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*Ambivalence and ambiguity in laterals and nasals**

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Ambivalent segments are speech sounds whose cross-linguistic patterning is especially variable, creating contradictions for theories of universal distinctive features. This paper examines lateral liquids, whose [continuant] specification has been the subject of controversy because of their ability to pattern both with continuants and with non-continuants, and because phonetically they are situated in the contested ground between two different articulatory definitions for the feature [continuant]. Evidence from a survey of sound patterns in 561 languages shows that lateral liquids, like nasals, pattern with continuants about as often as with non-continuants. Ambivalent phonological behaviour is argued to be natural and expected for phonetically ambiguous segments in a theory of emergent distinctive features where features are the result of sound patterns, rather than the other way around.

1 Introduction

It has long been known that some speech sounds have less predictable phonological patterning than others. While some sounds have attracted a broad consensus concerning their appropriate representation, the phonological ambivalence of others has led to disagreements in how they should be represented, and the precise nature of their phonological specification has remained murky. The feature [continuant] is involved in a number of cases of representational murkiness. Since its introduction, there has generally been consensus that fricatives and vowels are most definitely [+continuant], and that oral stops are certainly [−continuant]. But flaps, trills and lateral liquids have been observed patterning as continuants with fricatives and also patterning as non-continuants with stops. The feature

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specification of these liquids has been, appropriately, controversial. The analysis in this article will draw upon a connection between ambivalent phonological behaviour and phonetic ambiguity with respect to the relevant feature.

Focusing for the moment just on the voiced alveolar lateral liquid /l/, diverse phonological patterning and phonological analyses may be observed. For example, Jakobson *et al.* (1951) group laterals with [continuant] sounds (as opposed to [interrupted]), and Chomsky & Halle (1968) similarly group /l/ with [+continuant] sounds, but fifteen years later, Halle & Clements (1983), among others, group laterals with [−continuant] sounds. Kaisse's (ms) informal survey of eleven phonology texts from 1968 to present finds that six of them (55%) treat /l/ as [+continuant], three (27%) treat it as [−continuant] and two (18%) treat it as variable from language to language. Two of the most recent texts disagree on the [continuant] specification of /l/. It will be seen in the following pages that the actual cross-linguistic patterning of /l/ matches these percentages fairly closely.

The difficulty of categorising /l/ and other liquids on the basis of a phonetic definition of [continuant] is noted by Chomsky & Halle (1968: 318, emphasis in original):

> The characterization of the liquid [l] in terms of the continuant–noncontinuant scale is even more complicated [than the characterisation of other liquids]. If the defining characteristic of the stop is taken … as total blockage of air flow, then [l] must be viewed as a continuant and must be distinguished from [r] by the feature of 'laterality'. If, on the other hand, the defining characteristic of stops is taken to be the blockage of air flow *past the primary stricture*, then [l] must be included among the stops. The phonological behavior of [l] in some languages supports somewhat the latter interpretation.

In treating /l/ as a non-continuant, Halle & Clements (1983) accordingly adopt a definition that refers specifically to the MID-SAGITTAL region of the vocal tract, which is obstructed in the production of laterals (see also McCawley 1968: 26, n. 15). Kaisse (ms) summarises the lateral/[continuant] issue as follows: the status of laterals hinges on whether [continuant] is defined in terms of occlusion in the oral tract ('vowel tract', in *SPE* (Chomsky & Halle 1968: 318)) or occlusion in the *mid-sagittal* region of the oral tract. But conversely, the proper definition can only be determined by examining the *phonological patterning* of laterals. Kaisse examines seventeen languages in which [continuant] is relevant for characterising a phonological pattern involving /l/, and concludes that sonorant laterals are [−continuant], because they pattern that way in the great majority of the languages. She argues that the apparent counterexamples among the languages she analyses in depth are cases in which continuancy is not at the heart of the sound pattern, and therefore these cases may not provide information on continuancy at all. Van de Weijer (1995) deals with the murkiness of the patterning of liquids with stops and fricatives by

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proposing that liquids are not specified for [continuant] at the same level of the feature hierarchy as obstruents.

Kenstowicz & Kisseberth (1979: 21) summarise the broader state of affairs: phonological patterning motivates the partitioning of speech sounds according to manner features that may be very difficult to define phonetically:

> There are no truly satisfactory articulatory or acoustic definitions for the bases of these two different partitions [consonant and sonorant]. Nevertheless, they are crucial for the description of the phonological structure of practically every language.

Taking this as a starting point for an investigation into the behaviour and representation of lateral liquids and other seemingly ambivalent segments, there are essentially two observations: on the one hand it is clear, based on phonological patterning, that spoken languages exploit an opposition between segments with phonetic properties characterised as 'continuant' and 'interrupted'; on the other hand, it is not clear where the boundary lies, and /l/ is somewhere in the middle. In the course of this paper, it will also be seen that nasals also exhibit ambivalent behaviour, similar to what has been observed for lateral liquids.

The debate over whether /l/ or any other segment is [+continuant] or [−continuant] presupposes that it must be one or the other. This presupposition follows from the claim that distinctive features are universal, innate and explanatory (Chomsky 1968, Chomsky & Halle 1968, Clements 1985, etc.), summarised by Clements & Hume (1995: 245):

> Since features are universal, feature theory explains the fact that all languages draw on a similar, small set of speech properties in constructing their phonological systems. … Feature theory … has provided strong confirmation for the view that languages do not vary without limit, but reflect a single general pattern which is rooted in the physical and cognitive capacities of the human species.

Taken seriously, this claim means that the behaviour of /l/ is attributed to whether or not it possesses the specification [+continuant]. The indecision of the past half-century may be attributed to insufficient data or to the incorrect analysis of certain counterexamples. To understand the relationship between the feature [continuant] and segments such as lateral liquids and nasals, we can ask two questions:

(1) a. Are /l/ and other segments truly cross-linguistically ambivalent in their phonological patterning?
    b. If so, is there a way to predict the flexibility of a given partition and the behaviour of segments along the boundary?

This paper presents some results of the first large-scale survey of the patterning of segments in classes (Mielke 2004), in order to address both of these questions. §2 examines the results of this survey of phonological

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patterning in 561 languages, showing how lateral liquids, nasals and other consonants pattern with other segments. §3 will discuss various approaches to dealing with phonological ambivalence within phonological theory. After reviewing various ways in which innate feature theory could be altered in order to be compatible with these sound patterns, an account will be proposed which draws upon the phonetic dimensions that the feature [continuant] is grounded in. This approach to accounting for the observations which have been attributed to innate features, as well as the apparent counterexamples, will have broader implications for the general notion of natural classes.

2 Survey

The purpose of the survey is to explore the way that sounds group together in phonological patterns. Therefore, the survey is concerned with PHONOLOGICALLY ACTIVE CLASSES, as defined in (2).

(2) *Phonologically active class*
A group of sounds which, to the exclusion of all other sounds in an inventory, either undergo or trigger a phonological process.

This term is equivalent to the traditional use of NATURAL CLASS, but without the assumption that the class in question is 'natural' either phonetically or according to any particular feature theory. Throughout this paper, when these components of the traditional notion of natural class are intended, the terms FEATURALLY NATURAL CLASS and PHONETICALLY NATURAL CLASS will be used, as defined in (3).

(3) a. *Featurally natural class*
A group of sounds which, to the exclusion of all other sounds in an inventory, share one or more distinctive feature values *within a particular feature theory*.
b. *Phonetically natural class*
A group of sounds which, to the exclusion of all other sounds in an inventory, share some combination of measurable phonetic properties.

For example, Japanese has a well-known sound pattern in which unaccented /i ɯ/ are devoiced between voiceless consonants and word-finally after the same consonants, as in (4).[1]

(4) *Vowel devoicing in Japanese* (Vance 1987, Shibatani 1990)

/kɯtsɯ́/	→	[kɯ̥tsɯ]	'shoes'
/háʃi/	→	[haʃi̥]	'chopsticks'
/sɯsɯkí/	→	[sɯ̥sɯ̥ki]	'maiden grass'

[1] Note that the final /i/ in 'maiden grass' is not devoiced, because it is accented.

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Because the vowels /i ɯ/ are targeted by this sound pattern and /p t k s ʃ h/ trigger it, both of these are phonologically active classes, and provide data points for the survey. Additionally, both of these are featurally natural classes with respect to the feature system of *SPE*, among others, because they can be represented with the conjunction of one or more features, in this case [+high, +tense] and [−voice]. Finally, they are both phonetically natural classes as well, because they can be described, to the exclusion of all other sounds in the inventory, in terms of measurable phonetic parameters such as first formant frequency, duration and vocal fold vibration.

The consonants /t k s ʃ h/ are another phonologically active class in Japanese, because they are voiced when they appear initially in the second part of compounds, a pattern known as sequential voicing or *rendaku* (5a). /p/ is alone among the voiceless consonants in not participating in sequential voicing (5b).

(5) *Sequential voicing in Japanese*
(McCawley 1968: 187,Vance 1987, Shibatani 1990: 173–174)

a.	[ama]	+	[teɾa]	→	[amadeɾa]
	'nun'		'temple'		'nunnery'
	[ɯwa]	+	[tsɯmi]	→	[ɯwadzɯmi]
	'over'		'piling'		'upper load'
	[oo]	+	[same]	→	[oozame]
	'big'		'shark'		'big shark'
	[to]	+	[ʃimaɾi]	→	[todʒimaɾi]
	'door'		'closing'		'locking of a house'
	[tabi]	+	[hito]	→	[tabibito]
	'travel'		'person'		'traveller'
	[iɾoha]	+	[kaɾɯta]	→	[iɾohagaɾɯta]
	'Japanese syllable counting'		'cards'		'playing cards with *hiragana* on them'
b.	[genmai]	+	[pan]	→	[genmaipan]
	'whole rice'		'bread'		'whole rice bread'

While this is a phonologically active class, it is not a featurally natural class in *SPE*, because there is no conjunction of *SPE* features which can describe the set of all voiceless consonants except /p/. It is a phonetically natural class, though, because it can be described in terms of measurable properties such as lip closure, constriction degree and vocal fold vibration. An analysis of this sound pattern in *SPE* features requires devices beyond the scope of the feature system, such as rule ordering or antagonistic constraints.

Finally, the consonants /b d z n m ɾ/ are a featurally natural class in Japanese with respect to *SPE*, because they can be described with a conjunction of features such as [+voice, +anterior], and a phonetically natural class, because they can be described in terms of measurable properties

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such as stricture location and vocal fold vibration, but not a phonologically active class, because there is no reported sound pattern which targets or is triggered by specifically these segments.

The concepts phonologically active class, featurally natural class and phonetically natural class have often been conflated in phonological theory as the monolithic natural class. There is obviously a considerable amount of overlap, because featurally natural classes tend to be phonetically natural (because most if not all widely accepted features are phonetically defined) and because many phonologically active classes are natural both featurally and phonetically. It is clear that there are many phonetically and featurally natural classes which are not phonologically active in a given language or perhaps any language, and the survey results will show that many phonologically active classes are also not featurally or phonetically natural, and others are phonetically natural without being featurally natural. Due to the considerable overlap between phonetic and featural naturalness, it is difficult to assess how much responsibility each bears for the nature of phonologically active classes. The behaviour of ambivalent segments is very interesting with regard to this question, because many of the relevant classes are phonetically natural, even though they are featurally unnatural in theories where segments such as lateral liquids have a particular specification for the feature [continuant].

To collect data points for the survey, phonologically active classes of sounds were drawn from all available grammars of spoken natural languages (written in English) in the library systems of The Ohio State University and Michigan State University (Library of Congress subclasses PA, PB, PC, PD, PE, PF, PG, PH, PJ, PK, PL and PM), for a total of 561 languages.[2] References for languages mentioned below in the analysis are in the references section, and references for the rest of the 561 languages are available from the author. As described, these languages contain 6077 unique classes. The number of actual sound patterns represented is larger, because many of these classes are involved in multiple sound patterns in the languages where they occur. The database is discussed in much more detail in Mielke (2004), and is in the process of being made publicly available.

The classes in the database were analysed in terms of three different feature systems. These feature systems include the acoustically defined features of Jakobson *et al.* (1951; henceforth *Preliminaries*), the articulatorily defined features of *SPE* and the hierarchically organised privative

[2] Classes of sounds which are involved in phonotactic restrictions but not the target or trigger of a sound pattern were recorded, but are not included in the analysis presented here. This is due both to disagreement between phonologists over whether feature theory is responsible for defining them, and to the fact that these classes (based on the survey results) tend to be more idiosyncratic than the classes which undergo or trigger phonological patterns. The finding that many classes are featurally unnatural would likely be magnified if these classes were included in the analysis.

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and binary features of Unified Feature Theory (UFT), which, like *Preliminaries*, uses the same features for consonants and vowels, and which, like *SPE*, uses features which are generally defined articulatorily (Clements 1991, Hume 1994, Clements & Hume 1995). In addition, a less restrictive variant of UFT with full specification and binary-valued features was also considered.

2.1 Prototypically non-prototypical segments: lateral liquids

The phonological ambivalence of lateral liquids is assessed on the basis of the 928 phonologically active classes (out of a total of 6077) which contain at least one lateral liquid. These 928 classes were categorised according to their apparent specification for the feature [continuant]. The three feature theories differ in their treatment of the continuancy of lateral liquids. In *Preliminaries* and *SPE*, lateral liquids are [continuant] and [+continuant], respectively, while UFT treats them as [−continuant]. To negate the effects of differences between these feature theories that are unrelated to [continuant] but impact their ability to define classes, all of the feature analyses were duplicated, with each feature theory's [continuant] specification for lateral liquids reversed. For example, this approach prevents UFT's restrictive use of unary place features from resulting in a relative underrepresentation of [−continuant] classes. This added a few classes which were otherwise unspecifiable. Finally, distinctions which are intended by the theories' authors to be beyond the scope of the feature system (length in all three systems, and syllabicity in UFT) were accordingly allowed to define classes. The features used in each of these feature systems are listed in Table I, along with each feature system's [continuant] specification for lateral liquids. All of *SPE*'s features and most of *Preliminaries*' features are binary, having two values (+ and −). The *Preliminaries* feature system also includes the equipollent feature [compact/diffuse], which effectively has three values (compact, diffuse and neither). For the feature analysis, this is formally equivalent to a pair of binary features, and it is treated as such. No segment is both [compact] and [diffuse], and this is equivalent to the absence of segments which are both [+high] and [+low] in *SPE*-style feature systems. Unified Feature Theory has a set of binary features related to manner of articulation, as well as a set of unary features mostly related to place of articulation. These unary features have only one value (present). For instance, this means that while *SPE*'s [coronal] feature can define [+coronal] and [−coronal] classes, UFT's [coronal] features can only define classes of segments which bear the feature, i.e. there is no class of non-coronal segments. In the binary Unified Feature Theory variant, such a class *is* possible. UFT's list of features includes place features which may be referred to in three ways: as dependents of the C-place node, as dependents of the V-place node or either. For the purpose of defining natural classes, this amounts to three different features for each place feature.

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theory	/l̪ l ɭ ʎ …/	features
Preliminaries	[continuant]	*10 binary acoustically defined features* (1) vocalic/non-vocalic, (2) consonantal/non-consonantal, (3) interrupted/continuant, (4) checked/unchecked, (5) strident/mellow, (6) voiced/unvoiced, (7) grave/acute, (8) flat/sharp, (9) tense/lax, (10) nasal/oral *1 equipollent acoustically defined feature* (11) compact/diffuse
inverted *Preliminaries*	[interrupted]	
SPE	[+continuant]	*23 binary articulatorily defined features* (1) consonantal, (2) vocalic, (3) sonorant, (4) continuant, (5) voice, (6) nasal, (7) coronal, (8) anterior, (9) strident, (10) lateral, (11) back, (12) low, (13) high, (14) round, (15) distributed, (16) covered, (17) syllabic, (18) tense, (19) delayed primary release, (20) delayed release of secondary closure, (21) glottal (tertiary) closure, (22) heightened subglottal pressure, (23) movement of glottal closure
inverted *SPE*	[−continuant]	
UFT	[−continuant]	*17 binary features* (*effectively*) (1) sonorant, (2) approximant, (3) vocoid, (4) nasal, (5) ATR, (6) strident, (7) spread, (8) constricted, (9) voice, (10) continuant, (11) lateral, (12)–(14) anterior (C-place/V-place/either), (15)–(17) distributed (C-place/V-place/either) *18 unary features* (*effectively*) (18) C-place, (19) vocalic, (20) V-place, (21)–(23) pharyngeal (C-place/V-place/either), (24)–(26) labial (C-place/V-place/either), (27)–(29) lingual (C-place/V-place/either), (30)–(32) dorsal (C-place/V-place/either), (33)–(35) coronal (C-place/V-place/either) *potentially unlimited binary aperture features* (36) open 1 [, (37) open 2 [, …]]
inverted UFT	[+continuant]	
binary UFT	[−continuant]	*same as UFT, but all 36+ features are binary*
inverted binary UFT	[+continuant]	

Table I
Feature systems used in the analysis.

All possible feature characterisations of the 928 classes were computed, and 644 classes (69·4%) are characterisable by a conjunction of features within at least one of the feature systems in Table I (i.e. they are featurally

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natural classes). The remaining 284 (30·6 %) are featurally unnatural according to every one of the feature theories. This means they are not characterisable by a conjunction of features without ad hoc modifications such as the addition of new features tailor-made to account for specific classes which were not predicted to occur. This rate is slightly higher than the survey's overall featural unnaturalness rate of 24·65 % (i.e. 1498 of the 6077 classes are featurally unnatural in all three feature theories).

A good example of a featurally unnatural class is found in the Pama-Nyungan language Wangkangurru (Hercus 1994). In this language, the length of the first vowel in a word (which is the only accented vowel) is determined by the following consonant. /t̪ ɾ ɳ ɭ j w/ condition lengthening (6a), and /ɖ/ conditions partial lengthening in most vowels and generally conditions complete lengthening if the vowel is /a/ (rather than /i u/) (6b). While vowel lengthening is conditioned by the retroflex nasal and lateral, as well as the palatal and labiovelar glides, it is not conditioned by the retroflex glide /ɻ/, and while lengthening is conditioned by the dental stop, it is not conditioned by the corresponding dental sonorants (6c). For these reasons, this class is not featurally natural in any system. Further, even if the other dentals and retroflexes *did* participate, dentals and retroflexes do not form a featurally natural class to the exclusion of apical alveolars in any of the feature systems. Finally, the alveolar flap *does* participate, although the alveolar trill /r/ does not.

(6) *Consonant-conditioned vowel lengthening in Wangkangurru* (Hercus 1994: 44–45, 51)

a.	[wiːt̪i]	'sore'	[paːɾu]	'yellow ochre'
	[maːɳi]	'fat'	[guːɭa]	'cane grass'
	[puːju]	'spinifex'	[t̪iːwi]	'flower'
b.	[maːɖu]	'flavour'		
c.	[paɻu]	'light'	[paru]	'bony bream'
	[maɲi]	'untruth'		

The same language provides an example of a featurally natural class. /a/ is raised to [u] before retroflex consonants other than /ɻ/ (i.e. /ɖ ɳ ɭ/), as in [wʌɖu] 'child' and [wʌɳi] 'to grow' (Hercus 1994: 49).[3] This class can be defined as [consonantal, flat] in *Preliminaries* features, [+consonantal, −anterior, −high] in *SPE* features and [−continuant, −anterior, −distributed] in Unified Feature Theory.

The criteria for [continuant] specification are as follows. A class is necessarily [+continuant] or [−continuant] if it is characterisable using the feature [continuant] (or its counterpart [interrupted]) in one or more of the eight feature systems in Fig. 1, and it is *not* characterisable within any of these feature systems without using the *same* value of the feature

[3] Hercus does not transcribe lengthening in the examples of raising, or raising in the examples of lengthening.

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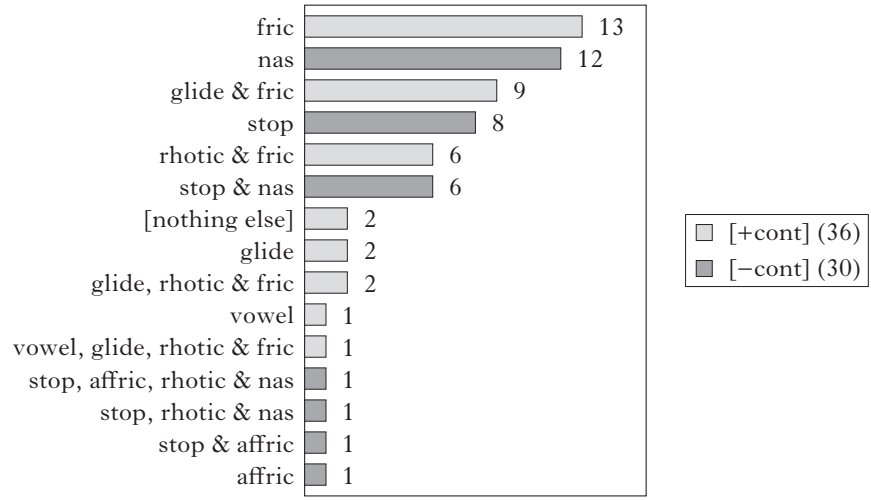


Figure 1
The other members of necessarily [+continuant] and [−continuant] classes containing lateral liquids.

[continuant]. These criteria exclude a number of classes which a phonologist would likely analyse using the feature [continuant], but which have alternative analyses that do not require the feature. These classes are excluded because they do not provide crucial evidence about the continuancy status of lateral liquids. For example, in the Mande language Boko/Busa (Jones 1998), /t d l/ cause a preceding nasal to assimilate in place to [n], but /s z j/ do not. The trigger class can be defined straightforwardly in Unified Feature Theory as [Coronal, −continuant], but it does not *require* [continuant] in order to be featurally natural. This can also be achieved using the features [strident] and [vocoid], and defining the class as [Coronal, −strident, −vocoid]. The class is definable in a parallel fashion in *Preliminaries* ([acute, mellow, consonantal]) and *SPE* ([+coronal, −strident]), where [−continuant] is not an option for a class containing a lateral liquid. Because of these alternate analyses, this class does not provide crucial evidence about the [continuant] specification of /l/.

Of the 644 classes with lateral liquids which are featurally natural in one or more of the theories in Table I, the vast majority (578) can be defined without the feature [continuant], and therefore cannot provide crucial evidence for either value of the feature. 66 classes *do* require one value of the feature [continuant], and among these, 36 are necessarily [+continuant] and 30 are necessarily [−continuant]. The composition of the classes in these two categories is shown in Fig. 1. Each bar represents a characterisation of the segments lateral liquids pattern with. Light bars represent traditionally [+continuant] segments, while dark bars represent traditionally [−continuant] segments.

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In the [+continuant] and [−continuant] classes that they participate in, lateral liquids occur most commonly with fricatives and nasals. Among the [+continuant] classes, lateral liquids occur in thirteen classes with at least one fricative in twelve languages (Arapesh, Agulis Armenian, Central Outer Koyukon, Ecuador Quichua, Ehueun, Epie, Lumasaaba, Manipuri, Yecuatla variety of Misantla Totonac (twice), Navajo, Shambala and Ukue), with at least one glide and one fricative in nine classes in eight languages (Ehueun, Epie, Lumasaaba, Mising, an innovative variety of Bearlake Slave, Temne (twice), Tswana and Umbundu) and with at least one rhotic and one fricative in six classes in five languages (Doyayo, Finnish (twice), Greek, Onti Koraga and Runyoro-Rutooro). Two or more lateral liquids occur with no other segments in two classes which are only characterisable in theories where they are [+continuant] (in Arabana and Dunquin Irish). Lateral liquids occur with at least one glide in two classes (in Okpe and Wiyot), with at least one rhotic, one glide and one fricative in two classes (in Doyayo and Estonian), with vowels in one class (in Yucatan Maya) and with vowels, glides, fricatives and a rhotic in one class (in Catalan).[4]

On the [−continuant] side, lateral liquids occur with at least one nasal in twelve classes in ten languages (Alyawarra, Basque, Dieri (twice), Gooniyandi, Koromfe, Libyan Arabic, Yucatan Maya, Spanish, Toba and Yir-Yoront (twice)), and with at least one oral stop in eight classes in seven languages (Catalan, Dholuo, the Kolkuma dialect of Ịjọ, Koromfe (twice), Turkish, Tsakhur and Tswana). Lateral liquids occur with at least one nasal and one oral stop in six classes (in Anywa, Arabana, Catalan, Nangikurrunggurr, Wangkangurru and Yir-Yoront), and there is one example each of lateral liquids occurring in classes with an affricate (in Guatuso), with affricates and oral stops (in Mishmi) and with oral stops, a nasal and a flap (in Agn Armenian).

Examples of laterals patterning with continuants and non-continuants are shown in (7) and (8). In Basque (Saltarelli 1988, Hualde 1991), nasals and laterals (i.e. /n n̪ ɲ l ʎ/), to the exclusion of rhotics (/r ɾ/), undergo place assimilation to a following consonant (7). This is the class [+sonorant, −continuant] in Unified Feature Theory. See Kaisse (2000, ms) for further arguments that laterals pattern as non-continuants in Basque.

(7) /l/ *patterning with non-continuants in Basque* (Hualde 1991: 96)

egu[m] berri	'new day'		
egu[ɱ] fresku	'cool day'		
egu[n̪] denak	'every day'	ata[l̪] denak	'every section'
egu[ɲ] ttiki	'small day'	ata[ʎ] ttiki	'small section'
egu[ŋ] gorri	'red day'		

[4] Note that this is not an exhaustive list of classes in the database which contain these segments, but an exhaustive list of the classes containing these segments which are featurally natural if and only if the feature [continuant] is involved.

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In Finnish (Sulkala & Karjalainen 1992), /t s n r l/ are possible stem-final consonants, and of these, /s r l/ trigger total assimilation of a following suffix-initial /n/ (8a). In the same environment, /t/ *undergoes* total assimilation to /n/ (8b).

(8) /l/ *patterning with continuants in Finnish*
(Sulkala & Karjalainen 1992: 387–388)

	active potential	*2nd part active*	
a. /pur/	[purrut]	[purree]	'bite'
/nous/	[noussut]	[noussee]	'rise'
/tul	[tullut]	[tullee]	'come'
b. /avat/	[avannut]	[avannee]	'open'

Further examples of laterals patterning with continuants and non-continuants are given in §2.4.

Recall that classes only supply crucial evidence if none of the three feature theories can account for them without using the feature [continuant]. A full 29 classes are characterisable without the feature [continuant] only by virtue of *SPE*'s little-used [heightened subglottal pressure], which distinguishes /l/ from /r/. These are primarily cases where lateral liquids pattern with nasals and/or unaspirated oral stops, which are [−heightened subglottal pressure], to the exclusion of /r/, which is [+heightened subglottal pressure]. In the absence of this feature, these classes would join the ranks of the [−continuant]. There are also several classes which would need to be [+continuant] if UFT's [±vocoid] and/or [±approximant] features were not available. If one feature system were to be selected as the correct one, the number of alternative analyses would be reduced, resulting in an increase in the number of classes requiring [+continuant] or [−continuant] and also an increase in the number of classes with no possible feature specification.

The most general observation to be made from these results is that lateral liquids do indeed pattern with continuants as well as non-continuants, and with surprising even-handedness, patterning 55% of the time with continuants and 45% of the time with non-continuants. Before accounting for the ambivalence of lateral liquids, these results are put into context with the patterning of other segments, to explore whether this kind of ambivalent behaviour is unique to lateral liquids.

2.2 Other continuants and non-continuants

These results have shown that lateral liquids can pattern as [+continuant] as well as [−continuant]. In order to learn whether lateral liquids are unique in this respect, the same analysis was conducted with voiced oral stops, voiced fricatives and nasals, produced at places of articulation from dental to palatal (i.e. /d̪ d ɖ ɟ/, /z̪ z ʒ ʐ ʑ ʝ/, /n̪ n ɳ ɲ/ and closely

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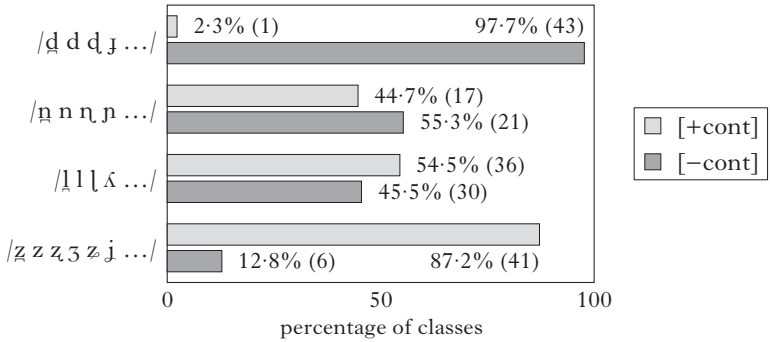


Figure 2

The patterning of four groups of coronal consonants with respect to [continuant].

related segments). This comparison was limited to voiced coronals, in order to eliminate confounds due to the fact that all lateral liquids in the sample are coronal and nearly all are voiced. While all of the feature theories in Table I treat oral and nasal stops as non-continuants and fricatives as continuants, variants with [continuant] specifications for each of the relevant classes of segments inverted were tried as well, to duplicate the analysis of lateral liquids and detect cases where a class containing one or more of these segments would be natural only in case the segment(s) had a [continuant] specification which is opposite its traditional specification, i.e. to find evidence that they too may be ambivalent.

Figure 2 shows a summary of the lateral liquid class data (36 [+continuant] *vs.* 30 [−continuant]) along with the same data for the other coronal consonants. Voiced coronal nasals show ambivalent behaviour comparable to lateral liquids, occurring in seventeen classes which are necessarily [+continuant] and 21 classes which are necessarily [−continuant]. The patterning of nasals is taken up in more detail in §2.3. The voiced oral stops occur in 43 classes which are necessarily [−continuant], and in just one class which is natural only if they are treated as continuants. This class is in the Dravidian language Koya Gondi (Subrahmanyam 1968). In this case, [d] is inserted between /ɖ v r j/ and /k'/ or a vowel (9). /p b m l k ŋ/ also occur finally, and do not trigger insertion. The class /ɖ v r j/ can be treated as [+voice, −syllabic, −lateral, +continuant] in *SPE* features if /ɖ/ is treated as [+continuant]. In reality, there are countless analyses of this pattern which are less dubious than treating /ɖ/ as a continuant. The point is that this is the *only* example where patterning motivates the analysis of a voiced coronal stop as a continuant, while there is ample evidence from the patterning of laterals for their analysis as both [+continuant] and [−continuant].

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(9) [d]-*insertion in Koya Gondi* (Subrahmanyam 1968: 109)

/uɖ-is/	→	[uɖd-is]	'to cause to plough'
/uɖ-it-aːna/	→	[uɖd-it-aːna]	'I will plough'
/uɖ-k'oː-nu/	→	[uɖd-k'oː-nu]	'I would have ploughed'
/koj-a/	→	[kojd-a]	'to plough'
/nor-a/	→	[nord-a]	'to wash'
/kav-a/	→	[kavd-a]	'to laugh'

The voiced fricatives occur in 41 classes which are necessarily [+continuant], but also in six classes which are natural only if the fricative is treated as a non-continuant. In Ndyuka (Huttar & Huttar 1994), /z/ appears to be straightforwardly patterning with stops instead of fricatives; word-initial nasals become syllabic before stops /b d g p t k/ and /z/, but not before /v f s h/ or any other consonants. In the other cases, the ambivalence appears to be best attributed to another segment. These are all classes of voiced obstruents which are subject to devoicing and/or trigger the voicing of voiceless obstruents. They involve /z/ and/or /ʒ/, along with any voiced affricates or stops occurring in the language (in Bulgarian, Cres Čakavian, Hungarian, Pengo and Slovene). In all five cases, the segments involved comprise all voiced obstruents except /β/ (in Pengo) or /v/ (in the rest). As traditionally analysed, these cases are less about the ambivalence of /z/ and /ʒ/ with respect to [continuant] and more about the ambivalence of /v/ and /β/ with respect to [sonorant], an analysis which is more consistent with other sound patterns in some of the languages.

This section has shown that oral stops and fricatives, which are expected to be prototypical [−continuant] and [+continuant] consonants, pattern as expected with respect to [continuant] in nearly all cases. Thus, the ambivalent behaviour of lateral liquids is indeed special. However, it is not limited just to lateral liquids. Rather, /v/ patterns with sonorants, and nasals pattern with continuant consonants in numerous cases, something which is explored in more detail below. While ambivalence for any of these segments, including oral stops and fricatives, is formally equivalent, there is a phonetic account: in all three cases of ambivalence seen so far, the segments involved are phonetically ambiguous with respect to the feature involved. Fricatives and oral stops are more prototypical (non-)continuants, and they are also much more consistent cross-linguistically in their phonological patterning with continuants and non-continuants.

2.3 The ambivalence of nasals

The investigation of consonants in §2.2 was intended to provide comparison for the lateral liquids produced at the same places of articulation, so the [continuant] specifications of only coronal nasals were manipulated. While useful for comparing nasals to lateral liquids, controlling for place of articulation is misleading with regard to questions about the continuancy

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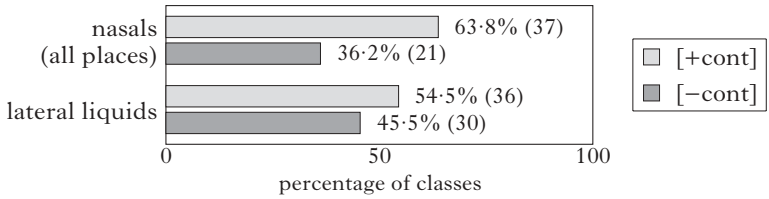


Figure 3

The patterning of nasals and lateral liquids as continuants and non-continuants.

of nasals, but based on this limited evidence, it appears that nasals can pattern as [+continuant]. This subsection analyses nasals for the sake of analysing nasals, considering all places of articulation in order to explore the possibility that all the nasals in a particular language might pattern as [+continuant]. Including nasals with continuants would require only a minor rewording of the definition of [continuant] (changing 'vowel tract' to 'vocal tract' or 'oral and nasal tracts'). Jakobson *et al.* (1951) do not specify nasals for the feature [continuant], and in their analysis of English, Chomsky & Halle (1968) make very little use of the fact that they define nasals as [−continuant].

The results of the analysis of nasals at all places of articulation are shown in Fig. 3, alongside the results for lateral liquids from Fig. 2. Taking all nasals into consideration reveals that they pattern as continuants 63·8% of the time. Considering nasals at all places of articulation shows 21 cases where nasals pattern with non-continuants (the same as in Fig. 2, because [−continuant] is the normal specification for nasals in all three feature systems) and 37 cases where nasals pattern with continuants. This is an increase (from Fig. 2) in the number of [+continuant] nasal cases, because this approach counts instances where all the nasals in a language (not just the coronals examined above) pattern with continuants. Among the 21 instances of nasals patterning with non-continuants are twelve classes in ten languages where nasals pattern with lateral liquids (in Alyawarra, Basque, Dieri (twice), Gooniyandi, Koromfe, Libyan Arabic, Yucatan Maya, Spanish, Toba and Yir-Yoront (twice)). These classes are featurally natural in theories where lateral liquids are [+continuant] as well as in theories where they are [−continuant], but are not featurally natural in any theory without the use of the feature [continuant]. The other cases are five with stops and/or affricates and lateral liquids (in Arabana, Capanahua, Nangikurrunggurr, Wangkangurru and Yir-Yoront), and four with stops and/or affricates (in Catalan, Comanche, Higi and Tiv).

Among the 37 instances of nasals patterning with continuants are fifteen cases where nasals pattern with lateral liquids in classes that are natural in theories where these are [+continuant]. This includes the twelve nasal-lateral examples listed above and three more (in Arabana, Wangkangurru and Warlpiri). The rest of the [+continuant] nasal cases are ten with one or

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more fricative (in Abun, Boraana Oromo, Bukusu, Korean, Lower Grand Valley Dani, Macuxi, Navajo, Russian, Uneme and West Greenlandic Inuktitut), five with fricatives and lateral liquids (in Amele, Faroese, Kalispel, the Kukú dialect of Bari and Onti Koraga), two with a fricative, rhotic and a lateral liquid (in Finnish and Mokilese) and five with some other combination of fricatives, glides, rhotics, lateral liquids and vowels (in Jacaltec, Samish, Northern Tepehuan, Tuvaluan and Wangkangurru).

An example from Bukusu is shown in (10). Nasals delete before fricatives and nasals (10a), but not before other consonants (Austen 1974: 53–57). Nasals assimilate in place before a stop (10b), except when that stop is /k/ (10c). The classes involved in this sound pattern are the assimilation targets /m n ɲ ŋ/, the deletion triggers /f s x m n ɲ ŋ/ and the sets of homorganic stops, affricates and glides (not including /k/), which trigger place assimilation. Of particular interest here is the patterning together of fricatives and nasals.[5]

(10) *Nasal deletion and assimilation in Bukusu*

a.	/i-n-fula/	→	[eːfula]	‘rain’
	/in-som-ij-a/	→	[eːsomia]	‘I teach’
	/i-n-xele/	→	[eːxele]	‘frog’
	/in-nuun-a/	→	[eːnuuna]	‘I suck’
	/in-meel-a/	→	[eːmeela]	‘I am drunk’
	/i-n-ɲaŋa/	→	[eːɲaŋa]	‘tomato’
	/i-n-ŋuaŋua/	→	[eːŋwaŋwa]	‘camel’
b.	/in-wulil-a/	→	[embulila]	‘I hear’
	/in-pim-a/	→	[empima]	‘I measure’
	/in-bon-a/	→	[embona]	‘I see’
	/in-ʧex-a/	→	[eɲʤexa]	‘I laugh’
	/ʧi-n-ɟu/	→	[ʧiɲʤu]	‘houses’
	/ʧi-n-jiṃbo/	→	[ʧiɲiṃbo]	‘songs’
	/i-n-goxo/	→	[eŋgoxo]	‘hen’
c.	/in-kanakana/	→	[enkanakana]	‘I think’

Another example of nasals patterning with continuants is found in the Samish dialect of Straits Salish (Galloway 1990: 3). In Samish, geminate stops and affricates are rearticulated (11a), while geminate fricatives and nasals are simply realised as long consonants (11b).

[5] A reviewer notes that the deletion of nasals before nasals and fricatives can be interpreted as two distinct processes, i.e. nasal degemination and pre-spirant nasal effacement. Both of these are attested in other languages, and there is no reason to expect them not to occur in the same language. On the other hand, any pattern involving a featurally unnatural class can be reanalysed as two or more identical patterns involving only featurally natural classes. It would be interesting to find independent evidence (beyond the expectation that nasals are [−continuant]) for treating Bukusu fricative/nasal deletion (or the other sound patterns involving nasals and fricatives) in this way.

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(11) *Geminate realisation in Samish* (Galloway 1990: 3)

a.	[ʔəmat^{h}t^{h}x^{w}]	'seat somebody'
	[ʔit^{h}t^{h}]	'to sleep'
	[k^{w}ɬ ʔiʔt^{h}t^{h}]	'still sleeping now'
	[sŋɛʧʧ]	'lagoon'
	[ʃŋɛʔʧəʧ]	'any bay'
b.	[t^{h}sasːən]	'I'm poor'
	[sʔasəsː tən' seləs]	'palm of your hand'
	[p^{h}ənːux^{w}əŋ]	'Matia Island'

From a theory-design standpoint, it does seem prudent to include nasals with non-continuants, if they must be universally either continuant or non-continuant. This allows a means of partitioning the sonorants (which, with the exception of glottal stop, are otherwise all [+continuant] in *SPE*) without referring to nasality, and a precise articulatory definition is possible (segments produced with a blockage of airflow in the *vocal* tract). However, if the goal is for phonologically active classes to be featurally natural, then the most important question is whether the partition which groups nasals with non-continuants is supported by phonological patterning. The non-continuancy of nasals appears to be relevant for only one rule in *SPE*, namely rule (56) in chapter 4, shown in (12). This rule inserts [u] to break up word-final stop + [l] clusters in derivable words exemplified by such paradigms as *table–tabular–tabulate*, *constable–constabulary*, *angle–angular–triangulate*, etc. (Chomsky & Halle 1968: 196).

(12) $$\emptyset \rightarrow u \,/ \begin{bmatrix} -cont \\ -voc \\ +cons \end{bmatrix} __ \, l + VC \, [-seg]$$

As this rule is formulated, nasals are subject to it as well, and although no such examples are given, Chomsky & Halle (1968: 196, n. 30) do suggest that the presence of [u] in words such as *formula* may be attributable to the same rule. If nasals were intended to trigger this rule, there would have been no way to make a featurally natural class out of oral stops and nasals in the *SPE* system without nasals being [−continuant]. Pairs such as *tremble–tremulous* indicate that Chomsky & Halle are correct to posit this class, but in view of all of the contrary evidence that is available from other languages, this single example does not warrant concluding that nasals are *universally* [−continuant]. The evidence presented in this section indicates that not only are nasals not exclusively non-continuant, but they are actually *more likely* to pattern with continuants to the exclusion of non-continuants than *vice versa*. The grouping of nasals with continuants is intuitive to many, and this intuition is indeed backed up by phonological evidence.[6]

[6] Anderson (1976) argues that nasals are [−continuant], noting that it is possible to define [continuant] in terms of continuous airflow, as opposed to the traditional definition which refers to a blockage in the oral cavity, and states that evidence as to which definition is correct must come from observing the patterning of nasals in

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2.4 Lateral ambivalence in action

Cases where /l/ has been argued to be [+continuant] or [−continuant] are well documented, and this subsection gives an example of each which illustrate another aspect of the ambivalence of /l/. If laterals are ambivalent because they are non-prototypical with respect to continuancy, they might be predicted to play a 'last-in'/'first-out' role in classes based on continuancy, something that would be reflected in differences between related varieties or related sound patterns. That is, by being in the middle, they have the opportunity to be incorporated by reanalysis into existing classes of more extreme (non-)continuants or to be jettisoned from classes that retain their more extreme members. As 'swing continuants', they are expected to come and go more freely than stauncher 'base' continuants and non-continuants. This section gives an example from Hungarian where a palatalisation pattern which affects more prototypical non-continuants also affects the lateral liquid in some cases and for some speakers, and an example from Catalan where spirantisation is triggered by classes of continuants which in some cases contain lateral liquids and in other cases do not.[7]

In Hungarian, /t d n/ coalesce with a following [j] across a morpheme boundary to form a geminate palatalised consonant, which Abondolo (1988: 63–65) treats as a combination of palatalisation[8] of the consonant preceding [j] (which may be underlying /i/) and *j*-assimilation, which totally assimilates the [j] to the preceding (now palatalised) consonant. Other non-palatalised coronal consonants (e.g. /s z/) trigger total assimilation of [j], but do not undergo palatalisation, resulting in a geminate unpalatalised consonant. /l/ undergoes palatalisation for some speakers (particularly in the verb inflection), meaning that it patterns with the

particular languages, and determining whether they pattern with stops or fricatives. He concludes that nasals are [−continuant] on the basis of a sound pattern in Finnish in which /n/ patterns with /t d/ to trigger spirantisation of /k/ to /h/, and a mutation pattern in Brythonic Celtic languages whereby /m/ (although not /n/) is spirantised along with the voiced oral stop series. Both of these cases happen to have been excluded from the current analysis, the Finnish case because it does not require the feature [continuant], as /t d n/ are the only non-strident non-vocalic consonantal coronals in Finnish, and the Celtic case because it does not involve a natural class in any of the feature theories (because /n/ does not participate). Further, [voice] could be used to define the Celtic class instead of [continuant]. While there are obviously many examples of nasals patterning with stops, the problem in this analysis is with the assumption that if nasals pattern with stops, then they must not pattern with continuants.

[7] Different feature theories are better equipped to deal with this type of ambivalence. For example, in Dependency Phonology and Element Theory (Harris 1994, Harris & Lindsey 1995), many intermediate segments are represented with a combination of the material the defines more extreme segments. In Element Theory, the role of [continuant] is largely filled by the elements [h] and [ʔ], and this allows a gradience in the representation that is not available with *SPE*-style features. The ability of Element Theory to handle cases of ambivalence is promising particularly if the representation of segments is determined on the basis of phonological patterning.

[8] Abondolo uses the term 'adpalatisation'.

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non-continuants for some speakers and with the continuants for others (Abondolo 1988: 64).[9]

As seen in (13a), inflectional suffix-initial /i/ coalesces with root-final /t d n/ (fairly prototypical non-continuants) to form a palatalised geminate version of the root-final consonant. Root-final coronal fricatives become non-palatalised geminates in the same environment (13b), while root-final /r/ also does not undergo palatalisation, and does not form geminates either (13c). Root-final /l/ (13d) patterns with /t d n/ for many speakers, especially in verbs, producing [jj], the geminate version of the palatal counterpart of [l].[10] For other speakers, and particularly in nouns, /l/ does not palatalise, patterning with /s z/ and /r/.

(13) *Palatalisation and* j*-assimilation with* /i/*-initial suffixes in Hungarian* (Abondolo 1988)

a.	/ad+ia/	→	[ɔdʲdʲɔ]	'he gives him'
	/lakat+ia/	→	[lɔkɔtʲtʲɔ]	'padlock 3SG'
	/lat+iatok/	→	[latʲtʲatok]	'you (PL) see it'
	/fon+iak/	→	[fonʲnʲak]	'they braid it'
	/køkørʧin+ia/	→	[køkørʧinʲnʲɛ]	'anenome 3SG'
b.	/is+ia/	→	[issɔ]	'he drinks it'
	/nez+iuk/	→	[nezzyk]	'we behold it'
c.	/var+ia/	→	[varjɔ]	'he awaits him'
d.	/dobal+ia/	→	[dobalja] ~ [dobajja]	'he throws it around'
	/enekel+iuk/	→	[enɛkɛjjyk]	'we sing it'
	/hotel+ia/	→	[hoteljɔ]/[hoteljɛ]	'hotel 3SG'

Palatalisation and *j*-assimilation fail to occur with suffixes that do not begin with /i/ (14).

(14) *Palatalisation and* j*-assimilation fail to occur elsewhere in Hungarian* (Abondolo 1988)

/ad+od/	→	[ɔdod]	'you give him'
/lakat+od/	→	[lɔkɔtod]	'padlock 2SG'
/lat+od/	→	[latod]	'you see it/him/her'
/fon+ala/	→	[fonal]	'twine'
/is+od/	→	[isod]	'you drink it'
/var+od/	→	[varod]	'you await him'

Imre (1972: 315) also reports also that /i/-conditioned palatalisation of /l/ in addition to /t d n/ is particularly prevalent in parts of the northern

[9] Abondolo (1988: 107) reports that 'surface forms with the sequence […lj…], i.e. those surfaced without adpalatalization, are decried by orthoëpists. Such forms seem to be gaining ground, with the assistance of the orthography and the pattern of nominal inflection, in which the adpalatalization of L is extremely rare'.

[10] The palatalised counterpart of [l] in most modern varieties of Hungarian is [j], but it was pronounced [ʎ] until the late eighteenth century, and continues to be [ʎ] in some regions (Kálmán 1972: 70).

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Palóc region (again, to the exclusion of fricatives and other continuants), where /t d n l/ also palatalise within morphemes before /i/ (and sometimes other high vowels): [dʲio] 'nut', [dʲinʲnʲe] 'melon', [tʲykør] 'mirror' and more rarely [dʲisno] 'pig', [tʲino] 'young ox', [jiba] 'goose'; cf. Standard Hungarian [dio], [dinʲnʲe], [tykør], [disno], [tino] and [liba].

Spirantisation of the voiced stops /b d g/ in Catalan is triggered by preceding vowels, glides, liquids and fricatives, but not by oral stops, nasals or word boundaries. While there are also conditions on which following segments trigger spirantisation, these differences among preceding contexts are apparent in environments where the stop/spirant precedes a vowel, shown in (15)–(17) (Wheeler 1979, Angelo Costanzo, personal communication). This pattern has been analysed as [continuant]-spread, similar to patterns in Spanish and Basque (e.g. Mascaró 1984, Hualde 1991, Kaisse, ms). The voiced stops /b d g/ are spirantised (i.e. become continuants) after vowels, glides and fricatives (traditional continuants), as well as rhotics, as shown in (15).

(15) a.	acaba	[əkaβə]	'ends'
	gaubança	[gəwβansə]	'rejoicing'
	bisbe	[bizə]	'bishop'
	barba	[baɾβə]	'beard'
b.	ferida	[fəɾiðə]	'wound'
	avui dia	[aβujðiə]	'nowadays'
	absurda	[əpsuɾðə]	'absurd (FEM)'
	agost de 1914	[eɣozðə …]	'August 1914'
c.	he guanyat	[eɣwəɲat]	'I've won'
	aigua	[ajɣwə]	'water'
	amarga	[əmaɾɣə]	'bitter (FEM)'
	els guants	[əɬzɣwans]	'the gloves'

Oral stops and nasals do not condition spirantisation of following voiced stops, which also do not spirantise word-initially, as in (16).

(16) a.	canvi	*[kamβi]	[kambi]	'change'
	advent	*[abβen]	[əbben]	'advent'
	Basta!	*[βastə]	[bastə]	'enough!'
b.	gendre	*[ʒɛnðɾə]	[ʒɛndɾə]	'son-in-law'
	un xic difícil	*[unʃigðifisil]	[unʃigdifisil]	'a bit difficult'
	Déu meu!	*[ðeumew]	[deumew]	'Good God!'
c.	sangonós	*[saŋɣunos]	[saŋgunos]	'bloody'
	drap gastat	*[dɾabɣəstat]	[dɾabgəstat]	'used cloth'
	Guaita!	*[ɣwajtə]	[gwajtə]	'look!'

As in Hungarian, the lateral liquids are ambivalent in their behaviour, patterning with continuants to condition the spirantisation of /b g/, but patterning with non-continuants in not conditioning spirantisation of /d/ (17). The fact that it is the lateral liquids which pattern both as

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continuants and non-continuants even within a sound pattern is consistent with the attribution of their ambivalent behaviour to their phonetic ambiguity.[11]

(17) a.	estalvis		[əstalβis]	'savings'
	molt bèstia		[moɫβɛstiə]	'very stupid'
b.	vol demanar	*[bɔlðəməna]	[bɔldəməna]	'wants to ask'
	gall dindi	*[gaʎðindi]	[gaʎdindi]	'turkey'
	caldre	*[kałðrə]	[kałdrə]	'to be necessary'
c.	colgar		[kulɣa]	'to bury'
	el gual		[əɫɣwaɫ]	'the ford'

Interestingly, affricates display ambivalence in a different way. The stop and spirant realisations of /b d g/ are both acceptable after affricates (18).

(18)	vaig voler	[baʤβulɛ]	~ [baʤbulɛ]	'I wanted'
	grapats de sorra	[gɾəpadzðə…]	~ [gɾəpadzdə…]	'handfuls of sand'
	vaig gosar	[baʤɣuza]	~ [baʤguza]	'I dared'

Being composed of stop and fricative components phonetically, affricates are potentially ambiguous with respect to continuancy. The observation that affricates may pattern as stops to the left and as fricatives to the right (edge effects) has led to the proposal that they are in fact contour segments at the feature level, bearing ordered [−continuant] and [+continuant] specifications (e.g. Hoard 1971, Sagey 1990). Others have argued, based on anti-edge effects, that affricates possess both values of the feature [continuant] (or equivalent), but that the two values are not ordered (e.g. Hualde 1988, Lombardi 1990, Schafer 1995). Still others have argued that affricates are not contour segments at all, but strident stops (e.g. Jakobson *et al*. 1951, LaCharité 1993, Rubach 1994, Kim 1997, Szigetvári 1997, Clements 1999). See Szigetvári (1997) for a review of these positions. The fact that various phonological phenomena have been observed and used to motivate various (mutually incompatible) representations for affricates suggests that they are parallel to laterals and other featurally ambiguous segments, and that a variety of representations may be needed to describe sound patterns that affricates participate in. Further, it is not surprising to find this case in Catalan where affricates are ambiguous between stops and fricatives in their interaction with segments to their right. An interesting difference is that while lateral liquids and nasals are ambiguous throughout, the ambiguity of affricates is one of scope. If the affricate is a single segment, then a segment that follows it is adjacent to a phonetically continuant interval, and also adjacent to a segment containing a phonetically non-continuant interval. The

[11] The fact that /l/ and /d/ are homorganic may be related to the fact that it is specifically /d/ which fails to be spirantised after /l/, and Harris (1984) makes this point for a very similar pattern in Spanish. However, /d/ is homorganic with other segments, such as /z ɾ/, which *do* trigger its spirantisation.

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spirantisation pattern in Catalan is consistent with this fact. Again, it is important that this ambivalence occurs to the right of affricates, where the ambiguity lies, rather than to the left, where affricates are more unambiguously non-continuant phonetically.

2.5 Summary

It has been seen in this section that lateral approximants pattern with continuants about as often as they pattern with non-continuants. Nasals, which have generally been treated as non-continuants, actually pattern with continuants in the majority of cases. One thing that laterals and nasals have in common is that they are phonetically ambiguous with respect to the continuancy dimension. Fricatives and oral stops, which are phonetically prototypical continuants and non-continuants, are much more consistent in their patterning with respect to [continuant]. Finally, it has been seen that lateral approximants may behave ambivalently within sound patterns in Hungarian and Catalan. Along the way, it has been seen that [v] can be ambivalent with respect to [sonorant], and that affricates may manifest a different type of ambiguity as ambivalence as well.

3 Discussion

It was shown in §2 that the phonological patterning of lateral liquids and even nasals is quite variable from language to language. Segments such as fricatives and oral stops are prototypical continuants and non-continuants, and are consistent cross-linguistically in their phonological patterning with respect to [continuant], but nasals and lateral liquids are phonetically ambiguous with respect to the letter and/or the spirit of the feature [continuant]. It will be argued in this section that this phonetic ambiguity can account for their phonological ambivalence.

3.1 Innate feature theories

The ambivalence facts are problematic for a strict interpretation of innate feature theory, in which phonological patterning is to be predicted by innate features, but there are conceivable ways to allow this type of behaviour without abandoning innate features. One way to deal with ambivalence within the prevailing feature systems is to say that segments in different languages realised phonetically as [l] may result from two distinct feature bundles, namely one that contains [+continuant] and one that contains [−continuant]. This raises the questions of whether these segments could also have two distinct phonetic realisations, and whether the appearance of one lateral liquid is an illusion perpetuated by the use of a single IPA symbol to represent them. While a tendency for phonetic details to correlate with phonological patterning would not be surprising, a systematic correlation between details of phonetic realisation

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and patterning with respect to [continuant] has not been suggested. In the absence of this evidence, the phonological patterning would need to be known before the feature specifications of [+continuant] and [−continuant] liquids could be determined, and so the phonetic properties and phonological patterning would not actually be predicted by a universal set of distinctive features. Further, this does not address the question of why [continuant] ambivalence happens with /l/ but not with /d/, /z/ or other segments, if the ambivalence is permitted by formal rather than phonetic factors. While voiced obstruents can exhibit ambivalent behaviour in other ways (e.g. with respect to [voice] and [sonorant]), individual voiced stops and fricatives do not pattern ambivalently with continuants and non-continuants in the way that laterals and nasals do.[12]

Two common responses to problems with innate features are to argue that some of the current features are wrong, or that one of the right features is missing. The feature [continuant] has been assigned different phonetic definitions in order to account for different sets of data, so one possibility for accounting for both sets of data within the same theory is to split [continuant] into two features, perhaps [continuant$_{\text{mid-sagittal}}$], which would require unrestricted airflow in the *mid-sagittal* region of the oral cavity for a + value (following Halle & Clements 1983, *inter alia*) and [continuant$_{\text{classic}}$], which would merely require unrestricted airflow through some part of the oral cavity for a + value (following Jakobson *et al.* 1951, *inter alia*). With this addition, laterals would be specified [+continuant$_{\text{classic}}$, −continuant$_{\text{mid-sagittal}}$], as shown in (19). Classes of stops and laterals would be featurally natural ([−continuant$_{\text{mid-sagittal}}$]), and so would classes of fricatives and laterals ([+continuant$_{\text{classic}}$]). However, nasals would still present a problem under this regime, requiring an additional feature [continuous airflow], which would group them with fricatives, vowels and glides, while they could still be grouped with stops and clicks by [continuant$_{\text{mid-sagittal}}$] and [continuant$_{\text{classic}}$]. See McCawley (1968: 26, n. 15) for related discussion on different interpretations of the feature [continuant].[13]

[12] Another possibility is that features do not need to account for the behaviour they are having difficulty accounting for. Flemming (2005) argues for a distinction between theoretical natural classes, which are defined with conjunctions of features, and descriptive natural classes, which are involved in descriptions of phenomena which may result from the interaction of constraints that do not refer directly to the class of sounds affected by their interaction. Mielke (2004) examines the possibility that recurrent featurally unnatural classes are easily described using disjunction or subtraction of frequent featurally natural classes (as would occur in interaction among constraints which refer to featurally natural classes) and finds that this is not the case. This is not problematic for Flemming's approach, which does not depend on innate features either.

[13] The situation depicted in (19) has been something of a *de facto* reality in phonological theory, because multiple feature systems have been in use for nearly the entire history of distinctive features.

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(19)

	[cont$_{\text{mid-sagittal}}$]	[cont$_{\text{classic}}$]	[continuous airflow]
stops	−	−	−
nasals	−	−	+
lateral liquids	−	+	+
fricatives	+	+	+

Features like [continuant], which appear to involve bundles of closely related phonetic dimensions, or dimensions that can easily partition segments in more than one place, are the ones which are expected be involved in the most cases of ambivalence. Consistent segments are the ones which are on the same end of each dimension in the bundle or are on the same side of all the reasonable boundaries (e.g. oral stops are on the – side no matter how continuancy is defined or where the line is drawn). Ambivalent behaviour occurs in segments which are not extreme enough phonetically that they pattern the same in each case.

Each value of each of [continuant$_{\text{classic}}$], [continuant$_{\text{mid-sagittal}}$] and [continuous airflow] corresponds to a clear set of phonetic properties, and each one is involved in sound patterns. Continuous airflow in the vocal tract, the oral cavity and the mid-sagittal region of the oral cavity are all phonetic dimensions that are relevant for speech, and various intermediate definitions probably are as well. For many phonologists, a phonetic dimension that is relevant for speech is precisely the definition of a distinctive feature. For example, Jakobson *et al.* (1951) documented the eleven phonetic oppositions they 'detected' in sound patterns, not a subset that they believed to be tied to innate features. In the last 50 years, more properties have been found to be relevant for sound patterns. Particular feature theories rule out particular properties (such as the phonetic properties associated with the 'other' definitions of [continuant]), but evidence from sound patterns (e.g. those in §2) shows that this makes incorrect predictions, and that a wide variety of phonetic properties appear to be relevant. To encode all of these relevant phonetic properties in an innate feature set would require a huge increase in the number of features. Expanding the set of innate features to cover all phonetic properties is equivalent to reducing the set of innate features and referring directly to phonetic properties. However, mainstream distinctive feature theory has operated under the assumption that some phonetic properties are irrelevant, and therefore a distinction needs to be maintained between properties which have features and properties which do not (see e.g. Clements & Hume 1995, quoted in §1 above). But the abundance of counterexamples has shown that concluding that a phonetic property is irrelevant should be the result of careful study of that property rather than the result of unawareness of or inattention to all but the classes which occur most frequently in the small fraction of human spoken languages which have been documented and discussed in the literature.

Relaxing the restrictions imposed by innate features, either by adding features or by adding representational variants to retroactively predict

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different behaviour, has the effect of reducing the ability of innate features to make predictions, without addressing the connections between phonetic ambiguity and phonological ambivalence, a retreat that does not introduce new insights or address additional relevant factors.

An alternative to a massive increase in the number of features is to posit only one [continuant] feature, but to allow some segments flexibility in which side of the boundary they are on, or to allow different languages to interpret the feature differently. Features could be learned on the basis of experience. Exposure to a language in which sound patterns motivate the grouping of laterals with fricatives but not stops would cause a learner to acquire a feature like [$\text{continuant}_{\text{classic}}$], and exposure to a language with sound patterns that motivate a grouping of laterals with stops but not fricatives would cause a learner to acquire a feature like [$\text{continuant}_{\text{mid-sagittal}}$]. In this case, though, innate features are not predicting sound patterns. They are simply not interfering with the representation of sound patterns. Innate features can be prevented from interfering with sound patterns involving ambivalent segments by allowing the specifications of some or all segments to be determined on the basis of patterning. Without evidence that any class is favoured over another hypothetical class in a way that is not related to phonetic naturalness, language change or other such available sources of explanation, it is unclear what is gained, apart from continuity with previous theories of phonology, from having innate features which are *filled in* on the basis of experience as opposed to non-innate (emergent) features which are *learned* on the basis of experience.[14] What would be useful in order to predict which features would be learned is not a theory of innate features, but a theory of what causes certain sound patterns to be the ones that learners are likely to be confronted with, as argued by Bach & Harms 1972, Lass 1975, Anderson 1981, Dolbey & Hansson 1999, Blevins 2004 and others.

Innate feature theory makes the claim that some phonetic parameters (those with innate features associated with them) are privileged over others, and should be better represented among sound patterns. Phonetically defined innate features are (intentionally) an idealisation of the many phonetic factors which are conceivably relevant to language, and based on evidence from observed phonologically active classes, they appear also to be (unintentionally) an idealisation of language data. While individual languages may discretise the phonetic space in different ways, evidence from ambivalent segments and elsewhere show that this discretisation is not 'determined absolutely, within general linguistic theory, and independently of the grammar of any particular language' (Chomsky & Halle 1968: 164). Innate feature theory equates 'core' phonologically active classes with featurally natural classes, but while there is considerable overlap, there is not identity.

[14] Taking into account language-specific phonological patterning in specifying the values of innate features is a more fundamental part of Element Theory (Harris 1994, Harris & Lindsey 1995).

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There is also considerable overlap between phonetic naturalness and phonological activity, so that featural and phonetic naturalness are quite easily confounded with one another, especially for the many familiar classes which are both phonetically and featurally natural, often involving a phonetic dimension with relatively clear phonetic correlates at both ends and a relatively clear boundary in between (such as voicing). The behaviour of ambivalent segments appears to have more in common with the gradient nature of the phonetic dimension(s) which features such as [continuant] are grounded in than it does with the features themselves.

Nearly 25 % of the classes from the survey are featurally unnatural in all three theories tested, and only a very small fraction of these pivot on the continuancy status of laterals and nasals. Making all of these featurally natural in innate feature theory (a point returned to below) would require a massive increase in the number of features in Universal Grammar, to the point where the theory no longer makes predictions about which classes are predicted and which are not (apart from predictions which can be made independently on the basis of phonetic naturalness, etc.).

The primary data for innate feature theory has been recurrent phonologically active classes. Innate features have been proposed to account for a wide range of the more commonly observed classes, and have done so most reliably for the segments with the most straightforward mapping between phonetic properties and phonological patterning. Where this mapping is relatively less categorical and more complicated (e.g. the patterning of laterals and nasals with continuants and non-continuants), innate feature theory has been relatively more stymied. While it appears that innate features are bypassed in cases such as those discussed in §2, there are other ways for phonetics to influence phonology and achieve many of the same effects attributed to innate features.

3.2 Historical residues

The strongest versions of innate feature theory might require the relationship between attested or attestable phonologically active classes and featurally natural classes to be identity. However, many phonologists may not expect features to predict all of the classes that occur, because many of the classes are historical residues from millennia of diachronic changes that may interfere with naturalness. The telescoping of multiple natural changes may result in seemingly arbitrary unnatural-looking synchronic patterns. In weaker versions of innate feature theory, these idiosyncratic classes might be treated as fundamentally different from featurally natural classes, but there is also a relationship between natural changes and featurally natural classes. The recurrent phonetically natural classes which have been treated as featurally natural may also be understood as simply *the most common types of historical residues*.

If there truly is a distinction between classes that innate features are or are not accountable for, there should be a theory-external way to distinguish

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them. One of the predictions of innate feature theory is that featurally natural sound patterns should be easier to acquire, because the features to represent them are already present in UG. Idiosyncratic diachronic residues would require a different kind of memorisation. Experimental evidence suggests that phonetically unnatural sound patterns are readily learnable (Onishi *et al*. 2002, Peperkamp & Dupoux, in press). Further, unnatural sound patterns are well attested, and have been shown to be stable (see e.g. Bach & Harms 1972, Buckley 2000). Survey evidence also does not support the natural–unnatural distinction among phonologically active classes (Mielke 2004). While studies such as Onishi *et al*. (2002) and Peperkamp & Dupoux (in press) have shown that phonetically unnatural sound patterns are learnable, others, such as Saffran & Thiessen (2003) and Wilson (2003), have shown that natural patterns may in fact be easier to learn. The finding that phonetically natural patterns are easier to learn is consistent with the *prevalence* of phonetically natural patterns in human languages (although learnability is not the only available explanation for their abundance), and the finding that phonetically unnatural classes are nonetheless learnable is consistent with the *existence* of phonetically unnatural patterns in human languages. However, no study has shown a clear boundary between easily learned patterns and less easily learned patterns, or a sharp difference in learnability that is directly attributable to featural naturalness.

In accounting for featurally unnatural classes, it makes sense to separate the classes into two categories: those which are phonetically natural and may have a transparent phonetic basis, but have the misfortune of being natural according to a set of properties for which a distinctive feature has not been proposed, and those which are phonetically unnatural, and likely arose via a series of changes which may each have been natural but whose end result is a phonetically unnatural class. One approach is to aggressively expand the innate feature set to account for *all* phonetically natural classes, while forsaking unnatural classes. Anderson (1981) argues that this can be a very difficult distinction to make, because many classes which appear to have a transparent basis in phonetically natural changes turn out to have very different origins. Further, a 'vast' theory of innate features which attempts to capture all phonetically natural classes without adopting an independent gradient notion of naturalness would need to draw a distinction between the most marginally natural (but perhaps unattested) classes which are admitted and classes for which there is no apparent phonetic basis (but which may be attested nonetheless) which are rejected.

Another approach, taking into account the experimental evidence that natural and unnatural classes may be processed the same way synchronically, is to treat all classes as historical residues, and to explore phonologically active classes in terms of their historical development, to understand the types of classes a learner may be called upon most frequently to acquire. In this view, featurally and phonetically natural classes are a special case of idiosyncratic historical residues, i.e. they are the ones which most transparently reflect their phonetic origins and which

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therefore occur most frequently and are most likely to be encountered and embraced by phonologists. In the same way, non-ambivalent segments can be interpreted as a special case where phonetic factors line up in such a way that sounds pattern consistently in different languages. In the nominal cases where there are multiple possible interpretations of a segment with respect to a phonetic dimension, segments are ambivalent. Because non-ambivalent segments have provided the primary data for innate feature proposals, it is the ambivalent segments which have appeared to be exceptional.

3.3 Emergence of features

Even without innate features to include the natural and exclude the unnatural, there are reasons to expect natural classes to be favoured in natural languages. First, phonological patterns can result from changes characterised as the phonologisation (Hyman 1976), conventionalisation or exaggeration (Janda 1999) of a previously 'insignificant' phonetic effect. Phonetic effects involve such factors as physiology and aerodynamics, and most humans have very similar vocal tracts and auditory systems and all are subject to the same laws of physics. Likewise, languages have similar classes involved in similar phonetically grounded sound patterns. Second, classes involved in sound patterns may change over time. Learners can arrive at the 'wrong' generalisation about a sound pattern, and the 'wrong' generalisation can become the prevailing version for a speech community. When this happens, the 'wrong' generalisation has become 'right'. The result may be a phonetically natural class that is not necessarily related to the original phonetic basis for the sound pattern. An obvious response is to ask what parameters contribute to these generalisations. If features were responsible, more featurally natural classes would be expected. Another possibility is that phonetic similarity is relevant, but phonetically defined features (i.e. a discretised subset of dimensions of similarity) are not.

Efforts to draw upon phonetic similarity to argue that recurrent phonologically active classes can be accounted for without innate features have been hampered by the lack of an objective means of measuring phonetic similarity without using features. For example, the similarity metric of Frisch *et al.* (1997) allows similarity between two segments to be computed, but does so on the basis of descriptive phonetic features. Mielke (2005) proposes a metric of phonetic similarity that is based on a combination of raw acoustic similarity, with articulatory measurements from ultrasound, visual and airflow sources. Such a metric allows statements to be made about likely and unlikely phonologically active classes, on the basis of phonetic similarity. Mielke (2005) demonstrates that a simulation of the acquisition of phonologically active classes (using a learner which has access to phonetic similarity information, and is able to generalise on this basis in order to learn classes based on incomplete data) favours phonetically natural classes simply on the basis of observable phonetic

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properties, supporting Mielke's (2004) model of the emergence of distinctive features.

The idea behind emergent feature theories is that the connections between sounds which may tend to pattern together are a result of similarities between these sounds. Sounds have articulatory and acoustic properties, and therefore similarities, because they are produced by a vocal tract and propagated as acoustic signals. The physical properties of speech sounds, as well as their existing roles in sound systems, afford them the *opportunity* to group together in sound patterns. When this happens, this grouping, a cognitive category if speakers recognise it, can be interpreted as a feature which can be said to have emerged and which learners of a language may acquire. In innate distinctive feature theory, these features have been interpreted as pre-existing cognitive entities. In emergent feature theory, recurrent classes are not the result of innate features, but the result of properties possessed by sounds simply as a result of the fact that they exist.

Pulleyblank (2003) argues that a theory of emergent features is more restrictive than a theory of innate features in accounting for covert feature effects, cases where a feature that is not active in an inventory plays a role in phonological patterning. Pulleyblank finds that covert feature effects appear only to involve features which are already motivated in the language, and takes this as evidence that a theory of emergent features is more restrictive than a theory of innate features, because these effects seem to be limited to features which would be expected to have emerged in language acquisition, and fail to exploit features argued to be provided by Universal Grammar that are not already apparent in the sound patterns of the language.

After being together for years, sound patterns, phonetic naturalness and distinctive features may all benefit from decoupling, in order to learn the ways in which the three are related.[15] The innate features approach has revealed many correlations between phonetic naturalness and phonological patterning, and it would be worthwhile at this point to investigate larger forces which contribute to these correlations, giving rise to the well-behaved cases that provide primary evidence for innate features, as well as ambivalent segments and unnatural classes.

4 Conclusion

This study has provided evidence that the long-standing indecision over the continuancy of lateral liquids is well founded. Lateral liquids and

[15] Ladefoged (2005) argues that the set of features necessary for describing lexical contrasts is different from the set of features needed for describing phonological patterns. Lin (2005) develops an algorithm for extracting classificatory features from waveforms, but the features a child might discover on the basis of acoustic and phonotactic information are not necessarily going to be the same features necessary to formulate sound patterns in the language.

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nasals pattern with continuants as well as non-continuants, and also participate in numerous featurally and phonetically natural and unnatural classes. The recurrent classes often involve phonetically similar segments, even when they cannot be characterised with traditional distinctive features, and the segments that tend to be ambivalent are the ones that are not prototypical examples of the + or − value of a relevant feature. Universal distinctive features are most reliable for predicting the behaviour of phonetically unambiguous segments, suggesting that the phonetic unambiguity is responsible for the phonological patterning. In the phonetic grey areas, where universal features would be expected to define clear boundaries between two values of a feature, the phonological patterning of sounds is as varied as the phonetic cues are ambiguous.

Appendix: Sources for survey languages mentioned by name

Abun (Berry & Berry 1999)
Alyawarra (Yallop 1977)
Amele (Roberts 1987)
Anywa (Reh 1996)
Arabana (Hercus 1994)
Arabic, Libyan (Abumdas 1985)
Arapesh (Fortune 1977)
Armenian, Agn (Vaux 1998)
Armenian, Agulis (Vaux 1998)
Bari, Kukú dialect (Cohen 2000)
Basque (Saltarelli 1988, Hualde 1991)
Boko/Busa (Jones 1998)
Bukusu (Austen 1974)
Bulgarian (Scatton 1984)
Čakavian, Cres (Houtzagers 1985)
Capanahua (Loos 1969)
Catalan (Wheeler 1979)
Comanche (Charney 1993)
Dani, Lower Grand Valley (Bromley 1961)
Dholuo (Okoth-Okombo 1982)
Dieri (Austin 1981)
Doyayo (Wiering 1994)
Ehueun (Elugbe 1989)
Epie (Elugbe 1989)
Estonian (Harms 1962)
Faroese (Lockwood 1955)
Finnish (Sulkala & Karjalainen 1992)
Gondi, Koya (Subrahmanyam 1968)
Gooniyandi (McGregor 1990)
Greek (Joseph & Philippaki-Warburton 1987)
Guatuso (Constenla 1981)
Higi (Mohrlang 1972)
Hungarian (Imre 1972, Kálmán 1972, Abondolo 1988)
Ịjọ, Kolkuma dialect (Williamson 1965)
Inuktitut, West Greenlandic (Fortescue 1984)
Irish, Dunquin (Ó Siadhail 1989)
Jacaltec (Day 1973)
Japanese (McCawley 1968, Vance 1987, Shibatani 1990)
Kalispel (Vogt 1940)
Koraga, Onti (Bhat 1971)
Korean (Lee 1989)
Koromfe (Rennison 1997)
Koyukon, Central Outer (Kroul 1980)
Lumasaaba (Brown 1972)
Macuxi (Carson 1982)
Manipuri (Bhat & Ningomba 1997)
Maya, Yucatan (Straight 1976)
Misantla Totonac, Yecuatla (MacKay 1999)
Mishmi (Sastry 1984)
Mising (Prasad 1991)
Mokilese (Harrison 1976)
Nangikurrunggurr (Hoddinott & Kofod 1988)
Navajo (Reichard 1974)
Ndyuka (Huttar & Huttar 1994)

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Okpe (Hoffmann 1973, Elugbe 1989)
Oromo, Boraana (Stroomer 1987)
Pengo (Burrow & Bhattacharya 1970)
Quichua, Ecuador (Orr 1962)
Runyoro-Rutooro (Rubongoya 1999)
Russian (Unbegaun 1957)
Shambala (Besha 1989)
Slave, Bearlake (Rice 1989)
Slovene (Herrity 2000)
Spanish (Cressey 1978)
Straits Salish, Samish dialect (Galloway 1990)
Temne (Wilson 1961)
Tepehuan, Northern (Bascom 1982)
Tiv (Abraham 1968)
Toba (Klein 2001)
Tsakhur (Schulze 1997)
Tswana (Cole 1955)
Turkish (Lewis 1967)
Tuvaluan (Besnier 2000)
Ukue (Elugbe 1989)
Umbundu (Schadeberg 1990)
Uneme (Elugbe 1989)
Wangkangurru (Hercus 1994)
Warlpiri (Nash 1986)
Wiyot (Reichard 1925)
Yir-Yoront (Alpher 1991)

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