the logically redundant values results in the contrastive specifications in (9).

As is evident, these specifications fail to distinguish between /i/ and /æ/.³

(9) a. Maranungku: Contrastive specification by FS

	i	æ	ɑ	ə	ʊ
[high]				-	+
[low]			+	-	
[back]	-	-	+		+

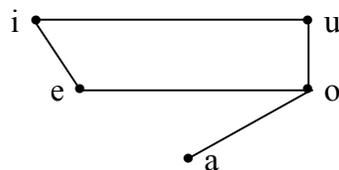
b. Redundancy rules:

- | | |
|---|---|
| i. [+low] \rightarrow [-high] | iv. $\begin{bmatrix} \text{-high} \\ \text{-back} \end{bmatrix} \rightarrow$ [+low] |
| ii. $\begin{bmatrix} \text{-low} \\ \text{-back} \end{bmatrix} \rightarrow$ [-high] | v. $\begin{bmatrix} \text{-high} \\ \text{-low} \end{bmatrix} \rightarrow$ [+back] |
| iii. [+high] \rightarrow [-low] | |

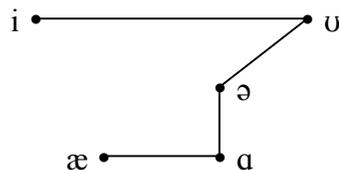
We can model the space corresponding to the inventories in (7) and (8) with diagrams as in (10). The lines connect neighbours that are distinguished by only a single feature. In the typical five-vowel inventory in (10a), every phoneme except /a/ has two such neighbours; the configuration shown results in sufficient contrastive features to uniquely characterize each phoneme.⁴ In (10b), however, /i/ and /æ/ occupy parallel positions in a contrast based on [back], but have no other neighbours that could further differentiate them; thus, they are assigned the same contrastive specifications, and cannot be distinguished.

(10) Distribution of phonemes in the space of features

a. /i e a o u/, features [high], [low], [back]



b. Maranungku, features [high], [low], [back]



Whether or not an inventory has paths that make its members distinguishable by FS is an accidental property, and should not be the basis of a theory of contrastiveness.⁵

CH does not depend on the members of an inventory having any particular pattern of distribution in the space of features, and does not succumb to these difficulties.

It is clear, then, that the two methods for determining contrast reviewed above are incompatible. They give different results even in simple cases, such as the example above with only two features and an inventory of three members. They also differ with respect to full specification (unnecessary in the hierarchical method, necessary in the logical redundancy method). The CH approach is additive, assigning contrastive features in succession, whereas the FS approach is subtractive, removing redundant features where possible. Further, the CH approach can give different contrastive representations for the same inventory and the same set of features, depending on ordering of the features; the FS approach, where it gives an answer, will always give the same contrastive representations for a given inventory and set of features. Most important, the FS approach does not work in many cases, whereas the CH procedure is guaranteed to give a result in every case.

Despite the clear differences between these methods of determining contrast, they have not been adequately differentiated in the literature. Sometimes we find both approaches apparently coexisting in the same work, with paradoxical results.

3. Some pre-generative approaches to contrast

3.1. Trubetzkoy

Trubetzkoy was the first phonologist to treat contrast formally. He did this in terms of the notion of *opposition*, where an opposition is the relation between any pair of contrasting members of an inventory (in our case, phonemes in a language). Though he contributed many insightful ideas and analyses, his discussion in the *Grundzüge* (1939, translated into

English as Trubetzkoy 1969) suggests that he did not have a single approach to distinguishing between contrastive and redundant values, but rather oscillated between the two incompatible approaches sketched above.

As part of his analysis of the logical basis of the concept of an opposition, Trubetzkoy (1969:68) calls attention to the properties common to the members of an opposition, what he calls their “basis for comparison.” In a *bilateral* opposition the sum of the properties common to both opposition members is common to them alone; in a *multilateral* opposition, the set of common properties are shared also by at least one other member of the inventory. According to Trubetzkoy (69), bilateral oppositions “are the most important for the determination of the phonemic content of a phoneme.” By *phonemic content* he appears to mean the set of contrastive (possibly only marked) specifications that characterizes a phoneme.

But how does one determine if an opposition is bilateral or multilateral? Trubetzkoy does not give a clear answer to this question. Consider again the miniature example in (1). If we adopt a hierarchical approach and limit oppositions to contrastive features, then on the ordering [voiced] > [nasal] (2a), /b/ and /m/ form a bilateral opposition because they are the only phonemes that share the common contrastive feature [+voiced]. However, /b/ and /p/ do not form a bilateral opposition, since /p/ shares no contrastive features with /b/ that it does not also share with /m/. In the ordering [nasal] > [voiced] (2b), it is /p/ and /b/ that form a bilateral opposition based on [–nasal], whereas *b:m* and *p:m* both form multilateral oppositions. That is, on the CH approach, determining that an opposition is bilateral or multilateral depends on the feature ordering.

In the FS approach, we must decide whether oppositions are to be evaluated on the basis of full specifications (1) or contrastive ones (5). If it is the former, then *p:b* and

b:m are both bilateral oppositions, whereas *p:m* is multilateral; if the latter, then there are no bilateral oppositions in this inventory.

We thus have at least four different classifications of the oppositions in (1), depending on which analysis we use: the CH approach gives two answers (depending on which feature ordering we choose), and the FS approach gives two more (depending on whether we use fully specified or contrastive feature values). So which approach does Trubetzkoy take?

Trubetzkoy's remarks on the subject do not add up to any one consistent approach, though he appears to presuppose the FS approach, at least in the earlier sections of the book. The statement that bilateral oppositions are important in determining phonemic content suggests that bilateral oppositions are in some sense prior to determination of contrastive values, as in the FS approach. On the one hand, he writes (68) that "only the phonologically distinctive properties are to be considered" in deciding if an opposition is bilateral or multilateral. But he goes on, "However, some nondistinctive properties may be taken into consideration as well" if these can contribute to making an opposition bilateral.

To illustrate, Trubetzkoy (1969:68–69) presents an example from Standard French. In this language, he observes, *d* and *n* "are the only voiced dental occlusives." He observes further that "neither voicing nor occlusion is distinctive for *n*, as neither voiceless nor spirantal *n* occur as independent phonemes." This notion of contrastiveness is consistent with the FS approach: if *n* is the only dental nasal, any other features it may have are predictable, hence not contrastive. Assuming that contrasts are established by FS, the status of selected oppositions in French is as in (11). Specifications that are redundant on this approach are underlined. In keeping with Trubetzkoy's observation,

d:n, and even *t:d*, do not form bilateral oppositions unless at least one redundant specification is taken into account.

(11) Determination of bilateral oppositions in French: FS approach

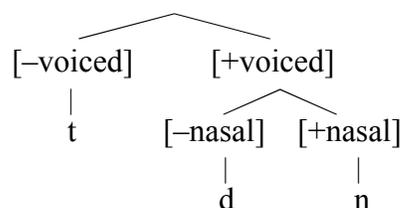
<i>Pair</i>	<i>In common</i>	<i>Shared with</i>	<i>Opposition</i>
<i>t:n</i>	[dental]	d	multilateral
<i>t:d</i>	[dental, <u>-nasal</u>]	–	bilateral
<i>d:n</i>	[dental, <u>+voiced, –continuant</u>]	–	bilateral
<i>d:b</i>	[+voiced, –nasal]	g	multilateral

Trubetzkoy provides no argument that *d:n* in fact *do* constitute a bilateral opposition in French. No empirical consequences to support this claim are adduced. In a hierarchical approach to contrastive specification, it is not at all obvious that voicing is redundant for /n/, or that *d:n* or *t:d* participate in bilateral oppositions. 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 (12a). 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 (12b), in which case nasals are not specified for voicing, *d:n* do not form a bilateral opposition, but *t:d* do.

(12) Determination of bilateral oppositions in French: CH approach

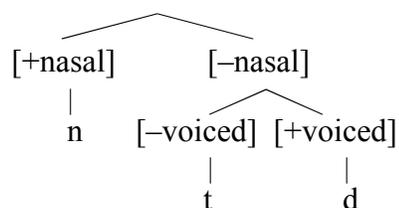
a. [voiced] > [nasal]:

/d/ ~ /n/ bilateral



b. [nasal] > [voiced]:

/t/ ~ /d/ bilateral



Though the discussion of bilateral oppositions in French presupposes an FS approach to contrast, Trubetzkoy takes a rather different tack in later sections of the *Grundzüge*, one consistent with what I have been calling the CH approach. Returning to French later in the book (1939:126), he considers whether the consonants /p b f v/ should be analyzed as occurring at a single place designated as ‘labial’, or whether the labial series should be split into two places, bilabial and labiodental. He argues for the latter, because “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.” Indeed, he 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. His analysis of the contrastive differences in the French obstruents can be summarized in (13).⁶

(13) French obstruents (based on Martinet 1964:65)

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

This result cannot be achieved by a FS theory that begins with full specification, because there would be no way to decide that the contrast in terms of [continuant] should be suppressed in favour of the place distinction. Nor is this always the case, in Trubetzkoy’s view. He observes that a similar issue arises in Greek, which 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 versus fricative or of place? Here 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 versus 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 inventory would thus be presented as in (14).

(14) Greek: major place, voicing, occlusion > minor place⁷

	Labial	Apical	Sibilant	Dorsal
voiceless stops	p	t	ts	k
voiceless fricatives	f	θ	s	x
voiced fricatives	v	ð	z	ɣ

The difference between the treatment of the place contrasts in Greek and French is consistent with a CH approach that assigns a different ordering of the continuant feature relative to minor place features in the two languages.

It is interesting that when he has empirical reasons for assigning contrastive features, Trubetzkoy tends to assume CH. For example, he observes (1969: 102-103) that a “certain hierarchy existed” in the Polabian vowel system 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.”). 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 (15). The diagram suggests that the feature [back] has wider scope than [round].

(15) Polabian (Trubetzkoy 1969: 102-3): [back] > [round]

front		back	
(unround)	round		
i	ï		u
ê	ö		o
e			ɑ
a			

3.2. Martinet and Jakobson on French contrastive features

Though Trubetzkoy did not follow any consistent procedure in determining contrastive specifications, his discussion of the French labial obstruent oppositions at least makes clear that one has to decide whether the contrast is based on place of articulation (bilabial /p b/ versus labiodental /f v/) or continuancy (stop /p b/ versus fricative /f v/). This issue was revisited a number of times by linguists in the Prague School tradition. Here I will consider two analyses, one by Martinet (1964) and the other by Jakobson and Lotz (1949). These analyses do not clarify the procedure for determining which features are contrastive. On the contrary, they are even less transparent than Trubetzkoy's discussion.

3.2.1. Martinet (1964): Contrasts based on place

Martinet's *Éléments de linguistique générale*, first published in 1960 and translated into English by Elisabeth Palmer (Martinet 1964), follows in the Prague School tradition of

phonological analysis. Martinet's analysis of the Standard French consonantal inventory appears to draw on Trubetzkoy's, though the theoretical basis for it is if anything even more obscure. This despite the fact that Martinet (1964:62-64) goes to some lengths to provide a method of determining what the relevant features are that characterize the set of contrasting phonemes for French. He does not, however, provide an algorithm or any general method, and his discussion leaves unexplained a series of questions as to why he makes the choices he does. His approach, as far as I can see, is consistent with neither FS nor CH.

Martinet (64) proposes the contrastive specifications shown in (16). He puts the names of the features in quotation marks to emphasize that these are not intended as exhaustive phonetic descriptions, but rather as phonological contrastive categories.⁸

(16) Contrastive sets of French consonants (Martinet 1964:64)

'unvoiced'	/p f t s š k/	'voiced'	/b v d z ž g/
'non-nasal'	/b d j/	'nasal'	/m n ɲ/
'bilabial'	/p b m/	'labio-dental'	/f v/
'apical'	/t d n/	'lateral'	/l/
'hiss'	/s z/	'hush'	/š ž/
'palatal'	/j ɲ/	'uvular'	/r/
'dorso-velar'	/k g/		

The contrastive features for voicing and nasality appear at first to follow from FS: the segments listed as contrastively 'unvoiced' or 'voiced' are those that have a direct counterpart in the other category; phonemes that are not contrastively voiced or voiceless include / m n ɲ l r j/, all of which lack voiceless partners. Similarly, only voiced /b d j/ are listed as contrastively 'nasal'. But the method is not consistently applied: /j ɲ/ are treated

as a minimal pair with respect to ‘nasal/non-nasal’ on a par with /b m/ and /d n/, despite the fact that /j/ is not an obstruent or a stop, and hence is distinguished from /ɲ/ by several other features. It is not explained why these features are suppressed here but not in other cases.

The remaining features do not fall into binary plus and minus groupings, and thus require some further interpretation. It is evident that Martinet is following Trubetzkoy’s approach in favouring place distinctions over occlusion: no feature like ‘continuant’ is listed in (16), though minor place distinctions, such as ‘bilabial’ and ‘labio-dental’, are. Unlike Trubetzkoy, Martinet does not make explicit his reason for favouring place over continuancy distinctions. This aspect of his analysis cannot be reconstructed in terms of a FS approach, because /b v/ are not distinguished only by place.

The lack of negative place designations such as ‘non-labial’, etc., suggests that Martinet conceives of place as a multi-valued feature, with values including ‘bilabial’, ‘labio-dental’, ‘apical’, ‘palatal’, ‘uvular’,⁹ and ‘dorso-velar’. Despite their names, which suggest a connection with stridency, the features ‘hiss’ and ‘hush’ can be interpreted as being values of this place feature as well; otherwise, we might have expected some segments to be contrastively ‘non-hiss’ or ‘non-hush’. The same considerations hold for the feature ‘lateral’.

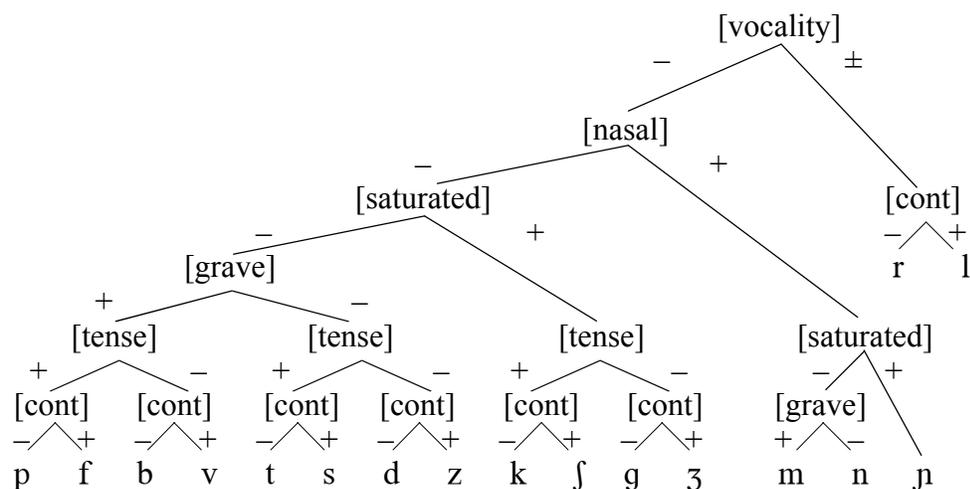
Martinet represents some of these features and phonemes in tabular form, shown in (17).¹⁰ With the feature ‘non-nasal’ omitted, this table begins to look more like the result of a CH approach to contrast, with the ordering [place] > [voiced] > [nasal].

(17) French consonants (Martinet 1964:65)

	'bilabial'	'labiodental'	'apical'	'hiss'	'hush'	'palatal'	'dorso-velar'
'voiceless'	p	f	t	s	ʃ		k
'voiced'	b	v	d	z	ʒ		g
'nasal'	m		n			ɲ	
						j	

3.2.2. Jakobson and Lotz (1949): Contrasts based on manner

Jakobson and Lotz (1949) take a different approach to French consonant contrasts than do Trubetzkoy and Martinet. They propose that French stops and fricatives are distinguished by manner rather than by place. They do not explicitly indicate how they arrive at their contrastive specifications, but their results are consistent with CH. Based on their representations, we can reconstruct their analysis in terms of the tree in (18).

(18) Contrastive Hierarchy for French consonants (Jakobson and Lotz 1949)¹¹

Though a hierarchical approach to contrast is only implicit in Jakobson and Lotz 1949, in the 1950s Jakobson and his collaborators explicitly proposed what I have been calling the CH approach and presented a number of arguments in favour of it (see Jakobson, Fant and Halle 1952, Cherry, Halle and Jakobson 1953, Jakobson and Halle 1956, Halle 1959). Jakobson, Fant and Halle (1953) go so far as to state that the “dichotomous scale” “is the pivotal principle of the linguistic structure.” Nevertheless, their use of it was inconsistent, perhaps because they were unable to arrive at a single universal hierarchy that could apply to all the languages they studied. Nor did they present empirical arguments that would connect it to phonological activity. Therefore, there was no defence when the use of “branching diagrams” (i.e., contrastive feature hierarchies) was challenged on various grounds by Stanley (1967); they do not appear in Chomsky and Halle 1968, who replaced CH and the underspecification of redundant features with full specification in the phonology combined with the beginnings of a theory of markedness.

Despite the arguments of Stanley (1967), underspecification began to reappear in generative phonology in the 1980s. However, CH, which could have given underspecification a principled rationale, did not reappear with it. Once again, the basis for distinguishing between contrastive and redundant specifications remained largely unstated and fatally vague, undermining a number of otherwise insightful proposals.

4. Some generative approaches to contrast

4.1. Structure Preservation (Kiparsky 1985)

Another example where an important theoretical proposal is undermined by a lack of an explicit theory of contrast concerns the development of theories of underspecification in

the 1980s. Kiparsky (1982, 1985) observes that voicing in English is distinctive for obstruents but not sonorants.¹² He proposes that this fact suggests that there exists a marking condition that prohibits voicing from being marked on sonorants in the lexicon (19a). He proposes further to extend this prohibition throughout the lexical phonology, a constraint he calls *Structure Preservation* (19b).

- (19) Underspecification and Structure Preservation (Kiparsky 1985:92)
- a. Marking condition: * $[\alpha\text{voiced}, +\text{sonorant}]$ in the lexicon
 - b. Structure Preservation: Marking conditions such as (19a) must be applicable not only to underived lexical representations but also to derived lexical representations including the output of word-level rules.

The marking condition in (19a), together with Structure Preservation (19b), accounts for the fact that English lexical voicing assimilation is triggered by and applies to obstruents, not sonorants.

The term ‘Structure Preservation’ is taken from syntax (Emonds 1976). Emonds’ initial definition is given in (20).

- (20) Structure-preserving transformation (Emonds 1976:3)
- A transformation...that introduces or substitutes a constituent C into a position in a phrase marker held by a node C is called “structure preserving.”

More informally, “a transformational operation is structure-preserving if it moves, copies, or inserts a node C into some position where C can be otherwise generated by the grammar.” In the syntactic theory assumed by Emonds 1976, Structure Preservation is

reasonably well defined, because it can be assessed against the set of phrase-structure rules.

In the theory of phonology assumed by Kiparsky (1985), however, there is no analog to the phrase-structure rules to provide a set of structures against which Structure Preservation can be assessed. The lack of an independent source of “structures” creates a serious ambiguity in the notion of Structure Preservation.

In the English example mentioned above, Kiparsky assumes that the relevant domain within which voicing is distinctive is that of the obstruent consonants. While this choice of relevant domain is quite plausible and perhaps correct, it is by no means self-evident. The domain relevant to a contrast is never simply given by the system. Failure to specify the principles that motivate conditions like (19a) causes Structure Preservation to be ill-defined.

One language in which this question arises in dramatic fashion is Russian. Maddieson (1984) presents the consonantal inventory of Russian as in (21).¹³

(21) Russian consonantal inventory (Maddieson 1984)

	bilabial	labio-dental	dental	dental/alveolar	palato-alveolar	palatal	velar
voiceless plosive	p		t				k
voiced plosive	b		d				g
vl. sibilant affricate				ts	tʃ		
vl. nonsibilant fricative		f					x
vl. sibilant fricative			s		ʃ		
vd. sibilant fricative			z		ʒ		
voiced nasal	m		n				
voiced trill			r				
vd. lateral approximant			l				
vd. central approximant						j	

In what class of segments is voicing contrastive in this language? Because of the existence of unpaired voiceless segments /f ts tʃ x/, there is no single answer to this question: the domain can be assigned in various ways, depending on how features are ordered. Proceeding from widest to narrowest, we can say that voicing is contrastive in any of the domains in (22).

(22) Domains within which voicing is potentially contrastive

- a. the language: [voiced] > all other features
- b. the obstruents: [sonorant] > [voiced] > other features

- c. the (obstruent) plosives and fricatives: [sonorant] > [continuant],
[delayed release] > [voiced]
- d. the non-fricatives and coronal fricatives: [sonorant] > [continuant] >
place features > [voiced]
- e. the stops and coronal fricatives: All other features > [voiced]

Each of these domain specifications is correct, in the sense that we can specify the domain so that voicing can indeed be said to be contrastive over that domain. Admittedly, some domain specifications are more natural than others. More particularly, each domain specification implies some hierarchy of features, as in (22).

Other scenarios are possible. For example, [voiced] can intervene between the place features dividing labial from velar fricatives. In that case, one of /f/ or /x/ will be contrastively voiceless, the other will not.

Observe how the notion of a ‘counterpart’ changes with the ranking of the features. Thus the question “does /ts/ have a voiced counterpart?” has no single answer. In (a), every voiced segment is a counterpart to /ts/ with respect to [voiced]; in (b), all the voiced obstruents {b, d, g, z, ʒ} are its counterparts; in (c) it has no voiced counterpart; in (d), the voiced counterpart of both /ts/ and /tʃ/ is /d/; in (e), it again has no voiceless counterpart.

By the same token, Structure Preservation requires an ordering of features against which it may be evaluated. To put the question concretely, is it a violation of structure preservation if /ts/ is voiced in the lexical phonology?

In the case of Russian, we must look to empirical evidence for information on what the actual patterning of the consonant system is. Voicing assimilation does not affect sonorants, nor do sonorants trigger it. Therefore, we conclude that voicing is non-

contrastive for sonorants. However, all the obstruents participate in voicing assimilation, including the affricates and non-coronal fricatives.¹⁴ This fact suggests that, unlike the sonorants, these phonemes are contrastively [-voiced].

Establishing a contrastive hierarchy for Russian would play the same role with respect to Structure Preservation that the phrase-structure rules played in Emonds' original syntactic formulation. Constraints such as (19a) could then be derived from the feature hierarchy in a systematic way.

4.2. Contrastive Underspecification (Steriade 1987)

Steriade (1987) argues that we must distinguish between two rule types. First, there are redundancy, or R-rules, which introduce a redundant value within a class for which that value is fully predictable. The familiar voicing on sonorants provides her prototypical example of an R-value introduced by an R-rule. The second class of rules, D-rules, introduce D-values, that is, contrastive feature values which distinguish between segments. In a language with voicing contrasts among obstruents, the feature [voice] is distinctive in the obstruent inventory, and so is a D-value for the obstruents. Steriade proposes that only R-values are underspecified; contrary to Kiparsky (1985), she proposes that both D-values (+ and –) are specified underlyingly. Thus, in a language with both voiced and voiceless stops, the voiced stops are specified as [+voice] and the voiceless stops as [-voice].

Steriade's proposal puts the notion of contrast at the centre of underspecification theory, by making a basic distinction between contrastive and redundant values. It thus becomes absolutely crucial to know whether a feature value is redundant or contrastive in any particular instance. Like Kiparsky, however, Steriade does not supply an explicit

formal mechanism for determining contrasts, but relies on analyses that are plausible-looking and yield the desired results.

The Pasiego dialect of Montañes Spanish has five vowels. Steriade (1987:343) argues that /a/, which neither triggers nor blocks a rule of height harmony, has no marking for the feature [high]. This is because “the impossibility of simultaneous [+high, +low] specifications establishes that the height of low vowels is a R-value” (342). This analysis appears to be unproblematic, especially when the vowel system is diagrammed as in (23), where /a/ is the obvious odd man out with respect to the feature [high]:

(23) Pasiego (Steriade 1987)

i		u	+high	
				D-class of [high]
e	o		-high	====
	a			R-class of [high]

However, these cases are deceptively simple looking: the basis according to which D-values are determined is not self-evident. The values in (23) correspond to (24a), and require [low] > [high]. If [high] > [low], as in (24b), [high] would be a D-value for /a/. Notice also that in the former case, the high vowels are specified [-low].

(24) Pasiego Spanish vowels: Possible orderings of [high] and [low]

a. low > high

b. high > low

i	e	a	o	u		i	e	a	o	u
+	-		-	+	high	+	-	-	-	+
-	-	+	-	-	low	-	+	-		

Similarly, Steriade (1987) argues that the low vowel /a/ is unspecified for [back] in triangular five-vowel systems such as those of Ainu and Tamil. Again, though she does not state this explicitly, the analysis relies on a contrastive feature hierarchy whereby [low] > [back]. A similar point can be made for the other cases she discusses.

Although Steriade (1987) makes no mention of the contrastive hierarchy as a general principle for determining if feature values are contrastive or redundant, she does propose a hypothesis that translates into a constraint on possible hierarchies. Dividing features into *stricture features* (essentially manner features for consonants and height features for vowels) and *content features* (place features for consonants and timbre features for vowels), she proposes that in a redundancy rule $[\alpha F] \rightarrow [\beta G]$, F may be a stricture feature and G may be a content feature, but not vice-versa. Thus, we may have a redundancy rule [+low] \rightarrow [+back], but not [+round] \rightarrow [+high]. This is tantamount to claiming that stricture features must always have wider contrastive scope than content features, that is, they are ordered higher in the contrastive hierarchy.¹⁵

4.3. Arguments against underspecification

The lack of formal contrastive underpinnings for the underspecification theories of the 1980s led to a backlash against underspecification in the 1990s. The main arguments, however, really concern the lack of a theory of contrast, rather than underspecification per se.

Thus, it has been argued (Steriade 1995, Kirchner 1997) that underspecification is applied inconsistently. For example, in most languages there are no voiceless sonorants and no nasal obstruents. In the first case, [+voice] is typically omitted from sonorants because it is predictable. By the same token, in the second case, [+sonorant] is

predictable given [+nasal]; nevertheless, this specification is rarely omitted. Numerous such cases can be adduced, and many analyses that have appealed to underspecification have indeed been inconsistent in this way.

The answer to the charge of inconsistency is that the contrastive feature hierarchy decides which features are omitted. In the above example, [sonorant] is a major class feature that is typically high in the order. Assuming [sonorant] > [voice], the inventory is divided into sonorant and nonsonorant sets before it is divided by [voice]; since there is no voicing contrast in the [sonorant] set, [voice] is redundant in that set, hence underspecified. Similarly, it is more common for [sonorant] to take scope over [nasal] than it is for [nasal] to take scope over [sonorant]. Therefore, [+sonorant] must be specified even where it is made logically redundant by [+nasal]. The hierarchy [nasal] > [sonorant] is less likely and could lead to an unusual set of contrasts in an inventory.¹⁶

The problem of inconsistency is thus not inherent to contrastive (under)specification itself, but rather to implementations of underspecification theory (such as that of Steriade 1987) that provide no principled rationale for distinguishing between contrastive and redundant feature values. The contrastive hierarchy provides such a rationale.

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* I am honoured to dedicate this paper to Jean-Roger Vergnaud, who has been a source of inspiration to me for many years. The example sentence used by Jakobson and Lotz (1949), which doubles as their dedication to Henri Muller, is appropriate here as well: *Cher Maître, voulez-vous nous permettre de vous présenter nos hommages et nos meilleures vœux de santé, de parfait bonheur et de tranquillité d'âme!*

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¹ It is not obvious that these are the operative features, or if they are, that they apply to these segments — see note 12 for some alternatives. In this paper I will use generally use the features as found in my sources.

² The specifications in (7a) violate the Distinctness Condition (Halle 1959:32), which holds that two phonemes are distinct (in contrast) if and only if at least one feature which is contrastive in both has a different value in each; that is, plus in the former and minus in the latter, or vice versa, but not zero.

³ Similar arguments hold against the procedure for contrastive specification discussed by Archangeli (1988). The failure of this class of algorithms does not constitute an argument against contrastive specification in general; see Dresher 2002, 2004 for further discussion.

⁴ This discussion assumes a space of only the three features [low], [high], and [back]. As shown above, adding even one feature, [round], enlarges the feature space in such a way that there are not sufficient near neighbours to distinguish the members of the inventory.

⁵ Hall (2004) argues that the existence of phonetic enhancement (Stevens, Keyser and Kawasaki 1986), which heightens phonetic contrasts by increasing the number of featural

distinctions between phonemes, dooms FS to failure. That is, any method relying on phonetic minimal pairs distinguished by only one feature is based on the wrong intuition about how segments in an inventory are distributed in the space of features.

⁶ As Trubetzkoy does not give a chart, I adapt this one from Martinet (1964), whose analysis is clearly influenced by Trubetzkoy.

⁷ I substitute phonetic transcription for Trubetzkoy's Greek letters.

⁸ 'Hiss' is the translator's rendering of Martinet's term 'sifflant', and 'hush' translates 'chuintant'. I use *j* in place of Martinet's *ñ*.

⁹ The representation of /r/ as 'uvular' is unexpected, as Martinet asserts elsewhere (54) that /r/ does not always have a uvular pronunciation in French. According to Trubetzkoy's criteria, variation in place of /r/ indicates that [uvular] is not the defining characteristic of the phoneme. Features such as 'rhotic' or 'liquid' and 'non-lateral' would appear to be more obvious choices, but these are not considered by Martinet, for reasons left unexplained.

¹⁰ Martinet comments that not all the phonemes and features listed in (16) appear in the table. Note that /j/ is listed in an unlabelled row.

¹¹ In the feature system assumed by Jakobson and Lotz (1949:152), "the liquids *l* and *r* are complexes combining the consonantal characteristic with a vocalic one." The full feature names are 'vowel/consonant', 'nasal/oral', 'saturated/diluted', 'grave/acute', 'tense/lax', and 'continuous/interrupted'. They consider the French *r* flap articulation to be interrupted, in contrast to the continuous lateral opening of *l*.

¹² The example of [voice] being predictable given [sonorant] is perhaps the oldest and most common example of underspecification in the literature (Stanley 1967, Kiparsky 1982, 1985). Nevertheless, it may not be a good example if, as has been argued,

sonorants do not have the same voicing feature as voiced obstruents (Piggott 1992, Rice 1993, Avery 1996, Boersma 1998). For purposes of this discussion, we will assume for the moment that sonorants do potentially bear a feature [voice] that is also carried by voiced obstruents. What is crucial here is the logic of the argument, whether or not sonorant voicing is in fact a good exemplar of it.

¹³ Maddieson's sources are Jones and Ward (1969) and Halle (1959). I omit the palatalized/velarized distinction from the chart. Following Calabrese (1995), I also omit /v/ from the underlying inventory. Russian is language 008 on the UPSID data base. I have left off Maddieson's dental diacritics from dentals (*t*, etc.), and substituted *š* for *ʃ*, *ž* for *ʒ*, and *ts* for "ts".

¹⁴ This fact was famously taken by Halle (1959) to argue against the post-Bloomfieldian taxonomic phonemic level. In post-Bloomfieldian theory, the voicing of /k/ to [g] changes one phoneme to another, and hence is a morphophonemic rule, whereas the voicing of /ts/ to [dz] is an allophonic rule.

¹⁵ Ghini (2001), however, proposes that place contrasts precede height contrasts.

¹⁶ Other theories have been proposed that posit dependency relations among features: markedness theory (Chomsky and Halle 1968, Kean 1975), feature geometry (Clements 1985, Clements and Hume 1995, Sagey 1986, Halle 1995), Government Phonology (Kaye, Lowenstamm and Vergnaud 1986), Dependency Phonology (Anderson and Ewen 1987), and Radical CV Phonology (van der Hulst 1996). The relationship of these theories to the Contrastive Hierarchy is complex, and cannot be discussed here, but all of them, in different ways, impose hierarchical relations among distinctive features.