PHONETIC CONSTRAINTS AND MARKEDNESS IN THE PHONOTACTICS OF AUSTRALIAN ABORIGINAL LANGUAGES

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PHONETIC CONSTRAINTS AND MARKEDNESS IN THE PHONOTACTICS OF AUSTRALIAN ABORIGINAL LANGUAGES

by

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A thesis submitted in conformity with the requirements
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Constraints and Markedness in the Phonotactics
of Austarlian Aboriginal languages
Doctor of Philosophy
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This thesis is a descriptive and theoretical analysis of distributional co-occurrence constraints on consonants, focusing on the Aboriginal languages of Australia. The two phonotactic positions in consonant clusters are found to be positions of neutralisation of feature contrasts which are present in other positions in the word, particularly between vowels. I present a series of generalisations which may be made on the permitted sequences of consonantal place features and manner features in clusters morpheme-internally. These patterns take the form of implicational relationships between segments and clusters, showing that an unmarked core of cluster types is present in all Australian Aboriginal languages, while languages vary in how they elaborate additional, more marked structures.

I argue that each phonotactic pattern is phonetically grounded. Unmarked clusters correspond to structures which are gesturally and/or perceptually simple and marked structures are gesturally and/or perceptually complex. I formalise each pattern of neutralisation within a constraints theory of markedness, and propose that constraints are phonetically grounded.

The goal of this thesis, then, is twofold. The first is to report the recurring generalisations in the Australian cluster phonotactics. The second is to argue for a relationship between phonotactic markedness and phonetics. I show that a phonetic theory of constraints accurately predicts the attested patterns.

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To my mother,
in loving memory.

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Chapter 1: Foundations

§1.0 Introduction.

The present work is a descriptive and formal treatment of the phonotactics of morpheme-internal consonant clusters in Australian Aboriginal languages. There are two primary goals. The first goal is a thorough description of the recurring patterns of markedness in the distribution of consonants in clusters, seen in implications and frequencies. The second goal is a theoretical formalism of these patterns of markedness. I adopt a non-derivational, constraints-based theory of phonotactics, arguing that markedness follows from constraint violation. I propose a substantive theory of constraints in which they promote the articulatory ease and perceptual recoverability of sound sequences.

Australian Aboriginal languages are very fertile ground for the investigation of phonotactics since they demonstrate a wide array of often very severe distributional restrictions on segments. The phonotactic survey in this thesis fills a gap in the current phonological literature, which includes no such description. Dixon 1980 devotes a section to an overview of Australian Aboriginal phonotactics but the treatment is by necessity an overview because of the broad scope of the book. It is hoped that the survey provided here will open up this very rich field of research to phonological investigation.

In the formal treatment of Australian phonotactics, I show that the data lead to a range of conclusions with far-reaching implications for issues of central importance in theoretical phonology. The principle theoretical claims are the following. (1) The empirical phenomenon of markedness, as expressed in implicational relationships and differential frequencies of features, derives from constraint violation (Calabrese 1988, Prince & Smolensky 1993, McCarthy & Prince 1995). (2) Constraints are phonetically grounded, promoting forms whose articulatory gestures are maximally simple and whose perceptual cues are maximally robust (Lindblom 1982, 1983, Ohala 1983, 1990, Kawasaki 1982). Forms which violate a constraint are necessarily marked since they contain complex gestures and/or opaque acoustic cues. Empirical phenomena of the scalarity of markedness, shown in multi-valued implicational scales of place and manner features, are effects of a general principle of constraint ranking which correlates with relative perceptual saliency and articulatory ease (Jun 1995, Kaun 1995 and Steriade 1995b). (3) Morpheme-internal segmental phonotactics are best understood in exclusively segmental terms, as string-wise constraints, rather than within a theory of prosodic licensing (Lamontagne 1993, Steriade 1995, see also Rice 1992 and Bures 1989). The string-wise constraints which Lamontagne assumes in accounting for the phonotactics of English consonant clusters are dissimilarity conditions such as the OCP and phonetic effects such as gestural overlap. (4) Constraints require reference to a wide range of both articulatory and acoustic features. As a result, phonological representations must include acoustic features (Jakobson, Fant & Halle 1952). This is demonstrated by the crucial role they play in many of the Australian phonotactic patterns. This casts doubt on the long held assumption that phonological features correlate almost exclusively with articulations (Sagey 1986, McCarthy 1988).

In this chapter, I discuss the traditional notion of markedness (§1.1), outline the constraints theory of markedness which I adopt (§1.2, §1.3), survey the genetic relationships among Australian languages (§1.4), and present the organisation of the thesis (§1.5).

§1.1 Markedness.

Markedness is observed in two phonotactic phenomena: implications and differences in frequency. In this section I discuss these two in the traditional literature on markedness as background to the formal treatment of markedness in the following two sections.

§1.1.1 Implication: markedness as demonstrated in patterns of exclusion.

The first evidence for markedness comes from implicational generalisations between features: marked segments imply their unmarked counterparts cross-linguistically. Greenberg 1966:13-24, following Trubetzkoy 1939/1969, discusses the role of implicational relationships between segments in determining their relative markedness: when the contrast between two segments is neutralised in a particular context, the neutral segment which occurs is phonetically closest to the unmarked member of the set.[1] For example, in German [p] and [b] contrast in onsets but only [p] occurs in codas, indicating that the voiceless segment is the unmarked member of the pair. This evaluation metric of markedness is empirically equivalent to the claim that unmarked features have a wider distribution than their marked counterparts (Hockett 1955:166-167). Using the German example again, [+voice] and [−voice] both occur in onsets but only [−voice] occurs in codas, indicating that [−voice] has the wider distribution of the two and is therefore to be considered less marked. Greenberg himself observes (Greenberg 1966:21) that neutralisation and asymmetrical distribution are alternate descriptions of the same phenomenon. Implications are therefore reliable indicators of markedness asymmetries.

[1]It is necessary that this neutralisation not be "externally determined," such as through assimilation to an adjacent segment, in which case the neutralised segment may receive the specification of a marked feature. Therefore only "internally" determined neutralisation is relevant to markedness.

The implied feature is less marked than the feature that implies it.[2]

Asymmetries in the distribution of features within a phoneme inventory are also relevant to markedness because they constitute another type of implication pattern. According to Greenberg 1966:21, "in statements of the type that in any language the number of phonemes with a particular feature is never greater than the number of phonemes with some other feature, it generally seems to be the set characterized by the marked feature which is less than or equal in number to the set with the unmarked feature." One example which Greenberg cites (following Ferguson 1963; see also Trubetzkoy 1939/1969:118-121) is the number of oral versus nasal vowel phonemes: no language has more nasal than oral vowel segments while many have more oral than nasal vowels. This is taken as indication that [+nasal] is the marked member of the nasal/oral pair among the vowels.

Feature co-occurrence evidence for markedness is very closely related to implication. We know from cross-linguistic evidence that [nasal] in the vowel system implies the presence of [oral] as a feature for vowels. This same implicational relationship, when applied language-internally, is true of each vowel *quality*. This allows the possibility of vowel inventories in which [nasal] is associated with certain vowel qualities but not with others. In other words, the marked status of the feature [nasal] for vowels means that it always implies an oral vowel counterpart, both cross-linguistically and language-internally.

[2]It should be noted that neutralised segments are not always identical to either of the members of the correlate set in a position of contrast. In articulatory and acoustic terms, neutralised segments are often intermediate between the contrasting phones, referred to as a *Mittelding* (Trubetzkoy 1939/1969). See also Butcher 1995 for extensive arguments that the articulation of neutral coronals in Australian Aboriginal languages demonstrates the Mittelding phenomenon (discussion in §2.1.3).

Greenberg's discussion on this point implies that mere numerical superiority of oral vowels over nasal vowel phonemes in inventories is sufficient to show the marked status of the feature [nasal]. However, the attested patterns of distribution are more principled than this. First, the set of nasal vowel qualities is a subset of the set of oral vowel qualities in the vowel inventory of any given language, i.e., nasal vowels have homorganic oral counterparts (although sometimes the homorganic correspondence is approximate rather than exact). Second, there is a great deal of cross-linguistic consistency in the vowel qualities which lack nasal articulation in languages with oral/nasal vowel asymmetries. Trubetzkoy 1939/1969:118-121 observes that in many languages the oral/nasal contrast is neutralised among mid vowels but not among peripheral vowels. Therefore implicational relationships as indications of markedness between features and segments are attested both cross-linguistically and within the phoneme inventories of individual languages.

§1.1.2 Frequency: markedness as demonstrated in patterns of relative preference.

Markedness is also indicated in the relative frequency of features: unmarked features are more frequent than marked features. The importance of frequencies in markedness theory has been investigated in depth in the traditional literature (Zipf 1935, 1949, Trubetzkoy 1939/1969:chapter VII, Ferguson 1963, Greenberg 1966; see also Maddieson 1984 for a more recent investigation of the relationship between *cross-linguistic* frequency of phonemes and markedness). Greenberg 1966:15-20 presents evidence from a genetically and geographically diverse sample of languages demonstrating the higher frequency of the unmarked member of a correlate set of segments relative to its marked counterpart. He shows that non-glottalised consonants occur at higher frequencies than their glottalised (ejective and implosive) counterparts (Hausa, Klamath, Coos, Yurok, Chiricahua, Maidu); unaspirated consonants are more frequent than aspirated consonants (Chiricahua); short vowels are more frequent than long vowels (Icelandic, Sanskrit, Czech, Hungarian, Finnish, Karok, Chiricahua); and oral vowels are more frequent than nasal vowels (Chiricahua). An important fact about the two indicators of markedness discussed here, implication and frequency, is that they are consistent with each other: features with a wider cross-linguistic distribution also occur at higher frequencies language-internally. This fact figures prominently in this thesis.

I draw attention at this point to an important distinction between accidental gaps and markedness as demonstrated in patterns of exclusion. Blevins 1995:227-228 suggests that in many languages phonotactic gaps should be treated as accidental gaps. This is especially indicated, she suggests, when there are no alternations enforcing the same gaps in morphologically complex forms and/or when loan words are not assimilated to conform to phonotactic constraints active in native vocabulary. However, accidental gaps are by definition random, while the phonotactic patterns among Australian Aboriginal languages are non-random: they show considerable cross-linguistic overlap, as we will see in the following chapters, and variability across languages can be shown to be based on phonetically grounded constraints. This cross-linguistic similarity in phonotactic patterns indicates that they are systematic rather than accidental. A similar view is argued for by Dyck 1995 regarding positional gaps in vowel inventories in Spanish and Italian dialects.

In a similar vein, because of the symmetry between patterns of exclusion and patterns of frequency as indicators of markedness, segmental contrasts which are absent in a specific position in one language are relatively infrequent in that position in other languages. This makes it difficult to analyse gaps in the inventory of permitted consonant

clusters when the language under investigation has not been thoroughly documented. If one language has a particular cluster, occurring at a low frequency, and the rather small published lexicon of a neighbouring language does not include an example of that cluster, it might be reasonable to assume that a slightly larger lexicon from the latter language would include the cluster in question. A phonotactic gap in a poorly documented language may thus be systematic (and therefore a pattern of exclusion) or the cluster in question may occur at a frequency low enough that it was not encountered in the elicited corpus (a frequency effect of markedness). But we will see that these are merely different instantiations of the same phenomenon: avoidance of marked features, whether that avoidance is manifested in an absolute or relative fashion. The two phenomena constitute a unified pattern. However, salvage studies[3] must be treated with caution, since the necessarily small corpus may not be representative of the language.

§1.1.3 Markedness: summary.

The term unmarked (or "harmonic," as used by Goldsmith 1993) refers to a phonotactically preferential status demonstrated by specific phonological features. Markedness is normally expressed as a relative relationship, such that feature [F] is *less marked than* or *harmonic to* [G]. There are two distinct empirical correlates to markedness. First, markedness is shown in cross-linguistic implication (1.i). Second, markedness is shown in language-internal frequency facts (1.ii).

[3]Salvage studies are language descriptions based on work with a small number of remaining speakers of the language, who often have not actively spoken the language since their youth, and sometimes on work with speakers who never had native fluency.

(1) Phonotactic markedness: [F] is less marked than [G] ("[F] ≻ [G]"), if:
 (i) [G] implies [F] cross-linguistically; and
 (ii) [F] is more frequent than [G] language-internally.

This definition of markedness is a descriptive statement, based on empirical observation of the distribution of phonological features within the morphemes of a language.

§1.2 The substantive content of markedness.

In the preceding section I defined the empirical correlates to markedness: implication and frequency. In this section I address the issue of why markedness exists. The answer that I propose is substantive in nature: forms are marked because they are gesturally and/or perceptually complex. I formalise the avoidance of complexity with constraints, pending more theoretical treatment of the constraints theory of markedness in §1.3. In this section, I discuss gestural and perceptual complexity in order, and then address the issue of conflict between these two criteria of markedness.

§1.2.1 Gestural complexity and markedness.

The first aspect of the substantive nature of the constraints theory which I propose is the following: simple gestures are less marked than complex gestures. I term this the gestural theory of markedness (GTM), expressed in (2).

(2) Gestural Theory of Markedness (GTM).
Articulatory gestures which deviate minimally from configurations of least effort are highly valued.

The notion of gesture has received considerable attention in Articulatory Phonology

(Browman & Goldstein 1989, 1992), and will be discussed in chapter 3 along with some other issues of segmental complexity. There are many issues in the measurement of effort and complexity which are not adequately resolved in the literature. But gestural simplicity of segments is commonly assumed to correlate closely with the segments which have the widest distribution in phoneme inventories and which are acquired by children first (Jakobson & Halle 1956, Jakobson 1962, Maddieson 1984, Rice & Avery 1995).

Under the GTM there is a continuum of markedness, or harmonic scale, from least to most marked based on how closely they correspond to configurations of least effort. Simple gestures are unmarked and complex gestures are marked. The notion that gesturally simple articulations are optimal has a long history in phonology, early references being Zipf 1935, 1949. Certain functionalist phoneticians and phonologists have fruitfully investigated the importance of gestural simplicity as a determinant of cross-linguistic generalisations on phoneme inventories, phonological alternations, etc. (Lindblom 1982, 1983, Ohala 1983). The minimisation of articulatory effort continues to play an important role in current work in theoretical phonology, often formalised as a constraint which promotes the reduction of consonantal gestures (Mohanan 1991, Jun 1995, Kirchner 1995, Steriade 1995b).

The GTM accurately predicts that contour and complex segments (such as geminate consonants and long vowels, partially nasal segments, segments with secondary articulations, doubly articulated segments) are marked compared to plain segments (i.e., segments which lack secondary articulations, etc.) (Greenberg 1966, Maddieson 1984). Even among the plain segments, there is evidence that certain gestures are less complex than others. It is widely argued from phonological evidence that alveolar coronals are less marked than non-coronals and other (non-alveolar) coronals (see Avery & Rice 1989, Paradis & Prunet 1989, the papers in Paradis & Prunet 1991 and references therein, Hamilton 1993a, McCarthy & Taub 1993). It is commonly argued that the unmarked status of alveolar coronals derives from an assumed gestural simplicity (e.g. Dixon 1980:185, Mohanan 1991). The proposal that alveolar coronals involve less articulatory effort than other articulations is consistent with their phonologically unmarked status. Also, this proposal is consistent with the inherent agility of the tongue tip and its proximity to the alveodental region. Evidence reported by Béland & Favreau 1991 from aphasic studies also suggests that alveodental coronals involve the least complex place gesture. These facts indicate that alveolars are relatively less complex than other articulations, and thus are highly valued under the GTM.

In addition to inherent complexity, gestures also have a contextual complexity. One common example of this is co-occurrence restrictions on segments with similar articulatory features. A sequence of gestures by the same articulator is gesturally complex and hence is marked since clusters preferentially use independent, spatially compatible articulators, thus allowing for temporal overlap of adjacent segments (Lindblom 1983). Such restrictions may be expressed as constraints promoting featural contours, a family of constraints indebted to the Obligatory Contour Principle which apply to adjacent instances of identical phonological features: *[F][F] (Leben 1973, Goldsmith 1976, McCarthy 1981, Yip 1988, 1989, Lamontagne 1993). I will propose a variety of constraints on adjacent occurrences of identical articulatory features in the formalism of Australian phonotactics.

Feature co-occurrence constraints on segment structure are also motivated by the GTM as an example of contextual complexity. Certain pairs of articulatory gestures make conflicting demands on the vocal organs, such as high-front tongue body gestures and

retracted tongue root. The co-ordination of such antagonistic gestures is marked (Archangeli & Pulleyblank 1994). I assume that "configurations of least effort" as given in the definition of the GTM refers to both inherent and contextual complexity.

Since complex gestures are marked compared to simple gestures under the GTM, constraints against complex features are more strictly enforced cross-linguistically than constraints against simple features. This is expressed as an ordering relationship between constraints, where strictly enforced constraints are ordered before weakly enforced constraints. Therefore constraints referring to gesturally complex features are ordered before filters referring to gesturally simple features. Given two gestural features [G] and [G'], where [G] is less complex than [G'], the GTM predicts that [G] is less marked than [G']. In other words, if [G'] is found then [G] is found as well. This is enforced by a universally fixed constraint ordering *[G'] ≫ *[G]. The double-headed arrow "≫" is to be read that *[G'] is ordered before *[G]. This ordering means that violation of *[G'], i.e., the presence of [G'], implies that *[G], i.e., the presence of [G], is violated under the same circumstances. Therefore forms which violate *[G'] are more marked than forms which violate *[G], all else being equal. This results in the empirical pattern that [G] is more widely attested cross-linguistically. These facts are summarised in (3).

(3) Gestural complexity as a determinant of constraint ordering.

Relative complexity.	Formal effect.	Empirical effect.
[G] is gesturally simple.	*[G] ordered low.	[G] is unmarked.
[G'] is gesturally complex.	*[G'] ordered high.	[G'] is marked.

This shows how the GTM acts as a determinant of phonotactic patterns in the formalism of constraint ordering.

As stated above, the differences between the plain consonantal place gestures with respect to gestural effort are poorly understood. But following the references cited above I assume that the gesture of apico-alveolar coronals is less complex than other gestures. This motivates the following fixed ordering: *[place] » *[alveolar], i.e., it is less marked to have the feature [alveolar] than other place features (see Prince & Smolensky 1993, McCarthy 1994 and Kiparsky 1994 for similar proposals). This assumption will play an important role in the discussion of the coronal phonotactics in §4.3.

§1.2.2 Perceptual complexity and markedness.

The second aspect of the substantive nature of constraints is that perceptually simple speech sounds are less marked than perceptually complex speech sounds. I term this the perceptual theory of markedness (PTM), expressed in (4).

(4) Perceptual Theory of Markedness (PTM).
Speech sounds which deviate minimally from configurations of maximal perceptual recoverability are highly valued.

Just as under the GTM there is a harmonic scale of speech sounds based on deviation from configurations of least effort, under the PTM there is a harmonic scale of speech sounds from least to most marked based on how robust their acoustic cues are. Simple percepts are unmarked and complex percepts are marked (Jun 1995 and Steriade 1995b). I assume that simple speech sounds in perceptual terms are those with robust spectral cues.

The PTM requires that filters referring to perceptually complex features are ordered higher (i.e., more strictly enforced) than filters referring to perceptually simple

features. Given two acoustic features [P] and [P'], where [P] is less complex than [P'], the PTM predicts that [P] is less marked than [P']. This is enforced by a fixed constraint ordering *[P'] » *[P]. The empirical correlate to this is that perceptually robust speech sounds are highly valued cross-linguistically, while languages only grudgingly elaborate perceptually opaque structures. These facts are expressed in (5)

(5) Perceptual complexity as a determinant of constraint ordering.

Relative saliency.	Formal effect.	Empirical effect.
[P] possesses robust spectral cues.	*[P] ordered low.	[P] is unmarked.
[P'] lacks robust spectral cues.	*[P'] ordered high.	[P'] is marked.

Aside from inherent robustness of acoustic features, phonetic context also plays an important role: spectral cues may be enhanced in some positions and masked in others. For example, many consonantal cues are tied to the C-V transition, which unreleased segments by definition lack (see discussion on references cited in §2.2.4). Under the PTM, these acoustic cues are less marked as features of released segments than of unreleased segments. This compels the following universally fixed ordering of constraints: *[P]˺ » *[P]. The symbol [˺], the IPA diacritic for unreleased consonants, refers to the absence of burst and vowel transition cues inherent in the C-V transition. These two constraints are defined in (6).

(6) Universally fixed constraint order: *[P]˺ » *[P]°.
*[P] =[P] is marked (when possessing C-V transition cues).
*[P]˺ =[P] is marked in the absence of C-V transition cues.

This ordering is responsible for the persistent neutralisation of feature contrasts of unreleased consonants cross-linguistically.

Certain features are more reliably cued in the V-C transition than in the C-V transition. This is the case with the acoustic feature of retroflex segments, [+flat]. Retroflex cues are largely absent in the C-V transition (see discussion in §2.2.3). In this case, the PTM requires that retroflexes having only V-C cues are more highly valued than retroflexes having only C-V cues. This is borne out in the distribution of retroflex segments in Australian Aboriginal languages (discussed in chapter 4 and appendix A).

It stands to reason that intervocalic consonants, possessing both attack (V-C transition) and release cues (C-V transition) have greater perceptual recoverability than segments which do not. The PTM predicts that this is the position of the greatest elaboration of features. This prediction is investigated and corroborated in chapter 3. Therefore the PTM compels the following two contextual orderings of [P], depending on whether [P] is more robust in the C-V transition (7.a) or the V-C transition (7.b).

(7) Context-specific robustness of perceptual cues as a determinant of constraint ordering.

a. [P] tied to release cues: $*[P]^{VC} \gg *[P]^{CV} \gg *[P]^{VCV}$
b. [P] tied to attack cues: $*[P]^{CV} \gg *[P]^{VC} \gg *[P]^{VCV}$

Another contextual effect of the PTM is the avoidance of the perceptual acuity required in distinguishing acoustically similar features in sequence. This reflects the importance of *spectral modulation* in the accurate perception of segment sequences, and therefore as a determinant of cross-linguistic phonotactic patterns (Kawasaki 1982). Spectral modulation is the degree of dissimilarity in the spectral properties of a sequence of segments. When the two segments have similar spectral properties the degree of modulation is low. The

features of the two segments are difficult to distinguish, and are marked as a result. As examples of this pattern, Kawasaki discusses consonant+glide and consonant+vowel sequences. She observes that labial+[w] and coronal+[j] sequences are disfavoured cross-linguistically. As well, sequences of a labial or velar consonant and a rounded vowel, and of a coronal consonant and a front vowel, are relatively rare.

The PTM predicts that sequences of segments with low spectral modulation are marked. Therefore [P] is more highly valued in the environment of non-[P] segments than in the environment of segments with the same feature. This motivates a constraint such as *[P][P] to formulate this pattern, formalised under the rubric of the OCP (8).

(8) Spectral modulation (OCP on acoustic features).
*[P][P] =Adjacent occurrences of [P] are marked.

Several constraints referring to acoustic features, such *[P][P]-type constraints and others referring to the presence/absence of release cues, will be put forward to account for Australian phonotactics.

Another acoustic determinant of recurring phonotactic patterns discussed by Kawasaki 1982 is the degree of acoustic difference between different sound sequences. She proposes that two sound sequences with similar spectral properties incur perceptual confusion and thus are susceptible to merger. I propose that when a form [Φ] is perceptually ambiguous between two phonological forms F and F', F is assumed as the representation corresponding to [Φ] where F is less marked than F'. The proposal that perceptually ambiguous forms are neutralised to the lesser marked phonological form is indebted to the notion of "Stampean occultation" (Prince & Smolensky 1993:50-51).

Prince & Smolensky discuss the possibility of the complete neutralisation of non-identical inputs (underlying forms), and assume that when two inputs are realised identically on the surface, the input which exists in the lesser marked relationship with the surface form is re-analysed as the lexical entry for both. This is closely related to the notion of Lexicon Optimization (LO) in Optimality Theory (Prince & Smolensky 1993:191-196). LO is defined as follows:

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

In Optimality Theory, surface forms have a potentially infinite set of hypothetical inputs. But, in practice, inputs are assumed to correspond to their surface realisation in a maximally harmonic fashion (barring, of course, contradictory evidence from alternations). LO states that the harmonic "candidate" input relative to an output form is selected as optimal based on the language's constraint ranking and stored as the lexical representation of the surface form. This is based on the non-controversial assumption that any asymmetry between underlying and surface forms may be tolerated only on the basis of empirical evidence (Kiparsky 1973). LO predicts that phonetically equivalent forms are assumed to have identical underlying forms, all else being equal. I extend this principle and assume, following Kawasaki 1982, that distinct forms which are too similar in perceptual terms to be reliably distinguished with any consistency are merged as well, in favour of the less marked.

§1.2.3 Conflict between gestural and perceptual constraints.

Certain classes of segments are marked under both the GTM and the PTM. Nasals illustrate this. Nasal segments are more complex than plain oral stops because of their velic gesture (assuming that [nasal] is a privative feature, see Steriade 1993b, 1995a, Browman & Goldstein 1989, 1992). Nasals are also acoustically complex: coupling the oral and nasal cavities as two connected resonating chambers blurs place features which are otherwise more robust (Malécot 1956). This accurately predicts that languages often have fewer place contrasts among nasals than stops (Greenberg 1966).

The GTM and PTM may make conflicting predictions with respect to markedness. Segments and segment sequences which are highly valued under the GTM are often marked under the PTM, and *vice versa*. Fricatives are an example. In gestural terms, fricatives are complex, since the correct spatial relationship between the active and passive articulators must be very precisely controlled in order to maintain turbulent airflow (Catford 1977, Ladefoged & Maddieson 1986). At the same time, fricatives are spectrally very robust. Their random high frequency energy patterns are very distinct from the spectral properties of the other manners of articulation, and also act as a very salient cue to place of articulation.

In instances of conflict between GTM and PTM predictions, languages follow different strategies. They may follow the GTM and elaborate gesturally harmonic features, or follow the PTM and elaborate perceptually harmonic features, or opt for some combination of the two. Therefore in the case of fricatives some languages have more stops than fricatives while others (including English) have fricatives which lack stop counterparts. There is further discussion of this in §4.3.

§1.2.4 **Constraint universality and violability.**

Two theoretical attributes of constraints follow as immediate consequences of their phonetically grounded nature. The first is universality: all constraints are active in the phonotactic grammars of all languages. Since constraints are expressions of articulatorily and perceptually marked features, the universality of the human vocal capacity and the constants of acoustic physics and aerodynamics imply that constraints are universally true. Note that the universality of constraints predicts a high degree of similarity in phonotactic patterns across languages. As we will see, this is certainly the case in Australian Aboriginal languages (see §1.4.3).

Second, constraints are violable. Since constraints are universal, we must assume that languages permit forms which do not satisfy every constraint. In a language L which tolerates surface violation of constraint C, C is said to be *relaxed* or *suppressed* in L. When L *does not* permit surface violation of C, C is said to be *unviolated* in L. Since constraints are substantive statements on gesturally and perceptually marked speech events, when C is relaxed in L this does not mean that C is inactive in L. Forms which are marked under C continue to demonstrate properties of markedness which derive from the fact that they are phonetically complex, such as low frequency. In other words, forms do not cease being marked when they are permitted in L. This is discussed further in §1.3.2.

To illustrate this I take the example of the distribution of nasal segments. A constraint *[nasal] is responsible for the marked status of this class, accounting for the fact that they imply stops. Nasal segments occur in most languages. In these cases, violation of the constraint *[nasal] is tolerated, but nasals are predicted to occur at lower frequencies than stops. If a language has no nasals this constraint is unviolated. In both

cases the language will have stops.

§1.2.4 **Morpheme-juncture tactics and alternations.**

I now briefly discuss the relationship between the phonetic constraints proposed in this thesis as an account of morpheme-internal phonotactics, and patterns of alternations attested in morphologically complex forms. It is widely recognised that many languages have alternations at morpheme junctures bringing derived segment sequences into line with morpheme-internal phonotactics. In these cases there is overlap in phonotactics found morpheme-internally and in derived environments. There has been a great deal of discussion in the literature on this redundancy, and a range of proposals attempting to account for it (Halle 1959, Stanley 1967, Chomsky & Halle 1968, Postal 1968, Kisseberth 1970, Shibatani 1973, Sommerstein 1974, Singh 1987, Paradis 1987, Myers 1991 and others).

These types of alternations are found in some Australian Aboriginal languages (see Hamilton 1989 for details). However, in many of these languages not all derived sequences that violate morpheme-internal phonotactics are repaired, and in others there are no alternations at all. Therefore, the set of consonant clusters which occur at morpheme junctures on the surface is typically less restrictive than what is attested morpheme-internally. Many language monographs contain two charts of permitted consonant clusters, one of morpheme-internal clusters and one of inter-morphemic clusters (for one example, see Waters 1989:15-16 on Djinang).

My treatment of phonotactics is restricted to patterns attested morpheme-internally. By "morpheme-internal" I exclude frozen reduplication and frozen compounds and complex forms. The reasoning behind this more restrictive criterion is that many languages have clusters at the junctures in frozen reduplications and compounds which are very unusual with respect to the observed regularities of clusters in forms that are not historically analysable.

There are two important observations in this discussion: there is overlap in the phonotactics of morphemes and of complex forms, but clusters are often permitted at morpheme junctures which do not occur morpheme-internally. I assume that the alternations in complex forms are triggered by the same constraints responsible for the morpheme-internal phonotactics, predicting the attested redundancy. I also assume that the more liberal inventory of clusters at morpheme junctures is predicted by morpheme faithfulness constraints which may conflict with the phonetic constraints. Reduplicative identity (McCarthy 1995) is an example. This constraint promotes the identical realisation of both members of a reduplicated form, even when this produces an otherwise ill-formed cluster. An example is the Wardaman form [wiridwirid], *rainbow bird*, with the cluster [dw] which is not attested morpheme-internally in this language. Hypothetical forms in which the cluster is repaired (such as by deletion: *[wiriwirid]) violate reduplicative identity. It is because of morpheme faithfulness constraints such as reduplicative identity that certain consonant clusters are preserved in complex forms which are not otherwise permitted. Other derived clusters are repaired, in violation of these faithfulness constraints. I assume that this asymmetry is the effect of language-particular ranking relationships between constraints which resolve instances of conflict between phonetic and faithfulness considerations (Prince & Smolensky 1993, McCarthy & Prince 1993). My hypothesis is that morpheme-internal phonotactics in Australian Aboriginal languages are entirely phonetic in nature, and so by restricting the focus of this investigation to these patterns I hope to discern the nature of phonetic constraints

more clearly.

§1.2.5 Summary.

In this section I have outlined a substantive theory of markedness: constraints and the ordering relationships between them which promote the gestural and perceptual optimality of phonological forms. As I argue in the following chapters, this restrictive view of markedness as the effect of constraint violation, which follows similar assumptions in other constraints-based frameworks (Archangeli & Pulleyblank 1994, Jun 1995 and Steriade 1995b), allows for an insightful analysis of phonotactic patterns in Australian Aboriginal languages.

§1.3 Constraints formalism of phonotactic patterns.

As mentioned in the introduction to this chapter, I assume a non-derivational, constraints-based formalism of the morpheme-internal phonotactics. I make similar assumptions to those in other constraints frameworks, such as the theory of phoneme inventories proposed by Calabrese 1988, work in Optimality Theory (Prince & Smolensky 1993, McCarthy & Prince 1993), and work in Grounded Phonology (Archangeli & Pulleyblank 1994). In this section I outline how the constraints component constitutes a theory of possible phonotactic patterns.

§1.3.1 Constraints formalism of implication.

As discussed to this point, constraint violation is the defining characteristic of marked forms (here and throughout I use "form" to refer to root morphemes). Markedness is always relative, expressed with reference to a particular constraint: form F' is marked compared to form F, expressed in notation as $F \succ F'$, if F' violates constraint C and F does not, all else being equal (10).

(10) A constraints theory of markedness.
Markedness: $F \succ F'$ where F' violates constraint C and F does not, *ceteris paribus*.

Note that the same difference in markedness between F and F' is true of all languages, since constraints and the fixed ordering relationships between them which follow from the GTM and PTM are universal. The definition of markedness is not language-specific. When F' violates C and F does not, F' is universally more marked than F.

According to this definition of markedness, forms which differ minimally in that one violates C and the other violates C' are not harmonically ordered. Under constraint C *alone* one is more marked than the other, but the opposite relation holds when evaluated under C'. In this case neither form is more marked than the other.

Implication follows directly from this constraints-based theory of markedness. Within any language grammar, a form which violates constraint C implies forms which do not. Implication is defined in (11.b). Here and throughout, Φ means "well-formed, permitted" and *Φ means "ill-formed, not permitted".

(11) Constraints and markedness.
a. Markedness: $F \succ F'$ where F' violates constraint C and F does not, *ceteris paribus*.
b. Implication: F' is Φ only if F is Φ, where $F \succ F'$.

The constraints and the ordering of constraints (following the GTM and PTM) produce a universally fixed harmonic scale of phonological forms, from least marked to most

marked. This harmonic scale is responsible for the implicational order which is attested in typology and language acquisition (Jakobson & Halle 1956, Jakobson 1962, Maddieson 1984). For similar assumptions, see Rice & Avery 1995 who assume that the harmonic scale derives from hierarchical structure rather than constraints. Following assumptions in these sources, I assume that in language acquisition children begin with a maximally harmonic grammar and acquire more marked structures (forms which violate constraints) under pressure of data.

There is a great number of constraints, meaning that the harmonic scale which they produce is very complex. To illustrate how constraints produce the harmonic scale, I will use an example assuming a universal grammar composed of two features, [F] and [G], and two constraints, *[F] and *[G]. In this grammar, there are four possible feature bundles, [F, G], [F,–G], [–F, G] and [–F,–G]. The two constraints produce the harmonic scale in (12), based on the status of each feature bundle under the constraints. This scale proceeds from least marked (top) to most marked (bottom). Since [–F, –G] violates neither constraint it is at the top; [F, G], which violates both, is at the bottom.

(12) Harmonic scale produced by the constraints *[F] and *[G].

Least marked= [–F,–G]

Marked= (*[F] violation) [F,–G] [–F, G] =Marked (*[G] violation)

Most marked= [F, G] (simultaneous violation of both *[F] and *[G])

The parallel branches on the scale represent bundles which are not in a harmonic ordering since they violate different constraints. Bundles imply the other bundles that they are linked to higher in the scale, so the possible phonotactic patterns assuming these features and constraints is any of (13.a-e). It is clear in these inventories that [F] implies [−F] and [G] implies [−G].

(13) Possible phonotactic patterns.
a. [−F,−G]
b. [−F,−G] [F,−G]
c. [−F,−G] [−F, G]
d. [−F,−G] [F,−G] [−F, G]
e. [−F,−G] [F,−G] [−F, G] [F, G]

Let us now assume a slightly more sophisticated grammar, with the same features and constraints but also a fixed ordering of the constraints: *[F] ≫ *[G], i.e., *[F] is more strictly enforced, meaning that forms which violate *[F] imply forms which violate *[G]. As in the previous example, [−F, −G] is the least marked bundle and [F, G] is the most marked. The relationship between [−F, G] and [F, −G] is different in this grammar, however, because of the ordering of the constraints: the form which violates *[G] is less marked. The resulting harmonic scale in this grammar is presented in (14).

(14) Harmonic scale produced by the constraint ordering *[F] ≫ *[G].

Least marked=	[−F,−G]
Marked (*[F] violation)=	[F, −G]
Marked (*[G] violation)=	[−F, G]
Most marked= (simultaneous violation of both *[F] and *[G])	[F, G]

The four possible phonotactic patterns based on this harmonic scale are presented in

(15). Although the addition of the fixed constraint ordering in this example makes the grammar seem more complex, it produces more implications between feature bundles, meaning that the harmonic scale is more linear and the set of possible phonotactic patterns more restrictive. In this case, there are four patterns instead of five, since (13.b) is no longer possible.

(15) Possible phonotactic patterns.
a. [−F,−G]
b. [−F,−G] [−F, G]
c. [−F,−G] [−F, G] [−F, G]
d. [−F,−G] [−F, G] [−F, G] [F, G]

As stated above, language acquisition begins by assuming a maximally harmonic grammar and marked structures are acquired only on the basis of positive evidence. A child, upon being exposed to [F, G], assumes that the other three bundles are well-formed as well under either of these two scenarios.

§1.3.2 Frequency and markedness.

Since marked structures are acquired only under pressure of data, the constraints, grounded as they are in universal articulatory and acoustic phonetics, exert constant pressure on phonotactic patterns towards less marked states (Lindblom 1983, Ohala 1990). There is evidence from the historical phonology of some Australian Aboriginal languages of heterorganic nasal+stop clusters in some (but not all) morphemes being reanalysed as homorganic clusters (Black 1980). This change is attested in a minority of morphemes in spite of the fact that heterorganic clusters have never been synchronically ill-formed in these languages. I show in detail in chapter 3 that homorganic clusters are

less marked than heterorganic clusters, meaning that this change is from marked to unmarked forms. When such historical changes affect only some of the morphemes with the marked feature, the frequency of the unmarked form increases while that of the marked form decreases. This contributes to the correlation between markedness and frequency indicated in (16.c).

(16) Constraints and markedness.
a. Markedness: $F \succ F'$ where F' violates constraint C and F does not, *ceteris paribus*.
c. Frequency asymmetries (f=frequency): $fF \geq fF'$ where $F \succ F'$.

§1.3.3 Summary.

In this section I have outlined how constraints predict the set of possible phonotactic grammars in natural languages. Foundational in this proposal is that forms which are phonetically complex imply forms which lack that complexity. The discussion in this thesis will show that this hypothesis accurately predicts the range of co-occurrence and implication patterns attested in phonotactic patterns in Australian Aboriginal languages, and so is an empirically rich and restrictive theory.

§1.4 The Aboriginal languages of Australian: overview.

§1.4.1 Genetic and geographical survey.

It is estimated that between 200 and 250 Aboriginal languages were spoken in Australia at contact, when Captain James Cook sailed into Botany Bay in 1770 (Dixon 1980:1; Yallop 1982:29). Of these more than half are no longer spoken, with considerably fewer still having any chance of surviving as a living language in the future.

Dixon 1980 provides the first scientific attempt to show the genetic unity of all

Australian languages. Dixon's demonstration is based largely on evidence from languages in the large Pama-Nyungan family, a relatively homogeneous group. However, Blake 1990a has reconstructed a set of proto-pronouns for the non-Pama-Nyungan languages which bear a strong resemblance to the reconstructed Proto-Pama-Nyungan pronouns (Blake & Dixon 1991:23-24).

Although the genetic unity of the Australian languages is now assumed, there is a great deal of variation among the languages. For discussion of the genetic classification of these languages, see Schmidt 1919, Capell 1956, O'Grady, Voegelin & Voegelin 1966, Wurm 1972, Blake 1990b. Yallop 1982:33, citing O'Grady, Voegelin & Voegelin 1966 and Wurm 1972, determines genetic relationships based on percentages of cognates. Assuming that languages sharing less than 15% percent of basic vocabulary belong to different families (within the larger Australian family), he shows that Australian languages can be divided into 27 distinct families. It should be noted that there is some disagreement about the precise number of families; for example, Blake & Dixon 1991:6 suggest that the number of families can be reduced to ten.

The Pama-Nyungan family includes roughly 175 of the approximately 250 languages on the continent, covering four fifths of its surface area. The non-Pama-Nyungan languages are concentrated in a relatively small area of the continent, the extreme northern area of the Northern Territory and Western Australia (see map in Appendix C). There is also an enclave of Pama-Nyungan languages in this area. These languages are in contact with the surrounding non-Pama-Nyungan languages and exhibit diffusion (Heath 1978b, 1981b, Waters 1989). This area of Australia is genetically very diverse. Several of the non-Pama-Nyungan families are represented by isolates. There is a great deal of morphological and syntactic variation among the 27 families. For example, in 23 of the families there is both prefixal and suffixal morphology, while the remaining four, including Pama-Nyungan, are entirely suffixing (Yallop 1982:47).

§1.4.2 Similarities in phonemic contrasts.

Despite the considerable cross-linguistic differences in morphology and syntax, and the often extremely restricted cognate vocabulary, the phonetics and phonology of the Australian languages are surprisingly consistent. For example, Australian languages are well known for their rich inventories of coronals, contrasting laminals and apicals. See Hamilton 1993a for a survey and theoretical discussion of Australian coronals. Also, phonemic fricatives are completely absent from the majority of Australian languages. While fricative phonemes are present in a restricted number of languages, in most of these languages they can be shown to be historically derived from stops (Dixon 1980:125). See Evans 1995 and Busby 1980 for surveys of fricative inventories in Australian languages. In addition, almost all the languages exhibit nasals corresponding to every stop. There are only a handful of languages that do not have this property; see §2.3.2. Other distinctive characteristics of the majority of Australian languages are the absence of a voicing contrast among stops (see Austin 1989 for a survey of languages which contrast two series of stops; see also Busby 1980), the presence of both lateral and vibrant liquids, and the existence of three glides, including an apico-postalveolar glide (see chapter 2).

§1.4.3 Concert: the uni-systematic nature of Australian phonotactic patterns.

The phonotactics of all Australian languages are also remarkably consistent (Dixon 1980:159). I will informally refer to this attribute of the phonotactic patterns of

Australian Aboriginal languages as *Concert*. Concert refers to the uni-systematic nature of phonotactic patterns in Australian Aboriginal languages: the overlap which distinct languages show in phonotactic patterns, and even the undercurrent of similarity in the empirically distinct phonotactic patterns cross-linguistically.

A comparison of phonotactics of different Australian languages reveals two things. First, there is considerable phonotactic variation but this variation is systematic and highly constrained. Many possible patterns are not attested, although they are structurally analogous to attested patterns. Second, the phonotactics of Australian Aboriginal languages exhibit a common "family resemblance." This aspect of phonotactics is only apparent when a large number of languages are compared. Therefore the phonotactics of Australian Aboriginal languages are all inter-connected and must be understood as a unified phenomenon. The full range of variation must be taken into consideration in giving a theoretical analysis of any one language or pattern. Put another way, observations on the phonotactics of all the languages necessarily inform the analysis of any single case. An account of one language or pattern is inadequate if it does not accurately predict the range of attested cross-linguistic variation, show how the pattern under question is consistent with the other patterns, and how all of the patterns together constitute a unified phonotactic phenomenon.

This thesis develops a theoretical model of phonotactics which reflects phonotactic Concert by explicitly expressing the underlying cross-linguistic unity of attested phonotactic patterns.

§1.4.4 A critique of non-formal accounts of Concert.

It might be suggested that Concert is due to the common genetic heritage of Australian

Aboriginal languages. In this hypothesis, Concert derives from the common retention of the phonotactic patterns of proto-Australian by all of the descendant languages. There are three problems with this assumption. First, the stability of the phonotactics over time requires a theoretical account. Proto-Australian was spoken a few thousand years ago. Its phonotactics, as reconstructed by Dixon 1980, are basically identical to those found today in many Aboriginal languages. During the same interval there has been considerable phonological change in some groups of languages, but Concert is still very apparent, even when these languages are considered. Furthermore, there has been considerable morphological and syntactic splintering in the language family. For the phonotactics of the Australian Aboriginal languages to show Concert, they must derive from universal principles which structure phonological grammar.

Second, attempting to account for the synchronic phonotactics of a language as a retention from Proto-Australian only shifts the problem: it fails to recognise the need for a theoretical account of the the phonotactics of proto-Australian.

Finally, Concert is about more than similarity. As stated above, there is often considerable language-to-language variation in phonotactics, but the variation is principled. A purely historical account of Concert cannot capture this. It fails to provide any insight into why certain phonotactic innovations have occurred repeatedly in languages all over Australia while many others have not occurred at all. I will leave this issue here, but I believe that the description and survey of the phonotactic patterns in following chapters will provide ample support for the stand taken.

Some final comments remain with regard to Concert as a phonotactic phenomenon among Australian languages. First, because of Concert, there is normally a genetically and geographically diverse sample of Australian Aboriginal languages which

show identical or very similar patterns. However, unusual sequences of historical sound changes can on occasion lead to isolated, idiosyncratic patterns which are best accounted for on diachronic rather than synchronic grounds. As a result, I will avoid making strong theoretical claims from patterns attested in only one language. The fact that the phonotactic patterns discussed in this thesis are attested in disparate languages, I believe, strengthens the importance of the observations. In the discussion of each pattern, data is normally presented from only one language but other languages which demonstrate the same pattern are listed in a footnote.

§1.4.6 Phonotactically irregular forms.

Another important point to clarify regarding the Australian phonotactics data is that many language-internal generalisations are truly exceptionless. Note, however, that there are classes of utterances in many languages which are structurally aberrant within the phonotactic system of the language. Ideophones, onomatopoeic forms, interjections, and words considered as "baby talk" are often phonotactically aberrant. For example, Ngalakan, reported as having default retroflex articulation of apicals in initial position (Merlan 1983), has two words with initial apico-alveolars, both interjections: [duŋ], *yummy!*; and [naman], *poor fella!* (Merlan 1983:9). Also, in Djapu the only vowel-initial words belong to the baby talk register (Morphy 1983:21). See Alpher 1994 for a thorough treatment of the phonotactics of ideophones in Yirr-Yorront, a language which shows many asymmetries in the phonotactics between words in the standard language and in ideophones.

Other classes of words are also often found to be phonotactically aberrant, particularly terms which are of spiritual importance (Dixon 1980:60). Nash 1990:213-214 observes that this is the case with the names of patrilects in Warumungu and Warlmanpa. For another example, Oates & Oates 1964 report that the only word with an initial [r] in Kuku-Yalanji is the form [ruɲaci], glossed as "an elder who is versed in all the knowledge of the Supreme Being and in all the lore of herbal remedies," obviously a lexeme of considerable spiritual significance.

All of the cases discussed here should not be considered "exceptions" to the phonotactics of the language since their aberrant phonological structure is intentional, conspicuous and psychologically important. One can view them as "exceptions that prove the rule."

Borrowings are also occasionally found to be unassimilated. Geographically contiguous Aboriginal languages often have identical or very similar phonotactic patterns. Therefore words borrowed between Aboriginal languages are often consistent with the phonotactics of the recipient language (but this is by no means always the case--it is common for languages to possess phonotactically aberrant words which are borrowings from other Aboriginal languages). But borrowings from English are often unassimilated and thus phonotactically conspicuous. An example is [ɹapiti], *rabbit*, which in many languages is the only word with a word-initial [ɹ]. All of the classes of words discussed here will be excluded from phonotactic generalisations which I make in this thesis.

§1.5 Organisation.

In this chapter I have given a general introduction to the thesis. I have discussed the basic empirical and theoretical issues which are foundational to this thesis, and I have introduced the languages and the data which are the focus of this study. The organisation of the remainder of this thesis is as follows. In chapter 2 I give a general introduction to

the building blocks of Australian phonotactics: the places and manners of articulation which are in contrast in these languages, the specifics of their articulatory and acoustic correlates, and the ways in which they are combined to form segmental inventories.

In chapter 3 I discuss the place phonotactics of intervocalic consonants and homorganic clusters. I show that in these contexts place features are unconstrained: there is no neutralisation of intervocalic place features, irrespective of whether the feature is part of the featural definition of one segment, as in a single segment, or two, as in a homorganic cluster. This is in contrast to other phonotactic positions, such as in heterorganic clusters and at a word-edge, where segmental contrasts are neutralised. I propose an acoustic account of the special status of intervocalic place features based on the assumption that places are maximally contrastive in contexts where they are maximally salient in perceptual terms.

In chapter 4 I treat the place phonotactics of heterorganic consonant clusters, and in chapter 5 I focus on the phonotactics of manner features in clusters. In each chapter, I survey the empirical facts, and propose a constraints-based account. In chapter 6 I discuss phonotactic patterns of consonant clusters where place and manner features interact. These patterns show that marked place and manner features neutralise each other. Therefore these patterns are cumulative markedness effects, or *ceiling effects*, on total markedness. I discuss the implications that these patterns have for non-derivational constraint-based theories. Conclusions are drawn in chapter 7.

There are also three appendices. Appendix A is a description of the phonotactics of word-initial and word-final consonants in Australian Aboriginal languages. I highlight the similarities and systematic differences between consonants in the two positions in clusters and in the word edge positions. Appendix B is the database of the phonotactics of the individual languages, with charts to show segments contrasted in intervocalic, initial, final positions and the permitted morpheme-intenal clusters. The references for each language are listed in this appendix in the entry for the language. Appendix C is a genetic and geographic overview of the Australian family.

Chapter 2: Australian consonantal features, segments and inventories.

§2.0 Introduction.

In the preceding chapter I introduced the general empirical and theoretical issues which are central in the phonotactic patterns of Australian Aboriginal languages. In this chapter I discuss the articulatory and acoustic attributes of the consonants which occur in these languages, and how segments combine to form the phoneme inventories.

The first section is an articulatory description of the places of articulation. Because the same place gestures apply to all of the manner classes, it is possible to describe the place gestures for just a single manner. In this discussion, the emphasis is on the coronal series, since the inventory of coronal articulations is a principal source of variability in Australian phoneme inventories. In the second section I discuss the acoustic features of the places of articulation.

The third section is devoted to the manner classes, the stops, nasals, laterals, vibrants and glides. I describe the features of each, and present the inventories of segments in each class. The symbols which I use for the commonly attested consonants are presented in (1), following the IPA conventions of 1993.

(1) Consonant phonemes in Australian Aboriginal languages.[1]

labial	lamino-dental	apico-alveolar	apico-postalveolar	lamino-alveopalatal	dorso-velar	
p	t̪	t	ʈ	c	k	fortis stop[2]
b	d̪	d	ɖ	ɟ	g	lenis stop
m	n̪	n	ɳ	ɲ	ŋ	nasal
	l̪	l	ɭ	ʎ		lateral
		r/ɾ				vibrant
w			ɻ	j		glide

§2.1 Place contrasts: articulatory features.

This section is an articulatory description of the place contrasts present in Australian Aboriginal languages. I focus on the stops, but the members of the same place series tend to be completely homorganic. Therefore the descriptions of the place gestures of stops apply equally to nasals and laterals as well. This discussion draws on studies by Dixon 1980 and Butcher 1995.

Australian languages include labial and dorsal series and at least two coronal series. In the inter-linguistic variation in place inventories, the coronal contrasts play the most important role. They are organised into two natural classes defined by the coronal subarticulators: the tip and the blade of the tongue. There are one or two series each of

[1]Here and throughout, "stop" refers to obstruent oral stops, "nasal" to sonorant nasal stops, and "lateral" to lateral sonorants.

[2]Most Australian Aboriginal languages have a single series of stops. In most languages which have this contrast it is distributionally restricted: typically intervocalic position and between an oral sonorant and a vowel. In the data cited in this thesis, I uniformly use voiceless symbols in non-contrasting languages. In contrasting languages I use the voiceless symbols for stops in phonotactic environments where the contrast is not present. See Austin 1989 for a general survey of the languages with two stop series. The terms "fortis" and "lenis" are used to describe the stop contrast in several Australian languages, assumed to refer to a contrast of muscular tension but usually also implying differences in voicing and length. I will adopt this term uncritically here, recognising that the precise nature of the contrast remains undefined.

apicals and laminals in each language. Languages with two apical series contrast them at alveolar and postalveolar places of articulation. Languages with two laminal series contrast them at dental and alveopalatal places of articulation.

§2.1.1 Apical articulations.

The apico-alveolars involve contact of the tip of the tongue in front of the alveolar ridge but behind the front teeth. The band of contact along the midline is very narrow. The apico-postalveolars (often referred to as apico-domals or retroflexes) show contact of the tongue tip centred from the first premolar and behind, thus in the postalveolar and prepalatal regions, and sometimes even further back. The underside of the blade sometimes flaps against the alveolar ridge in the release as the articulator returns to its neutral position. The articulation of retroflexes is less uniform than it is for the alveolars, and the band of contact is somewhat broader.

§2.1.2 Laminal articulations.

The alveopalatals involve contact of the blade of the tongue along a very broad band over the postalveolar and alveolar regions. They are actually more anterior than the retroflexes, and show a considerable amount of overlap with the alveolars along the passive articulator. The tip of the tongue is pointed down, usually touching the back of the lower teeth. The dentals show an extremely broad band of contact, considerably broader than even the alveopalatals, between the blade and the front of the alveolar ridge and the back of the teeth. They are articulated tip-up, with the tip usually protruding between the teeth so that these are technically interdentals, but in some languages the tongue tends to remain behind the teeth.

§2.1.3 Articulation of neutralised coronals.

Many languages do not have all four coronal series, having a single, neutral apical series and/or a single, neutral laminal series. An investigation by Butcher 1995 compares the articulation of apical and laminal consonants between contrasting (e.g., double-apical) languages and non-contrasting (e.g., single-apical) languages. His findings, based on palatographic evidence, indicate that in the non-contrastive languages the single apicals and laminals do not correspond exactly to either series in the contrasting languages. For the apicals, the neutral series is less advanced than the apico-alveolar series in contrasting languages but they are not retroflexed to the point of involving sublaminal contact. For the single laminal series, the band of contact is normally more advanced than is typical of lamino-alveopalatal segments in contrasting languages, but they are not tip-up like dentals. The observation is that the neutral series are intermediate in articulatory terms between the corresponding two series in contrasting languages, showing the *Mittelding* phenomenon (see chapter 1, footnote 2 for a definition).

The argument which Butcher makes is that neutral coronals are articulatorily invariant as Mittelding phenomena (Trubetzkoy 1939/1969). This is in contrast with reports in many language monographs to the effect that either: (1) neutral coronals show allophonic alternation between the proto-typical articulations of the two contrastive series; or (2) neutral coronals uniformly correspond to the articulation of *one* of the two contrasting series. In the former case, [t̪] and [c] are stated as the two possible surface realisations of /TH/, the neutral laminal oral stop; and [t] and [ʈ] are the surface realisations of /T/, the neutral apical. The conditioning element in the case of the laminal variation is often the quality of the following vowel: alveopalatal allophones precede [i] and dental allophones precede [u] and [a]. Almost all languages have alveopalatal

allophones before [i] at least sporadically. Some single-laminal languages are reported as having less variant allophony, with exclusively alveopalatal allophones. One language, Kala Lagaw La, is reported as having exclusively dental allophones (Butcher 1995:33).

Reports on the default articulation of neutral coronals are the impressionistic observations of field researchers. Butcher 1995 analyses the articulation of neutral coronals in non-contrasting languages, and the articulation of neutralised apicals in word-initial position in double-apical languages which have a neutralised apical series in this position. Butcher argues that palatographic evidence indicates that the gestures of neutral laminals in single-laminal languages are invariant, irrespective of the vocalic environment. He suggests that the position of the tongue body in the production of adjacent vowels does not condition any variation in the articulatory gesture of the tongue tip or blade (as indicated in the palatograms). Thus the perceived allophonic variation is "the perceptual consequence of co-production of the consonant with surrounding vowels" (Butcher 1995:34). In other words, the articulatory gesture of a neutral laminal preceding [i], as indicated in the band of contact in palatograms, is identical to the articulation of the same phoneme preceding [a], but the movement of the tongue body in anticipation of the following vowel modifies the vocal space in such a way that laminal segments *sound different* in these two contexts.

The facts support Butcher's analysis of neutralised word-initial apicals in contrasting languages. While Butcher's results are suggestive, some evidence suggests that his results are not extendable to all neutralisation positions. For example, he does not discuss the neutralisation of the laminal contrast in pre-consonantal and word-final positions (see §4.4). Laminals in these positions are reported as being neutralised to alveopalatal articulation. The published reports indicate that this is a uniform and unambiguous phenomenon: the articulation of the neutralised series corresponds exactly or very closely to the articulation of the alveopalatal series when in a position of contrast. There are too many coronal neutralisation patterns which remain to be investigated for us to assume that Butcher's proposal holds in every case.

Second, the full range of published observations on the articulation of non-contrasting laminal and apical segments implies that the articulation of non-contrasting coronals is a variable phenomenon. This contradicts Butcher's proposal. The reports of language-to-language variation in the articulation of neutral coronals is especially strong in this regard. Dyirrbal, Warrgamay and Nyawaygi, occupying a continuous portion of the rainforest coast of north Queensland, all have a single laminal series. These languages are a continuum from one extreme to the other in the articulation of these laminal segments. In Dyirrbal, the furthest north, laminals are reported as uniformly alveopalatal, lacking dental allophones. In Warrgamay alveopalatal articulation is standard, but dental allophones are attested as an optional realisation preceding [u] and [a]. In Nyawaygi, the furthest south, laminals are largely dental, with alveopalatal allophones attested sporadically before [i] (Dixon 1981:16, Dixon 1983:440-441). Similar variation is attested among closely related dialects of the Western Desert language (O'Grady, Voegelin & Voegelin 1966:140). Dialects of Watjarri are also reported as differing in the articulation of the neutral laminal series, northern dialects having primarily dental allophones (even before [i]) and southern dialects having alveopalatal allophones (Douglas 1981:203). Inter-linguistic variation in the default articulation of neutral coronals is inconsistent with the uniformity which Butcher argues for. Butcher argues that neutral laminals merely sound different in different vocalic contexts. This does not predict the variation in the auditory perception of these segments when in the same vocalic context, such as in

cognate forms in different languages or dialects of the same language.

In summary, Butcher's evidence is interesting and suggestive. However, the hypothesis that neutral coronals are articulatorily uniform as *Mittelding* phenomena is only suggestive at this point as only a small subset of the whole range of coronal neutralisation patterns was examined. In addition, Butcher's hypothesis appears to be contradicted by the reported cross-linguistic and cross-dialectal variation in the articulation of neutral laminals between dental and alveopalatal realisations in otherwise identical forms. Butcher would predict that these forms should be perceived identically. The conclusion that I draw differs from Butcher's: he would conclude that neutral coronals lack the specific articulator site features possessed by coronals in positions of contrast. I will assume that neutral coronals do not necessarily lack these features. This point will be important in the chapters that follow.

§2.1.4 Articulatory features.

Having described the place gestures, I turn to the formal feature representation of these contrasts. I assume the privative active articulator features [labial], [dorsal] and [coronal], following Sagey 1986, McCarthy 1988 and most subsequent work in feature geometry theory, and other feature theories (e.g., Articulatory Phonology, Browman & Goldstein 1989, 1992). (I use the term *privative* in the sense used by Trubetzkoy 1939/1969, to mean that the absence of the feature is not phonologically active). Dixon 1980 is an early reference for [labial] and [dorsal] as monovalent features, drawing from evidence in Australian languages. Avery & Rice 1989, Paradis & Prunet 1989, the papers in Paradis & Prunet 1991 and the references which they cite include extensive discussion of [coronal]. Hamilton 1993a defends the notion of coronals as a natural class in Australian languages, defined as such by the feature [coronal].

Apicals and laminals are clearly natural classes in Australian phonology (Dixon 1980, Hamilton 1993a), but there is less unanimity in the literature on how to represent this in feature terms. There are phonological patterns which make reference to each of the classes of apicals and laminals, and so a monovalent theory of feature specification requires two features [apical] and [laminal] (Hamilton 1993a, Gnanadesikan 1993; see also McGregor 1990). Since these are both active articulators, this usage is consistent with the privative features for the labial, dorsal and coronal articulators. A theory which allows both monovalent and bivalent features may capture the apical vs. laminal distinction with [±distributed] (Chomsky & Halle 1968, Mester 1986, McCarthy 1988, Yip 1989, Keating 1988, 1991). Originally proposed by Chomsky & Halle (1968), this feature refers to the length of the constriction of an articulation along the direction of airflow (see the discussion of the band of contact for apicals and laminals in §2.1.1 and §2.1.2). Dixon 1980 uses [±laminal] and Ladefoged 1989 uses [±apical]. There are some interesting long-distance harmony patterns between laminals to which apicals are transparent, and *vice versa*, which is evidence for using the two monovalent features, but these patterns are at present poorly understood (some discussion is in Hamilton 1993a). I will use the two monovalent features [apical] and [laminal].

Dixon 1980 proposes that the site contrasts among the apicals and laminals (alveolar vs. postalveolar for the apicals, and dental vs. alveopalatal for the laminals) are represented by the bivalent features [±retroflex] among the apicals and [±dental] among the laminals. Whether this is the best approach or not, one thing which is certain is that no single feature, such as [±anterior], is responsible for this contrast in both classes (Dixon 1980, Hamilton 1993a, Gnanadesikan 1993).

Originally proposed by Chomsky & Halle 1968, [anterior] was assumed to have scope over the entire vocal tract, and so it predicted natural classes of segments by passive articulator in front of and behind the corner of the alveolar ridge. Kenstowicz & Kisseberth 1979:248, however, observed that giving this feature broad scope divides the place contrasts into natural classes which are not actually attested in phonological processes, i.e., the [+ant] places [p], [t̪], [t] and the [-ant] places [ʈ], [c], [k] are not natural classes. Based on this observation, Yip 1989 proposed to locate it under the coronal node in a feature geometry framework. This was desirable, she argued, because this feature has scope only over coronals instead of over all place contrasts. Interestingly, in support of the notion that this feature is located under the coronal node, she explicitly assumes (p.350) that [±anterior] is a phonologically relevant contrast for the coronals--that coronals are organised phonologically by articulation in front of and behind the corner of the alveolar ridge. In Australian four-coronal languages, this predicts two natural classes, one comprising dentals and alveolars and the other retroflexes and palatals. However, Yip adduced no evidence in support of this assumption. Indeed, there is no evidence that these are natural classes in Australian Aboriginal languages (Hamilton 1993a) or in other languages with rich coronal inventories (Gnanadesikan 1993; see also Diffloth 1975 on the coronal phonology of the Dravidian language Irula). In fact, there are no natural classes among the four coronal series other than the two defined by the apical and laminal articulators (Hamilton 1993a).

The feature [±anterior] is problematic for other reasons. As recognised by Keating 1991, the stipulation of an arbitrary point on the roof of the mouth, the corner of the alveolar ridge, ignores the fact that there is a considerable amount of variation in the point of articulation. Reinforcing this problem is the fact that the band of contact of lamino-alveopalatals regularly straddles the corner of the alveolar ridge (see §2.1.2), meaning it is impossible to categorise them as either [+anterior] or [−anterior].

There are few theory-independent criteria for choosing between the possible monovalent and bivalent approaches to representing the site contrasts among the apical and laminal classes. Therefore I will remain consistent with the privative feature specifications assumed to this point and assume four site features [dental], [alveolar], [postalveolar] and [alveopalatal] for the coronals, in addition to [velar] for the dorsals (see Browman & Goldstein 1989 for similar assumptions).

Narrow feature descriptions of some of the place gestures also include tongue body features. Lamino-alveopalatal and dorso-velar articulations are both produced with a [high] gesture of the tongue body (Chomsky & Halle 1968:304-306). (The [high] specification of alveopalatals and dorsals becomes crucial in §4.5.) Dorso-velar by definition is a [high] back tongue body gesture. Lamino-alveopalatals involve a [high] gesture of the front tongue body in order to raise the blade into a position to articulate in the alveopalatal region. Although lamino-alveopalatals are phonologically laminal rather than predorsal, laminal and front tongue body gestures cannot be produced completely in tandem (see Browman & Goldstein 1989:225 and references cited therein; see also Keating 1988a, 1991 on palatals as complex corono-dorsal gestures). Furthermore, the high F2 formant loci of alveopalatals indicates fronting and raising of the tongue body. The common observation that the high front vowel [i] conditions alveopalatal articulation of neutral laminals (see discussion of Butcher 1995 in §2.1.3; see also §3.4) is further evidence that alveopalatals are [high]. Apicals, labials and lamino-dentals, on the other hand, are articulated without the tongue body raised above its neutral position.

In summary, the articulatory features for the six place series are presented in (2). This set is not exhaustive, but it is all the features which I refer to.

(2) Articulatory features of the places of articulation.

Labial	[p]	[labial]
Lamino-dental	[t̪]	[coronal], [laminal], [dental]
Apico-alveolar	[t]	[coronal], [apical], [alveolar]
Apico-postalveolar	[ṭ]	[coronal], [apical], [postalveolar]
Lamino-alveopalatal	[c]	[coronal], [laminal], [alveopalatal], [high]
Dorso-velar	[k]	[dorsal], [velar], [high]

§2.2 Perceptual/Acoustic correlates of the places of articulation.

I argue in this thesis that, in addition to articulatory features (e.g. Sagey 1986, McCarthy 1988), acoustic features (Jakobson, Fant & Halle 1963, Jakobson & Halle 1956, Fant 1960) play a crucial role in the formalism of place phonotactics of consonant clusters (see chapter 4). This requires a feature theory which includes both articulatory and acoustic information. In this section I survey the acoustic properties of the places of articulation which serve as the auditory cues distinguishing between them. I focus primarily on the coronal series. The principal studies of the spectral properties of Australian Aboriginal consonants are Busby 1979 based on a wide survey of Australian languages, McGregor 1990:54-57 on Gooniyandi, Evans 1985:495-501 on Kayardild, Anderson 1993 on Tiwi, Bradley 1980 on Yanyuwa, McDonald 1977 on Yaraldi. The facts surveyed in this section are largely culled from these references.

§2.2.1 Vowel formant transitions.

Transitions are the product of the movement of the vocal organs between the steady state of a vowel and a consonantal occlusion. The vocal space is modified as the active articulator is in motion, modifying the resonance of the oral cavity. Therefore different consonantal articulations produce unique vowel formant transition cues. The transitions of the second formant are the primary transition cues for distinguishing the labial, alveolar and dorsal places of articulation (Liberman, Delattre, Gerstman & Cooper 1967:159). The approximate frequencies of F1, F2 and F3 of the four coronal laterals, reported by Busby 1979:161, are given in (3.a). The formant frequencies for the six nasal stops reported by Busby 1979:163 are given in (3.b). The approximate formant loci for the six oral stops in Gooniyandi reported by McGregor 1990:56 are given in (3.c).

(3) Spectral properties of the places of articulation: formants and vowel formant transitions.

a. Lateral segment formants (averaged over several languages), Busby 1979:161.

	[l]	[ɭ]	[l̠]	[ʎ]
F1	483	458	469	489
F2	1509	1493	1611	2009
F3	2632	2377	2589	2900

b. Nasal formants (averaged over several languages), Busby 1979:163.

	[m]	[ʁ]	[ɳ]	[n̠]	[ɲ]	[ŋ]
F1	567	469	502	532	550	556
F2	1285	1502	1735	1654	2156	1441
F3	2211	2279	2129	2499	2936	2215

c. Oral stop loci averages for Gooniyandi, McGregor 1990:56.

	[p]	[t]	[ʈ]	[t̠]	[c]	[k]/-i	[k]/-u
F1	500	500	500	750	300	700	200
F2	1000	1750	1600	1600	2200	1500	750
F3	2500	2750	1800	2500	3000	2000	--

The two non-coronal articulations are grave, i.e. they have second formant structures concentrated at relatively low frequencies (Jakobson, Fant & Halle 1963). In acoustic terms, labials and dorsals are distinguished by the property of *compactness* which dorsals possess. Compactness is the noticeable convergence of the F2 and F3 of the neighbouring

vowel(s). This produces a prominence in the mid-frequency range which can be a robust cue (Stevens 1989:17-18).

§2.2.2 Lamino-alveopalatals.

Of the four coronal articulations, the lamino-alveopalatals have the most distinct F2 transition attributes. Lamino-alveopalatals are distinguished by a high F2, typically a few hundred Hz higher than any of the other articulations. The F2 is often at or near its position in the cardinal high front vowel [i]. In acoustic feature theory, this feature is [+sharp]: "acoustically, sharp phonemes in contradistinction to the corresponding plain ones are characterised by an upward shift of some of their upper frequency components" (Fant 1960:219-220; see also Jakobson & Halle 1956:31). The other coronal series are all [-sharp]. In impressionistic terms, the vowel formant transition cues of lamino-alveopalatal segments are most robust in the V-C transitions. Language descriptions often mention the diphthongisation which these segments condition on preceding vowels (for one example, see Patz 1991:254 on Djabugay).

§2.2.3 Apico-postalveolars.

Of the three remaining coronal articulations apico-postalveolars have the most distinctive vowel formant transition attributes. Both apical series have very similar and overlapping F2 attributes. This reflects the fact that the tongue body is positioned similarly for both. But apico-postalveolars are distinguished from alveolars and from all other articulations by a low F3 locus. This is seen very dramatically on spectrograms where the F3 falls in the V-C transitions as the tip of the tongue is retroflexed to articulate in the postalveolar region. The acoustic feature defining apico-postalveolars is [+flat]: "Acoustically, flat phonemes in contradistinction to the corresponding plain ones are characterised by a downward shift or weakening of some of their upper frequency components" (Fant 1960:219). The other coronal series are all [-flat] since they do not have such reduction of the F3 frequency.

The perceptual correlate of the falling F3 is the "r-colouring" of vowels preceding apico-postalveolar segments. This is constantly commented on in language descriptions as the prime acoustic cue for the postalveolar feature of the following apical segment. Retroflexion of the following vowel, if any, is only very brief and slight, and it is seldom mentioned in language descriptions (McGregor 1990:70-71 on Gooniyandi, Platt 1972:7 on Gugada, and Blake 1979b:190 on Pitta-Pitta are notable exceptions in remarking on perceptible retroflexion in the C-V transition). Anderson 1993 gives an articulatory and aerodynamic account of the presence of retroflex cues in the V-C context rather than the following C-V transitions. She demonstrates that burst cues of alveolar and postalveolar apicals are almost identical, which means that they are distinguished on the basis of the acoustic properties of the V-C transition alone. Therefore the primary cues distinguishing retroflexes from the other coronals are found in the V-C transition (Hamilton 1993a, Steriade 1995a, 1995b, Anderson 1993).

The retroflexion of the tongue tip to articulate at the postalveolar region is a complex gesture which involves a radical displacement of the articulator from neutral position. In spectrograms the period of time over which the F3 is falling is greater than is the case in vowel formant transitions of the other places. This reflects the period required to complete the apico-postalveolar gesture. Three recurring allophonic patterns in Australian Aboriginal languages involving retroflex segments are related to these facts. Each involves maximising the length of vowels preceding apico-postalveolar segments.

The apparent connotation is that short vowels are not long enough to allow the retroflex gesture and accomodate the [+flat] cue in the V-C transition. This jeopardises the possibility of reliably distinguishing them from acoustically similar segments. First, in various languages vowels are allophonically lengthened before apico-postalveolar segments only (e.g., Kayardild, Evans 1985:504). Second, in some languages all consonants except retroflexes are allophonically lengthened in intervocalic position; see, for example, Wordick 1982:12-13 on Yindjibarndi, and Hercus 1994:43-44 on Baagandji. In a related pattern, Hercus 1994:37-40 observes that retroflexes are the least likely of the four coronal series to be pre-stopped in Australian Aboriginal languages. Pre-stopping is an allophonic pattern closely related to consonant lengthening. Avoiding lengthening of a consonant is one strategy which preserves the length of the preceding vowel. Finally, retroflexion is often observed as most salient following the low vowel [a]; see Dunn 1988:33 on Badimaya, Chadwick 1975:3 on Jingili, Marsh 1969:135 on Mantjiltjatjarra, Hansen & Hansen 1969:175 on Pintupi, Nordlinger 1993 on Wambaya, and Jagst 1975:26-27 on Warlpiri. This fact is possibly related to the inherent length of [a] relative to the high vowels (Lehiste 1970:18-27, Catford 1977, Laver 1994:435-436).

§2.2.4 Alveolars and dentals.

The formant transitions of alveolars and dentals are essentially identical and cannot be used to distinguish between them (Bradley 1980, Evans 1985). Therefore other spectral properties of these two places of articulation are responsible for this contrast. Bradley 1980 discusses a variety of possibilities, all of which appear to be present as strategies of allophony to enhance the distinction between these two series. These are duration of adjacent vowels, duration of the segment itself, voicing, and spectral properties of the burst. The first three of these are related: in a range of languages lamino-dental stops are allophonically long (with concomitant shortening of a preceding vowel) and voiceless, [t̪ː], while apico-alveolar stops are short and voiced, often being realised as a tap, [ɾ] (see discussion in Evans 1985).

Properties of the burst play a distinctive role in certain languages as well. Dental stops are commonly reported as having an affricated release. The place of articulation of stops is cued in very distinct ways in V-C and C-V transitions: V-C cues are formant transitions alone while C-V cues include both the vowel formant transitions and the properties of the burst. The burst at the release of an oral stop is a reliable cue of place of articulation because the spectrum of the burst is largely determined by the resonating cavity forward of the constriction. But in formant transitions, "the pattern is determined as much by the cavity in back of the constriction as in front and is thus subject to more overlaid and thus obscuring influences" (Ohala 1990:265; see also Ohala & Kawasaki 1984).

A variety of perceptual experiments corroborates that the burst more saliently cues a stop's point of articulation than the vowel formant transitions. For example, the place of unreleased final stops, where there are formant transitions but no burst, are frequently misidentified (Householder 1956). Other research has indicated that even the burst of a prevocalic stop alone (without formant transitions) is sufficient to cue its place of articulation (Winitz, Scheib & Reeds 1972). Also, a wide body of work suggests that place cues in the C-V transition are more robust than cues in the V-C transition for intervocalic consonants. When the consonants in spliced V-C and C-V transitions have different places of articulation, with a gap equal to that typical of a single stop, listeners generally "hear" only the consonant cued by the C-V transition (Repp 1976, 1977a, 1977b,

1978, Fujimura, Macchi & Streeter 1978, Dorman, Raphael & Liberman 1979, Streeter & Nigro 1979, Ohala 1990).

McGregor 1990:56-57 provides some discussion of the burst properties of stops in Gooniyandi. The different stops have distinct burst properties depending on their place of articulation. There is a period of noise at release of 1 to 2 msecs for bilabial and alveolar stops, 2 to 3 msecs for the dorsal stop, and 5 to 7 msecs for the alveopalatal stop. The noise of the alveolar is about half the length of the dental and is concentrated at lower frequencies. The dental oral stop has noise in the burst spike concentrated fairly evenly over the whole frequency range (McGregor 1990:57, Evans 1985:499). The release turbulence of dental stops is responsible for 'affricated release' often attributed to these segments in language descriptions. Apico-alveolar stops, in contrast, have a clean release.

Burst cues are not as salient for classes of segments other than stops. But perceptual evidence indicates that place features of nasals are also more saliently cued in the presence of release cues than in unreleased nasals. The most reliable place cues for nasals are found at the release: Kurowski & Blumstein 1984 argue that the nasal murmur and the vowel formant transitions immediately surrounding the release are sufficient alone to reliably cue the place of a nasal.

Finally, segments not in a C-V context, as in the case with pre-consonantal segments and unreleased word-final consonants, do not possess release cues to distinguish between them. Since release cues play such an important role in distinguishing alveolars and dentals, it is not surprising that these two series are not contrasted in pre-consonantal and word-final positions in Australian Aboriginal languages (see §4.4).

§2.2.5 Summary: acoustic features.

In the acoustic feature theory of Jakobson, Fant & Halle 1963, Jakobson & Halle 1956, and Fant 1960, non-coronal consonants are distinguished by the feature [+grave], low frequency cues in the burst spectra and second formant loci. Dorsals show a convergence of the second and third formants, a property expressed by the feature [+compact]. In this way dorsals are spectrally distinct from labials.

Among the four coronal series, all [−grave], alveopalatals are distinguished by the feature [+sharp], high F_2 vowel formant transition loci. Retroflexes are [+flat], low F_3 loci. Alveolars and dentals are both [−sharp, −flat], with overlapping mid-range F_2 loci. Their transition cues are so similar that the spectral contrast between these two series must be found in terms of properties of the burst.

As this discussion indicates, Jacobson, Fant and Halle assumed bivalent feature power. To my knowledge the equivalent acoustic properties expressed within a monovalent feature theory have not been investigated. A set of possible monovalent alternates to the traditional acoustic features might be: [comp] for [+compact]; [low F2] for [+grave]; [mid F2] for [−grave, −sharp]; [hi F2] for [+sharp]; [lo F3] for [+flat]; and [mid F3] for [−grave, −flat]. However, I will maintain the standard features for ease of exposition. The feature values for the six place series are presented in (4). Note that there is no vowel formant transition feature to distinguish dentals and alveolars. This contrast appears to be captured by a feature inherent in the nature of the release, but I will not take a specific stand on this point.

(4) Acoustic features of the places of articulation.

Labial	[+grave], [−comp]
Lamino-dental	[−grave], [−sharp], [−flat]
Apico-alveolar	[−grave], [−sharp], [−flat]
Apico-postalveolar	[−grave], [−sharp], [+flat]
Lamino-alveopalatal	[−grave], [+sharp], [−flat]
Dorso-velar	[+grave], [+comp]

§2.2.6 On redundancy.

The feature representations which I assume, and which I argue are motivated by the constraints, have a high degree of redundancy. For example, the articulatory features which define an apico-postalveolar gesture and the acoustic feature [+flat] imply each other. Redundancy is potentially problematic in feature representations since *by definition* it overgenerates predicted phonological contrasts. In order to resolve this redundancy problem, I assume a rich module of co-occurrence restrictions on features. For example, the acoustic feature [+flat] is inherently tied to the apico-postalveolar gesture since retroflexion of the tongue tip is the only gesture which is capable of modifying the vowel space in such a way as to produce the [+flat] acoustic effect. I assume that a constraint or group of constraints restricts the association of [+flat] to retroflex segments. This constraint, which is phonetically grounded and I assume is universally unviolated, enforces the mutual implication that exists between these acoustic and articulatory features. This ensures that their demarcative power does not predict any more than the one place series (by ruling out [−flat] apico-postalveolars and [+flat] non-apicals). The function of these constraints is similar to that of the morpheme structure rules of Chomsky & Halle 1968, except that they are universal and unviolated. Therefore, in a representational model which includes narrow, non-contrastive phonetic detail, the constraints play a crucial role in encoding redundancy into the system, and thereby ensuring that the demarcative power of the features predicts *all and only* the permitted phonemic contrasts. Therefore I follow Mohanan 1991, Hamilton 1993c, McCarthy & Taub 1993, Steriade 1995, and others, and reject a theory which disallows redundant features to function as a part of underlying representations (e.g. Kiparsky 1985, Paradis & Prunet 1989, Avery & Rice 1989).

§2.3 Manner classes.

Having discussed the range of place contrasts, in this section I survey the inventories of manner contrasts which are attested in Australian Aboriginal languages. This section is divided into subsections devoted to each of the manner classes of consonants: the stops, nasals, laterals, vibrants and glides. In each I detail the manner of articulation and discuss their place contrasts. I show that stops always show the full range of place contrasts, and that nasals and laterals imply stops at the same place of articulation.

§2.3.1 Oral stops.

Australian Aboriginal languages typically possess a single series of stops. The standard articulation is voiceless and unaspirated. There is, however, a range of variation on this pattern, both cross-linguistically and language-internally. There are some languages where the normative articulation of stops is reported as being voiced (this is reported for Yidiny, Wambaya and Yuwaalaraay; see the entry for each language in Appendix B), but in most of these languages voiceless allophones occur at least sporadically in some context. There are also recurring generalisations in the contextual conditioning of stop voicing: voiced allophones typically occur following a nasal. There is also variation in terms of tension: fortis or lenis allophones predominate in individual languages, and there

is contextual variation in tension as well.

Another allophonic pattern of stops is the tendency to spirantisation and lenition. The conditioning environment is generally intervocalic or between an oral sonorant and a vowel. Place features play an important role since labial and dorsal stops are more likely than coronals to be realised as spirants. Spirant allophones are generally voiced. Therefore the stop phonemes /p/ and /k/ have the range of allophones [p, b, β] and [k, g, ɣ]. The lamino-dental stop /t̪/ undergoes spirantisation to [ð] in certain languages as well. In some languages the labial and dorsal stops alternate with lenited approximant allophones, both as [w]. Both laminal oral stops occasionally are found to alternate with a lenited allophone [j]. Apical stops do not undergo spirantisation, but they lenite to tap or trill articulation in many languages, so much so that the alveolar stop is frequently hard to distinguish from the vibrant phoneme [r].

In summary, the allophonic realisation of stops in Australian Aboriginal languages shows a considerable degree of variation in voicing, degree of stricture and tension. This range of variation includes patterns which are contextually conditioned and patterns which are in free variation. There is also considerable language-to-language variation in the norms of stop allophony.

I now give a survey of the inventories of stops found in Australian Aboriginal languages. The presence of labial and dorsal series is invariant. Therefore, the number of apical and laminal series (either one or two each) can be used to categorise phoneme inventories. I will name each inventory by the number of laminal and apical series which it contrasts: e.g. "2-laminal/1-apical" being a language which contrasts two series of laminals but only one apical series. There are four possible inventories of place contrasts. In the following stop inventories I will use the symbols T to represent the neutral apical stop (as opposed to languages which contrast [t] with [ʈ]) and TH for the neutral laminal stop (as opposed to languages which contrast [c] with [t̪]; see the discussion in §2.1.3 on neutralisation). The languages with each inventory are listed in footnotes; the reader is referred to appendix B for fuller information on each language, including the reference, the full phoneme inventory, and notes on the allophonic variation of the segments. Information on the genetic and geographic distribution of each language is presented in appendix C.

(5) Place inventories in Australian Aboriginal languages.

a. 1-laminal/1-apical:[3]	p		T		TH	k
b. 2-laminal/1-apical:[4]	p	t̪	T		c	k
c. 1-laminal/2-apical:[5]	p		t	ʈ	TH	k
d. 2-laminal/2-apical:[6]	p	t̪	t	ʈ	c	k

An additional dorso-palatal place of articulation has been assumed for four languages in

[3]Languages: Bandjalang, Djabugay, Dyirbal, Kuku-Yalanji, Gumbaynggir, MalakMalak, Nganyaywana, Nyawaygi, Warrgamay, Yaygir, Yidiny.

[4]Languages: Aghu-Tharrnggala, Anguthimri, Anindilyakwa (traditional language), Gog-Narr, Kukatj, Kuku-Thaypan, Kurrtjar, Kuuku-Ya'u, Mbabarram, Ngiyambaa, Olkol, Uradhi, Wik-Ngathana, Yuwaalaraay.

[5]Languages: Alawa, Bardi, Djaru, Djinang, Jingili, Gaagudju, Garawa, Gugada, Gunin, Limilngan, Madhimadhi, Mangarrayi, Mantjiltjarra, Marra, Murinh-patha, Ngalakan, Ngarndji, Nyangumarta, Nyigina, Nyungar, Pintupi, Umbugarla, Ungarinyin, Walmatjarri, Wambaya, Wardaman, Warlmanpa, Warlpiri, Warndarrang, Warumungu, Watjarri, Wergaia, Yankuntjatjarra, Yawuru.

[6]Languages: Alyawarra, Arabana-Wangkangurru, Arrernte, Baagandji, Badimaya, Bidyara-Gungabula, Bularnu, Diyari, Djambarrpuyngu, Djapu, Gaalpu, Garlali, Gooniyandi, Guugu-Yimidhirr, Jiwarli, Kalkatungu, Kayardild, Kaytetye, Kitja, Kukatj, Marrgany-Gunya, Martuthunira, Miriwung, Muruwari, Ngandi, Ngarigu, Ngawun, Nhukunu, Nunggubuyu, Panyjima, Payungu, Pitta-Pitta, Ritharrngu, Tharrgari, Warluwarra, Wembawemba, Yandruwanhdha, Yanyuwa, Yindjibarndi, Yirr-Yorront, Yukulta.

the Gulf Country of the Northern Territory.[7]

§2.3.2 Nasals.

In this section I discuss the manner and place of articulation of nasal segments, and I survey their distribution in consonant phoneme inventories, particularly in reference to their counterpart stops.

Discussion of the manner of articulation of these segments is straightforward: they are realised with vocal cord vibration, complete oral occlusion and velic opening allowing nasal airstream. There is little allophonic variation from this standard except that in many languages some may have a conditioned pre-stopped realisation in certain contexts.

In terms of place of articulation, it is standard for each stop to have a corresponding nasal at the same place of articulation. This is by far the majority pattern in Australia. In each case, the articulatory gesture of the stop is identical to the gesture attested in the articulation of the nasal. I show the inventories of stops and nasals for the four place inventory types in (6).

[7]These languages are Garawa, Jingili and Ngarndji (all with coronal inventory 1-laminal/2-apical), and Yanyuwa (2 laminal/2 apical). If this "dorso-palatal" series is to be taken as a distinct, discrete place of articulation, Yanyuwa will have seven distinct places. For further discussion on this series, see Dixon 1980:142 and the references for the individual languages. The articulation is reported to be similar to the fronted velar articulation before the high front vowel in English as in the word *key* (see Kirton & Charlie 1979 on Yanyuwa). It is not completely clear that these articulations are to be distinguished from lamino-alveopalatal plus dorsal clusters; a cluster analysis may be possible, and at the very least if this series is to be taken as a distinct place, it is clear that these segments have recently evolved from clusters (Dixon 1980:142).

(6) Nasal stop inventories: nasal stops tend to match oral stops at all contrastive places of articulation

a. 1-laminal\1-apical:[8]	p		T		TH	k
	m		N		NH	ŋ
b. 2-laminal\1-apical:[9]	p	t̪	T		c	k
	m	n̪	N		ɲ	ŋ
c. 1-laminal\2-apical:[10]	p		t	ʈ	TH	k
	m		n	ɳ	NH	ŋ
d. 2-laminal\2-apical:[11]	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ

In a minority of languages there is a gap in the inventory of nasals. The reverse pattern, with a nasal in a place series but no stop, is unattested. There are no examples of a gap in the nasal inventory in the labial or dorsal series. As with the stops, there is always at least one apical and one laminal nasal. Therefore gaps occur only in one of the laminal or apical series in languages which contrast two laminal or apical series. As a result, no languages with place inventory 1-laminal\1-apical have a gap in the nasal inventory.

A small minority of double-laminal languages have a neutral laminal nasal. The

[8]Languages: Bandjalang, Djabugay, Dyirbal, Gumbaynggir, Kuku-Yalanji, MalakMalak, Nganyaywana, Nyawaygi, Warrgamay, Yaygir, Yidiny.

[9]Languages: Aghu-Tharrnggala, Anguthimri, Anindilyakwa (traditional language), Gog-Narr, Kukatj, Kuku-Thaypan, Kurrtjar, Kuuku-Ya'u, Mbabarram, Ngiyambaa, Olkol, Uradhi, Wik-Ngathana, Yuwaalaraay.

[10]Languages: Alawa, Bardi, Djaru, Djinang, Djinba, Gaagudju, Gugada, Gugu-Badhun, Gunin, Limilngan, Madhimadhi, Mangarrayi, Mantjiltjarra, Marra, Murrinh-patha, Ngalakan, Nyangumarta, Nyigina, Nyungar, Pintupi, Tiwi, Umbugarla, Ungarinyin, Walmatjarri, Wambaya, Wardaman, Warlmanpa, Warlpiri, Warndarrang, Warumungu, Watjarri, Wergaia, Yankuntjatjarra, Yawuru.

[11]Languages: Alyawarra, Arabana-Wangkangurru, Arrernte, Baagandji, Badimaya, Bidyara-Gungabula, Bularnu, Diyari, Djambarrpuyngu, Djapu, Gaalpu, Garlali, Gooniyandi, Guugu-Yimidhirr, Jiwarli, Kalkatungu, Kayardild, Kaytetye, Kitja, Marrgany-Gunya, Martuthunira, Miriwung, Muruwari, Ngarigu, Ngawun, Nhukunu, Nunggubuyu, Panyjima, Payungu, Pitta-Pitta, Ritharrngu, Tharrgari, Warluwarra, Wembawemba, Yandruwanhdha, Yindjibarndi, Yirr-Yorront, Yukulta.

main allophone of the laminal nasal are reported as alveopalatal in these languages. The inventories of nasals and stops in these cases are shown in (7); see also (9).

(7) Gaps in nasal inventories: laminals

a. 2-laminal\1-apical | nas 1-laminal\1-apical:[12]	p	t̪	T		c	k
	m		N		NH	ŋ
b. 2-laminal\2-apical | nas 1-laminal\2-apical:[13]	p	t̪	t	ʈ	c	k
	m		n	ɳ	NH	ŋ

In double-apical languages, the two apical stops may have a neutral apical nasal counterpart. The attested inventory which demonstrates this gap is given in (8); see also the inventory in (9).

(8) Gaps in nasal inventories: apicals

2-laminal\2-apical | nas 2-laminal\1-apical:[14]	p	t̪	t	ʈ	c	k
	m	n̪	N		ɲ	ŋ

One final pattern of gapping is found.[15] This is in a language with place inventory 2-

[12]Languages: Gugu-Badhun.

[13]Languages: Ngandi, Wembawemba. The neutral laminal nasal segment in Wembawemba is reported as corresponding in articulation to the lamino-alveopalatal oral stop. Both are reported as being "slightly palatalised alveo-dental" (Hercus 1986:10-11).

[14]Languages: Bidyara-Gungabula. Breen 1973 does not provide a detailed description of the articulation of the neutral apical nasal in Bidyara-Gungabula, but he lists it in the phoneme chart as the nasal counterpart to [t], not [ʈ].

[15]In addition to the gaps discussed in this section, one of the languages with the controversial "dorso-palatal" series lacks the nasal counterpart to the oral stop in this series. This language is Jingili (see Dixon 1980:142).

laminal\2-apical for stops but with neutral apical and laminal nasals. The inventory for this type of inventory is shown in (9).

(9) Gaps in nasal inventories: apicals and laminals

<table>
<tr><td>2-laminal\2-apical|nas 1-laminal\1-apical:[16]</td><td>p</td><td>t̪</td><td>t</td><td>ʈ</td><td>c</td><td>k</td></tr>
<tr><td></td><td>m</td><td></td><td>N</td><td></td><td>NH</td><td>ŋ</td></tr>
</table>

In summary, nasals imply stops at the same place of articulation. This is shown by the fact that there are no languages where nasals lack stop counterparts.

§2.3.3 Laterals.

In addition to stops and nasals, Australian Aboriginal languages contrast three classes of oral sonorants: laterals, vibrants and glides. The laterals and vibrants are grouped together as the class of liquids. The two liquid manners share many phonotactic attributes in Australian Aboriginal languages, and therefore are often referred to together in the discussion in this thesis. In this section I discuss the manner and place features of laterals.

In Australian languages laterals are voiced sonorants. There is a mid-saggital coronal occlusion combined with lateral airflow allowing continuous passage of air and thus precluding a significant increase in intra-oral pressure. In some languages, velarised lateral allophones are reported in the environment of a back vowel. Aside from this there is little surface allophony of lateral segments except for the phenomenon of pre-stopping,

[16]Languages: Miriwung, Ngarigu. The neutral nasals in Ngarigu appear to correspond to the alveolar and alveopalatal oral stops. The Ngarigu monograph is a salvage study and thus should therefore be treated with caution (see §1.1.2). The two neutral coronal nasals in Miriwung show some contextual variation between the two contrasting articulations of the corresponding oral stops (Kofod 1978:10-12).

which is a contextually-conditioned pattern of allophony of laterals in many languages.

All of the languages in Australia have lateral phonemes with the exception of one dialect of Thargari. In the so-called "l-dialect" of Thargari there are four lateral phonemes while in its sister dialect, the "d-dialect," the laterals have undergone a recent diachronic change, becoming voiced stops (Austin 1981b:213).[17]

I now discuss generalisations of place contrasts for laterals. Lateral inventories are an important defining variable of phoneme inventories in Australian languages. Two generalisations may be made regarding the composition of lateral inventories: lateral phonemes imply stops at the same place of articulation; and laminal laterals imply apical laterals.

In languages with 1-laminal\1-apical place inventory, two options are encountered: either the inventory will have a single lateral with apical articulation (10.a) or it will have both a laminal and an apical lateral (10.b).

(10) Lateral inventories in 1-laminal\1-apical languages: laminal laterals imply apical laterals.

<table>
<tr><td>a. 1-laminal\1-apical|lat 0-laminal\1-apical:[18]</td><td>p</td><td>T</td><td>TH</td><td>k</td></tr>
<tr><td></td><td></td><td>L</td><td></td><td></td></tr>
<tr><td>b. 1-laminal\1-apical|lat 1-laminal\1-apical:[19]</td><td>p</td><td>T</td><td>TH</td><td>k</td></tr>
<tr><td></td><td></td><td>L</td><td>LH</td><td></td></tr>
</table>

[17] Austin 1981:213 fn.14 indicates that there are examples of sporadic fluctuation between laterals and stops in d-Thargari, and one verbal suffix morpheme appears on the surface with an invariant [l].

[18]Languages: Bandjalang, Djabugay, Dyirbal, Gumbaynggir, Kuku-Yalandji, Nyawaygi, Warrgamay, Yaygir, Yidiny.

[19]Languages: Malak-Malak, Nganyaywana.

Similar observations emerge in place inventory 2-laminal\1-apical languages: an apical lateral is always present, whether or not laminal laterals are permitted (11). In some languages which permit laminal laterals, a neutral laminal lateral is attested corresponding to both contrasting laminal stops. The default articulation of these neutral laminal laterals varies from language-to-language (see the footnotes).

(11) Lateral inventories in 2-laminal\1-apical languages:laminal laterals imply apical laterals.

a. 2-laminal\1-apical|lat 0 laminal\1-apical:[20]	p	t̪	T	c	k
			L		
b. 2-laminal\1-apical|lat 1-laminal\1-apical:[21]	p	t̪	T	c	k
			L	LH	
c. 2-laminal\1-apical|lat 2-laminal\1-apical:[22]	p	t̪	T	c	k
		l̪	L	ʎ	

The same patterns obtain in double apical languages: laminal laterals imply apical laterals, and laterals imply homorganic stops. The lateral inventories in place inventory 1-laminal\2-apical languages are given in (12), and for place inventory 2-laminal\2-apical languages in (13).

[20]Languages: Aghu-Tharrnggala, Anguthimri, Gog-Narr, Kuku-Thaypan, Kukatj, Kuuku-Ya'u, Mbabarram, Ngiyambaa, Uradhi, Wik-Ngathana, Yuwaalaraay.

[21]Languages: Kurrtjar [ʎ] (i.e., the neutral laminal lateral in Kurrtjar is alveopalatal), Oykangand dialect of Olkol [l̪] (the neutral laminal lateral in Oykangand is dental).

[22]Languages: Anindilyakwa, Olkol.

(12) Lateral inventories in 1-laminal\2-apical languages: laminal laterals imply apical laterals.

a. 1-laminal\2-apical|lat 0 laminal\1-apical:[23]	p	t	ʈ	TH	k
		L			
b. 1-laminal\2-apical|lat 0 laminal\2-apical:[24]	p	t	ʈ	TH	k
		l	ɭ		
c. 1-laminal\2-apical|lat 1-laminal\2-apical:[25]	p	t	ʈ	TH	k
		l	ɭ	LH	

(13) Lateral inventories in 2-laminal\2-apical languages: laminal laterals imply apical laterals.

a. 2-laminal\2-apical|lat 0 laminal\1-apical:[26]	p	t̪	t	ʈ	c	k
			L			
b. 2-laminal\2-apical|lat 0 laminal\2-apical:[27]	p	t̪	t	ʈ	c	k
			l	ɭ		
c. 2-laminal\2-apical|lat 1-laminal\2-apical:[28]	p	t̪	t	ʈ	c	k
			l	ɭ	LH	
d. 2-laminal\2-apical|lat 1-laminal\2-apical:[29]	p	t̪	t	ʈ	c	k
			L		LH	
e. 2-laminal\2-apical|lat 2-laminal\2-apical:[30]	p	t̪	t	ʈ	c	k
		l̪	l	ɭ	ʎ	

[23]Languages: Wergaia.

[24]Languages: Djinang, Gaagudju, Mangarrayi, Marra, Ngalakan, Ngalkbun, Ngandi, Tiwi, Wambaya, Warndarrang.

[25]Languages: Alawa, Bardi, Djaru, Garawa, Gugada, Gunin, Limilngan, Madhimadhi, Mantjiltjarra, Murinh-patha, Ngarndji, Nyangumarta, Nyigina, Nyungar, Pintupi, Umbugarla, Ungarinyin, Walmatjarri, Warlmanpa, Warlpiri, Warumungu, Watjarri, Yankuntjatjarra, Yawuru.

[26]Languages: Bidyara-Gungabula, Guugu-Yimidhirr, Kayardild, Lardil, Wembawemba.

[27]Languages: Djambarrpuyngu, Djapu, Gaalpu, Kukatj, Muruwari, Ngawun, Ritharrngu, Tharrgari, Warndarrang, Yindjibarndi, Yukulta.

[28]Languages: Gooniyandi [ʎ], Kitja [ʎ], Marrgany-Gunya [ʎ], Nunggubuyu [l̪], Yirr-Yorront [l̪].

[29]Languages: Miriwung.

[30]Languages: Alyawarra, Arabana-Wangkanguru, Arrernte, Baagandji, Badimaya, Bularnu, Diyari, Garlali, Jiwarli, Kalkatungu, Kaytetye, Martuthunira, Nhukunu, Panyjima, Payungu, Pitta-Pitta, Warluwarra, Yandruwanhdha, Yanyuwa.

In lateral inventories which match a neutral apical lateral to two contrasting apical stops or a neutral laminal lateral to two contrasting laminal stops, these may justifiably be considered inventory gaps, similar to what was discussed for nasals above. But the preference for symmetrical inventories is not as strong for the laterals as it is for the nasals: fewer languages neutralise the double-apical or double-laminal contrast among nasals than among laterals.

This survey of lateral inventories indicates that laminal laterals are marked in terms of their distribution in phoneme inventories in Australian Aboriginal languages. This markedness is motivated on articulatory grounds, based on the fact that a laminal wedge and lateral airflow are antagonistic gestures (see Archangeli & Pulleyblank 1994, who assume that feature co-occurrence filters are highly valued where the two features are antagonistic gestures, in which cases the coordination of the two gestures is marked). Laterals require maximisation of airflow around the tongue. When the tip is the articulator, air may pass around the relatively agile and narrow blade. However, when the blade is the articulator, the midsagittal obstruction is more substantial and the air must past around the bulkier and less agile front portion of the tongue body. Therefore lateral airflow around a laminal wedge requires greater articulatory precision than around an apical wedge. The marked status of laminal laterals is articulatorily grounded, based on the articulatory markedness inherent in the precision involved in co-ordinating these two articulations simultaneously.

§2.3.4 Vibrants.

In addition to lateral liquids, Australian languages contrast vibrant liquid phonemes. The vibrant manners of articulation are trill and tap. The phonetic symbols which I use for

the vibrant segments in Australian Aboriginal languages are in (14). The symbols for the apical glides are presented as well for comparison.

(14) "Rhotic" segments in Australian Aboriginal languages (IPA symbols).

Vibrants	[r]	Apico-alveolar trill.
	[ɾ]	Apico-alveolar tap or flap.
	[ɽ]	Apico-postalveolar tap or flap.
Glides	[ɹ]	Apico-alveolar glide.
	[ɻ]	Apico-postalveolar glide.

Liquids, both laterals and vibrants, are characterised by a gesture of contact in the oral cavity without a concomitant obstruction to airflow. Laterals accomplish this with a central occlusion combined with narrowing of the tongue body mass to allow lateral airflow. In the case of vibrants, the interuption of the airstream is so rapid that there is no effect on intra-oral pressure. In fact, the gesture(s) of the tongue tip in trills is incidental, brought about as an effect of the Bernoulli principle as the pressure between the tongue tip and the alveolar ridge decreases when the air flows rapidly through the oral cavity (Chomsky & Halle 1968:318).

Laterals often occur at more than one coronal place of articulation, but the majority pattern is that phoneme inventories have one vibrant. Even among languages which have more than one vibrant, they are restricted to apical articulation. This is likely related to the inherent agility of the tongue tip and the articulatory agility required in trill/tap gestures.

Among the languages with a single vibrant, it is an apico-alveolar segment whose normal manner of articulation is a tap, [ɾ], which is also realised as a brief trill, [r], either in free variation or in particular environments. For example, a tap realisation is typical preceding a non-apical consonant in a cluster. It is also reported for many languages that a trilled realisation of this segment is characteristic of emphatic and excited speech, and that a tap realisation is standard otherwise. In the text and in the phoneme chart tables in Appendix B I tend to use "r" (in double quotes) to refer to the vibrant phoneme, without taking a stand on its precise manner of articulation in languages where there is variation. Of all the languages with a single vibrant, there is only one language where it is not alveolar. This language is Anguthimri, with the apico-postalveolar vibrant [ɽ].

A small number of languages contrast two apical vibrant phonemes. In some the contrast is one of place of articulation: an apico-alveolar vibrant in contrast with an apico-postalveolar counterpart (15.a). This contrast is attested only among double-apical languages (but see the entry for Kurrtjar in appendix B), meaning that vibrants imply homorganic stop counterparts (but see the discussion of Nyawaygi immediately below). An equally small number of languages contrast vibrants by manner of articulation instead of place: an alveolar trill, [r], versus an alveolar tap, [ɾ].

(15) Non-lateral liquid inventories.

a. Non-lateral liquids contrasted by place:[31]	t "r"	ʈ ɽ
b. Non-lateral liquids contrasted by manner:[32]	t r ɾ	ʈ

[31]Languages: Amurdak, Djinggili, Kurrtjar, Warlpiri, Wembawemba, Wergaia. (See also Kurrtjar)

[32]Languages: Arabana-Wangkangurru, Gog-Narr, Kukatj, Kurrtjar, Muruwari, Nhukunu, Pitta-Pitta. (See also Diyari and Marrgany-Gunya).

Dixon 1980 proposes that ["r"] and the glide [ɻ] are a natural class defined by the feature [rhotic]. He argues that these segments are contrasted on the basis of their place features alone, with the difference in manner being underspecified. In support of this analysis, Dixon adduces evidence from allophonic variation: /ɻ/ is sometimes reported as having a sporadic retroflex tap realisation, [ɽ]; and sometimes /"r"/ alternates with the alveolar approximant [ɹ], especially between low vowels. He does not discuss the feature content of the "rhotics" in multiple vibrant inventories. The fact that some languages contrast the homorganic apico-postalveolar vibrant and glide segments [ɽ] and [ɻ] (Amurdak, Anguthimri, Kurrtjar, Warlpiri) indicates that a feature to express the contrast between (homorganic) vibrants and glides is required in at least these languages, contrary to Dixon's proposal. Further arguments against [rhotic] are presented in §2.3.5.

One final point on allophony: in many languages the apical stop is optionally realised as a tap or trill intervocally (see, for example, Dixon 1981:16 on Warrgamay, Dixon 1977:32-3 on Yidiny, Haviland 1979:38 on Guugu-Yimidhirr). This can make them difficult to distinguish from "r". In one language, Nyawaygi, the contrast between *t and *r has undergone a recent neutralisation process (Dixon 1983:439-40). In Nyawaygi the phones [t] and ["r"] occur in complementary distribution: [t] following the alveolar nasal [n], and ["r"] elsewhere (in word-initial, word-final, pre-consonantal, and intervocalic positions).

§2.3.5 Glides.

The final major manner category contrasted in Australian Aboriginal languages is the glides. Glides are oral sonorants involving articulatory approximation in the oral cavity but without contact of the articulators and without turbulence in the airstream.

Three glide phonemes are commonly attested in the segmental inventories of almost all Australian Aboriginal languages. These are the labial-velar [w], the palatal [j] and the apico-postalveolar [ɹ]. By including [ɹ] with the glides I follow McGregor 1988, who argues against Dixon's 1980 feature [+rhotic] which defines [r] and [ɹ] as a natural class. McGregor points out that there is no evidence of these two segments acting as a natural class to the exclusion of other oral sonorant segments. He proposes to align [ɹ] with the glides rather than with the liquids on the basis of similarities in phonotactic distribution. For example, liquids are unmarked in the first position of a consonant cluster (C_1) and glides are marked in this position (see §5.2.4). The same pattern is attested in word-final position. Conversely, glides are less marked than liquids in word-initial position. In all of these patterns, [ɹ] tends to pattern with [w] and [j] rather than with the liquids.

The articulatory and aerodynamic similarity between [ɹ] and the other glides (versus the very distinct articulation of liquids, which involve contact rather than approximation of the articulators) favour this analysis as well. There is mention of [ɹ] being realised sporadically as [j] in various languages, especially in the environment of a following high front vowel, i.e., [aɹi] fluctuating with [aji]. See, for example, Douglas 1981:204 on Watjarri and Marsh 1969:133 on Mantjiltjatjarra. [ɹ] and [j] have a similar vocal tract configuration, and so this alternation can be analysed as [ɹ] only taking on the place features of [i]. O'Grady, Voegelin & Voegelin 1966:85 mention that there is free variation between [ɹ] and [j] in Palyku, apparently irrespective of vocalic context. Hercus 1994:45 comments on a similar phenomenon in Pitta-Pitta, Wangkumarra, and other languages to which they are related. Interesting evidence for the perceptual similarity of the retroflex and palatal glides comes from the historical phonology of Arandic. Koch

1995 reports on Kaytetye that retroflex segments in the proto-language (which perceptually are distinguished by retroflex vowel colouring in the V-C transition, see §2.1.2) have descended as pre-palatalised apico-alveolars, i.e., *[ʈ] → [ʲt].

The interaction between the glides [w] and [j] and their homorganic vowels is very complex and unstable. Because all high vocoids (both vowels and glides) are similar acoustically, sequences of high vocoids are seldom distinguished. This fact has a wide range of empirical correlates in the phonotactics of Australian Aboriginal languages; there is some discussion of this in §5.2.4. Because the apico-postalveolar glide [ɹ] does not have a direct vowel counterpart in Australian Aboriginal languages, it does not show the range of interactions with vowels demonstrated by [w] and [j]. Its realisation as a voiced apico-postalveolar approximant is largely uniform. Languages seem to vary in whether this phoneme is articulated with a strongly retroflex tongue position or with the tongue body bunched. Hercus 1994:45 suggests that this variation allows for an account of why [ɹ] is difficult to distinguish from [j] in some languages but not in Arabana-Wangkangurru where the retroflex acoustic cues of this segment are more robust.

Some languages expand on the basic three-glide inventory by adding either a dorso-velar (16.a) or a lamino-dental (16.b) glide; others have a smaller inventory in lacking [ɹ] (16.d). In (16) I give an inventory of oral stops to demonstrate which place class each glide falls into. Even though [j] corresponds to the lamino-alveopalatal stop, the articulation of [j] is technically palatal rather than alveopalatal.

(16) Inventories of glides.

place series:	p	t̪	t	ʈ	c	k
glide inventories:						
a.:[33]	w			ɻ	j	ɰ
b.:[34]	w	j̪		ɻ	j	
c.:	w			ɻ	j	
d.:[35]	w				j	

The glides [ɰ] and [j̪] have a very marginal status, and are largely ignored in this thesis.

Finally, the place features of the palatal glide [j] require comment. In this thesis I assume that the palatal glide possesses the same consonantal place features which define the members of the lamino-alveopalatal series. Evidence from some non-Australian languages suggest that [j] lacks coronal place features. For instance, this segment is transparent to the *nati* rule in Sanskrit while "true" coronal consonants block it (Schein & Steriade 1986). However, in its phonotactic behaviour in Australian Aboriginal languages, [j] patterns with the laminal consonants. This is amply demonstrated in the data presented in this thesis. Other evidence from alternations in Australian languages demonstrates that [j] and the other laminal segments possess overlapping place features. For example, in Kayardild, sequences of a laminal stop followed by [w] at a morpheme boundary contract to [j]: /t̪+w/ and /c+w/ → [j] (Evans 1985:42). I assume that this

[33] Languages: Arrernte, Kaytetye. The number of language with this glide inventory is hard to determine. Several languages have been reported as having a voiced dorsal fricative phoneme [ɣ] but the articulation of these segments is very lenis and it is possible that at in least some of these languages it should be analysed as a glide (for example, see Tiwi).

[34] Languages: Kurrama, Yindjibarndi. Some older Yindjibarndi speakers maintain the dental glide, but many younger speakers currently pronounce it as a dental lateral.

[35] Languages: Bandjalang, Kuuku-Ya'u, Madhimadhi, Wembawemba, Wergaia. In some of the languages which have this inventory, the historic *ɻ has descended as a glottal stop.

derived [j] is the product of the place features of the stop and the manner features of the labial-velar glide.

§2.3.6 Manner features.

I assume a set of privative features to define the manner natural classes: [nasal], [lateral], [vibrant] and [glide]. Other features which demarcate the manner classes, and which are referred to by constraints proposed in chapter 5, are [sonorant], [obstruent] and [approximant].

[Sonorant] captures nasals, laterals, vibrants and glides as a class. Chomsky & Halle 1968:302 define sonority in articulatory terms, based on the amount of constriction in the vocal cavity. Ladefoged 1971:58 gives an acoustic definition of sonorants: they are phones "with an auditory property which arises from their having a comparatively large amount of acoustic energy within a clearly defined formant structure." The feature [obstruent] defines segments which have a radical obstruction in the oral cavity, defining the stops in Australian Aboriginal languages. For [approximant], I follow the definition of this feature argued for by Clements 1990, where it is essentially equivalent to the class of oral sonorants.

§2.4 Conclusion.

This completes the survey of the place and manner of articulation contrasts in Australian Aboriginal languages. The place and manner features are the building blocks of the segmental phonotactics to be discussed in the following four chapters. Note that I do not intend this discussion of features to be exhaustive; I have discussed only the features which are relevant to the constraints formalism of the phonotactic patterns.

In the appendix immediately following this chapter, I give a chart of the most common segments in Australian Aboriginal languages with the features that define them.

Appendix to Chapter 2: Consonantal features.

The place features for all the segments in the same column are the same (with the exception of [w]), and so they are given only for the stops at the top of each column. The articulator features are given first, followed by the acoustic features of the places, and then the manner features.

[p] [labial]	[t̪] [coronal] [laminal] [dental]	[t] [coronal] [apical] [alveolar]	[ʈ] [coronal] [apical] [postalv]	[c] [coronal] [laminal] [alveopal] [high]	[k] [dorsal] [velar] [high]
[+grave] [−compact]	[−grave] [−sharp] [−flat]	[−grave] [−sharp] [−flat]	[−grave] [−sharp] [+flat]	[−grave] [+sharp] [−flat]	[+grave] [+compact]
[obstruent]	[obstruent]	[obstruent]	[obstruent]	[obstruent]	[obstruent]
[m] [sonorant] [nasal]	[n̪] [sonorant] [nasal]	[n] [sonorant] [nasal]	[ɳ] [sonorant] [nasal]	[ɲ] [sonorant] [nasal]	[ŋ] [sonorant] [nasal]
	[l̪] [sonorant] [approx] [lateral]	[l] [sonorant] [approx] [lateral]	[ɭ] [sonorant] [approx] [lateral]	[ʎ] [sonorant] [approx] [lateral]	
		["r"] [sonorant] [approx] [vibrant]			
[w] [labial] [dorsal] [high] [round] [sonorant] [approx] [glide]			[ɻ] [sonorant] [approx] [glide]	[j] [sonorant] [approx] [glide]	

Chapter 3: The special status of intervocalic place features.

§3.0 Introduction.

In this chapter I discuss the privileged phonotactic status of intervocalic consonants and homorganic clusters in Australian Aboriginal languages. I focus on homorganic clusters and their unmarked status compared to heterorganic clusters. It is a long-standing assumption in phonological representations that homorganic clusters, like single segments, possess a single place feature (see discussion and references in §3.4.1). In Australian Aboriginal languages all segments and segment sequences which are characterised with an intervocalic place feature, i.e., single intervocalic segments and homorganic clusters, show maximal contrastiveness of place features. I argue for an acoustic account of these facts. Intervocalic place features benefit from vowel formant transitions in both the V-C and C-V transitions. Therefore intervocalic place features are more salient than place features which are cued only in the V-C or the C-V context. Since intervocalic position is the position of maximum saliency of place features, they are less prone to reduction than is the case in other positions. I propose that this follows from a constraints formalism in which *[place] constraints referring to intervocalic features, which possess both release and attack cues, are ordered lower than *[place] constraints which possess only attack or release cues. This follows from the perceptual theory of markedness in §1.2.2.

(1) Context-specific robustness of perceptual cues as a determinant of constraint ordering.

a. [place] tied to release cues:	$*[place]^{VC} \gg *[place]^{CV} \gg *[place]^{VCV}$
b. [place] tied to attack cues:	$*[place]^{CV} \gg *[place]^{VC} \gg *[place]^{VCV}$

Following a brief introduction to the consonantal phonotactic positions (§3.1), I

demonstrate that intervocalic position is the position of maximal contrast for place features in §3.2. This is followed by a survey of the data relevant to the phonotactics of homorganic clusters (§3.3). Evidence from implications (§3.3.1) and frequencies (§3.3.2) indicates that homorganic clusters are less marked than heterorganic clusters. In §3.4 an additional indication of the unmarked status of homorganic clusters over heterorganic clusters is discussed: place features are fully contrastive in intervocalic homorganic clusters, a pattern of symmetry between homorganic clusters and single segments. The account of the special status of homorganic clusters which I argue for is presented in §3.4.2. The special status of homorganic clusters poses a threat to more traditional prosodic accounts of phonotactic patterns since intervocalic position has no unique prosodic status. This is discussed in §3.5. Therefore, I argue that an account of this pattern of the Australian phonotactics is motivated on acoustic grounds rather than on grounds of prosodic licensing.

§3.1 Phonotactic positions.

There are five distinct consonantal phonotactic positions in the word in Australian Aboriginal languages (Dixon 1980:159-178). These are presented in (2). Consonant clusters ($C_1.C_2$) are normally heterosyllabic.

(2) Word templates (Dixon 1980):

$C_{init}VC_{inter}V(C_{fin})$
$C_{init}VC_1.C_2V(C_{fin})$

C_{init}	Word-initial consonant
C_{inter}	Intervocalic consonant
C_{fin}	Word-final consonant
C_1	Pre-consonantal consonant
C_2	Post-consonantal consonant

As discussed by Dixon, consonants in word-initial position (C_{init}) and consonants in the second position of a word-internal cluster (C_2) show similar, but usually distinct, phonotactic constraints. Obstruents are more highly valued than sonorants in these positions, and non-coronals are less marked than coronals. In addition, word-final consonants (C_{fin}) and consonants in the first position of a cluster (C_1) are similar in their phonotactics. In these positions sonorants are less marked than obstruents and coronals are less marked than non-coronals. Intervocalic position (C_{inter}) stands out as the only structural position in the word where all of the consonants in the inventory of the language in question are in contrast. The five consonantal phonotactic positions can be organised into three classes, grouped together by similarity in phonotactics (3).

(3) Classes of positions based on similarity in phonotactic patterns.

a. Class I	C_{init}	(i.e., #<u>C</u>V)	{ Obstruents less marked than sonorants
	C_2	(i.e., C.<u>C</u>V)	Non-coronals less marked than coronals
b. Class II	C_1	(i.e., V<u>C</u>.C)	{ Sonorants less marked than obstruents
	C_{fin}	(i.e., V<u>C</u>#)	Coronals less marked than non-coronals
c. Class III	C_{inter}	(i.e., V<u>C</u>V)	{ All segments in contrast

Note that these phonotactic position classes are defined in terms of their vocalic context: C_{init} and C_2 both are prevocalic positions and thus have only release cues; C_{fin} and C_1 are postvocalic positions, lacking release cues; C_{inter} is the only position where consonants have acoustic cues in the the V-C and the C-V transitions.

Many have proposed that consonantal phonotactic constraints relate to prosodic positions (syllable onsets and codas) (see the *Prosodic Licensing* literature, Itô 1986, 1989, Goldsmith 1990, Itô & Mester 1993, Blevins 1995). However, the Australian positions are

not definable in prosodic terms. C_{inter} is not a position which has any unique prosodic status: it is an onset but does not exhaust the class of onset positions in the word templates of Australian languages. C_{init} and C_2 are both onsets but have neutralisation of place features, in contrast with C_{inter}. Therefore some onset positions show phonotactic constraints but intervocalic onsets do not. This is problematic for a prosodic theory of phonotactic positions since there is no way to distinguish between these two types of onsets in purely prosodic terms. A recurring theme in this thesis is that Australian Aboriginal phonotactics are best formalised in segmental rather than prosodic terms. See the discussion in §3.5 and §4.12 for further critique of prosodic licensing.

In this chapter the focus is restricted to the phonotactic behaviour of segmental representations with an intervocalic consonantal place feature: C_{inter} and homorganic C_1C_2 clusters.

§3.2 Intervocalic position as the position of maximal contrast for place features.

Intervocalic position stands out as the only environment where all consonantal place contrasts are active. This is shown in (4), with data from Kalkatungu. Kalkatungu has six contrastive places of articulation. All six places contrast in C_{inter}. Data illustrating these contrasts for the stops and nasals are given in (4).

(4) Full range of place contrasts active in intervocalic position: Kalkatungu data.

	Stop place contrasts in C_{inter}.			c. Nasal place contrasts in C_{inter}.		
labial	[p]	mapa	*head*	[m]	ŋamaɳa	*chest*
lamino-dental	[t̪]	wat̪ara	*come up*	[n̪]	yaŋkan̪a	*alone*
apico-alveolar	[t]	kata	*cover*	[n]	n̪ani	*who*
apico-postalveolar	[ʈ]	paʈa	*mud*	[ɳ]	waɳa	*mound*
lamino-alveopalatal	[c]	kaca	*dew*	[ɲ]	n̪aɲi	*see*
dorsal	[k]	t̪akar	*neck*	[ŋ]	kaŋa	*poison*

In all of the other phonotactic positions in the word in Kalkatungu only a subset of the place contrasts occur. In heterorganic N(asal)-O(bstruent) clusters severe constraints apply to the place of articulation of both segments. Only apico-alveolar and postalveolar segments occur in C_1 and labials and dorsals in C_2. The two laminal articulations do not occur in either position. There is neutralisation at word edges as well. The contrast between the two apical series is neutralised in C_{init}, and only three coronal series out of the six contrastive place series occur in C_{fin}. Kalkatungu is typical of the Australian Aboriginal languages: the full range of phonemic place contrasts are present in C_{inter}, and an impoverished subset of these contrasts is licensed in other structural positions.

§3.3. The special status of homorganic clusters.

Nearly all Australian Aboriginal languages allow both homorganic and heterorganic N-O clusters. But the phonotactic patterns indicate that homorganic N-O clusters are less marked than heterorganic clusters. First, heterorganic clusters imply homorganic N-O clusters cross-linguistically. Second, homorganic clusters occur at higher frequencies in languages which permit both.

§3.3.1 Markedness as demonstrated in implication.

From a cross-linguistic perspective languages which have N-O clusters divide into those which permit homorganic clusters only and those which have both homorganic and heterorganic clusters (Prince 1984:242-243, Clements 1990:321-322; see the typologies of syllable phonotactics in Goldsmith 1990 and Blevins 1995). There are no languages in which heterorganic N-O clusters are Φ (well-formed, licensed) while homorganic clusters are *Φ (ill-formed, unattested). Within Australia, the vast majority of languages allow

both types of clusters, but Tiwi and Anguthimri are examples of Australian languages allowing only homorganic N-O clusters.[1] The inventories of N-O cluster-types are given in (5.a,b): languages which allow only homorganic N-O clusters (5.a) and languages which allow both homorganic and heterorganic N-O clusters (5.b). There are no known examples of languages which permit heterorganic but not homorganic N-O clusters (5.c).

(5) Distributional generalisation: word-internal N-O clusters.
a. {homorganic N-O}
b. {homorganic N-O; heterorganic N-O}
c. *{heterorganic N-O}

Greenberg 1978:253-254 observes that the same implicational relationship between homorganic and heterorganic clusters is attested at word-edges. Certain languages allow homorganic N-O clusters to occur word-initially (8.a). An example language is Kalkatungu (data in (6) are from Blake 1979a:12).

(6) Kalkatungu word-initial homorganic N-O sequences: mpuː, *rotten*; n̪t̪iː *rouse*; ɳʈia, *stone*; ɲca- *sniff*; ŋkaː, *yam*.

A small number of other languages permit both homorganic (7.a) and heterorganic (7.b) N-O sequences word-initially (8.b). Data in (7) are from Kuku-Thaypan (Rigsby 1976).

[1]The only clusters in Tiwi are homorganic N-O sequences. In Anguthimri, N-O sequences are necessarily homorganic, but heterorganic cluster types are attested, especially non-continuant plus glide sequences. Anindilyakwa may be another example of a language which lacks heterorganic N-O clusters, if the reported dorsal plus labial sequences are to be analysed as complex segments (see the entry for Anindilyakwa in Apendix B).

(7) Kuku-Thaypan word-initial N-O sequences:
a. mpu, *urine*; n̪t̪er, *tongue*; nta, *shoulder*; ɲcun, *scorpion*; ŋker, *flesh, muscle*
b. npajl, *hot*; nkje- *sit*.

There are no languages in Australia which permit heterorganic but not homorganic N-O clusters word-initially.

(8) Distributional generalisation: word-initial N-O clusters.
a. {homorganic N-O}[2]
b. {homorganic N-O; heterorganic N-O}[3]
c. *{heterorganic N-O}

---

[2]Languages: Alawa, Alyawarra, Andegerebenha, Anguthimri, Arrernte, Garawa, Kalkatungu, Mbabarram, (Warlpiri), Yanyuwa. In several of these languages the homorganic N-O sequences have been proposed as unit pre-nasalised stop phonemes (see Sharpe 1972:16 on Alawa, Crowley 1981:155 on Anguthimri, Kirton & Charlie 1978:189 on Yanyuwa). Many authors of language descriptions treat word-initial distribution as the litmus test on this question: if a language permits homorganic N-O clusters in C_{init} then they are analysed as single segments. This is considered as constituting a simplification of the word-initial phonotactics of these languages, to maintain an otherwise strict "only single segments occur initially" word template. Warlpiri has one word with an initial cluster, [mp], leading the author of one description of Warlpiri phonology, Jagst 1975, to analyse all of the homorganic N-O sequences as unit phonemes, both word-initially and intervocalically.

The simple fact that sequences of segments can occur at word-edges should not force us to consider them unit phonemes, as demonstrated by the presence of heterorganic N-O sequences at both word-edges in some Australian languages. Also, in many of these languages with the proposed pre-nasal phonemes, they do not occur word-finally. But there is also positive evidence in Australian phonology that homorganic and heterorganic N-O sequences are treated identically. See discussion in Hamilton 1989, and the treatments of nasal dissimilation in Hercus 1994:57-59 on Arabana-Wangkangurru, McConvell 1988 on Gurindji, Blake 1979a:18-19 on Kalkatungu, Heath 1981:53-54 on Marra, Sutton 1978:241-242 on Wik-Ngathana, Wordick 1982:33-35 on Yindjibarndi. In nasal dissimilation, root-internal N-O clusters, both homorganic and heterorganic, condition dissimilation of a N-O cluster at a suffix juncture (Kirton & Charlie 1978:189 admit that this is problematic for their unit phoneme analysis of homorganic N-O sequences in Yanyuwa). However, recent work by Steriade 1993b on the structure of partially nasal segments makes homorganic N-O clusters and pre-nasal stops look very similar in structural terms. This largely obviates the issue here.

[3]Languages: Aghu-Tharrnggala, Kuku-Thaypan, Kurrtjar.

The same implicational relationship between homorganic and heterorganic N-O clusters is attested word-finally as well. One language which allows homorganic but not heterorganic N-O sequences word-finally is Nyungar. Data from Nyungar are presented in (9).

(9) Nyungar word-final homorganic N-O clusters: jump, *death magic*; ŋunt, *elder brother*; ŋuɳʈ, *chest*; maɻaɲc, *vegetable food*; jimuŋk, *forehead*.

Several Australian languages permit both homorganic and heterorganic N-O clusters word-finally. Illustrative data from Olkol are given in (10). Word-final homorganic N-O sequences are in (10.a) and heterorganic N-O sequences in (10.b). Crucially, there are no languages which have heterorganic but not homorganic N-O clusters word-finally (10.c).

(10) Olkol word-final N-O sequences
a. amp, *pronominal*; an̪t̪, *pubic covering*; ant, *small*; aŋaɲc, *nothing*; aŋk, *leaf sp.*;
b. ank, *gallery rainforest*; anp, *river bank*.

(11) Distributional generalisation: word-final N-O clusters.
a. {homorganic N-O}[4]
b. {homorganic N-O; heterorganic N-O}[5]
c. *{heterorganic N-O}

The implicational relationship in the distribution of word-final homorganic and heterorganic N-O clusters is the same as has been observed word-internally and initially.

The generalisation which emerges from this discussion is that heterorganic N-O

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[4]Languages: Nyungar. Also, Madhimadhi has [nt] as its only word-final cluster.

[5]Languages: Kok-Narr, Kurrtjar, Olkol, Oykangand, Yirr-Yorront.

sequences imply homorganic clusters cross-linguistically, and this relationship obtains in all structural positions where clusters are permitted.

§3.3.2 Markedness as demonstrated in frequency asymmetries.

The second major indication of the phonotactically harmonic status of homorganic N-O clusters comes from frequency disparities. When one counts the N-O clusters in the lexicon of an Australian language it quickly becomes apparent that homorganic sequences outnumber heterorganic clusters by a considerable margin. Thompson 1988:9 gives data for the total numbers of occurrences of the permitted word-medial consonant clusters in Kuuku-Ya'u, using a lexicon of 1156 words. The numbers for the homorganic and heterorganic clusters are given in (12), demonstrating the unmistakable predominance of the homorganic clusters.[6]

(12) Occurrences of homorganic and heterorganic N-O clusters in Kuuku-Ya'u.

a.	mp	60	b.	np	8
	n̪t̪	47		nk	9
	nt	35			
	ɲc	49			
	ŋk	73			

Similar frequency disparities are attested between homorganic and heterorganic N-O clusters at word-edges in languages that allow these structures. My own survey of the

[6]Limilngan is unusual in its phonotactics of homorganic clusters. [mp] is the most frequently attested cluster, but all of the other homorganic N-O sequences are either very rare, occur only in suspected loan words, or are completely unattested. For example, [ŋk] is found only once and [n̪t̪] is not attested. Limilngan is truly unusual from the point of view of its phonotactics. To my knowledge it is the only language within Australia which does not unambiguously show homorganic N-O clusters as less marked than heterorganic N-O clusters since heterorganic clusters occur at relatively high frequencies.

vocabulary of Aghu-Tharrnggala in Jolly 1989 indicates that roots with initial homorganic clusters are common while only a handful have initial heterorganic N-O clusters. Similar observations regarding the frequencies of final clusters surface in Olkol vocabulary. Total occurrences of the homorganic and heterorganic N-O clusters in word-final position from the nominal vocabulary of the Oykangand and Olgol dialects are given in (13) (Hamilton, unpublished field notes).

(13) Occurrences of word-final homorganic and heterorganic N-O clusters in Olkol.

a.	mp	18	b.	np	6
	n̪t̪	7		nk	4
	nt	9			
	ɲc	15			
	ŋk	15			

In summary, the frequency facts discussed in this section clearly indicate that homorganic N-O clusters are less marked than heterorganic N-O clusters.

§3.4 Phonotactic symmetry between single segments and homorganic N-O clusters.

Another indication of the harmonic status of homorganic clusters is the fact that phonemic place contrasts are not neutralised in these clusters. In this way, single intervocalic consonants and intervocalic homorganic N-O clusters are symmetrical in the place phonotactics. I demonstrate this from Kalkatungu. I showed in (4) that all six places of articulation in Kalkatungu are in contrast in C_{inter}. Homorganic N-O clusters demonstrate maximal place contrastiveness as well, as shown in the data in (14).

(14) Kalkatungu place contrasts in homorganic nasal plus oral stop sequences.

labial	[mp]	campar	*saliva, phlegm*
lamino-dental	[n̪t̪]	kan̪t̪a	*head*
apico-alveolar	[nt]	wantaḷ	*mussel sp.*
apico-postalveolar	[ɳʈ]	paɳʈa-paɳʈa	*gecko sp.*
lamino-alveopalatal	[ɲc]	kaɲcali	*hang down*
dorsal	[ŋk]	waŋka	*leg*

Homorganic clusters stand in sharp contrast with heterorganic clusters. As discussed above, severe constraints apply to place features of segments in heterorganic N-O clusters in Kalkatungu. This is the final indication of the special status of homorganic clusters.

§3.4.1 On the feature content of homorganic clusters.

I propose that single intervocalic segments and intervocalic homorganic N-O clusters demonstrate identical place phonotactics because of their representational similarity: both possess a single intervocalic place feature. From the earliest work in autosegmental feature geometry it was assumed that homorganic clusters are linked to a single place feature instead of both segments being linked to adjacent instances of the same place feature (e.g., Steriade 1982, Clements 1985, and subsequent feature geometric work on homorganic clusters, such as Itô 1986 and other references listed below; and work on the OCP and place features, such as McCarthy 1981, 1986). Other representational frameworks of feature organisation assume that homorganic N-O clusters share a single place feature (as, for example, in the Articulatory Phonology framework of Browman & Goldstein 1989, 1992, in which both segments in a homorganic N-O cluster are characterised formally with a single oral gesture).

The notion that homorganic clusters possess a single place feature is indebted to

work on the structurally ambiguous status and behaviour of geminates (Steriade 1982, Prince 1984, Hayes 1986a, 1986b, Schein & Steriade 1986, *inter alia*). These works developed the notion that geminates have a single melodic position while at the same time occupy two timing and/or syllabic positions. Therefore rules or constraints referring only to the melody tier by necessity treat geminates as single segments. The same logic is extended to the place tier: constraints referring to the place tier are expected to treat single segments and homorganic clusters identically (Steriade 1982, Prince 1984:242-243, Clements 1990:321-322). Further evidence that homorganic clusters possess a single place feature comes from place assimilation processes. Hayes 1986a, 1986b analyses assimilation rules as the propagation of the place feature of one segment onto another segment by autosegmental spreading. This reinforces the doubly-linked representation of homorganic sequences.

The default realisations of single segments and homorganic clusters in some languages provide further evidence that they have similar place representations. Ngiyambaa contrasts dental and alveopalatal laminals in the vocalic contexts [a_a] and [a_u], as shown in the minimal pair in (15.a). Homorganic laminal N-O clusters also contrast in these environments, as shown in (15.b). In some vocalic environments the contrast between the two laminal series is not active. In these environments single intervocalic laminal consonants and homorganic laminal N-O clusters have default dental or alveopalatal articulation. When adjacent to the front vowel [i] the neutral laminal segments are realised as alveopalatal (15.c-d), and in the context [u_u] they are realised as dental (15.e). Data here are from Donaldson 1980:51-56.

(15) Contrastive and default articulation of laminals in Ngiyambaa.

a. laminal segments in contrast	kat̪al	*bough shed*
	kacal	*wooden water vessel*
b. homorganic clusters in contrast	wan̪t̪uka	*later on*
	maɲcu	*leech*
c. no contrast in environment i__a	kiNHar ([ɲ])	*thin*
	kiNH.THar ([ɲc])	*diarrhoea*
d. no contrast in environment a__ı	makaNHi ([ɲ])	*tree sp.*
	ya:NH.THipu ([ɲc])	*in a circle*
e. no contrast in environment u__u	ŋuruNHu ([n̪])	*crabhole*
	puNH.THu ([n̪t̪])	*sated*

These facts demonstrate that homorganic N-O clusters show the same pattern of allophony as single segments. This is elegantly understood under the assumption that both phonetic sequences are characterised with a single intervocalic place feature, motivated by the phonetic fact that both are articulated with a single laminal gesture of occlusion. Therefore these facts constitute evidence that single segments and homorganic clusters are both represented with a single place features, allowing for a unified treatment of this pattern of allophony in Ngiyambaa.

§3.4.2 Intervocalic place features and the perceptual theory of markedness.

It is clear from the discussion in the preceding sections that intervocalic position is unique as the position of maximal contrast of place features in Australian Aboriginal languages. In this section I argue that the special acoustic/perceptual status which intervocalic place features possess is responsible for their special phonotactic status. This special acoustic/perceptual status rests in the fact that place features are most salient when flanked by vowels.

Independent acoustic cues signal the place features of a consonant in the V-C context and in the C-V context (see discussion in §2.1.2.8). In the V-C context place

features are cued by vowel formant transitions, and in the C-V context place features are cued by vowel formant transitions as well as the burst properties of a plosive. An intervocalic consonant benefits from both sets of place feature cues, and as a result is more salient than consonants which are cued by only C-V or V-C properties. The consonantal positions which possess only C-V or V-C cues correspond to all of the positions of neutralisation: C_{fin} and C_1 segments possess only V-C cues and C_{init} and C_2 segments possess only C-V cues.

Not only do intervocalic consonants benefit from both sets of place cues, but they are also preserved from the obscuring influences of place cues exerted by an adjacent consonant, as in co-articulation. See the literature on gestural overlap and gestural hiding, such as Browman & Goldstein 1989, 1992, and the references therein. When distinct segments are co-articulated, their place cues are simultaneous, meaning that the less robust of the two sets of cues is perceptually weak. For example, it is well known that in English and other languages, the place cues of alveolar coronals are perceptually opaque under co-articulation with a following non-coronal (Gimson 1962, Bailey 1969, 1970, Blust 1979, Zsiga & Byrd 1990, Byrd 1992, Nolan 1992, Lamontagne 1993). Also, place assimilation, both historically and synchronically, is understood at least partially as an effect of overlapping of the place cues of two segments (Ohala 1990, Jun 1995). Intervocalic consonants by definition are not subject to these obscuring influences. Likewise, intervocalic homorganic clusters are defined by a single place feature which possesses both V-C and C-V place cues in a fashion similar to single intervocalic consonants. My proposal that features are unmarked in positions where they are perceptually robust predicts that homorganic clusters are less marked than heterorganic clusters since the homorganic clusters have a single place feature.

The free occurrence of place of articulation intervocalically receives a formal account in the perceptual theory of markedness, described in chapter 1 (§1.2.2). Recall that I proposed that constraints against the occurrence of features occur in a fixed ordering relationship based on the relative perceptual recoverability of the feature involved. The enhanced saliency of place features in intervocalic position means that *[place] constraints in C_{inter} are less strictly enforced than constraints referring to the same features in non-intervocalic positions. This may be expressed formally as a fixed constraint ordering: $*[place]^{CV}$, $*[place]^{VC} \gg *[place]^{VCV}$. Since intervocalic place features have more cues, the perceptual theory of markedness requires that $*[place]^{VCV}$ is the lowest ranked constraint. This hierarchy expresses the fact that consonantal place contrasts are universally more likely to be neutralised when adjacent to a consonant, as in heterorganic clusters, than when in intervocalic position. Place features are licensed in C_{inter} only at the cost of violating $*[place]^{VCV}$. But since it is the lowest ranked constraint, licensing place features in other structural positions implies that the same features are licensed in C_{inter} as well. This requires that place features are elaborated in C_{inter} before other positions. Therefore the inventory of place features licensed in C_{inter} corresponds to the traditional notion of the *phonemic* inventory of places of articulation.

§3.4.3 Prosodic licensing.

I have presented an account of homorganic cluster phonotactics in acoustic terms. I now present a critique of a recent account of the same patterns formulated in a theory of prosodic licensing. In this section I argue that the facts discussed in this chapter demonstrate that the formalism of prosodic licensing does not predict the attested special status which homorganic clusters display.

The preferential phonotactic status of homorganic clusters compared to heterorganic clusters has been discussed extensively in the literature and analysed within a variety of theoretical frameworks (Hankamer & Aissen 1974, Steriade 1982, Prince 1984, Itô 1986, 1989, Goldsmith 1990, Yip 1991, Itô & Mester 1993, Blevins 1995, Steriade 1995a). Recent approaches within the framework of *Prosodic Licensing* (Itô 1986, 1989, Goldsmith 1990, Itô & Mester 1993, Blevins 1995) emphasise the defective nature of the syllable coda position, proposing that it is unable to license the full set of consonantal features active in the language. Therefore these approaches are framed in notions of licensing relationships between units of prosody and segmental features.

The argument proceeds that the coda is inherently defective and thus subject to constraints on its ability to license consonantal feature contrasts which are permitted in an onset. Thus codas may contain only segmental content which they are able to license, or link to features licensed in an adjacent segment. A recent instantiation of this type of constraint applying to codas is the Coda Place Condition in Prosodic Phonology (Itô & Mester 1993, following on similar conditions in Itô 1986, 1989). This is a restriction on linking between a mora and a consonantal place node. The version of Prosodic Phonology presented in Itô & Mester 1993 expresses segmental licensing in terms of "safe prosodic paths" which are defined by path conditions on the linking between prosodic and segmental structure. Brief definitions of the relevant concepts are given in (16).

(16) Prosodic Phonology: an informal subset of basic concepts (Itô & Mester 1993)
a. *Prosodic Path* (informal definition): A prosodic path is a sequence of nodes and association lines connecting prosody and elements of segment structure.

b. *Safe Prosodic Path*: A prosodic path is safe iff it obeys all path conditions.

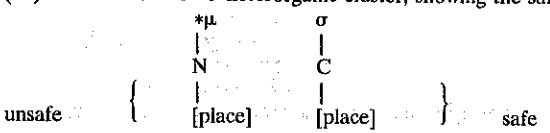
c. *Coda Place Condition* (a path condition active in Japanese): A path between a mora and a consonantal place node, μ-[place], is not safe.

*μ
|
[place]

d. *Segment Licensing* (informal definition): A node is licensed if it terminates at least one safe path; segments are licensed if their root[7] and place nodes are licensed.

The Coda Place Condition (CPC) (16.c) generates the pattern attested in languages that allow only homorganic clusters. In languages, such as Japanese, where surface forms are consistent with the CPC, the coda is unable to license an independent place node. In this case the coda segment may link to the place node of a following onset segment producing a homorganic sequence. As a result homorganic clusters are well-formed even if the coda is unable to license a place node since the segment "piggy-backs" on the place node in the following onset by autosegmental spreading. Heterorganic clusters (17) are impossible because the path from the coda mora to the place node it dominates is not safe (by the CPC) and so the place node does not terminate a safe path and the segment it is a part of cannot be licensed (16.d).

(17) Structure of a N-O heterorganic cluster, showing the safety status of each path.

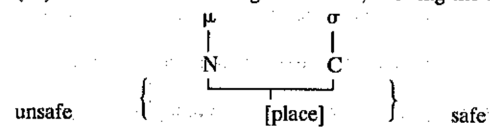


In Japanese homorganic clusters, the single place node terminates two prosodic paths,

[7]The licensing of root nodes is not relevant in the present discussion.

one initiated from μ, in a coda, and one from σ, in an onset. According to segment licensing (16.d), as long as at least one of those paths is safe then the place node itself will be licensed, and with it both segments in the cluster. The path from the coda μ to the place node is unsafe, ruled as such by the CPC, but there is no restriction on a place node occurring in the following onset. Therefore the path from σ is safe, the place node is licensed, and the structure of homorganic clusters in (18) is well-formed.

(18) Structure of a homorganic cluster, showing the safety status of each path.



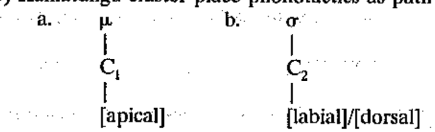
These types of prosodic accounts of the special status of homorganic clusters encounter problems in Australian Aboriginal languages. I will show here that one problem with the prosodic approach is that it cannot allow the set of features permitted in doubly-linked structures to exceed the sum of the features permitted independently in the two positions. I will use the language Kalkatungu to illustrate this. The combined place features contrastive in both positions in heterorganic clusters does not exhaust the set of places contrastive in homorganic clusters in Kalkatungu. Kalkatungu allows only apico-alveolars and apico-postalveolars in C_1 (19.a) and labials and dorsals in C_2 (19.b). Laminal segments are ∗Φ in either position in heterorganic clusters.

(19) Place contrasts in Kalkatungu heterorganic clusters.

a.	C_1 places	apico-alveolar
		apico-postalveolar
b.	C_2 places	bilabial
		dorso-velar

Following the prosodic licensing "safe paths" formalism discussed above, let's assume that these facts may be expressed as the following path conditions: The path from a coda mora to a C_1 place node specified with the apical articulator, μ-[apical] (20.a), is a safe path; and the path from a syllable to a C_2 place node specified with the labial or dorsal articulator, σ-[labial]/[dorsal] (20.b), is a safe path.

(20) Kalkatungu cluster place phonotactics as path conditions.

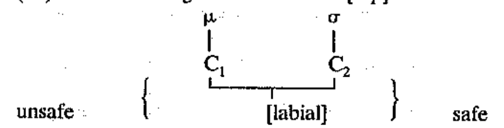


As a result, both of the relevant paths in a Kalkatungu apical+labial N-O cluster, such as in [aṉpa], *collect*, or [wanpa], "*double broom*" *instrument*, are safe. The path μ-[apical] of the C_1 segment is safe following (20.a) and the path σ-[labial] of the C_2 segment is safe following (20.b). Similar observations will apply to apical+dorsal clusters. The path conditions for Kalkatungu heterorganic clusters rule out clusters where either or both of the members are laminal, accurately reflecting the surface distribution of laminal segments in Kalkatungu.

Consider now the structure of homorganic labial or dorsal clusters, as in [campar], *saliva, phlegm* (21). The place node in this structure terminates the safe path σ-[labial].

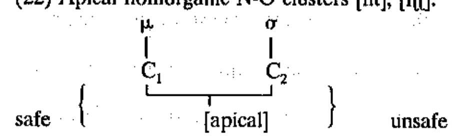
Because the place node is licensed in this way, labial articulation of the C_1 nasal stop is licit in spite of the fact that the path μ-[labial] is not safe. Therefore the structure in (21) is well-formed in Kalkatungu under a prosodic phonology account.

(21) Labial homorganic N-O cluster [mp].



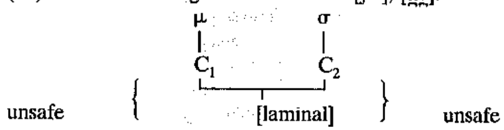
The homorganic apical N-O clusters [nt], [ṉṯ], as in the Kalkatungu forms [wantaḻ], *mussel sp.*, and [paṉṯa+paṉṯa], *gecko sp.* in (22) is well-formed for similar reasons. The place node in this structure terminates the safe path μ-[apical]. Therefore the place node is licensed and apical articulation of the C_2 oral stop is possible in spite of the fact that the path σ-[apical] is not safe. In this theory the two place nodes in (21) and (22) are licensed through prosodic paths initiated from different elements of prosodic structure.

(22) Apical homorganic N-O clusters [nt], [ṉṯ].



Finally, let us consider the structure for lamino-alveopalatal and lamino-dental homorganic N-O clusters. The path conditions (18.a,b) do not permit the laminal articulator to be licensed in either C_1 or C_2. Therefore both of the paths which the place node terminates in (23) are unsafe. Since the place node in this structure does not terminate a safe path, this structure is predicted as ill-formed. This is an undesirable result since homorganic laminal clusters are permitted in Kalkatungu, as in [kan̪t̪a], *head*, and [kaɲcali], *hand down*.

(23) Laminal homorganic N-O cluster [ɲc], [n̪t̪].



This and similar types of prosodic licensing accounts of Kalkatungu homorganic N-O clusters predict that laminal clusters are impossible since the laminal places are not independently licensed in either C_1 or C_2 in heterorganic clusters. As I have shown, this prediction is incorrect. Therefore prosodic licensing is inadequate as a theory of the special status of homorganic clusters.

§3.5 Summary of the unmarked status of homorganic N-O clusters.

In summary, intervocalic position is the position of maximal contrast for consonantal place features. In Australian Aboriginal languages, single intervocalic segments and homorganic clusters show maximal contrastiveness of place features. This fact is motivated on acoustic grounds, based on the assumption that features are more likely to be targets for neutralisation in contexts where they are not saliently cued. Central in this account is the fact that intervocalic place features have augmented saliency because they benefit from perceptual cues in both the V-C and C-V transitions. I have argued that this acoustic account is superior to competing theories of the special status of homorganic

clusters such as prosodic licensing.

§3.6 Homorganic L-O clusters.

In addition to homorganic N-O clusters, many Australian Aboriginal languages also have homorganic L-O clusters, discussed in this section. There is reason to believe that these clusters, like the homorganic N-O clusters, have a single place feature. Based on the representational similarity between homorganic N-O and L-O clusters, a natural assumption would be that homorganic L-O clusters show a similar unmarked phonotactic status. However, the distributional behaviour of homorganic L-O clusters reveals a marked status compared to homorganic N-O clusters, and even compared to *heterorganic* L-O clusters.

In this section, I demonstrate the marked status of homorganic L-O clusters, and propose an account of it. I propose that the two segments in L-O clusters are produced with distinct gestures of the same articulator (here I assume a definition of *gesture* indebted to work in Articulatory Phonology, Browman & Goldstein 1989, 1992). This is in spite of the fact that they are, strictly speaking, homorganic (because they involve the same articulator). I distinguish two types of homorganic sequences, monogestural and bigestural. Homorganic N-O clusters, in contrast with homorganic L-O cluster, are monogestural, and I propose a constraints formalism which expresses that they are unmarked because of this fact.

§3.6.1 Implication.

It is a clear pattern in Australian phonotactics that homorganic L-O clusters are marked compared to heterorganic L-O clusters and homorganic N-O clusters. I begin by demonstrating this from implicational patterns. Homorganic L-O clusters have a relatively restricted cross-linguistic distribution. They occur in a relatively small subset of languages which permit homorganic N-O clusters and heterorganic L-O clusters. Also, even among the languages which permit homorganic L-O clusters, not all permit the full set of clusters corresponding to each lateral phoneme. The table in (24) organises languages into three columns based on whether they disallow homorganic L-O clusters (24.a), or allow the full set (24.b), or permit only a subset of the possible clusters (24.c). The languages are organised horizontally according to their phonemic inventory of contrastive coronal places and their inventory of lateral segments (see chapter 2 for details; "1-1/lat0-1" means a 1-laminal/1-apical language with a single apical lateral, etc.).

(24) Cross-linguistic patterns in the distribution of homorganic L-O clusters:.

Inventory	a. Absent	b. Present-complete	c. Present-partial
(i) 1-1/lat0-1	Bandjalang		
	Djabugay		
	Gumbaynggir		
	Kuku-Yalanji		
	Nyawaygi		
	Warrgamay		
	Yaygir		
	Yidiny		
(ii) 1-1/lat1-1	MalakMalak		
	Nganyaywana		
(iii) 2-1/lat0-1	Anguthimri	Kuuku-Ya'u	
	Gog-Nar	Ngiyambaa	
	Kuku-Thaypan	Umpila	
	Mbabarram		
	Uradhi		
	Wik-Ngathana		
	Yuwaalaraay		
(iv) 2-1/lat1-1	Kurrtjar		
(v) 2-1/lat2-1	Anindilyakwa		
	Olkol		
(vi) 1-2/lat0-1	Wergaia		
(vii) 1-2/lat0-2	Gaagudju		Marra
	Mangarrayi		
	Ngalakan		
	Ngandi		
	Tiwi		
	Wambaya		
	Warndarrang		
(viii) 1-2/lat1-2	Garawa	Alawa	Djaru
	Gunin	Gugada	Nyigina
	Limilngan	Mantjiltjarra	Ungarinyin
	Madhimadhi	Murrinh-patha	Walmatjarri
	Ngarndji	Nyangumarta	Warumungu
	Warlmanpa	Pintupi	Watjarri
	Warlpiri	Yankuntjatjarra	
(ix) 2-2/lat0-1	Bidyara-Gunabula		
	Guugu-Yimidhirr		
	Kayardild		
	Wembawemba		
(x)2-2/lat1-1			Miriwung
(xi) 2-2/lat0-2	Djambarrpuyngu	Yukulta	Muruwari
	Djapu	Warndarrang	
	Gaalpu		
	Kukatj		
	Ngawun		
	Ritharrngu		
	Tharrgari		
	Yindjibarndi		
(xii) 2-2/lat1-2	Nunggubuyu	Yirr-Yorront	Gooniyandi
(xiii) 2-2/lat2-2	Badimaya	Alyawarra	Panyjima
	Bularnu	Arabana	Pitta-Pitta
	Jiwarli	Arrernte	Warluwarra
	Martuthunira	Baagandji	
	Payungu	Diyari	
	Yanyuwa	Garlali	
		Kalkatungu	
		Yandruwanhdha	

It is clear from this table that homorganic L-O clusters are permitted in a minority of languages, an initially surprising observation when compared with the pan-Australian distribution of homorganic N-O clusters.

There is no way of predicting whether a language allows homorganic L-O clusters.

It certainly cannot be predicted with complete accuracy from the phoneme inventory or any other obvious attribute. Ngiyambaa and Yuwaalaraay (24.iii), Warlpiri and Pintupi (24.viii), and Alyawarra and Yanyuwa (24.xii) are examples of pairs of languages with essentially identical phoneme inventories and phonotactic patterns from approximately the same regions of Australia. Furthermore, the pair of Ngiyambaa and Yuwaalaraay are quite close genetically. But in each case the two languages differ in that the first does and the second does not allow homorganic L-O clusters.[8]

§3.6.2 Frequency asymmetries.

Another indication of the marked status of homorganic L-O clusters is that they occur at lower frequencies than their heterorganic counterparts (in languages which permit both structures). This is the opposite of the behaviour of N-O clusters, where homorganic clusters are always more frequent than heterorganic clusters. Frequency data of the permitted word-medial L-O consonant clusters in Kuuku-Ya'u illustrate this (Thompson 1988:9). Kuuku-Ya'u has a single lateral phoneme, and so there is one possible homorganic L-O cluster.

[8] There is one variable in the phoneme inventories which shows a partial correlation to whether the language permits these clusters: languages which allow only apical laterals tend not to allow homorganic L-O clusters, while languages with laminal laterals tend to allow them. This tendency is most robustly seen in languages with place inventory 2-lam/2-apic. Of these languages, a majority of those which permit laminal laterals (xii and xiii) have homorganic L-O clusters; on the other hand, most of the languages without laminal laterals (ix and xi) do not allow them. I have no thoughts on why this is the case.

(25) Occurrences of heterorganic and homorganic L-O clusters in Kuuku-Ya'u.

a.	lp	23	b.	lt	2
	lt̪	11			
	l̄c	17			
	lk	36			

The low frequency of homorganic L-O clusters clearly indicates their marked status.

§3.6.3 Incomplete place contrasts in homorganic L-O clusters.

The third phonotactic asymmetry between homorganic L-O and N-O clusters is the presence of gaps in the set of expected homorganic L-O clusters in several languages. While there is always a full set of homorganic N-O clusters (one-to-one correspondence between nasal phonemes and homorganic N-O clusters), not all languages have a homorganic L-O cluster corresponding to each lateral phoneme. Languages which have an incomplete set of possible homorganic L-O clusters are listed in column (24.c).[9]

[9] Most of these languages have only the lamino-alveopalatal cluster [ʎc] (which in some is in contrast with the apical+laminal cluster [lc]) and lack the apical homorganic clusters [lt] and [ɭʈ]. The languages which have homorganic laminal L-O clusters but lack homorganic apical L-O clusters are Djaru, Nyigina, Panyjima, Pitta-Pitta, Ungarinyin, Walmatjarri, Warluwarra, Warumungu, Watjarri (see also Gooniyandi). The homorganic laminal cluster always has a low frequency. The absence of the apical clusters may thus be accidental in some cases, since it is expected to have a low frequency as well. This is suggested in Gooniyandi, which has [ʎc] a few times, [lt] as a marginal cluster attested once, and [ɭʈ] is not found. But most of these languages are concentrated in the north-west of Australia, suggesting that this pattern is an areal phenomenon, evidence that it is not accidental.

Pitta-Pitta and Warluwarra are both 2-laminal\2-apical languages with both laminal laterals; they have [l̪t̪] and [ʎc] but the apical clusters are not found. The descriptions of both lanuages are salvage studies, so this may be an effect of the size of the vocabulary database. Panyjima has the same phoneme inventory and has [ʎc], lacking the apical clusters and [l̪t̪]. Dench 1991:131 proposes that this pattern is systematic, deriving from the constraints on permitted heterorganic clusters. Noting that [ʎ] is independently well-formed in C_1 and [c] in C_2 in heterorganic clusters, he proposes that [ʎc] is the concatenation of these two segments. He explains the absence of [lt] and [ɭʈ] by appealing to the fact that [t] and [ʈ] are not permitted in C_2 in heterorganic clusters.

§3.6.4 Reversal in the markedness of manner features in homorganic clusters.

One final pattern shows that homorganic L-O clusters are more marked than homorganic clusters: homorganic L-O clusters occur at lower frequencies in languages which permit both. This is shown with frequency data from Ngaanyatjarra (Harvey ms.) (26).

(26) Ngaanyatjarra cluster frequencies: homorganic N-O and L-O clusters.

nt	29	lt	10
ɳʈ	29	ɭʈ	11
ɲc	13	ʎc	7

In chapter 5 I demonstrate that laterals are less marked than nasals in C_1 in certain classes of heterorganic clusters. But in homorganic clusters there is a reversal, as shown in (26): homorganic N-O clusters occur at higher frequencies than their homorganic L-O counterparts. This reversal of the markedness relationship between [nasal] and [lateral] in C_1 is further indication of the marked status of homorganic L-O clusters.

§3.6.5 The representation of homorganic L-O clusters.

We have seen clear evidence that homorganic L-O clusters are marked. This appears to contradict the patterning seen earlier: homorganic sequences and single segments have free distribution intervocalically, unlike heterorganic clusters. In this section I propose a gestural account of the marked status of homorganic L-O clusters.

Dentals do not occur in heterorganic clusters, and he would argue that this explains the absence of [l̪t̪] (note that [n̪t̪] is permitted). For a variety of reasons, this type of solution is not possible in Pitta-Pitta (laminals don't occur in either C_1 or C_2 in heterorganic clusters), Ungarinyin ([ʎ] isn't licensed in C_1), Warluwarra ([ʎ] isn't licensed in C_1 and [c] isn't licensed in C_2 following a lateral segment) and Warumungu ([c] isn't licensed in C_2 following a lateral segment). (See the entry for each language in appendix B.)

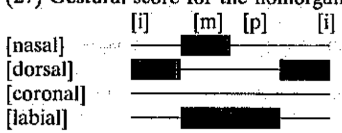
To highlight the representational similarity between homorganic L-O clusters and homorganic N-O clusters, I begin by briefly defending the premise that homorganic L-O clusters have a single place feature. First, place features are licensed in homorganic L-O clusters which are not otherwise licensed in the position in question. Apical stops occur in C_2 in the clusters [lt] and [ɭʈ]. Most languages do not permit apicals in C_2 in heterorganic clusters. Assuming that these clusters possess a single [apical] feature allows the apical oral stops to be licensed in C_2 in the same way they are in the corresponding N-O clusters [nt] and [ɳʈ], following the constraints formalism already described.

Second, stops frequently undergo place assimilation to an adjacent lateral, and *vice versa*. Evidence comes from alternations in morphologically complex forms. Suffix-initial coronal oral stops assimilate in place of articulation to root-final laterals in many Australian languages. See, for example, Blake 1979a:17 on Kalkatungu: /t̪ail+t̪u/ → [t̪ailtu], *firm-ergative*, and /wantaɭ+t̪u/ → [wantaɭʈu], *shell-erg* (stem-final nasals condition the same assimilation: /mucuɳ+t̪u/ → [mucuɳʈu], *chicken hawk-erg*). The spreading analysis of assimilation (Hayes 1986a, 1986b) requires that the assimilated clusters which are the output of these rules share a single place feature.

In spite of this representational similarity between homorganic N-O and L-O clusters, I argue that they differ in gestural complexity. In my account of the marked status of homorganic L-O clusters, I take as a starting point the notion of the gesture in Articulatory Phonology (AP, Browman & Goldstein 1989, 1992).

In AP, *gestures* are represented as features organised into bundles on tiers corresponding to the active articulators. There are tiers corresponding to the labial articulator (the LIPS tier in AP, or my [labial]), the coronal articulator (termed tongue tip, TT, by Browman & Goldstein, but it subsumes both the apical and laminal coronal sub-articulators; equivalent to [coronal]), the tongue body (TB, equivalent to [dorsal]), and the velum (VEL, equivalent to [nasal]).[10] A gesture on the velum (i.e., [nasal]) tier defines nasality. The tiers are parallel, and the features displayed on the tiers are assumed to have internal duration and thus are *phased* with respect to each other, allowing overlap between gestures on distinct tiers. This gives the formal representation of gestures in Articulatory Phonology the appearance of a gestural *score*. For example, the nasal segment [m] has synchronous gestures on the [labial] and [nasal] tiers. A gestural score for the sequence [impi] is presented in (27). The gestures are darkened. The single gesture on the [labial] tier is the labial articulation of both segments. The gesture on the [nasal] tier (the lowering of the velum) overlaps with only the first half of the period of the [labial] gesture, creating the homorganic N-O cluster. The [dorsal] gestures before and after the cluster are for the high front vowel [i]. There are no coronal gestures in the sequence [impi], and thus the [coronal] tier is empty.

(27) Gestural score for the homorganic sequence [impi].



In AP gestures are not merely slots on a tier. They are feature bundles, composed of the following featural information: Constriction location (CL), more commonly known as the passive articulator; constriction degree (CD), corresponding to aperture; and constriction

[10]They also assume a glottal articulator tier, which is not relevant here.

shape (CS), which denotes instances where segments differ in the shape of the articulator. The CD features for consonants are [closed] for non-continuants (oral and nasal), [critical] for fricatives and [narrow] for approximants. These correspond to [−cont], [+cont, −son] and [+cont, +son] in standard feature terms.

The constriction features (CL, CD and CS) are all crucial in the definition of a gesture. Two gestures are identical only where all of their features are identical. Therefore gestures which differ by only one of these features are formally non-identical, corresponding to distinct gestural events. This definition of gesture in AP is presented in (28).

(28) Gesture: Two gestures are identical only if they are produced by the same articulator and have identical place, aperture and constriction shape features.

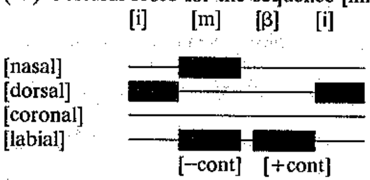
The [labial] gestures of the stop [p] and the nasal [m] are identical in this definition since they have identical place ([bilabial]) and CD ([−cont]) features.[11] These two segments differ in that [m] possesses an independent [nasal] gesture, but this is independent of their structures on the [labial] tier. In contrast, the bilabial stop [p] and the bilabial fricative [β] involve non-identical gestures, since they have different aperture features: [−cont] for the [m] ([closed] in Browman & Goldstein's terms) and [+cont] for the [β] (or, [critical]). A sequence of homorganic segments which differ in one (or more) of the constriction features is represented formally as two distinct gestures. A [mβ] sequence thus cannot be represented with a single [labial] gesture. Two segments are monogestural

[11]The gestures for these segments are also non-distinct in lacking constriction shape features.

only where they possess identical values for all of the features which define a gesture.

In these gestural terms, there are two types of homorganic clusters: those which involve a single gesture of an articulator (such as the [labial] gesture for [mp]); and those which involve two gestures by the same articulator. The cluster [mβ] is an example. Its gestural score, with two [labial] gestures, is presented in (29), for comparison with the score for the monogestural cluster [mp] (see (27)).

(29) Gestural score for the sequence [imβi].



This formalism provides insight into the well known asymmetry in the place assimilation of nasals to following obstruents. A variety of work has drawn attention to a significant cross-linguistic generalisation that homorganic nasal plus fricative clusters are more marked than homorganic nasal plus stop clusters (Clements 1987, Selkirk 1988, Padgett 1991). In AP, the bigestural complexity of homorganic nasal plus fricative clusters predicts that they are marked compared to the monogestural simplicity of homorganic nasal plus stop clusters.

This is hypothetical for Australian Aboriginal languages, since they typically do not have fricative phonemes. But similar observations apply to homorganic L-O clusters. Laterals and stops in the same place series have distinct stricture features, stops being obstruents and laterals being approximants. They are thus similar to the nasal+fricative

clusters, being characterised by non-identical gestures.

In their discussion of the representation of lateral sonorants in AP, Browman & Goldstein 1989:228-229 propose that laterality is represented by a constriction shape feature on the [dorsal] tier, [narrowed], which describes the narrowing of the tongue mass to allow lateral airflow. They further propose that the [approximant] aperture feature of laterals is on the [dorsal] tier, and that lateral [coronal] gestures are [−cont], as in stops and nasals. This approach is problematic since it is inconsistent with both phonological and articulatory facts. It is generally recognised that there is a close association between lateral manner and coronal place, based on phonological evidence (Rice & Avery 1991a, Shaw 1991 and Blevins 1995). Furthermore, the coronal articulator, as defined by Keating 1991, is in different positions for central and lateral segments. The rim of the tongue, defined as a part of the apical articulator by Keating (1991:31, following Ladefoged 1989) is lowered in the case of the apical lateral [l] but is raised making an articulation with the upper premolars and the sides of the alveolar ridge in the case of the apical stop, [t]. These facts indicate that [lateral] is to be considered a constriction shape feature of [coronal] gestures (in addition to the [narrowed] feature on the [dorsal] tier). Because of this, laterals and stops in the same place series have non-identical [coronal] gestures and the two segments in homorganic L-O clusters are formally separate gestures.

§3.6.6 Formalism of the marked status of bigestural homorganic clusters.

The formal assumptions in AP are not entirely satisfactory in how they resolve the marked status of homorganic L-O clusters. The formalism of gestures in AP requires that bi-gestural clusters have complex place structure. This allows an account of some of the marked properties of L-O sequences. However, a theory which requires homorganic L-O clusters to have a sequence of place features is contradicted by the strong evidence that these clusters have a single place feature from licensing and assimilation facts (as discussed above). At the same time, the definition of the gesture in AP plays an important role in predicting the marked status of homorganic L-O clusters.

I now set out in brief the properties of a theory which is able to account for the complex phonotactic behaviour of homorganic L-O clusters based on their gestural complexity while maintaining the observation that they have one place feature. I propose that heterorganic clusters and bigestural homorganic clusters are both marked, but in different ways. Heterorganic clusters are marked because of the perceptual complexity of consonants which possess only V-C or C-V transition cues (discussed in §3.4.2). This is expressed formally by the constraint ordering *[place]^{CV}, *[place]^{VC} $\gg$ *[place]^{VCV} Homorganic L-O clusters clearly possess both V-C and C-V place cues and thus are not marked on this count. Bigestural homorganic clusters, on the other hand, are complex because of the inherent difficulty in executing a sequence of gestures by the same articulator at the same place of articulation. Sequences of gestures preferentially use independent, spatially compatible articulators, thus allowing for temporal overlap of adjacent segments (Lindblom 1983:240). Homorganic laterals and stops cannot be overlapped and in this regard such sequences are marked. I formalise this with a *COMPLEX constraint, expressed in (30).

(30) *COMPLEX
Avoid sequences of consonants which involve distinct gestures by the same articulator.

Heterorganic L-O and N-O clusters such as [lp], [lk] and [np], [nk] are marked because

they violate *[place]^{CV} and *[place]^{VC}. These clusters do not violate *COMPLEX since the segments in each cluster are produced by different articulators. Homorganic L-O clusters such as [lt] and [ʎc] violate *COMPLEX, but they do not violate *[place]^{CV} and *[place]^{VC} since they have an intervocalic place feature. Homorganic N-O clusters do not violate any of these constraints: they are unmarked under *COMPLEX since they are monogestural; and they do not violate *[place]^{CV} and *[place]^{VC}. These facts are outlined in (31); asterisks indicate constraint violations.

(31) Constraints evaluation of L-O and N-O clusters.

Clusters	Constraint evaluation *[place]/C_V, *[place]/V_C	Constraint evaluation *COMPLEX
[lp]	* (marked)	(unmarked)
[lt]	(unmarked)	* (marked)
[np]	* (marked)	(unmarked)
[mp]	(unmarked)	(unmarked)

The constraint evaluation shown in this table demonstrates that the least marked cluster type is a homorganic N-O sequence. Whether a language elaborates heterorganic clusters or bigestural homorganic clusters depends on whether the constraints *[place]^{CV}, *[place]^{VC} or *COMPLEX are violated. The Australian facts indicate that *[place]^{CV} and *[place]^{VC} are more prevalently relaxed in these languages than *COMPLEX, since heterorganic clusters are more widely attested than homorganic L-O clusters. At the same time, the fact that homorganic L-O clusters possess a single intervocalic place feature allows them to demonstrate the special properties described earlier in this section, such as the licensing of the apical place features in C_2.

§3.7 Summary.

I have shown in this chapter that homorganic clusters have a special status in Australian Aboriginal languages. Homorganic N-O clusters are attested in all languages and at higher frequencies than other cluster types. Also, place features are attested in intervocalic homorganic clusters which are not permitted in either C_1 or C_2 in heterorganic clusters. I account for these facts based on the perceptual theory of markedness: intervocalic place features have more perceptual cues, and thus are unmarked.

Homorganic L-O clusters demonstrate some of these same special attributes of homorganic N-O clusters. For example, coronal stops (especially apicals) are often licensed in C_2 in these clusters when they are not licensed in that position in heterorganic clusters. This and other facts from assimilation alternations indicate that homorganic L-O clusters, like their N-O counterparts, have one place feature. However, homorganic L-O clusters are marked, shown in their restricted distribution cross-linguistically and their low frequencies language-internally. This marked status is elegantly accounted for by appealing to the notion of *gesture* from Articulatory Phonology. Drawing upon the notion, I have argued that homorganic L-O clusters are bigestural and homorganic N-O clusters are monogestural. Bigestural clusters are by definition more complex than monogestural clusters, allowing a felicitous account of the otherwise unexpected markedness of L-O clusters.

Chapter 4: Place phonotactics of heterorganic consonant clusters.

§4.0 Introduction.

In the preceding chapter I showed that the position of maximal contrast for consonantal place features, C_{inter}, is the context of maximal saliency of place features. I argue that this is because intervocalic place features possess more cues than place features in other environments. This finding is consistent with a theory that features are preserved in contexts where their perceptual cues are robust. Also in line with the perceptual theory of markedness is the fact that place features are neutralised in positions in which they possess only V-C or C-V cues. This is what obtains in heterorganic consonant clusters.

This chapter is a descriptive survey and theoretical treatment of the place phonotactics of heterorganic consonant clusters in Australian Aboriginal languages. The first section is a general introduction to the descriptive generalisations which I make from the data. I also introduce the constraints which formalise the phonotactic patterns. The following nine sections are devoted to discussion of nine distinct recurring patterns in the data. In each of these sections, I give a description of the pattern of markedness in question. Markedness is realised primarily in implication, but additional evidence comes from asymmetrical frequencies. I also discuss the important role which acoustic saliency and articulatory considerations play in motivating the markedness pattern and present a constraints formalism of the pattern.

§4.1 Constraints and markedness in place phonotactics.

There are nine recurring patterns in the phonotactics of place features in heterorganic clusters. These are discussed in sections §4.2 through §4.10. In considering these patterns all together, it becomes apparent that markedness relationships hold between the place features in C_1 and C_2, and that these markedness relationships are the opposite in these two positions. In Hamilton 1989 I described the markedness relationships through the use of a scale, shown in (1). The descriptive value of this place scale in Australian phonology is further investigated in Hamilton 1992, 1993c, to appear, Harvey 1992c and Evans 1995.

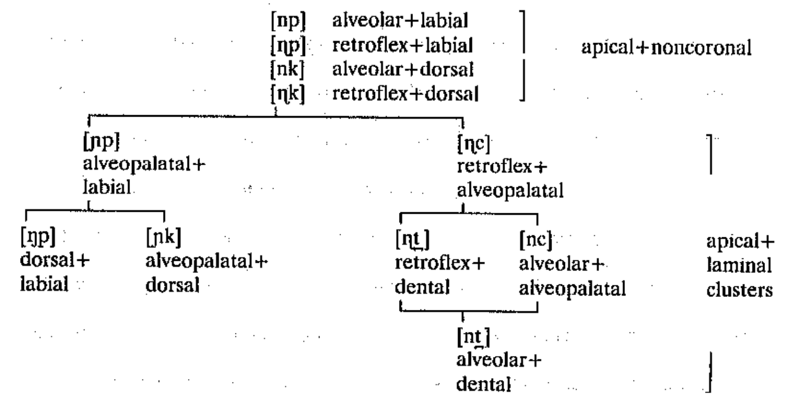
(1) The place scale (Hamilton 1989).
Labial > Dorsal > Laminal > Apical

This scale is to be read as follows: features to the right on this scale are less marked in C_1 than features to their left; and features to the left on this scale are less marked in C_2 than features to their right (2). The descriptive patterns of markedness expressed in these scales are the effect of the place constraints discussed in this chapter.

(2) Harmonic scales of place features in C_1 and C_2.
C_1: Apical ≻ Laminal ≻ Dorsal ≻ Labial
C_2: Labial ≻ Dorsal ≻ Laminal ≻ Apical

I now briefly present a descriptive typology of inventories of place contours in consonant clusters in Australian Aboriginal languages. The implicational relationships between place contours are presented in (3). This is a harmonic scale, with the least marked place contours at the top and more marked place contours occupying the lower branches in the diagram. Possible inventories of clusters are necessarily continuous portions of this harmonic scale, beginning from the top (see discussion of harmonic scales in §1.3.1).

(3) Path of elaboration of consonant clusters: place contours.



All of the pair-wise implicational relationships expressed in this chart (i.e., alveopalatal+labial clusters imply apical+noncoronal clusters, etc.) are demonstrated in detail in the body of this chapter. This harmonic scale predicts the ten inventories of place contours presented in (4.a-j). (Here I ignore the asymmetries between the apical+laminal contours; these are discussed in detail in §4.7 and §4.8.) The languages which show each pattern are listed; two of the patterns are unattested. I have primarily used the inventory of N-O clusters to determine the inventory of permitted place contours. Other cluster types, such as N-N and O-O clusters, often have fewer places (see chapter 6 for discussion).

(4) Place contour inventories drawn off harmonic scale (3).
a. apical+noncoronal [np], [nk] (etc.)

Languages: Arabana, Alyawarra, Arrernte, Diyari, Garlali, Gog-Narr, Kalkatungu, Kaytetye, Kuuku-Ya'u, Mbabarram, Nganyaywana, Ngawun, Ngiyambaa, Olkol, Pitta-Pitta, Uradhi, Wembawemba, Yandruwanhdha, Yaygir, Yuwaalaraay.

b.	apical+noncoronal	[np], [nk] (etc.)
	alveopalatal+labial	[ɲp]

Languages: Baagandji, Badimaya, (Bularnu), Nhukunu.

c.	apical+noncoronal	[np], [nk] (etc.)
	apical+laminal	[nc] (etc.)

Languages: Djabugay, Dyirbal, (Gugada), Kukatj, Nyawaygi.

d.	apical+noncoronal	[np], [nk] (etc.)
	apical+laminal	[nc] (etc.)
	alveopalatal+labial	[ɲp]

Languages: Djaru, Kayardild, Kitja, Yanyuwa, Yidiny, Yukulta.

e.	apical+noncoronal	[np], [nk] (etc.)
	alveopalatal+labial	[ɲp]
	alveopalatal+dorsal	[ɲk]

Languages: Bidyara, Marrgany, Muruwari, Nyungar, Warumungu.

f.	apical+noncoronal	[np], [nk] (etc.)
	apical+laminal	[nc] (etc.)
	alveopalatal+labial	[ɲp]
	alveopalatal+dorsal	[ɲk]

Languages: Bardi, Gaagudju, Garawa, (Gooniyandi), Jiwarli, Kuku-Yalanji, Mantjiltjarra, Nunggubuyu, Nyangumarta, Nyigina, Panyjima, Payungu, Pintupi, Walmatjarri, Warlmanpa, Watjarri, Yankuntjatjarra, Yawuru, Yindjibarndi.

g.	apical+noncoronal	[np], [nk] (etc.)
	alveopalatal+labial	[ɲp]
	dorsal+labial	[ŋp]

Languages: (unattested)

h.	apical+non-coronal	[np], [nk] (etc.)
	apical+laminal	[nc] (etc.)
	alveopalatal+labial	[ɲp]
	dorsal+labial	[ŋp]

Languages: Gunin (see also Jingili).

i.	apical+noncoronal	[np], [nk] (etc.)
	alveopalatal+labial	[ɲp]
	alveopalatal+dorsal	[ɲk]
	dorsal+labial	[ŋp]

Languages: (unattested, but see Bandjalang)

j.	apical+noncoronal	[np], [nk] (etc.)
	apical+laminal	[nc] (etc.)
	alveopalatal+labial	[ɲp]
	alveopalatal+dorsal	[ɲk]
	dorsal+labial	[ŋp]

Languages: Djambarrpuyngu, Djapu, Gaalpu, Marra, Ngalakan, Ritharrngu, Wambaya.

The lion's share (over three-quarters) of the languages in the database which this thesis is based on have one of these inventories of place contours. The other languages allow more complex inventories, but the core of clusters listed in the scale are generally present as well (for example, Djinang, Mangarrayi, Miriwung, Murinh-patha and Wardaman; see footnote in §4.6). A small number of languages have one or two clusters which appear anomalous. For example, Warluwarra has the cluster [mt̪] but otherwise is a very regular-looking pattern (4.a) language.

I discuss nine general patterns of markedness in the following nine sections of this chapter. Each is a pair-wise markedness asymmetry between two cluster types. These relations, taken together, motivate the constraints which produce the harmonic scale of clusters presented in (3). First, coronals (apicals and laminals) are less marked than noncoronals (labials and dorsals) in C_1, while the opposite relationship holds in C_2. In other words, heterorganic clusters are preferentially coronal+noncoronal, as discussed in §4.2. Among the noncoronals, labials are less marked than dorsals in C_2. Labials have a wider distribution in this position: dorsals imply labials in C_2 following a lamino-alveopalatal segment (discussed in §4.5). In C_1, however, dorsals are less marked than labials, since the unmarked noncoronal+noncoronal cluster is dorsal+labial (§4.10). Among the coronals, laminals imply apicals in C_1 (§4.3, §4.6) while the opposite relation holds in C_2 (§4.6). These patterns motivate the harmonic scales presented in (2).

Other phonotactic patterns which do not have a direct bearing on the place scale in (1) are also discussed in this chapter: lamino-alveopalatals are less marked than lamino-dentals in both C_1 (§4.4) and C_2 (§4.8); apico-postalveolars are less marked than apico-alveolars in apical+laminal clusters (§4.7); and heterorganic sequences of two apicals or two laminals are extremely marked (§4.9).

§4.1.1 Constraints.

There are two types of constraints which enter into my account of place phonotactics: constraints neutralising place features in consonantal positions lacking C-V acoustic cues and OCP-type dissimilarity conditions.

First, I assume a family of constraints neutralising place features in C_1, *[place]˺ (5) (Jun 1995). The symbol [˺], the IPA diacritic for unreleased consonants, refers to the absence of burst and vowel transition cues inherent in the C-V transition.

(5) C_1 place neutralisation.
*[place]˺ =[place] is marked in the absence of C-V release and vowel transition cues.

The form and function of these constraints correspond to similar negative constraints on place features assumed in Optimality Theory by Prince & Smolensky 1993, McCarthy 1994 and Kiparsky 1994. The neutralisation of place contrasts in syllable codas is

discussed in the constraints literature as well. I avoid reference to syllable position (see chapter 3 for arguments in support of this move) and assume acoustic facts in encoding releases and transitions in the formalism of the constraints (Jun 1995).

By *family* of constraints, I mean that there are distinct constraints referring to each consonantal acoustic place feature. Pre-consonantal position is well-known cross-linguistically as a position of neutralisation of place features, as demonstrated in the unmarked status of intervocalic consonants and homorganic clusters. Heterorganic clusters are licensed at the cost of *[place]˺ violations. In languages which exercise this option, including most Australian Aboriginal languages, there are asymmetries in which place features are licensed in C_1 and which are not. Within the perceptual theory of markedness, this is because the acoustic features occupy different positions on the continuum of relative robustness in C_1: different features are cued with different degrees of reliability when they lack release cues. For example, in English and many other languages, alveolar stops and nasals are assimilated in a coda. In Korean, coronals assimilate as in English and labials assimilate to a following dorsal segment, but dorsals are not neutralised in a coda (Iverson & Kim 1987, Cho 1990, Avery & Rice 1989, Rice 1994, Jun 1995; Avery & Rice report that labials also assimilate to following dorsals across a word-boundary in English fast speech phenomena). Jun argues that these facts may be accounted for on acoustic grounds through a fixed ranking of place constraints determined from the relative saliency of each feature when cued by V-C formant transitions alone. The facts from English and Korean indicate that dorsals are less likely than labials and alveolars to be neutralised. As discussed in §4.10, the same difference between labials and dorsals with respect to distribution in C_1 is attested in Australian Aboriginal languages.

The [+flat] feature of retroflexes and the [+sharp] feature of lamino-alveopalatals are very salient in the V-C transition. Because of the robustness of these place cues, the perceptual theory of markedness predicts that segments which possess these features are unmarked in C_I. This unmarked status is expressed formally as a low hierarchical ranking for *[+flat]' and *[+sharp]'. In my formalism of the Australian phonotactics, I propose the following hierarchical ordering of the *[place]' constraints (6). The evidence for this ordering is presented incrementally over the course of this chapter.

(6) Acoustic constraint scale:

*[+grave, −compact]' (i.e., labials) ≫
*[+grave, +compact]' (i.e., dorsals) ≫
*[−grave, +sharp]' (i.e., lamino-alveopalatals) ≫
*[−grave, +flat]' (i.e., apico-postalveolars)

This ordering is required to account for the markedness relationships between the place classes in C_I. There is no perceptual literature on the relative saliency of the features [+compact], [+sharp] and [+flat] in unreleased contexts. Therefore I cannot prove that this ordering falls out from the perceptual theory of markedness, i.e., that [+flat] is more salient in C_I than [+sharp], which in turn is more salient than [+compact]. However, impressionistic observations of segments with these features suggest that retroflexes and alveopalatals are more robust than dorsals. Language descriptions frequently make mention of the "r-colouring" of vowels preceding retroflexes and of the palatal off-glide of vowels preceding alveopalatals. Dorsals do not condition distinctive allophonic variation in preceding vowels as robustly and uniformly in Australian Aboriginal languages. These facts are consistent with the constraint ordering given above.

Since these constraints are expressed as restrictions on unreleased consonants, they apply to both C_I and C_{fin} segments. However, there is typically a wider range of place contrasts at the word edge position, with the segments occurring in C_I a subset of those occurring in C_{fin} (see Appendix A). This is undoubtedly because edge and non-edge positions have distinct cues, with word-final consonants often benefiting from release cues in the case of following sonorant-initial words, allophonic utterance-final vowel paragogy, or utterance final releases of consonants. All of these are cues which are unavailable to consonants overlapped by a following consonant. Therefore I assume that these constraints are implemented differently in these positions. See the discussion of word-edge phonotactics in appendix A.

I also assume a family of constraints under which adjacent occurrences of the same feature are marked (7). This is indebted to the Obligatory Contour Principle but recast as a constraint (Leben 1973, Goldsmith 1976, McCarthy 1986, Odden 1986, 1988, Yip 1988, Lamontagne 1993).

(7) Contour Constraint.
*[F][F] =Adjacent occurrences of [F] are marked.

The relevance of the OCP to consonant co-occurrence constraints, particularly with respect to place features, is well known (McCarthy 1981, 1986, Yip 1988, 1989). Note that these constraint have the surface effect of promoting dissimilarity between the sets of consonants which may occur in the two positions in consonant clusters. As discussed in §1.2, these constraint are motivated on articulatory and/or acoustic considerations. When motivated as an articulatory constraint, they reflect the conflict between the desire to overlap adjacent segments and the inability to overlap similar gestures (Lindblom 1983). When motivated as an acoustic constraint, they represent the marked status of clusters which lack *spectral modulation*. As discussed by Kawasaki 1982, low spectral modulation means that the perceptual cues of the two segments in the sequence are too similar for them to be reliably distinguished.

Kawasaki discusses a second determinant of recurring phonotactic patterns: the degree of acoustic difference between different sound sequences. She proposes that two sound sequences with similar acoustic properties incur perceptual confusion and thus are susceptible to merger. My account of two important phonotactic patterns crucially depends on the neutralisation of acoustically similar sound sequences; see §4.4 (see also the discussion of glide and vowel sequences in §5.2.1). In such cases, otherwise problematic phonotactic patterns are accounted for elegantly within a theory requiring the acoustic differentiation of sound sequences.

§4.2 The harmonic status of coronal+noncoronal place contours.

One robust pattern in heterorganic clusters in Australian Aboriginal languages is that they are predominantly, and in many languages exclusively, coronal+noncoronal. Bidyara-Gungabula is an example. In this language apical and laminal segments occur in C_1 and labial and dorsal segments occur in C_2. Data in (8) are from Breen 1973:21-22.

(8) Bidyara heterorganic N-O clusters

coronal+noncoronal	apical+labial	[np]	ŋunpita	*to swim*
	laminal+labial	[ɲp]	kuɲpit	*sweat*
	apical+dorsal	[nk]	punkaɲ	*turkey*
	laminal+dorsal	[ɲk]	paɲkalu	*old kangaroo*

*coronal+coronal
*noncoronal+noncoronal
*noncoronal+coronal

Bidyara is only one of many languages in Australia in which heterorganic N-O clusters are restricted to coronal+noncoronal place contours.[1]

Constraints interact to produce the unmarked status of coronal+noncoronal clusters. I propose that a Contour constraint against adjacent coronals, *[cor][cor], interacts with a *[place]' constraint to capture the Bidyara pattern. The constraint *[cor][cor] is motivated on both articulatory and acoustic grounds. As an articulatory constraint, it reflects that articulatory independence is an important factor in cluster structure. In other words, the task of producing a sequence of coronal articulations involves an inherent gestural deficit. As an acoustic constraint, it reflects the difficulty of the perceptual task of distinguishing a sequence of place cues which share the property [−grave]. Recall that [−grave] among consonants is the acoustic equivalent of [coronal], referring to the spectral attribute of F2 loci in the mid to upper frequencies. These two constraints, *[cor][cor] and *[−gr][−gr], have the same empirical effect since they refer to the same class of segments, but they are formally distinct. I will collapse them together as *[cor][cor].

---

[1]Languages which permit only coronal+non-coronal heterorganic N-O clusters: Alyawarra, Arabana, Arrernte, Baagandji, Badimaya, Bidyara, Bularnu, Diyari, Garlali, Gog-Narr, Kalkatungu, Kaytetye, Kuku-Thaypan, Kuuku-Ya'u, Marrgany, Mbabarram, Muruwari, Nganyaywana, Ngawun, Nganyaywana, Ngiyambaa, Nhukunu, Nyungar, Olkol, Pitta-Pitta, Ungarinyin, Uradhi, Warlpiri, Warumungu, Wembawemba, Yandruwanhdha, Yaraldi, Yaygir, Yuwaalaraay. For purposes of simplicity I have chosen to focus on the phonotactics of heterorganic N-O clusters. Some of these languages permit non-coronal segments in C_2 following laterals or the trill but this does not diminish the point which is being made.

I propose a second constraint, *[+grave]', which interacts with *[cor][cor] to produce the pattern in Bidyara. This constraint reflects that [+grave] transition cues are perceptually complex in C_1, and segments which possess this feature are marked. Noncoronals are marked cross-linguistically in both C_1 and C_{fin}, and language researchers report that in languages which permit [m] and [ŋ] word-finally these segments are very easily confused. In the historical phonology of Dalabon and Nunggubuyu forms with word-final *m have descended with [ŋ], thus resolving this confusion (Mark Harvey, pers. comm.). The facts indicate that [+grave] acoustic cues are not robust in C_1.

Ruling out noncoronals in C_1 (by *[+grave]') and coronal sequences (by *[cor][cor]) successfully reduces the set of licensed place contours to the coronal+noncoronal sequences. This is demonstrated diagrammatically in (9). In the four columns (9.a-d) I give the four possible sequences of coronals and noncoronals. In the two rows (9.i-ii) I give the two constraints which are responsible for the pattern.

(9) Constraint interaction: the harmonic status of coronal+noncoronal clusters.

	a.[np], etc. cor+noncor	b.[nc], etc. cor+cor	c.[ŋp], etc. noncor+noncor	d.[mt], etc. noncor+cor
i. *[+gr]'	(unmarked)	(unmarked)	* (marked)	* (marked)
ii. *[cor][cor]	(unmarked)	* (marked)	(unmarked)	(unmarked)

Cor+noncor clusters are the only ones which violate neither *[+grave]' nor *[cor][cor]. The pattern in Bidyara is captured by proposing that both constraints are unviolated.

This pattern requires that the coronal places are licensed in C_1. This is in violation of the *[place]' constraints referring to the [−grave] features which occur in that position. Therefore *[+gr]' is unviolated in Bidyara while *[−gr]' is violated. This may be

expressed as a fixed dominance relationship between *[+gr]' and *[−gr] (10).

(10) C_1 acoustic constraint hierarchy (to be revised):
*[+grave]' (i.e., noncoronals) ≫
*[−grave]' (i.e., coronals)

This dominance relationship formally expresses the fact that noncoronals imply coronals in Australian Aboriginal languages.

§4.3 Apicals less marked than laminals in C_1.

Having seen that coronal+noncoronal clusters have an unmarked status in Australian phonotactics, I now discuss the markedness asymmetry between the two coronal articulator features [apical] and [laminal] in C_1. Implication and frequency evidence indicates that apicals are less marked in this position than laminals. The implicational evidence comes from languages which permit apical segments but not laminals in C_1.[2] Kalkatungu is an example. As opposed to Bidyara, which permits both apical and laminal segments in C_1, Kalkatungu permits only apicals.

[2]Languages which permit apicals but not laminals in C_1: Alyawarra, Arabana, Arrernte, Badimaya, Diyari, Garlali, Kalkatungu, Kok-Narr, Kuku-Thaypan, Kuuku-Ya'u, Mbabarram, Muruwari, Ngawun, Ngiyambaa, Olkol, Oykangand, Pakanh, Pitta-Pitta, Umpila, Ungarinyin, Uradhi, Warlpiri, Yandruwanhdha, Yirr-Yorront, Yuwaalaraay.

(11) Kalkatungu heterorganic N-O cluster data

apical+noncoronal	apico-alveolar+labial	[np]	t̠unpun	*log*
	apico-postalveolar+labial	[ɳp]	aɳpai	*to collect*
	apico-alveolar+dorsal	[nk]	kunka	*branch*
	apico-postalveolar+dorsal	[ɳk]	aɳka	(no gloss)
*laminal+noncoronal				
*coronal+coronal				
*noncoronal+noncoronal				
*noncoronal+coronal				

Frequency data corroborate the unmarked status of apicals versus laminals in C_1. In (12) I present frequency data from a lexicon count of Ngaanyatjarra, reported in Harvey 1992. In Ngaanyatjarra, every heterorganic cluster with a laminal segment in C_1 has a counterpart cluster with an apico-alveolar segment in C_1, all else being equal. In every case the apico-alveolar C_1 clusters occur at greater frequencies.

(12) Ngaanyatjarra: the higher frequency of apicals versus laminals in C_1.

	Apical C_1		Laminal C_1	
N+labial stop	[np]	8	[ɲp]	2
	[ɳp]	6		
N+labial stop	[nm]	4	[ɲm]	1
	[ɳm]	5		
L+labial stop	[lp]	17	[ʎp]	7
	[ɭp]	14		
N+dorsal stop	[nk]	16	[ɲk]	1
	[ɳk]	8		
L+dorsal stop	[lk]	20	[ʎk]	12
	[ɭk]	9		

With regard to the phonotactics of apicals in C_1, almost every double-apical language licenses both apical series in this position, i.e., both the alveolar and postalveolar series occur. Thus both apical series are less marked than laminals in C_1.

The markedness asymmetry between apicals and lamino-alveopalatals in C_1 is the

result of both perceptual and articulatory constraints. (Lamino-dentals are even more marked than alveopalatals in C_1. This is discussed in §4.4. I ignore dentals in the discussion in this section.)

Recall from §2.2.3 that retroflexes are [+flat]. They are thus subject to the constraint *[+fl]'. The [+fl] feature is very salient in the V-C context, perceived as "r-colouring" on the preceding vowel. Since features are elaborated in contexts where they are salient, *[+fl]' is ranked low. The fact that retroflexes are less marked in C_1 than alveopalatals, which are [+sharp], is expressed formally by the constraint ordering *[+sh]' ≫ *[+fl]', allowing us to revise our ordering of *[place]' constraints (13).

(13) C_1 constraint hierarchy (to be revised):

*[+grave]'	(i.e., non-coronals)	≫
*[−grave, +sharp]'	(i.e., lamino-alveopalatals)	≫
*[−grave, +flat]'	(i.e., apico-postalveolars)	

The fact that retroflexes have robust cues in the V-C transition indicates that their preferential distribution in C_1 is an effect of the perceptual theory of markedness. As we have seen, apico-alveolars are also unmarked in C_1. However, given their acoustic features, they are predicted to be highly marked in this position under perceptual considerations. The tongue tip is the most agile of the active articulators, and so has the greatest inherent velocity. The denti-alveolar region is the site nearest to the neutral position of the tongue tip. Because of the agility of the tongue tip and its proximity to the alveolar ridge, apico-alveolar gestures have a shorter period than other articulations. Further, apico-alveolars by definition lack lip and tongue body gestures which modify the resonance of the oral cavity. As a result, the vowel formant transitions of alveolars are the briefest and the least robust of all the places. This means that alveolars are most vulnerable to gestural overlap. The place cues of alveolars are perceptually opaque in this context, and thus an exclusively perceptual theory of markedness predicts that apico-alveolars are marked in C_1.

The effect of gestural overlap on the place cues of coda alveolars has been studied extensively in the literature. It is well known that, in English and other languages, word-final alveolar stops and nasals are often perceived as assimilated in place of articulation to a following noncoronal (Gimson 1962, Bailey 1969, 1970). Nolan 1992 demonstrates from electropalatographic evidence that final alveolar gestures are present in these cases, but are reduced in degree to a variable extent. Nolan's experiment indicates that alveolar transition cues may be perceptually opaque in the environment of a following noncoronal segment. Acoustic experiments reported by Zsiga & Byrd 1990 and Byrd 1992 corroborate this. They demonstrate that vowel formant transitions in a [V-C_1-C_2] context, where the C_1 segment is alveolar, vary depending on the place of articulation of the C_2 segment. In forms such as 'bad pick' and 'bad kick', formant transition cues in the V-C context showed frequencies more typical of the following C_2 labial or dorsal rather than the C_1 alveolar. This indicates that the noncoronal gesture overlaps with the onset of the tongue tip gesture of the C_1 alveolar. The successful detection of a C_1 alveolar is therefore severely hampered by gestural overlap with a following noncoronal segment. In contrast with these facts, word-final noncoronals do not assimilate to a following coronal. This is proposed by Jun 1995 as an effect of the robust formant transition cues of noncoronals compared to alveolars (see further discussion in §4.10). He proposes a fixed constraint ranking in Optimality Theory whereby alveolar is the least stable place feature when lacking C-V release cues. Jun uses this to account for

the lack of alveolar plosives in pre-consonantal codas morpheme-internally in Korean and English, and for their synchronic assimilation to following segments across morpheme-boundaries. These acoustic facts account for the widely noted marked status of coronal+noncoronal clusters cross-linguistically (Blust 1979 and references therein, Steriade 1982, Lamontagne 1993).

Australian phonotactics fly in the face of these facts. Apico-alveolars are the least marked segments in C_1 preceding labials and dorsals. There is no reason to believe that Australian apico-alveolars possess some acoustic attribute which renders them salient in C_1 and which alveolars in languages such as Korean and English lack. Assuming that Jun is correct in proposing a fixed hierarchical ranking such that alveolar is highly marked pre-consonantally, these facts suggest that the account of the preferential distribution of alveolars in C_1 must appeal to articulatory rather than acoustic considerations. Alveolars are harmonic under the gestural theory of markedness, a constraint preferring configurations of least effort. For arguments showing the unmarked status of alveolars in gestural terms, see §1.2.1. Therefore Australian languages value retroflexes over alveopalatals in C_1 because the former are perceptually optimal, while apico-alveolars are valued over alveopalatals because alveolars are gesturally optimal. The fixed ordering relationships between the perceptual and articulatory constraints which we have seen to this point are presented in (14).

(14) C_1 constraint hierarchy (to be revised):

Acoustic constraints:	*[+grave]' ≫ *[−grave]', *[+sharp]' ≫ *[+flat]'
Articulatory constraints:	*[place] ≫ *[alveolar]

§4.4 Lamino-alveopalatals less marked than lamino-dentals in C_1.

There is another phonotactic pattern relevant to the marked status of laminals in C_1. Of the two laminal series, alveopalatals are less marked in C_1 than dentals. Among almost all of the double-laminal languages dentals are not permitted in this position. Australian languages are monolithic in the uniformity they show in this pattern: I am aware of only three languages which are reported to contrast dental and alveopalatal laminals in C_1, and even in these case the contrast is contextually limited.[3] Ritharrngu is a language which shows the majority pattern. This language contrasts dental and alveopalatal laminals in prevocalic positions (see data in (17) for demonstration of the dental/alveopalatal contrast in Ritharrngu), but in C_1 only alveopalatals occur. Analogous forms with lamino-dentals in C_1 are ∗Φ (ill-formed).

(15) Ritharrngu heterorganic clusters.

lamino-alveopalatal+labial	[ɲp]	kaɲpu	*string fishnet*
lamino-alveopalatal+dorsal	[ɲk]	piɲkur	*plant sp.*, Tectincornia australasica
∗lamino-dental+labial			
∗lamino-dental+dorsal			

The absence of lamino-dentals in C_1 in languages such as Ritharrngu is typically analysed as a neutralisation of the contrast between the two laminal series (Dixon 1980). However, I propose that the marked status of dentals in C_1 is actually the effect of the acoustic neutralisation of apico-alveolars and lamino-dentals. This pattern stems from the inability to distinguish alveolars from dentals in the absence of C-V release and vowel formant transition cues.

[3]Gooniyandi has both alveopalatals and dentals in C_1, but the only minimal contrast is between the clusters [ɲm] and [n̪m]. Miriwung is reported as contrasting [cp] with [t̪p], while all other laminal C_1 segments are alveopalatal: [ɲp], [ɲm], [ɲw], [ck], [ct] (note that [tp] is not reported in this language, possibly indicating that the cluster reported as [t̪p] was misheard and is in fact [tp]). McDonald 1977:119 reports that in Yaraldi the two laminal laterals are in contrast in C_1 in clusters preceding [k]; at the same time there is no evidence of a double-laminal contrast among nasals in C_1--only dental allophones are reported in this case. Therefore the C_1 double-laminal contrast in Yaraldi is extremely restricted. Furthermore, the source on Yaraldi is a salvage study based almost exclusively on taped material. It is tempting to assume that the Yaraldi facts have been misrepresented.

Recall from the discussion in §2.2.4 that alveolars and dentals in C_1 do not have spectrally distinct vowel formant transition cues and a release is normally required to distinguish them. Of the two laminal articulations, alveopalatals possess the more robust vowel formant transition feature [+sharp]. In languages which permit laminal segments in C_1, apical segments occur as well, as shown in the fact that laminals imply apicals there (§4.3). Therefore there is pressure to maximise the perceptual distance between these two classes of segments. Since the spectral cues of alveolars and dentals are identical in C_1, and this position does not benefit from release cues in the C-V transition to enhance the contrast between these two articulations, it is impossible to distinguish alveolars and dentals in C_1.

I follow Kawasaki 1982 in assuming that acoustically similar sound sequences are likely targets for neutralisation. Kawasaki argues that the degree of acoustic difference between two sound sequences is directly related to the likelihood of the two occurring in contrast. I propose that when a form [Φ] is perceptually ambiguous between two phonological forms F and F', F is assumed as the representation corresponding to [Φ] where F is less marked than F'. Since apico-alveolars are gesturally less complex than laminals, alveolars are less marked than lamino-dentals under the gestural theory of markedness. As a result, acoustically [−flat, −sharp] coronals in C_1 are assumed to be apico-alveolar.

I have argued in this section that dentals and alveolars are too similar in acoustic terms to be consistently distinguished in C_1, where they lack C-V burst and formant transition cues. The perceptual theory of markedness makes strong predictions about the phonotactic distribution of the dental/alveolar contrast. First, it predicts that a direct phonemic contrast between dentals and alveolars will be more restricted than other place contrasts. Second, it predicts that the contrast will be restricted to positions where its cues are salient.

These predictions are borne out since intervocalic position is the only context where dentals and alveolars appear in contrast in most Australian Aboriginal languages. All other positions lack either V-C or C-V cues, and these segments are seldom contrasted in these positions. For example, in C_{init}, the dental [t̪] occurs but the alveolar [t] is absent in many languages, either by a total restriction against apicals altogether or by default postalveolar articulation of apicals in this position (see discussion in Appendix A). At the same time, the contrast between these two articulations is attested word-initially. The presence of release cues, which appear to play a crucial role in this contrast, is undoubtedly responsible for this. But in languages where [t̪] and [t] are both present, the alveolar occurs at such a low frequency that the functional load of the dental/alveolar contrast is minimal.

To summarise, the distribution of the dental/alveolar contrast is heavily skewed into intervocalic position in Australian Aboriginal languages, the environment where place features are known to be most robust. I motivate the neutralisation of these two series from the fact that they have the same acoustic features, [−flat] and [−sharp]. Following traditional assumptions in phonology (Trubetzkoy 1939/1969), two segments may be neutralised only when they share some feature in common. Apico-alveolars and

lamino-dentals share no articulatory features which are not also shared by the two other coronal places as well: they differ in both articulator ([apical] versus [laminal]) and site ([alveolar] versus [dental]) features. The fact that alveolars and dentals share the features [−flat] and [−sharp] predicts that the contrast between them may be neutralised. This is important motivation for introducing acoustic features into the formalism of the coronal co-occurrence constraints. See §4.8 for development.

§4.5 The marked status of alveopalatal+dorsal clusters.

The fourth place phonotactic pattern in consonant clusters is the marked status of clusters containing two [high] segments. The [high] consonants are the lamino-alveopalatals and the dorsals (see §2.1.4). Baagandji demonstrates this pattern. In Baagandji, heterorganic N-O clusters are all coronal+noncoronal. Both apicals and lamino-alveopalatals are licensed in C_1. However, alveopalatals in C_1 are restricted to occurring preceding a labial segment, i.e., alveopalatal+dorsal clusters are ruled out. Therefore the place contours attested in heterorganic clusters in Baagandji are apical+labial (16.a), apical+dorsal (16.b) and alveopalatal+labial (16.c). The alveopalatal+dorsal place contour is *Φ (16.d) in spite of the fact that the laminal feature and the dorsal feature are independently well-formed in C_1 and C_2, respectively.

(16) Baagandji place contours.

a. apical+labial	[np]	panpuɭa	*wild cabbage*
	[ɳp]	paɳpa	*neck, throat*
	[lp]	palpa	*ashes*
	[ɭp]	wiɭpa	*waist*
b. apical+dorsal	[nk]	manku	*mouse sp.*
	[ɳk]	maɳku	*lower arm*
	[lk]	pilka-	*run away*
	[ɭk]	paːɭku-	*make a noise*

c. alveopalatal+labial	[ɲp]	puɲpa	*mushroom*
	[ʎp]	t̠aʎpa	*close by, near*
d. ∗alveopalatal+dorsal			

The pattern of allowing labials but not dorsals in C_2 following a laminal segment is not uncommon in Australian Aboriginal languages.[4]

I assume that the marked status of alveopalatal+dorsal clusters derives from the fact that both articulations are produced with a [high] gesture of the tongue body. The articulatory precision required in co-ordinating tongue body gestures in sequence motivates a constraint ∗[hi][hi]. In languages where this constraint is unviolated, alveopalatal+dorsal clusters are ∗Φ while alveopalatal+labial clusters are Φ; alveopalatal+labial clusters are licensed in this case only because labials are not [high]. Alveopalatal+dorsal clusters may only be licensed in violation of ∗[hi][hi].

§4.6 Apical+laminal as the unmarked coronal+coronal place contour.

Although coronal+noncoronal is the least marked structure for heterorganic consonant clusters, a wide and diverse range of languages permit sequences of heterorganic coronals. The generalisation in languages which permit coronal clusters is that the

[4]Languages which have [ɲp] but not ∗[ɲk] (i.e., which permit alveopalatal+labial but not alveopalatal+dorsal N-O clusters): Baagandji, Badimaya, Bularnu, Djamindjung, Djaru, Djinggili, Gunin, Kayardild, Kitja, Limilngan, Nakkara, Nhukunu, Yanyuwa, Yidiny, Yukulta.

Language which have [ɲm] but not ∗[ɲŋ]: Alawa, Bidyara, Djaru, Djinggili, Garawa, Gugada, Gumbaynggir, Jiwarli, Kayardild, Mantjiltjarra, Marra, Marrgany, Miriwung, Murinh-patha, Ngalakan, Nyangumarta, Nyungar, Panyjima, Payungu, Ritharrngu, Walmatjarri, Wambaya, Warumungu, Watjarri, Yankuntjatjarra, Yanyuwa.

Languages which have [cp] but not ∗[ck]: Garawa, Gunin, Kayardild, Kitja, Ngalakan, Ngandi, Wambaya, Warlmanpa, Warumungu, Yanyuwa, Yindjibarndi, Yukulta.

unmarked option is apical+laminal; laminal+apical clusters are marked.[5] Ritharrngu permits apical+laminal clusters; laminal+apical clusters are ∗Φ. Data from Ritharrngu are presented in (17).

(17) Ritharrngu apical+laminal cluster data:

apico-postalveolar+lamino-dental	[ɳt̪]	piɳt̪ar-u-	*to use bad language*
apico-alveolar+lamino-alveopalatal	[nc]	kanci	*stork*
apico-postalveolar+lamino-alveopalatal	[ɳc]	piɳcaraʔ	*axe*

The Ritharrngu pattern, allowing only the apical+laminal contour in coronal sequences, is the majority pattern among Australian languages.[6] The few languages which permit laminal+apical clusters always permit apical+laminal clusters. Therefore implicational evidence indicates that apical+laminal is the lesser marked coronal+coronal option. Furthermore, there is clear evidence even in the languages which permit both that the laminal+apical contour is marked. This evidence comes from frequency and feature co-occurrence facts.[7]

[5]Heterorganic clusters of two apicals or laminals are marked for reasons discussed in §4.9.

[6]Languages which permit apical+laminal N-O but not laminal+apical N-O clusters: Alawa, Bardi, Djabugay, Djambarrpuyngu, Djamindjung, Djapu, Djaru, Djinang, Jingili, Dyirrbal, Gaagudju, Gaalpu, Garawa, Gooniyandi, Gugada, Gumbaynggir, Gunin, Guugu-Yimidhirr, Jiwarli, Kayardild, Kitja, Kukatj, Kuku-Yalanji, Mangarrayi, Mantjiltjarra, Marra, Miriwung, Murinh-Patha, Ngalakan, Ngandi, Nunggubuyu, Nyangumarta, Nyawaygi, Nyigina, Panyjima, Payungu, Pintupi, Ritharrngu, Umbugarla, Walmatjarri, Wambaya, Wardaman, Warlmanpa, Warndarrang, Warrgamay, Watjarri, Wemba-Wemba, Yankuntjatjara, Yanyuwa, Yawuru, Yidiny, Yindjibarndi, Yukulta.

[7]Languages which permit laminal+apical clusters: Miriwung has [ct] as its sole laminal+apical cluster. In contrast, a wide range of different apical+laminal clusters are attested in Miriwung: [nt̪], [nc], [nɲ], [tc], [lc], [lɲ], [rc], [rt̪], [rɲ], [rj]. The greater range of manner features which may associate with the apical+laminal place contour is further evidence of its lesser marked status in spite of the fact that both apical+laminal and

In §4.3 I demonstrated that apicals are less marked than laminals in C_1 in coronal+noncoronal clusters. The unmarked status of the two apical series in C_1 accurately predicts that apical+laminal is the unmarked coronal sequence. There is one complication with this account of the marked status of laminal+ apical clusters. There are many languages which license laminals in C_1 in coronal+noncoronal clusters (by allowing [ɲp] and [ɲk], etc.), but exclude laminal+apical clusters. The fact that these languages permit laminals in C_1 indicates that violations of the constraints *[+sharp]' and *[laminal] are permitted in these languages. Also, the fact that these languages permit apical+laminal clusters indicates that they tolerate surface violation of *[cor][cor]. Based on these facts we predict laminal+apical clusters, which are in fact *Φ in all but a small number of languages. In chapter 6 I will develop a theory of cumulative markedness which will account for this problem. For now, suffice it to say that in the majority pattern clusters may violate *either* *[+sharp]' *or* *[cor][cor], *but not both.*

§4.7 Neutralisation of the double-apical contrast in apical+laminal clusters.

In this and the following section I discuss the phonotactics of apical+laminal clusters. I show that the following harmonic scale is attested (18), repeated from (3).

laminal+apical are permitted. I am not aware of published frequency data for Miriwung, but I predict that this language's one laminal+apical cluster has very low frequency. Murrinh-patha has [ɲt] attested in one form, compared with a range of apical+laminal clusters ([nc], [nɟ], [tc], [tɟ], [lc], [lj], [ɭj], [rc], [rj]), many occurring at relatively high frequencies. The low frequency of the one laminal+apical cluster in this language is consistent with markedness.

(18) Harmonic scale of apical+laminal cluster types.

[ɳc]
retroflex+alveopalatal

[ɳt̪]
retroflex+dental

[nc]
alveolar+alveopalatal

[nt̪]
alveolar+dental

This harmonic scale reflects two facts: apico-postalveolars are less marked than apico-alveolars in C_1, and lamino-alveopalatals are less marked than lamino-dentals in C_2. The former pattern is discussed in this section, and the latter pattern in the next. The constraints account of these two patterns is presented in §4.8.

In several languages the double-apical contrast is neutralised in C_1 preceding a laminal C_2. In the majority of these languages the neutralised apical is retroflex. I illustrate this pattern with data from Marra. In Marra apico-alveolars and apico-postalveolars contrast in C_1 in apical+labial (19.a) and apical+dorsal (19.b) clusters.

(19) Marra data: apical+noncoronal clusters.

a. apical+labial	[np]	manpar	*wound*
	[ɳp]	kaɳpara	*sugarleaf tree*
b. apical+dorsal	[nk]	mankiɻir	*killer*
	[ɳk]	paɳkipa	*fat green turtle*

In apical+laminal clusters, however, the C_1 apical segment is necessarily retroflex (19.c). These apical+laminal clusters are in contrast with homorganic laminal clusters (19.d).

(19) Marra data: apical+laminal and homorganic laminal clusters (here "N"=neutral apical nasal as default [ɳ]).

c. apical+laminal	wuNcur+wuNcur	*tree sp.*
	puruwaNci	*tree sp.*, Acacia holosericea
d. homorganic laminal	ŋuɲcu	*identical*
	ŋaraɲci	*grass (generic)*

Marra is a single-laminal language. In certain double-laminal languages the same pattern of neutralisation of apicals to retroflex in C_1 is attested, while both laminal series are in contrast in the following C_2 position. An example language is Kayardild. In this language, the attested apical+laminal N-O clusters are [ɳc] and [ɳt̪] (Evans 1985:513). Analogous forms with an apico-alveolar segment in C_1, such as [nc] and [nt̪] are *Φ in Kayardild.

Since coronal+coronal clusters are marked (§4.2), they occur at low frequencies. Therefore, in a language which has instances of [ɳc] but not [nc], or *vice versa*, in many cases this is likely to be an accidental gap. Evidence in certain languages suggests this. For example, Warlmanpa has [nc] as its only coronal+coronal N-O cluster ([ɳc] is not reported) and [ɭc] as its only coronal+coronal L-O cluster ([lc] is not reported). The fact that the missing N-O cluster has an alveolar C_1 while the missing L-O has a postalveolar C_1 suggests that these are gaps are accidental rather than systematic. For this reason, conclusions based on gaps in the inventory of coronal+coronal clusters must be made with caution. In certain languages, however, the evidence indicates that gaps are systematic. In these languages, all of the permitted apical+laminal clusters have a postalveolar C_1. In Yanyuwa and Garawa, [ɳc], [ʈc] and [ɳɲ] are the attested apical+laminal clusters. In all three clusters (N-O, O-O and N-N; these languages lack L-O and L-N coronal sequences) alveolars are not found preceding a laminal (i.e., alveolar+laminal N-O, O-O and N-N clusters are not reported: *[nc], *[tc], *[nɲ]). As in

Marra and Kayardild, both apical series are licensed in C_1 in coronal+noncoronal clusters. It is unlikely that the missing clusters are accidental gaps since it is specifically the alveolar series which is missing in each case. For other examples, Mantjiltjarra and Payungu have [ɳc] and [ɭc], lacking the counterpart clusters with alveolars in C_1 (i.e., *[nc] and *[lc]). Not in every case is postalveolar the default articulation of the neutral apical series, but this is the majority pattern.

The above facts all indicate that retroflexes are less marked than alveolars preceding a laminal segment. This proposition is further supported by evidence from allophonic assimilation of morpheme-internal alveolar+laminal sequences. Facts from Yukulta indicate that alveolars are more likely than retroflexes to assimilate to following laminal stops morpheme-internally. Yukulta contrasts the homorganic L-O sequences [l̪t̪], [ʎc] and heterorganic retroflex+laminal sequences [ɭt̪] and [ɭc]. Data are presented in (20).

(20) Yukulta data.

/lc/	[ʎc]	ka[ʎc]uɻu	*water goanna*
/ɭc/	[ɭc]	ka[ɭc]irulu	*kin term*
/lt̪/	[l̪t̪]	pu[l̪t̪]i+pu[l̪t̪]i	*rat*
/ɭt̪/	[ɭt̪]	pu[ɭt̪]aŋara	*flying fox*

Since Yukulta lacks laminal lateral phonemes, in a traditional generative framework the initial laterals in the homorganic laminal clusters may be assumed to correspond to apico-alveolars underlyingly (Keen 1983:195). This means that this assimilation is not structure preserving.[8] Djapu has a similar pattern to Yukulta. In this language, morpheme-internal /lt̪/ optionally assimilates to [l̪t̪], but /ɭt̪/ does not (/lc/ does not assimilate to [ʎc] for reasons discussed in §4.8). Like Yukulta, Djapu lacks laminal laterals.

In a related pattern, certain languages (Marra, Warndarrang) have a single fortis lamino-alveopalatal stop [cː] on the surface. This segment is in contrast with the standard series of stops in these languages, including [c], which are primarily lenis. These languages have the retroflex+laminal cluster [ʈc] but lack the corresponding alveolar+laminal cluster [tc]. Therefore [cː] may be analysed as underlying /tc/ (Heath 1981a:20 on Marra, Heath 1980b:8 on Warndarrang). (This analysis is further supported by the fact that stop clusters are fortis in these languages.) In this analysis, the alveolar, not the postalveolar, undergoes assimilation to the following laminal. The assimilation processes discussed here indicate that alveolars are more prone than retroflexes to assimilate to a following laminal.

The important observation to make here is that apico-alveolars are neutralised in apical+laminal clusters. This produces the pattern in which only apico-postalveolars occur in C_1 in these clusters. In spite of the preferential status which both alveolar and

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[8]Ngawun has the surface homorganic L-O cluster [ʎc] but lacks laminal lateral phonemes (see discussion at Breen 1981b:23). There are no phonetic apical+laminal L-O clusters. These facts indicate that assimilation to the following laminal stop has neutralised both apical laterals in this language.

In §3.6.3 I discussed that several languages have homorganic laminal L-O clusters but lack homorganic apical L-O clusters. In most of these languages, the homorganic laminal sequences ([ʎc], and in some languages [l̪t̪]) are in contrast with alveolar+ laminal sequences, [lc] and [lt̪] (see Djaru, Nyigina, Panyjima, Walmatjarri). Therefore, in these cases the homorganic clusters are not derived from clusters with an underlying alveolar C_1. However, a minority of these languages, including Ngawun, lack surface apical+laminal L-O clusters. In these cases it is possible to assume that homorganic L-O clusters are entirely absent underlyingly and are derived by assimilation (see also Ungarinyin, Warluwarra, Warumungu).

retroflex apicals have in C_1 preceding noncoronals, alveolars are the marked member of the two apical series when preceding a laminal. This pattern has acoustic motivation. In apical+laminal clusters, which are acoustically [-grave][-grave], the two place features are acoustically similar and therefore difficult to distinguish in sequence. As a result they are prime candidates to be perceived as homorganic sequences. However, retroflexes have robust acoustic cues in C_1. Retroflexes are [+flat], a feature very salient in the V-C transition (§2.2.2). Apico-alveolars, with the acoustic features [−flat, −sharp], have comparatively weak acoustic cues in C_1 (§4.3). Therefore the fact that retroflexes are less marked than alveolars in C_1 is consistent with the perceptual theory of markedness.

The pre-laminal neutralisation of alveolars is closely related to the phonotactic pattern described in the following section. I discuss the constraint formalism for both patterns at the end of that section.

§4.8 Neutralisation of the double-laminal contrast in apical+laminal clusters.

In the preceding section I showed that the double-apical contrast is subject to neutralisation in apical+laminal clusters. The double-laminal contrast is neutralised in apical+laminal clusters in certain languages as well. An example is Jiwarli. Jiwarli is a four-coronal language. Both apical series occur in contrast in C_1 in apical+laminal clusters. But only alveopalatals occur in the C_2. Therefore the contrast between the two laminal series is neutralised in this position, and the neutral laminal series has default alveopalatal articulation. The attested apical+laminal N-O clusters in Jiwarli are [nc] and [ɳc] (Austin 1992b). Analogous clusters with a lamino-dental segment in C_2, such as [nt̪] and [ɳt̪], are *Φ.

Additional evidence that alveopalatals are less marked in apical+laminal clusters comes from morpheme-internal alternations. In Djapu, another four-coronal language, /lt̪/ assimilates to [l̪t̪] but /lc/ does not assimilate (Djapu lacks phonemic laminal laterals). This indicates that dentals are more likely than alveopalatals to condition assimilation of a preceding alveolar and therefore are more marked in apical+laminal clusters.

Neutralisation of lamino-dentals in apical+laminal clusters is motivated on perceptual grounds. The place cues of a laminal C_2 segment must be distinguished from those of the preceding apical in order to successfully perceive the cluster as heterorganic. The formant transition cues of alveopalatals are more distinct from apical cues than those of dentals, by virtue of their [+sharp] attribute. Therefore, apical+alveopalatal sequences have greater spectral modulation than apical+dental sequences.

Neutralisation of dentals in C_2 is considerably less common than is the case in C_1 (§4.4). This may be an effect of the fact that dental stops may have a slightly affricated dental release (this is attested to varying degrees from language to language), which acts as a place cue in the C-V transition. Affricated release is strictly a C-V context place cue for stops, and is unavailable as a place cue for C_1 segments.

In certain languages, both of the neutralisation patterns discussed in this and the preceding section are attested. This is the case in Panyjima. Like Marra, Panyjima has a neutralised apical series in C_1. Also, in Panyjima the double-laminal contrast is neutralised in C_2. Panyjima data are presented in (21), with the four homorganic N-O coronal clusters in part (a) and the single heterorganic N-O coronal+coronal, with a retroflex apical in C_1 and an alveopalatal laminal in C_2, in part (b).

(21) Panyjima coronal clusters ("TH"=neutral laminal oral stop with default [c] realisation; "N"=default apical nasal stop realised as default [ɳ]).

a.	apico-alveolar	[nt]	canta	*lame*
	apico-postalveolar	[ɳʈ]	kaɳʈa	*teardrop*
	lamino-dental	[n̪t̪]	pan̪t̪ara	*jealous*
	lamino-alveopalatal	[ɲc]	waɲca	*dog*
b.	apical+laminal	N.TH	ŋaN.THa (i.e., [ŋaɳca])	*shingle*

Among double-laminal languages which permit apical+laminal clusters, the failure to license the contrast between the two laminal series in C_2 is common.[9]

The discussion in this and the preceding section indicates that alveolar is the marked member of the apical series in C_1 and dental is the marked of the two laminal series in C_2. Panyjima demonstrates both patterns since apical+laminal clusters are restricted to retroflex+alveopalatal sequences.

Nunggubuyu demonstrates both patterns as well, but in a different way. Nunggubuyu allows all apical+laminal clusters except the one which is *doubly-marked*, with an alveolar in C_1 and a dental in C_2. Nunggubuyu contrasts [n], [ɳ] and [ɲ] in C_1 preceding [c] in C_2 (i.e., [nc] ≠ [ɳc] ≠ [ɲc]). Nunggubuyu is also a double-laminal language which licenses both laminal places in C_2. Although alveolars are licensed preceding the alveopalatal [c], alveolars are neutralised in apical+dental clusters. Preceding [t̪] only [ɳ] and [n̪] are in contrast (i.e., [ɳt̪] ≠ [n̪t̪]), indicating default postalveolar articulation of an apical nasal in this context. The phone [n] does not contrast with [ɳ] preceding [t̪] (Heath 1984:20). The range of possible apical+laminal articulations and their status in Nunggubuyu is displayed in (22), with data in (23).

[9]Double-laminal languages which have alveopalatals but not dentals in C_1: Gooniyandi, Jiwarli, (Marra), Muruwari, Ngawun, Olkol, Panyjima, Payungu, (Warluwarra), (Warndarrang), Yandruwanhdha, Yanyuwa, Yindjibarndi, Yirr-Yorront.

(22) Nunggubuyu apical+laminal articulations.

Phonetic sequence	Articulatory description	In contrast?
[nc]	apico-alveolar+lamino-alveopalatal	yes
[ɳc]	apico-postalveolar+lamino-alveopalatal	yes
*[nt̪]	apico-alveolar+lamino-dental	neutralised
[ɳt̪]	apico-postalveolar+lamino-dental	yes

(23) Nunggubuyu apical+laminal cluster data.

[nc]	mancar	*leaves and branches*
[ɳc]	ŋaɳci	*baler shell*
[ɳt̪]	maːɳt̪a-	*to make (good)*

The fact that [nt̪] is *Φ in Nunggubuyu further corroborates that alveolars are marked in C_1 and dentals are marked in C_2 in apical+laminal clusters.[10] Four-coronal languages which allow this cluster (see Djapu and Gaalpu) typically allow the other three apical+laminal clusters as well.

There are five patterns in the apical+laminal cluster phonotactics. In the first, the double-apical contrast is neutralised in C_1 (to retroflex articulation) but both laminal articulations are licensed in C_2 (pattern A; Marra, Kayardild, Yukulta L-O clusters). In the second, the double-laminal contrast is neutralised in C_2 (to alveopalatal articulation) but both apical series are licensed in C_1 (pattern B; Jiwarli). In the third, the double-laminal contrast is neutralised in C_1 and the double-laminal contrast is neutralised in C_2, leaving only one well-formed cluster: retroflex+alveopalatal (pattern C; Panyjima). In the fourth, alveolar+dental clusters are *Φ but the other apical+laminal place contours are Φ (pattern D; Nunggubuyu). In the fifth pattern, all four apical+laminal sequences are licensed (pattern E; Djapu, Gaalpu). These patterns are presented diagrammatically in (24). These facts indicate that [nt̪] is the most marked apical+laminal cluster, and that

[10]Some other languages which show the same pattern here as Nunggubuyu are Djambarrpuyngu, Ngandi and Ritharrngu.

[ɳc] is the least marked.

(24) Apical+laminal place contour patterns of neutralisation.

		[nc]	[ɳc]	[nt̪]	[ɳt̪]
pattern A:	neutralised apical+contrastive laminal	*	Φ	*	Φ
pattern B:	contrastive apical+neutralised laminal	Φ	Φ	*	*
pattern C:	neutralised apical+neutralised laminal	*	Φ	*	*
pattern D:	contrastive apical+neutralised laminal *or* neutralised apical+contrastive laminal	Φ	Φ	*	Φ
pattern E:	contrastive apical+contrastive laminal	Φ	Φ	Φ	Φ

I now present a constraints formalism of the phonotactics of coronal+coronal clusters. The five patterns are the effect of the interaction of Contour constraints referring to the acoustic features [−flat] and [−sharp] vowel formant transitions of the four coronal series. The feature values of the four coronal articulations for the acoustic features [±flat] and [±sharp] are repeated in (25), from the discussion in §2.2.

(25) Coronal acoustic features.

	[±flat]	[±sharp]
lamino-dental	−	−
apico-alveolar	−	−
apico-postalveolar	+	−
lamino-alveopalatal	−	+

The relevant constraints are *[−fl][−fl] and *[−sh][−sh]. Under *[−fl][−fl], sequences of two [−flat] coronals are marked; under *[−sh][−sh], sequences of two [−sharp] coronals are marked.[11] The status of each cluster under these constraints is presented in (26).

[11]These constraints predict the hypothetical corresponding constraints *[+fl][+fl] and *[+sh][+sh]. These constraints have no effect in Australian Aboriginal languages, which have at most one [+flat] series and one [+sharp] series of coronals.

The constraint formalism of the five patterns is presented in the diagram in (27), and presented more fully in the subsequent discussion.

(26) Constraints account of markedness patterns in apical+laminal clusters.

	[nc]	[ɳc]	[nt̪]	[ɳt̪]
*[−fl][−fl]	*		*	
*[−sh][−sh]			*	*

(27) Apical+laminal place contour patterns of neutralisation.

	[nc]	[ɳc]	[nt̪]	[ɳt̪]	
pattern A:	*	Φ	*	Φ	*[−fl][−fl] unviolated; *[−sh][−sh] relaxed (Kayardild, Yukulta L-O clusters)
pattern B:	Φ	Φ	*	*	*[−fl][−fl] relaxed; *[−sh][−sh] unviolated (Jiwarli)
pattern C:	*	Φ	*	*	Both *[−fl][−fl] and *[−sh][−sh] unviolated (Panyjima)
pattern D:	Φ	Φ	*	Φ	*Either* *[−fl][−fl] *or* *[−sh][−sh] relaxed (Nunggubuyu)
pattern E:	Φ	Φ	Φ	Φ	Both *[−fl][−fl] and *[−sh][−sh] relaxed (Djapu, Gaalpu)

Pattern A is produced by the constraint *[−fl][−fl], since in each of the *Φ clusters, [nc] and [nt̪], both of the segments are [−flat]; the two attested clusters ([ɳc] and [ɳt̪]) are [+flat][−flat]. The functional correlate of this constraint is the following: distinct coronal places of articulation can be distinguished in sequence only when they differ in value for the feature [±flat].

Pattern B is produced by the constraint *[−sh][−sh]. This is because in each of the *Φ clusters, [nt̪] and [ɳt̪], both of the constituent segments are [−sharp]; the two attested clusters are [−sharp][+sharp]. The perceptual correlate of this constraint is the following: distinct coronal places can be distinguished in sequence only when they differ in value for the feature [±sharp].

Pattern C is the pattern present in grammatical systems where both *[−fl][−fl] and *[−sh][−sh] are unviolated. In this system, the three *Φ clusters are ruled out by either one, or both, of these constraints: [nc] violates *[−fl][−fl]; [ɳt̪] violates *[−sh][−sh]; and [nt̪] is ruled out by both *[−fl][−fl] and *[−sh][−sh]. The perceptual correlate of this pattern is the following: distinct coronal places can be distinguished in sequence just in case *both* the C_1 segment is [+flat] *and* the C_2 segment is [+sharp].

Pattern D is accounted for on the assumption that a violation of either one or the other of these two constraints is permitted, but clusters which violate both are *Φ. The perceptual correlate of this pattern is the following: distinct coronal places can be distinguished in sequence just in case *either* the C_1 segment is [+flat] *or* the C_2 segment is [+sharp]. Finally, pattern E is the pattern in a grammatical system where both *[−fl][−fl] and *[−sh][−sh] are relaxed, allowing all four apical+laminal sequences.

Note that *[−fl][−fl] and *[−sh][−sh] do not occur in a fixed order. This is shown in the fact that if one constraint is relaxed it does not imply that the other is as well. In pattern A, *[−sh][−sh] is relaxed but *[−fl][−fl] is not, and pattern B has the reverse.

§4.9 The marked status of heterorganic apical and laminal clusters.

There is one final phonotactic pattern relating to clusters of coronals, which I discuss in this section. Clusters of coronals that share the same articulator (apical or laminal) necessarily share the articulatory site as well. Data for apicals (28.a) and laminals (28.b) are given from Djapu (Morphy 1983).

(28) Djapu data: apical and laminal clusters are necessarily homorganic.

a. [nt] ʈuntu *friend*

[ɳʈ] miːɳʈuŋ *snail*

*[ɳt]

*[nʈ]

b. [n̪t̪] kuːn̪t̪a- *fetch, get*

[ɲc] kuːɲcu *beeswax*

*[n̪c]

*[ɲt̪]

This pattern is exceptionless in Australian languages, with a small number of provisos.[12] This generalisation applies to N-O and L-O clusters. It may be that heterorganic apical and laminal clusters are possible where one member is a glide, such as in /jt̪/ and /ɻt/, but the status of these cases is unclear: the glide in /jt̪/ is likely more dental than otherwise, and the stop in /ɻt/ is probably very close to [ʈ].

As the facts from Djapu demonstrate, hypothetical heterorganic apical clusters such as [nʈ] and [ɳt] are absent, as are heterorganic laminal clusters. An articulatory account for this pattern is readily apparent: all N-O clusters in Australian Aboriginal languages involve a single gesture of oral occlusion in the case of homorganic clusters, or a sequence of two gestures of oral occlusion by two distinct active articulators. A

[12]The most serious of these provisos is that Nyigina is reported as contrasting heterorganic and homorganic apical N-O clusters. Stokes 1982:24 provides the following minimal sets to illustrate this contrast: mantu, *foul*; manʈu, *louse*; maɳʈu, *pregnant*; cantu, *rear another's child*; canʈu, *woman*. Unfortunately, the author of this monograph does not provide any commentary on this extremely unusual phonotactic state of affairs. The second proviso: Wik-Nganhchara is reported as having heterorganic laminal clusters, the language name containing an example. Third, Australian languages also assimilate heterorganic apicals and laminals across morpheme (and word) boundaries, a phenomenon directly related to the morpheme-internal pattern. However, in some languages, heterorganic laminals are not assimilated when in contact at a morpheme juncture. See, for example, Djambarrpuyngu, where inchoative /–t̪u/ assimilates to a root-final lamino-alveopalatal nasal, but ergative /–t̪u/ does not (Wilkinson 1991:64-65). Djambarrpuyngu also has a borrowed lexical item with a heterorganic laminal cluster: cact̪u, *Thursday*.

sequence of two non-continuant occlusions by the same active articulator is clearly a gesture of considerable complexity. This can be expressed formally by OCP-type dissimilarity constraints on the coronal sub-articulator: *[apical][apical] and *[laminal][laminal].

The marked status of heterorganic apical and laminal clusters is a phonotactic pattern which has a straightforward articulatory account. But it can be understood in acoustic terms as well. I demonstrate this from the apical clusters. The prime vowel formant transition cues essential in the double apical contrast appear in the V-C context (§2.2.3). The spectral properties of both apical series are essentially identical at release (Anderson 1993). In apical clusters, a C_2 apical will be assumed by the listener to have the same site feature as the C_1 apical segment since it is in the V-C context where the cues relevant to this contrast are housed. Therefore, a contrast between alveolar and postalveolar articulation in C_2 is not possible following an apical segment.

§4.10 Dorsal+labial as the unmarked noncoronal+noncoronal place contour.

In the preceding sections we have seen that there is a distinct preference for coronal+noncoronal clusters (§4.2). I have shown that many languages contradict this tendency by elaborating coronal+coronal clusters (§4.4). A considerable number of languages also allow sequences of noncoronals. In these languages, dorsal+labial clusters are less marked than labial+dorsal clusters. This is shown primarily in implication: most of these languages allow dorsal+labial clusters and exclude labial+dorsal clusters. This is the case in Ritharrngu. Data of dorsal+labial clusters in Ritharrngu are given in (29).

(29) Ritharrngu heterorganic clusters.

dorsal+labial	[ŋp]	paŋpaḻaŋ	*brain*
	[ŋm]	ŋaŋmiri	*tern sp. (bird)*
	[kp]	ŋakpanŋa	*palm sp.*, Ptychosperma elegans
*labial+dorsal			

A wide range of languages demonstrate this pattern.[13] The few languages which permit labial+dorsal clusters also permit dorsal+labial clusters. Therefore implicational evidence indicates that dorsal+labial is the lesser marked of the two noncoronal cluster options. Even in the languages which permit both cluster types there is additional evidence, such as feature co-occurrence patterns, that the labial+dorsal contour is marked.[14]

The markedness asymmetry between dorsals and labials in C_1 has acoustic motivation. Dorsals have more salient V-C transition cues than labials. Jun 1995 uses this to account for why dorsals are less likely than labials to assimilate to a following consonant. This asymmetry is attested in Korean synchronic assimilation facts. In Korean, labials assimilate to a following dorsal but dorsals never assimilate to any place of articulation. This indicates that [dorsal] is less likely than other place features to be neutralised in a coda. Jun motivates this based on the distinct [+compact] vowel formant

[13]Languages which permit dorsal+labial but not labial+dorsal clusters: Alawa, Djambarrpuyngu, Djamindjung, Djapu, (Djaru), Djinang, Gaalpu, Gooniyandi, Gugada, Gunin, Limilngan, Marra, Nakkara, Ngalakan, Ngalkbun, Ngandi, (Nunggubuyu), Ritharrngu, Umbugarla, Wambaya, Warndarrang, (Yanyuwa).

[14]Languages which permit labial+dorsal clusters: Bandjalang has [mk] versus [ŋp] and [ŋm], the greater range of manner features which may associate with the dorsal+labial place contour being evidence of its lesser marked status (see discussion in chapter 6). Djinang has [mk], [mg] versus [ŋb], [kp], [km]. Djinggili has [mk], [pk] versus [ŋp], [ŋm]. Mangarrayi has [mk] versus [ŋp], [kp], [km]. Miriwung has [ŋp], [kp] versus [mk], [pk]. Murinh-Patha has [mg], [mŋ], [pk] versus [ŋb], [kp], [gb], [km], [gm]. Wardaman has [mk] versus [ŋp], [ŋm], [kp]. One language is problematic for the generalisation made in this section: Gumbaynggir has the labial+dorsal clusters [mk], [mŋ], while lacking dorsal+labial clusters.

transition cues of dorsals compared to labials and alveolar coronals, which have less distinct formant transitions. Lamontagne 1993:103-104 points out that labial+dorsal clusters are perceptually more complex than other clusters. He discusses a perceptual experiment reported by Repp 1983 indicating that the place features of labial+dorsal sequences are less reliably cued than in other place contours.

I follow Jun 1995 and assume that the [+compact] quality of dorsals makes them less likely targets for place assimilation in C_1. This salient spectral property of dorsals predicts that they are more stable in C_1 than labials and as a result are less prone to neutralisation in this position. The marked status of labials in C_1 relative to dorsals is expressed formally in the constraint ordering *[−compact]⌈ » *[+compact]⌈ among acoustically grave segments. The effect of this dominance relationship is that languages are less likely to permit surface violations of *[−compact]⌈ than is the case with *[+compact]⌈. In other words, labials, which are [−compact], are more likely to be ill-formed in C_1 than dorsals, which are [+compact]. Once this ordering between acoustic features is incorporated into the patterns we have already seen in this chapter, the resulting ordering of acoustic features is as presented in (30).

(30) Acoustic constraint scale:

*[+grave, −compact]⌈	(i.e., labials) »
*[+grave, +compact]⌈	(i.e., dorsals) »
*[−grave, +sharp]⌈	(i.e., lamino-alveopalatals) »
*[−grave, +flat]⌈	(i.e., apico-postalveolars)

§4.11 Cluster constraints as a challenge to prosodic theories of phonotactics.

Several of the phonotactic patterns discussed in this chapter are *cluster constraints*, or *sequencing effects*. In other words, these are constraints such that the set of place features permitted in one position of a cluster cannot be expressed without reference to the place feature of the segment in the other position. This aspect of cluster phonotactics is problematic within a theory of prosodic licensing. I now discuss why this is the case.

Prosodic licensing as an account of phonotactics is a strictly "vertical" relationship between prosodic positions and their dependent segments and features. A result of this is the principle of *Locality* (Itô 1986): there is no way for one prosodic position to influence the licensing of features in another position, even when the two positions are adjacent, such as in a heterosyllabic consonant cluster (i.e., a coda-onset sequence). This framework allows constraints/rules to have trans-syllabic effects but it is assumed that they have this power only when they refer exclusively to the feature melody. Constraints/rules which refer to higher levels of structure, such as positions in a syllable or word template, are constrained by Locality. As a result "horizontal" sequencing effects between consonants in the heterosyllabic C_1 and C_2 positions are inherently problematic within a prosodic licensing theory of phonotactics.

I begin by reviewing the patterns which are clearly cluster constraints and are problematic in a theory of phonotactics based on prosodic positions. First, I showed in §4.2 that coronal+noncoronal clusters are less marked than other cluster types. This means that noncoronals are less marked than coronals in C_2, an onset following a consonant, while all place features are in contrast in C_{inter}, an intervocalic onset position. In §4.8 I showed that in a subset of the languages which permit apical+laminal clusters only alveopalatals occur in C_2. This means that lamino-alveopalatals are less marked than lamino-dentals in C_2, while both laminal series are licensed in C_{inter}. These types of phonotactic asymmetries between C_2 and C_{inter} do not readily fall out in a theory of

prosodic licensing, since both positions, as onsets, are prosodically identical.

I showed in §4.5 that in many languages alveopalatals occur in C_1 only when C_2 is labial, in spite of the fact that both labials and dorsals are licensed in C_2 following an apical segment (i.e., [np], [ɲp], [nk], *[ɲk]). In other words, an alveopalatal+labial sequence is less marked than an alveopalatal+dorsal sequence, while there is no harmonic ordering between apical+labial and apical+dorsal sequences. This indicates that licensing of place features in C_1 and C_2 cannot proceed independently of each other: the features licensed in these two positions (apicals and alveopalatals in C_1, and labials and dorsals in C_2) incorrectly predict the possibility of alveopalatal+dorsal clusters. This sequencing effect is an example of a pattern such that feature [F] in C_1 and feature [G] in C_2 are not permitted to occur in sequence in a consonant cluster, even though [F] and [G] are independently well-formed in C_1 and C_2, respectively.

A similar sequencing effect is demonstrated in Ritharrngu. Ritharrngu permits apical+laminal clusters (see §4.6) and dorsal+labial clusters (§4.10) in addition to coronal+noncoronal clusters. The set of permitted place feature contours in heterorganic clusters are presented with data in (31).

(31) Ritharrngu heterorganic N-O clusters.

apical+labial	[np]	panpuɭara	*flower sp.*
	[ɳp]	paɳpalɲu	*death adder*
laminal+labial	[ɲp]	kaɲpu	*string fishnet*
dorsal+labial	[ŋp]	paŋpaɭaŋ	*brain*
apical+dorsal	[nk]	pankuca	*shark sp.*
	[ɳk]	kaɳki	*cypress pine*
laminal+dorsal	[ɲk]	piɲkur	*plant sp.*, Tectincornia australasica
apical+laminal	[ɳt̪]	piɳt̪ar-	*to use bad language*
	[nc]	kanci	*stork*
	[ɳc]	piɳcaraʔ	*axe*

Note that the cluster phonotactics in Ritharrngu cannot be formulated as independent constraints on the two C slots. This is shown in the fact that the set of place contrasts permitted in one position is dependent on the place of articulation of the other. In particular, [dorsal] is permitted in C_1 (in dorsal+labial clusters) and laminal in C_2 (in apical+laminal clusters), but not simultaneously: clusters of the form dorsal+laminal are *Φ. As a result, formalising the Ritharrngu cluster phonotactics as the local licensing of features in C_1 and C_2 overgenerates the set of predicted clusters.

Third, I showed in §4.6 that in the majority of languages laminals are permitted in C_2 only when preceded by an apical segment. In §4.7 I showed that, in a subset of the languages which permit apical+laminal clusters, the C_1 apical segment is necessarily retroflex. Both alveolars and postalveolars are licensed in apical+noncoronal clusters. In other words, the double-apical contrast is licensed in C_1 just in case the C_2 segment is labial or dorsal; preceding a laminal only apico-postalveolars occur. Both patterns are examples of sequencing constraints in which the set of features contrastive in one position in a cluster depends on the place feature of the segment in the other position.

In summary, the non-local aspect of the place phonotactics means that these patterns cannot be expressed as *coda conditions* in traditional prosodic licensing terms. This is because prosodic licensing is unable to express consonant co-occurrence conditions that do not coincide with syllable boundaries. As a result the cluster phonotactics discussed in this chapter are best expressed in segmental rather than prosodic terms.

§4.12 Conclusion.

In this chapter I have proposed a constraints account of the place phonotactics of

consonant clusters of Australian Aboriginal languages. The constraints make copious use of both articulatory and acoustic features. The use of acoustic features is notable, given the fact that place contrasts have been expressed almost exclusively by articulatory features, beginning with Chomsky & Halle 1968. Acoustic restrictions were shown to be necessary to account for several of the patterns discussed in this chapter. In addition, all of the constraints are segmental in nature and are analysed here as phonetically grounded conditions, motivated by articulatory ease and perceptual recoverability.

The constraints presented in this chapter are discussed again in chapter 6, in dealing with cumulative markedness. Additional evidence for the markedness patterns discussed in this chapter, and for the constraints which account for them, will be presented at that time. The constraints proposed in this chapter are repeated below. The constraints on the acoustic place features in positions lacking release cues are in a universally fixed order, shown in (32.a). The contour constraints, listed in (32.b,c), are not ordered.

(32) Place constraints in Australian Aboriginal languages.
a. Acoustic constraint scale:

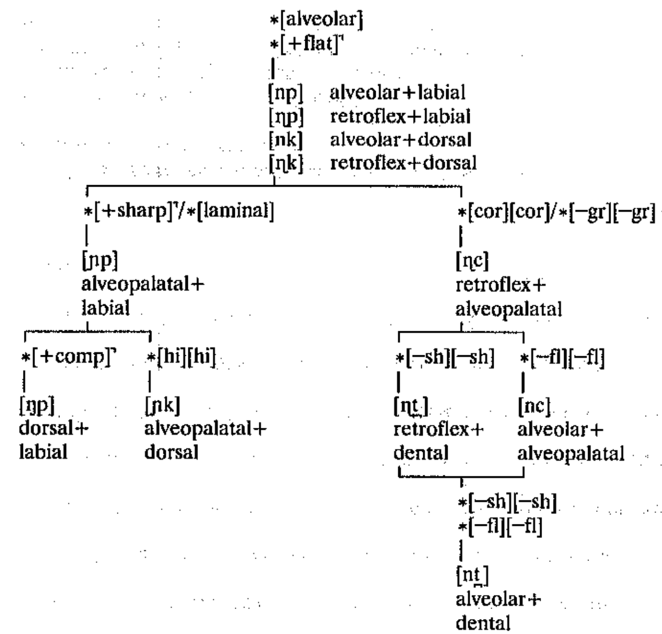
*[+grave, −compact]˺	(i.e., labials) »
*[+grave, +compact]˺	(i.e., dorsals) »
*[−grave, +sharp]˺	(i.e., lamino-alveopalatals) »
*[−grave, +flat]˺	(i.e., apico-postalveolars)

b. Articulatory contour constraints:
*[hi][hi]
*[cor][cor]
*[apical][apical]
*[laminal][laminal]

c. Acoustic contour constraints:
*[−grave][−grave]
*[−sharp][−sharp]
*[−flat][−flat]

I now repeat the harmonic scale of the place contours from (3), with the constraints inserted into the chart to illustrate how the relaxing of constraints elaborates an increasingly complex inventory (33). There are more place contours attested in Australian languages than are presented in this chart. But the additional clusters are highly marked, and involve elaboration of marked structure below the paths in this scale.

(33) Constraint-generated path of elaboration of place contours.



Chapter 5: Manner phonotactics in consonant clusters.

§5.0 Introduction.

This chapter is a descriptive survey and theoretical treatment of the phonotactics of manner features in consonant clusters in Australian Aboriginal languages. There are several patterns which are drawn from the data. Once these phonotactic generalisations are all taken into account, the following markedness scales of manner features in C_1 and C_2 emerge:

C_1: liquid ≻ nasal ≻ obstruent, glide
C_2: obstruent ≻ nasal, glide ≻ liquid[1]

The descriptive generalisation which these scales capture is the often noted generalisation that consonant clusters preferentially have falling sonority, with segments of high sonority being unmarked in C_1 and segments with low sonority being unmarked in C_2 (see the Syllable Contact Law of Murray & Vennemann 1983). The one important way in which these scales depart from this generalisation is the somewhat anomalous distribution of glides: glides are more marked in C_1 and less marked in C_2 than is expected on the basis of sonority considerations. For this reason, these are not reverse scales as was the case with the place phonotactics (see (2) in chapter 4).

In §5.1 I show that son-obst clusters are less marked than other cluster types. Among the sonorants, which are harmonic in C_1, I show that liquids are less marked than

[1]The notation "obstruent, glide" in the C_1 harmonic scale signifies that there is no harmonic ordering between these two features in this position. The same applies to "nasal, glide" in the C_2 harmonic scale.

nasals in this position preceding noncoronal consonants (§5.2), while glides are marked (§5.3). I then discuss the phonotactics of son-son clusters. I show that N-N clusters are less marked than liquid-N sequences (§5.4) and liquid-G sequences, both of which are, in turn, less marked than N-G sequences (§5.5). Finally, I discuss in §5.6 the marginal status of liquids in C_2.

§5.1 The least marked consonant clusters are son+obst.

The first generalisation in the manner phonotactics of consonant clusters is the preference for sonorants in C_1 and stops in C_2. The fact that consonant clusters are preferentially son-obst is shown from a wide range of evidence. First, there is implicational evidence from examining the clusters as a whole: son-obst clusters occur in all Australian Aboriginal languages, while son-son, obst-obst and obst-son clusters are less marked to varying degrees. There is a small number of languages which exclude all cluster types other than son-obst. An example is Tiwi, in which all consonant clusters are homorganic N-O sequences.[2]

A second source of evidence for this comes from examining the markedness patterns in C_1 and C_2 individually. Consider first C_1. The implicational evidence that sonorants are preferred in this position is very strong. Many languages lack obstruents altogether in this position, and those which permit obstruents also permit sonorants.[3]

[2]There are also only son-obst clusters reported in the lexicon of Nhukunu (Hercus 1994). In spite of the fact that the size of the lexicon is substantial, Hercus' work on Nhukunu is a salvage study, and so this type of generalisation should be treated with caution.

[3]Languages which permit obstruents (stops) in addition to sonorants in C_1: Alawa, (Arabana), Bidyara, Bularnu, Djambarrpuyngu, Djapu, Djaru, Djinang, Djinggili, Gaagudju, Gaalpu, Garawa, Gog-Narr, Gooniyandi, Gunin, Kayardild, Kitja, Kuuku-Ya'u,

The frequency evidence is also robust: clusters with an obstruent in C_1 are consistently uncommon to marginal. McGregor 1990:87 reports of Gooniyandi that O-O clusters constitute 4% of all consonant clusters, compared with 11% for heterorganic N-O clusters.[4] In the figures reported for Kuuku-Ya'u by Thompson 1988, the cluster [tp], which is the only obst-obst cluster in this language, occurs at a considerably lower frequency than its corresponding son+obst clusters, as shown in the data in (1).

(1) Frequencies of L-O, N-O and O-O manner contours: Kuuku-Ya'u.

	L-O		N-O		O-O	
apical+labial	lp	23	np	8	tp	3

Turning now to C_2, evidence that obstruents are less marked than sonorants in this position comes from both implicational and frequency evidence. I mentioned above that there are only one or two languages which permit only oral stops in C_2, Tiwi being the clearest example. At the same time, we have no languages which permit sonorants but not obstruents in C_2. Therefore the facts demonstrate that sonorants imply obstruents in this position.

In languages which permit sonorants in C_2, these clusters occur at comparatively low frequencies. I illustrate this by comparing the frequencies of nasals to stops. Cluster

(Limilngan), Mangarrayi, Marra, Miriwung, Murinh-patha, Ngalakan, Ngandi, Nhukunu, Nunggubuyu, Nyangumarta, Nyigina, (Payungu), Ritharrngu, Tharrkari, Umbugarla, Ungarinyin, Uradhi, Walmatjarri, Wambaya, Wardaman, Warlmanpa, Warluwarra, Warndarrang, Warumungu, Yanyuwa, Yindjibarndi, Yukulta. In all of the remaining languages stops are $*\Phi$ in C_1.

[4]A total of 64% of clusters are N-O, including homorganic clusters. But since stop clusters are heterorganic, it is necessary to compare the frequency of stop clusters with the frequency of *heterorganic* N-O clusters.

frequencies based on their manner contours published for Gooniyandi (McGregor 1990:87) indicate a predominance of N-O clusters compared to N-N clusters. In Gooniyandi, heterorganic N-O clusters constitute 11% of all intervocalic clusters in the dictionary. In contrast, N-N clusters constitute a total of only 3%. Similar facts obtain in other languages. Thompson 1988:8-9 gives the total number of occurrences of the permitted clusters in Kuuku-Ya'u. These frequencies indicate a preference for a stop C_2 over a nasal C_2. A similar pattern obtains in the cluster frequencies from Yidiny (figures from Harvey 1992b). The figures for various example clusters from both languages are given in (2), illustrating this pattern. I compare the clusters on the basis of their manner features only; clusters on the same row have the same place features.

(2) Comparative frequencies of distinct manner contours: Kuuku-Ya'u and Yidiny.

	Kuuku-Ya'u				Yidiny			
	N-O		N-N		N-O		N-N	
apical+dorsal	nk	9	nŋ	2	nk	45	nŋ	1
	L-O		L-N		L-O		L-N	
apical+labial	lp	23	lm	9	lp	52	lm	16
apical+laminal	lt̪	11	ln̪	2	lc	14	lɲ	1
apical+dorsal	lk	36	lŋ	2	lk	56	lŋ	12
	G-O		G-N		G-O		G-N	
laminal+labial	jp	8	jm	3	jp	23	jm	7
laminal+dorsal	jk	12	jŋ	2	jk	24	jŋ	6

The pattern which emerges in this section is that clusters preferentially have falling sonority. Segments of high sonority are unmarked in C_1 and segments with low sonority are unmarked in C_2.

In order to account for this observation, that the least marked manner contour in consonant clusters is son-obst, I propose a constraint against obstruents which lack release cues: *[obst]˺. Since sonorants are less marked than obstruents in positions lacking release cues, I also propose that this constraint is in a hierarchical ordering with a similar constraint against unreleased sonorants: *[son]˺. These two constraints are in the following ordering relationship: *[obst]˺ ≫ *[son]˺.

These two constraints, and the ordering relationship between them, is motivated on perceptual grounds. Unreleased sonorants and obstruents have distinct spectral cues. As defined in acoustic terms by Ladefoged 1971:58, sonorants have a comparatively large amount of acoustic energy compared to obstruents, within a clearly defined formant structure. Both classes of segments lack release cues in C_1 and both have vowel formant transition cues in C_1, but sonorants have acoustic energy and formant structure which are cues to both manner and place of articulation. Obstruents by definition lack these cues. These additional cues play a crucial role in enhancing the perceptual recoverability of the place features in C_1. Thus, in pre-consonantal position, the lateral [l] has two sets of perceptual cues: its apico-alveolar formant transitions and the formant structure typical of lateral articulation and of an alveolar articulation (see §2.2.1). A pre-consonantal stop such as [t], however, only has the formant transition cues. Therefore the fact that stops lack the acoustic energy of sonorants means that sonorants are more robust acoustically when unreleased. These perceptual facts motivate the constraint ordering: *[obst]˺ ≫ *[son]˺. This ordering promotes the distribution of sonorants in C_1, thus accounting for the attested pattern.

I also assume a dissimilarity or contour constraint on adjacent sonorants, *[son][son], following Lamontagne 1993. I assume an acoustic definition for the feature [sonorant] in this constraint. Lamontagne assumes that the OCP governs this feature. However, since the OCP applies to gestures, and sonorants are produced with a range of

gesture types, an acoustic motivation for this constraints appears apt. Many languages prohibit sequences of sonorants. This constraint promotes the harmonic status of son+obst manner contours in its interaction with *[obst]˺. First, son+son manner contours are marked by *[son][son]. Second, obst-obst and obst-son clusters are marked by *[obst]˺. The son-obst manner contours are the only ones which do not incur a violation of either *[obst]˺ or *[son][son]. Thus, these two constraints produce the harmonic status of son-obst manner contours, as shown in (3).

(3) Constraint formalism of the harmonic status of the son+obst clusters.

	son+obst	son+son	obst+obst	obst+son
*[obst]˺	(unmarked)	(unmarked)	* (marked)	* (marked)
*[son][son]	(unmarked)	* (marked)	(unmarked)	(unmarked)

§5.2 Liquids less marked than nasals in C_1.

Although sonorants are unmarked in C_1, the sonorants don't all have the same status in this position. I show in this section that liquids are less marked than nasals in C_1 position preceding a noncoronal.

Most Australian Aboriginal languages permit both nasals and liquids in C_1, and so there is no evidence from implications to illustrate this markedness relationship.[5] Evidence from frequency asymmetries provides further corroboration that liquids are less marked than nasals in C_1 preceding noncoronal segments. Frequency data from four languages are given in (4): Gaagudju, Harvey 1992a; Kuuku-Ya'u, Thompson 1988;

[5] There are two languages which may constitute cases where liquids are Φ but nasals are *Φ in C_1 (see the entry for each language in appendix B): Anindilyakwa and Tharrkari. Note that Tiwi allows only nasals in C_1, but this is accounted for by the preference for nasals over liquids in C_1 of homorganic clusters (see §3.6).

Ngaanyatjarra and Yidiny, Harvey 1992b. Note that there is the occasional inconsistency, such as the low frequency of [lk] in Gaagudju. I ignore such inconsistencies when they appear to be nothing more than isolated anomalies.[6]

(4) Frequency data showing liquids are less marked than nasals in C_1.

Language	Sonority contour / Place contour	r-O		L-O		N-O	
Gaagudju	apical+labial	rp	14	lp	17	np	10
	apical+dorsal	rk	15	lk	4	nk	6
Kuuku-Ya'u	apical+labial			lp	23	np	8
	apical+dorsal			lk	36	nk	9
Ngaany.	apical+labial	rp	15	lp	17	np	8
				ɭp	14	ɳp	6
	apical+dorsal	rk	42	lk	20	nk	16
				ɭk	9	ɳk	8
Yidiny	apical+labial	rp	33	lp	52	np	36
	apical+dorsal	rk	57	lk	56	nk	45

The frequency asymmetry data between liquids and nasals indicates a preferential status of liquids over nasals in C_1 in coronal+noncoronal clusters. (Note that nasals are less marked than laterals in C_1 in *homorganic* clusters, for reasons independent of manner constraints. See chapter 3, especially §3.6.)

Despite this difference between liquids and nasals with respect to distribution preceding noncoronals, it cannot be generalised to all C_1 contexts. The evidence from the

[6]My criteria for determining between isolated anomalies and non-random patterns in frequencies are the following. First, language-internal evidence: the high frequency of [lp] compared to [np] in Gaagudju makes L-O clusters look unmarked, suggesting that the low frequency is anomalous. Cross-linguistic evidence also suggests that this is an isolated anomaly: [lk] typically occurs at very high frequencies, as shown in the other three languages. These factors make it difficult to claim that Gaagudju's low frequency for [lk] is non-random.

phonotactics of apical+laminal clusters indicates that there is no harmonic ordering between nasals and liquids in C_1 in these clusters. There is clear evidence against an implicational relationship between them in this position: a number of languages have laterals but not nasals in this context (i.e., [ɭc], [ɭt̠] but *[ɳc], *[ɳt̠])[7] and other languages have the opposite pattern (i.e., [ɳc], [ɳt̠] but *[ɭc], *[ɭt̠]).[8] Reported figures on the frequences of these clusters also indicate no uniform pattern of markedness (Harvey 1992b).[9]

To sum up to this point, the observed pattern is that nasals are marked compared to laterals preceding heterorganic noncoronals. (In this pattern, vibrants pattern with laterals in showing high frequencies.) Preceding heterorganic laminals there is no harmonic ordering between nasals and laterals. This pattern is summarised in (5).

(5) Phonotactics of nasals and laterals in C_1.

a. Laterals are less marked than nasals in C_1 in coronal+noncoronal clusters.
[lp], [ɭp], [lk], [ɭk] ≻ [np], [ɳp], [nk], [ɳk]

b. No harmonic order between laterals and nasals in C_1 in apical+laminal clusters.
[lc], [ɭc], [lt̠], [ɭt̠] ≈ [nc], [ɳc], [nt̠], [ɳt̠]

[7]Languages which allow laterals but not nasals in C_1 in apical+laminal clusters: (Anindilyakwa), Kurrtjar, Kuuku-Ya'u, Mbabarram, Muruwari, (Ngawun), Ngiyambaa, Ungarinyin, Yuwaalaraay. See also Kitja, Kukatj and Yukulta which have lateral+dental but not nasal+dental clusters (see §6.5). None of these languages (except Ungarinyin) has phonemic homorganic L-O clusters, and it is possible that these apical+laminal L-O clusters are allophonically assimilated (which is known to be the case in Ngawun).

[8]Languages which allow nasals but not laterals in C_1 in apical+laminal clusters: Bardi, Jingili, Garawa, Gooniyandi, Gunin, Umbugarla, Wambaya, Yanyuwa.

[9]Harvey 1992b reports the following figures for Ngaanyatjarra: 15 root-internal occurrences of [lc], 8 of [ɭc], 13 of [nc], and [ɳc] unreported, indicating a slight plurality of lateral C_1 clusters. In Yidiny, the nasal C_1 cluster is more common: 33 occurrences of [nc] versus 14 of [lc]. These figures are based on very sizable vocabulary databases.

The account which I propose is closely related to the fact that laterals are not articulated at non-coronal places of articulation. The only exception to this as a universal generalisation is the presence of dorsal laterals in a small number of non-Australian languages. Even these segments display certain phonetic and phonological attributes of coronals (Levin 1988). In fact, Levin 1988 argues that [lateral] is not dorsal phonologically, but is a dependent of coronal. Following this line of reasoning, the feature [lateral] is incompatible with noncoronal places of articulation, under the formal definition of the term *compatibility* in (6).

(6) Gestural compatibility.
A manner feature is compatible with a place feature when the co-occurrence of the two features is permitted under universal articulatory restrictions.

The manner feature [nasal] is compatible with all of the oral places, while [lateral] is only compatible with the coronal places. Under this notion of compatibility, the phonotactic pattern displayed in (5.a,b) is accounted for by the constraint in (7).

(7) Unassimilation.
A cluster is marked if the manner feature of the C_1 segment is compatible with the place feature of a following heterorganic consonant.

This constraint captures the fact that assimilation is common in clusters. Failure of assimilation is marked with nasals, but is common with laterals because of the restriction of laterals to coronal place.

The cluster [np] is marked under this constraint since [nasal], the manner feature of the C_1 segment, is compatible with [labial], the place feature of the following segment.

The counterpart L-O cluster, [lp], is not marked since [lateral] is not compatible with [labial]. This accounts for the difference in markedness between nasals and laterals in heterorganic clusters preceding noncoronals.

In apical+laminal clusters, however, both nasals and laterals are marked in C_1 under Unassimilation. Both [nasal] and [lateral] are compatible with [laminal]. Therefore the constraint Unassimilation predicts the phonotactic pattern described in (5.a,b).

This constraint is motivated on perceptual grounds. Recall from the discussion of Kawasaki 1982 in §1.2.2 and §4.4 that spectrally similar sound sequences tend to be neutralised: forms which have similar perceptual cues tend not to be contrasted language-internally. The cluster [np] is perceptually complex under this assumption because of the presence of [mp] in the system (as shown in chapter 3, heterorganic N-O clusters imply homorganic N-O clusters). Sequences such as [np] tend strongly to be reanalysed as homorganic sequences in natural languages, a pattern given a perceptual account by Ohala 1990. Since [nasal] is compatible with noncoronal places, the place cues of an unreleased nasal coronal are easily reinterpreted as noncoronal under gestural overlap with a following noncoronal segment.

The cluster [lp] is less complex perceptually since there is no homorganic labial L-O cluster competing with it. [lp] competes with [lt], but the place cues of noncoronals are sufficiently robust in the C-V transition that the distinction between these two has a high degree of perceptual recoverability. The place cues of laterals in a position lacking a release are vulnerable to gestural overlap with a non-coronal. But they are less vulnerable than is the case with a nasal since the spectral properties of laterality, which are robust in C_1, are inconsistent with non-coronal place cues.

In addition to the Unassimilation facts which promote the assimilation of a C_1

nasal to a following noncoronal, another pattern also contributes to the difference between nasals and laterals with respect to their presence in C_1. This has to do with the perceptibility of their place features in a position where they cannot benefit from C-V release and transition cues. Liquids are favoured because they possess oral rather than nasalised transitions, the latter being less helpful in identifying place. It is widely recognised that nasal segments lack certain salient acoustic attributes which their oral counterparts possess. For example, Malécot 1956 and others have shown that the place cues of nasals are weaker than they are for stops. This is particularly the case with unreleased nasals, since Kurowski & Blumstein 1984 have shown that the spectral properties of nasals around their release (including the end of the nasal murmur and the start of the vowel formant transitions) are the most salient cue for place of articulation. Also, the introduction of nasalisation in vowels diminishes the perceptual distinctiveness between vowel features (Beddor 1993:182-183). The lowering of the velum, thereby coupling the oral and nasal cavities as two connected resonating chambers, is the source of the spectral complexity of nasal segments.

The cues for nasal segments as a class are highly distinct from non-nasals (Ohala 1990:261). But the perceptual neutralisation of contrasts among nasal segments in contexts where their place cues are not recoverable may condition the assimilation of nasals as a class. In addition to the Unassimilation account of the marked status of nasals compared to liquids preceding noncoronal segments, the perceptual deficit of unreleased place features of a nasal segment provides further motivation for the neutralisation of the class of nasals in C_1. This motivates another constraint, ∗[nasal]˥, which formalises this fact.

I have shown in this section that liquids have a wider distribution in C_1 than

nasals. This is an apparent challenge to the common observation in non-Australian languages that nasals and not liquids occur in this position. Tiwi is an Australian example of this: clusters in Tiwi are homorganic N-O sequences; L-O and r-O clusters are not permitted. I propose that the harmonic status of N-O clusters in these languages is because they are homorganic (see the typology of syllable rhyme structures in Goldsmith 1990:128). As discussed in chapter 3, homorganic N-O clusters are less marked than homorganic L-O clusters. Therefore I predict that nasals are harmonic in C_1 only under homorganicity, and that laterals are less marked in this position otherwise.

§5.3 Vibrants in C_1 of apical+laminal clusters.

The third pattern of manner phonotactics is the difference between laterals and vibrants in C_1 in apical+laminal clusters. In this position, vibrants are less marked than other sonorants. I account for this pattern by appealing to the Unassimilation constraint.

The unmarked status of vibrants preceding laminals is demonstrated from implicational evidence: apical+laminal N-O and/or L-O clusters imply vibrant+laminal clusters. In languages which show this pattern, laterals and nasals are licensed in C_1 but are restricted to occurring in cor-noncor clusters. The relevant pattern of permitted clusters in a typical language which demonstrates this pattern is shown in (8).

(8) Preferential distribution of the vibrant in C_1 in apical+laminal clusters.

	r-O	L-O	N-O
apical+labial	rp	lp ɭp	np ɳp
apical+dorsal	rk	lk ɭk	nk ɳk
apical+laminal	rc	(∗lc ∗ɭc)	(∗nc ∗ɳc)

This pattern is attested in a range of languages. Diyari is an example. Relevant data showing the asymmetry in the place features contrasted in r-O and L-O clusters are presented in (9).

(9) Diyari data.

r-O clusters			L-O clusters		
[rp]	karpa-	*sew*	[lp]	kilpari-	*disbelieve*
			[ɭp]	paɭpa	*some*
[rk]	t̪arka-	*stand*	[lk]	palka-	*split*
			[ɭk]	paɭka-	*go on a journey*
[rc]	parcaɲa-	*all*	(*[lc] *[ɭc])		

The facts seen in this section indicate that laterals (and nasals) are more likely than vibrants to assimilate in place of articulation to a following laminal. The fact that vibrants are restricted to apical articulation in Australian Aboriginal languages is crucial: vibrants cannot assimilate in place of articulation to a laminal, but laterals and nasals, which may be laminal, can. On this basis, I propose that the Unassimilation constraint (7) is responsible for the Diyari pattern.

The manner feature [vibrant] is not compatible with articulator features other than [apical].[10] Therefore a sequence of a vibrant and a laminal is unmarked under Unassimilation. As discussed in §5.2, laterals preceding a laminal segment are marked under this constraint, thus producing the difference in the distribution of laterals and vibrants attested in Diyari. The perceptual correlate of the Unassimilation constraint expresses this pattern of markedness as follows. The apical+laminal cluster [lc] is perceptually complex because distinguishing it from the homorganic counterpart [ʎc]

[10]Non-apical vibrants are permitted, particularly uvulars. It may be necessary for language-particular constraints on feature co-occurrence information to be encoded into the definition of Compatibility.

requires considerable perceptual acuity. The Unassimilation account of the Diyari pattern predicts that homorganic laminal L-O clusters occur in these languages; this prediction is borne out.[11]

Morpheme-internal assimilation facts in Ngawun illustrate that apical laterals are marked when followed by a laminal segment. Ngawun has the cluster [rc] but lacks apical+laminal L-O clusters. Ngawun has a surface homorganic laminal L-O cluster [ʎc], but since Ngawun lacks phonemic laminal laterals this cluster is analysed as underlying /lc/ (Breen 1981b). Ngawun demonstrates the same pattern as Diyari (see discussion of the neutralisation of alveolars in apical+laminal clusters in §4.7). The fact that the vibrant manner feature is inherently tied to the apical feature in Australian languages means that these segments are resistant to place assimilation preceding a laminal segment. Under the Unassimilation constraint, this is the cause of preferential distribution of the vibrant in C_1 over other manner features (nasal, lateral) which are compatible with a wider range of place features. To summarise, the discussion of the Unassimilation constraint in this and the preceding section indicates that manner features with restrictions on permitted place contrasts are relatively unlikely to undergo assimilation.

§5.4 The marked status of glides in C_1.

The third pattern of manner phonotactics which I discuss in this chapter is the fact that

[11]Languages which have this pattern: Arabana, Arrernte, Diyari, Kaytetye, (Ngawun), Warlpiri, Warluwarra, Warumungu, Yandruwanhdha. Of these, Arabana, Arrernte, Diyari, Kaytetye, Warlpiri and Yandruwanhdha have a full set of homorganic L-O clusters; Ngawun, Warluwarra and Warumungu have only laminal homorganic L-O clusters (see §3.6.4).

glides have a marked distribution in C_1. This pattern is inconsistent with the otherwise unmarked status of sonorants in C_1 (see §5.1).

The marked status of glides in C_1 compared to nasals and liquids is demonstrated most forcefully on implicational evidence. A large number of languages do not permit glides in C_1 at all, while allowing both nasals and liquids.[12] Of the languages which permit glides in C_1, all have nasals and liquids. Therefore the necessary components of an exceptionless implicational relationship are present: glides imply the other sonorant manners of articulation (nasals and liquids) in C_1.

I propose to account for the marked status of glides in C_1 on perceptual grounds. This account is based on the notion of spectral modulation (Kawasaki 1982), in particular the similar spectral attributes of vowels and glides. Ruling out glides on perceptual grounds allows us to maintain the otherwise general pattern of the formally optimal status of sonorants in this position.

There are two partially overlapping aspects to the perceptual deficit of syllable-final vowel+glide sequences. First, it is clear that syllable-final sequences of a high vowel plus its homorganic glide, i.e., [ij] and [uw], lack an acoustically clear transition (Kawasaki & Ohala 1980:533). Because of this, tautosyllabic sequences of [w]+round vowel and [j]+front vowel (in either order) are marked cross-linguistically (Kawasaki 1982). These facts have a variety of empirical correlates in Australian Aboriginal languages. First, these languages typically do not contrast word-initial [ji]~[i] and [wu]~[u]. Individual

[12]Languages which exclude glides in C_1 but allow other sonorants: Alyawarra, Arabana, Arrernte, Baagandji, Bardi, Bidyara, Bularnu, Diyari, Garawa, Gog-Narr, Gooniyandi, Gunin, Jiwarli, Kalkatungu, Kaytetye, Kitja, Kukatj, Kurrtjar, Mantjiltjatjarra, Marrgany, Martuthunira, Nganyaywana, Ngawun, Ngiyambaa, Nhukunu, Nyangumarta, Panyjima, Payungu, Pitta-Pitta, Wambaya, Wardaman, Warlmanpa, Warumungu, Watjarri, Yandruwanhdha, Yankuntjatjarra, Yanyuwa, Yawuru, Yukulta.

languages vary in having pronunciations predominantly with or without the glide on the surface, or there may be free variation. In only a very small number of languages are these two pronunciations the basis for a lexical contrast.[13] An inability to contrast high vowel+glide in sequence is demonstrated in other recurring phonotactic patterns. First, among Australian Aboriginal languages, a contrast between [iː] and [iji]; and [uː] and [uwu]; is extremely marked.[14] Also, in many languages [w] and [j] are neutralised when occurring between non-identical high vowels, i.e., in the contexts [i_u] and [u_i]. Kalkatungu has [iju] but not *[iwu] and [uwi] but not *[uji] (indicating that the place features for the glide in this context are drawn from the preceding vowel); see the discussion in Blake 1979a:22-24. Kayardild has the opposite pattern: [iwu] but not *[iju], and [uji] but not *[uwi] (Evans 1985) (indicating that the place features are drawn from the following vowel in this case). Muruwari has [uwi], [uji] and [iju] in contrast but lacks *[iwu] (Oates 1988:36-37). This could be an accidental gap, but even if this is the case the low frequency of high vowel+glide+high vowel sequences is an effect of their markedness. These facts all indicate a perceptual deficit inherent in discerning the transition between high vowels and glides.

I propose that these facts provide an account for the marked status of [j] and [w] in C_1 following their homorganic high vowel: absence of spectral distance. And, indeed, some languages neutralise glides *only* in this context (e.g., Ngiyambaa, where [j] occurs word-finally *except* following [i], Donaldson 1980:44). However, this is only a partial

[13]Nunggubuyu and Yawuru appear to make this contrast.

[14]Hosokawa 1991:88 reports that /iː/ and /iji/ are in contrast on the surface in Yawuru: the former is realised uniformly as [iː] while the latter varies freely between [iː] and [iʲe], and this distinction is the basis for a lexical contrast. As far as I am aware this is the only language which has been proposed to have this contrast morpheme-internally.

account of the marked status of glides in C_1 as it offers no account of the marked status of glides following other vowels. There is a more general property of vowel+glide sequences which is also responsible for the marked status of glides in C_1. Here I follow Kawasaki 1982 in assuming that acoustically similar sound sequences, F and F', are likely targets for neutralisation. In other words, the degree of acoustic difference between F and F' is directly related to the likelihood of the two occurring in contrast within a language (see discussion in §4.4). Therefore, the marked status of glides in C_1 can be accounted for on the basis of their having a high degree of acoustic similarity to other sound sequences. The immediate candidate F' to an F with a glide in C_1 is a form where the glide is not in C_1 but instead is followed by its homorganic vowel, i.e., F=[májpa] versus F'=[májipa]. On the difficulty involved in distinguishing these sequences, see for example Oates 1988:35-36 on the problem of whether syllable-final phonetic [aɪ] in Muruwari should be phonemicised as /ai/, /aj/ or /aji/. On Ritharrngu, Heath 1980a:9 states: "In the environment V_C and V_# it is difficult to distinguish [wu] from [w] and [ji] from [j], although I think that these distinctions do exist."

Under certain circumstances prosodic considerations might be able to disambiguate F and F' in these cases. For example, if the second syllable in a form such as [majipa] were a potential stress position, then this would enhance the acoustic contrast between [majpa] and [majipa] (in other words, [majípa] is less likely than [májipa] to be confused with [májpa]). However, the typical stress patterns largely abrogate this as a possibility: Australian Aboriginal languages tend to have uniform initial syllable stress. These facts taken together mean that stress cannot disambiguate pre-consonantal [aj] and

[aji] sequences within a morpheme.[15]

Assuming that glides are marked in C_1 because of the potential perceptual confusion with vowels, one can predict that the apico-postalveolar glide [ɻ] should be the least marked glide in this position since it does not have a direct homorganic vowel counterpart. Its unmarked status also follows from place phonotactics, since apicals are least marked in this position (§4.2, §4.3).

In summary, the acoustic similarity in the surface realisation of pre-consonantal sequences such as [j] and [ji] provides motivation for the tendency of these sequences to be neutralised cross-linguistically. Thus glides are marked in C_1. Central in this account is the following assumption: when a surface form [Φ] is phonetically ambiguous between phonological representations F and F', F is assumed as the underlying form of [Φ] where $F \succ F'$. Again consider the two forms [majpa] and [majipa]. The unmarked status of CV syllables (Jakobson & Halle 1956) indicates that [majipa] is less marked than [majpa], and as a result [majipa] is selected as the phonological representation of a phonetically ambiguous surface form. This account predicts that pre-consonantal glide+vowel sequences such as [ji] are permitted in every language which lacks pre-consonantal glides. I am aware of no languages in Australia which contradict this prediction.

[15]Certain prosodic allomorphic and morpho-phonological processes may also be able to disambiguate these forms, particularly those which are sensitive to a syllable count. An example is an allomorphic process in which the form of an affix is determined by the number of syllables in the root. Certain Australian Aboriginal languages have this type of allomorphy of the ergative marker: /-ŋku/ on disyllabic stems and /-lu/ on tri-syllabic and longer stems. This is attested in Warlpiri (Dixon 1980:308). In a language like Warlpiri, the allomorph of the ergative marker will disambiguate between roots /majpa/ (which will take ergative /-ŋku/) and /majipa/ (which will take ergative /-lu/), even when the roots have identical pronunciation. However, Warlpiri does not permit glides in C_1.

§5.5 Son-son sequences: N-N less marked than liquid-N clusters.

To this point I have demonstrated that son-obst clusters are harmonic in Australian Aboriginal languages. One of the constraints which plays a role in producing the unmarked status of son-obst manner contours is ∗[son][son]. Under this constraint, sequences of sonorants are marked. As with any other constraint, ∗[son][son] is violable on a language-particular basis. Australian languages have four series of sonorants: a nasal series and two oral series, liquids (laterals and vibrants) and glides. Therefore, relaxing ∗[son][son] launches a wide range of possible son-son clusters types. I discuss the markedness relationships between them in this and the following section. These relationships are expressed in (10).

(10) Markedness ordering among the son-son cluster types.
a. N-N ≻
b. {liquid-N, liquid-G} ≻
c. N-G

N-N is the least marked son-son cluster type. This is shown primarily from implicational evidence: in several languages, N-N is the only permitted son-son contour. Typically, these languages have the following inventory of manner contours in clusters: N-O, L-O, r-O and N-N. Bidyara-Gungabula is an example of a language which exhibits this pattern.[16] Bidyara data are presented in (11)

[16]Languages which have N-N as its only son-son cluster type: Arabana, Badimaya, Bidyara, Diyari, Garlali, Gog-Narr, Jiwarli, Pitta-Pitta.

(11) Bidyara data.

a. son-obst	N-O	[np]	ŋunpiṯa	*to swim*
		[nk]	punkaɲ	*plain turkey*
		[ɲp]	kuɲpiṯ	*sweat*
		[ɲk]	paɲkalu	*old man kangaroo*
	L-O	[lp]	wilpiṯ	*lizard sp.*
		[lk]	kalkaɲ	*large intenstine*
	r-O	[rp]	kurpa	*to come*
		[rk]	purku	*shield*
b. son-son	N-N	[nm]	kunma	*to break*
		[nŋ]	wanŋu	*woman*
		[ɲm]	waɲma	*to make*
	∗L-N			
	∗r-N			

Clusters such as [lm] or [rm] are ∗Φ in spite of the fact that we know from the set of attested clusters that [l] and [r] are independently permitted in C_1, and [m] in C_2.

Other languages allow both N-N and the liquid-N cluster types. Walmatjarri is an example. Liquid+glide clusters are ∗Φ in Walmatjarri.[17] Data illustrating the three son-son manner contours N-N, r-N and L-N in Walmatjarri are presented in (12).

(12) Walmatjarri data: son-son clusters.

N-N	[ɳm]	waɳmi	*friendly*
r-N	[rm]	cirmiɭ	*sweat*
L-N	[lm]	palma	*creek*
∗r-G			
∗L-G			

The unmarked status of N-N clusters compared to other son-son cluster types is motivated on both perceptual and representational grounds. First, sequences of an oral

[17]Languages which demonstrate this pattern: Arrernte, Baagandji, Gugada, Guugu-Yimidhirr, Kalkatungu, (Kaytetye), Kitja, Kuku-Yalanji, Marrgany-Gunya, Nganyaywana, Ngawun, Nyangumarta, Nyungar, Payungu, Pintupi, Walmatjarri, Watjarri, Yandruwanhdha, Yankuntjatjarra, (Yuwaalaraay).

sonorant and a nasal sonorant are perceptually complex. This promotes sonorant clusters which are uniform in terms of velum position and predicts the marked status of liquid-N clusters. Second, N-N clusters lack articulatory complexity which other son-son sequences have: N-N sequences are characterised by a single manner gesture, and therefore the Bidyara pattern follows from the unique ability of [nasal] to show geminate ambiguity effects.

Consider first the issue of articulatory complexity. The velum is a sluggish articulator. As a result, velo-pharyngeal port opening and closing gestures easily become desynchronised with intended transitions between oral and nasal segments (see Ohala & Ohala 1993:228-231 for discussion). The result may be that the velo-pharyngeal gesture overlaps with the oral configuration of the nasal segment, resulting in partial de-nasalisation (as in intrusive stop formation in English). Alternatively, the velo-pharyngeal gesture may overlap with the non-nasal segment, resulting in nasalisation of the oral segment adjacent to the nasal.

When velic opening precedes the movement of the oral articulators to their configuration for the nasal segment, the result is anticipatory nasalisation of the preceding segment (see Cohn 1993 on English vowel nasalisation). Sonorant consonants and vowels have been shown to have lower velum positions than obstruents (Bell-Berti 1993). In other words, the velic configuration of sonorants is more similar to nasals than is the case with obstruents. Therefore, oral sonorants are prime candidates as targets for nasalisation when adjacent to a nasal. The preference for nasal spreading is overcome in the case of N-O clusters since obstruents have higher velum positions than sonorants.

Now consider the perceptual complexity of son-son sequences other than N-N. The result of overlap of a [nasal] gesture on a sonorant is that the orality of the sonorant

is perceptually opaque. Therefore the articulatory precision required in synchronising a velo-pharyngeal port opening gesture with an oral articulation, particularly of a sonorant, may trigger assimilation. There is evidence from alternations of the nasalisation of oral sonorants adjacent to a nasal at a morpheme boundary. This is attested in Kayardild (Evans 1985:38-43): /kiɲin+wari/, *body-PRIV*, is realised as [kiɲinmari]. Also, in Pintupi there is inter-dialectal variation between [r] and [n] preceding a nasal (i.e., [rm] in some dialects is [nm] in others, Hansen & Hansen 1978:33-34); a similar pattern is attested in Kukatj (Breen 1992:13).

On the basis of these facts I propose a constraint which promotes a uniform velum position across both members of a cluster of sonorants (13).[18]

(13) Velum Uniformity Constraint (VUC): *[son, oral][son, nas]
*[son, nas][son, oral]

Under this constraint, liquid-N clusters such as [lm] are marked because of the reduced recoverability of the features of the oral sonorant preceding a nasal. Sonorant clusters where both are nasal (and where both are oral, see below) do not violate this constraint.

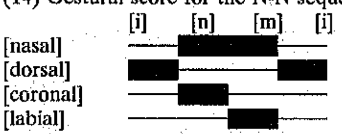
In addition to this perceptual account of the unmarked status of N-N clusters, I also argue that these clusters are unmarked from an articulatory and formal

[18]In some languages, sequences of a nasal and a stop are rendered uniform for velum position as well. In Nunggubuyu and elsewhere, stops are nasalised by a following nasal across a root-suffix boundary. In Tharrgari, an epenthetic syllable [−pa], which is added to unsuffixed consonant-final roots to enforce a vowel-final word template, assimilates to [−ma] following a nasal. In Tharrgari historical phonology, all heterorganic N-O sequences have descended as O-O clusters (homorganic N-O sequences have descended as an innovative series of voiced stops). Such patterns imply a more general version of the VUC, without reference to sonority, ranked lower than the more specific version here.

representational point of view. In the representation of manner contrasts in Articulatory Phonology, nasality is the only manner feature capable of associating to two segments simultaneously (see §3.6.6 for discussion of gestural representations in Articulatory Phonology). Nasality is represented formally as a gesture on the [nasal] tier. Other manner contrasts are represented as constriction degree and constriction shape features inherently tied to oral articulator gestures, lacking an independent status.

As an example, the N-N cluster [nm] possesses a single [nasal] gesture which is phased synchronously with the [coronal] and the [labial] oral gestures. In gestural terms, [nasal] is an intervocalic feature for this cluster in the same way that the [labial] gesture is for the homorganic N-O sequence [mp] (see §3.6.5). The gestural score for the sequence [inmi] is presented in (14).

(14) Gestural score for the N-N sequence [inmi].



One result of the Articulatory Phonology framework is that [nasal] is the only manner feature capable of showing the properties of geminate ambiguity, expressed in the feature geometry literature by linking of one feature to two segmental melodies. Thus nasal clusters escape the effects of *[manner]' constraints.

To summarise, I have shown in this discussion that there is both perceptual and articulatory motivation of N-N as the unmarked son-son cluster type. I now discuss one further issue in the phonotactics of liquid-N clusters. Although liquids are marked in

clusters preceding nasals, implicational facts indicate that there is a difference between laterals and vibrants in this position: vibrants are less marked than laterals. This is shown in languages in which vibrants are permitted preceding a nasal but laterals are not. Baagandji shows this pattern:[19] Baagandji has one r-N cluster, [rm], but L-N clusters such as [lm] are *Φ (15).

(15) Baagandji cluster data: laterals imply vibrants in C_1 in liquid-nasal clusters.

son-obst	N-O	[np]	panpuḷa	*wild cabbage*
		[ɳp]	paɳpa	*neck, throat*
		[ɲp]	t̠aɲpa-	*to shine, glow*
		[nk]	manku	*mouse sp.*
		[ɳk]	paɳku	*lower arm*
	L-O	[lp]	palpa	*ashes*
		[ɭp]	kaɭpi	*clear*
		[ʎp]	t̠aʎpa	*close by, near*
		[lk]	kalkara	*sky*
		[ɭk]	paːɭku-	*to make a noise*
	r-O	[rp]	t̠urpa	*to run*
		[rk]	panarka	*sandhill mulga (tree sp.)*
son-son	N-N	[nm]	paːnmulu	*knob-tailed gecko*
		[ɳm]	kaɳma-	*to steal*
	r-N	[rm]	t̠armaɲa	*light, not heavy*
			kaʎirmanta	*cold*
	*L-N	*[lm], etc.		

This pattern suggests that laterals are more likely to assimilate to a following nasal than vibrants. Evidence from loan word assimilation in Warumungu suggests that this is the case. Warumungu permits r-N clusters but L-N clusters are very marginal, attested in a very small number of forms. L-N clusters in loan words from Warlmanpa are assimilated. For example, the word for the Warlmanpa people and language, [waɭmanpa], is

[19]Languages which permit vibrants but not laterals in C_1 preceding a nasal (r-N, *L-N): Anindilyakwa, Baagandji, Mantjiltjarra, Marrgany-Gunya, Pintupi, Wambaya, Warlpiri, Yandruwanhdha, Yankuntjatjarra, Yindjibarndi.

pronounced [waɳmanpa] in Warumungu (Simpson & Heath 1982:34).

I include this pattern for typological completeness, but I will not formalise it here. I will mention, however, that it is possible that this difference in the distribution of laterals and vibrants is an effect of the fact that laterals have an oral tract configuration more similar to nasals than is the case with vibrants. It is widely recognised that vibrants are more sonorant than laterals, reflecting the fact that vibrants are articulated with a greater degree of aperture of the vocal tract. A variety of sonority hierarchies proposed in the literature make a distinction between laterals and "r-sounds". In every case, the "r-sounds" are argued to have higher sonority (Jesperson 1904, Heffner 1960, Selkirk 1982, Zec 1988). The greater sonority of vibrants reflects their comparatively more open articulation. Laterals, on the other hand, are articulated with a [−cont] coronal gesture on the midsagittal line of the oral cavity. Based on these facts I predict that the acoustic quality of a lateral when overlapped with anticipatory nasalisation is perceptually more similar to a nasal segment than is the case with a vibrant. It is possible that this is the motivating factor in the marked status of laterals compared to vibrants in liquid-N clusters, but this issue requires specific acoustic investigation.

§5.6 Liquid+glide and glide+nasal clusters.

After N-N clusters, Australian Aboriginal languages elaborate liquid-N clusters and/or liquid-G clusters. There is no harmonic ordering between these cluster types, shown in the fact that there is no implicational relationship between them: languages may have either one or both. Walmatjarri, discussed in the preceding section, is a language which has N-N and liquid-N clusters but lacks liquid-G clusters. Panyjima has the pattern complementary to Walmatjarri: like Walmatjarri, it has N-N clusters, but instead of

liquid-N clusters it has liquid-G clusters.[20] Data are presented in (16).

(16) Panyjima data: son-son clusters.

a. N-N contour	ɳm	waɳmi	*friendly*
b. L-G contour	lw	-lwuɻu	*habitual (verbal suffix)*
d. *L-N			

Although there is not a harmonic ordering between liquid-G clusters and liquid-N clusters, shown in the lack of an implicational relationship between them, there are considerably fewer languages which have the Panyjima pattern than the Walmatjarri pattern.

Both clusters imply N-N clusters cross-linguistically. As discussed in the preceding section, liquid-N clusters are marked because they violate Velum Uniformity. In order to express the marked status of liquid-G clusters, I propose that they violate a constraint against sequences of approximants: *[approx][approx]. Recall that the approximants constitute the class of oral sonorants. Since liquids and glides, as approximants, have similar vocal tract configurations, liquid-glide sequences lack acoustic modulation and therefore are perceptually complex. In Warluwarra there is a pattern of free variation in which the clusters /lw/ and /lɰ/ are optionally realised as [lː]. This assimilation of a glide to an adjacent lateral is evidence that a transition between them in sequence may not be perceptually recoverable.

Gaalpu demonstrates the next step of elaboration of son-son sequences. Gaalpu has N-N, liquid-N clusters, like Walmatjarri, and liquid-G clusters, like Panyjima, in

[20]Languages which demonstrate this pattern: Bularnu, Ngiyambaa, Panyjima, (Warluwarra), Yawuru.

addition to N-N clusters, which are relatively unmarked. Data illustrating the full range of manner contours in consonant clusters are presented in (17).

(17) Gaalpu data: son-son clusters, and the marked status of nasal+glide clusters.

Manner contour		Data		
son-obst	N-O	[np]	manpaŋu	*bird sp.*
	L-O	[lp]	ɻalpa	*immediately, quickly*
	r-O	[rp]	warpuɻu	*smell (scent, odour)*
	G-O	[ɻp]	t̪uɻpu	*behind, end*
obst-obst	O-O	[tp]	kuɖatpa	*type of wood used for spear shaft*
son-son	N-N	[nm]	cinmiɻ	*edge*
	r-G	[rw]	ɭirwi	*coals*
	L-G	[ɭw]	maɭwija	*emu*
	G-G	[ɻj]	wiɻjar	*turtle sp.*
	L-N	[lm]	wu:lma	*thunder*
	r-N	[rm]	cirmaŋa	*echidna*
	G-N	[ɻm]	kaɻma	*ceremony*
	*N-G			

N-G clusters are *Φ in Gaalpu. In spite of the fact that nasals are Φ in C_1 and glides are Φ in C_2, these sequences do not co-occur: clusters such as [nw] and [nj] are *Φ. N-G have the most restricted distribution among Australian Aboriginal languages of the four son-son cluster types discussed here; they are attested in a relatively small sample of languages.[21]

I formalise the pattern in Gaalpu by making reference to the constraints *[son][son] (see §5.1), *[nas]' (§5.2) and the Velum Uniformity Constraint (§5.5). N-G is the only cluster type which is marked under all three of these constraints, and thus it is predicted to be relatively more marked. It is evident that Gaalpu permits violation of all three of these constraints individually in different clusters. Gaalpu has a wide range of

[21]Languages which permit N-G clusters: Alawa, Gaagudju, Mangarrayi, Miriwung, Warluwarra.

son-son clusters, all of which violate *[son][son]. N-G is the most marked son-son cluster type since it also violates the VUC and *[nasal]'. I present in (18) the status of each of the son-son cluster types under the four that constraints produce their phonotactic patterns.

(18) Constraint evaluation of son-son clusters.

	N-N	liquid-N	liquid-G	N-G
*[son][son]	*	*	*	*
*[nasal]'				*
VUC		*		*
*[approx][approx]			*	

Gaalpu licenses nasals in C_1 in N-O clusters, in violation of *[nas]' (N-N clusters are not considered a violation of this constraint, since the nasal feature in this case is intervocalic, §5.4). And Gaalpu has L-N and r-N sequences, which violate VU. I propose, however, that Gaalpu rules out N-G clusters by not tolerating simultaneous violation of both constraints. Accounts of phonotactic patterns based on cumulative constraint violations have already been discussed in chapter 4 (§4.6 and §4.8), and will be developed in chapter 6.

The absence of the N-G cluster type is another demonstration of the preference for a falling sonority contour in clusters: a sonority increase (as in the transition from a nasal stop to a glide) over the course of a consonant cluster is ill-formed in Gaalpu. The requirement that (heterosyllabic) consonant clusters have a decrease in sonority has a long history in various theoretical frameworks in phonology such as the Syllable Contact Law (Murray & Venneman 1983) and the Sonority Sequencing Generalisation (Clements 1990, Blevins 1995 and references therein).

(19) Constraints on sonority contours in intervocalic clusters.
a. *Syllable Contact Law* (Murray & Venneman 1983): In any sequence $VC_1.C_2V$, the sonority of C_1 must be greater than that of C_2.

b. *Sonority Sequencing Generalisation* (Clements 1990, Blevins 1995, and references therein): Between any member of a syllable and the syllable peak, a sonority rise or plateau must occur.

These two principles overlap in their surface effect: in well-formed representations an intervocalic C_1C_2 sequence is necessarily heterosyllabic where the sonority of C_1 exceeds the sonority of C_2. One difference is that the Syllable Contact Law (SCL) expresses this non-locally, by making reference to segment structure on both sides of the syllable boundary, while the Sonority Sequencing Generalisation (SSG) expresses it locally.

The Gaalpu pattern is consistent with the Syllable Contact Law (19.a). Note that the Sonority Sequencing Generalisation (19.b) does not make the same prediction. Since the SSG evaluates sonority contours locally (i.e., syllable-internally), there is no way to predict that a heterosyllabic cluster involving a sonority rise is ill-formed. The hypothetical syllables [man] and [wi] are both fine according to the SSG (both are attested in the Gaalpu data cited above). But the local power of the SSG cannot rule out concatenating these syllables to form a word such as [man.wi], which is *Φ in Gaalpu. For references making formal recognition of the non-local nature of manner phonotactics in consonant clusters, see the Government Phonology literature (especially with reference to "interconstituent government"): Kaye, Lowenstamm & Vergnaud 1990, Harris 1990, Kaye 1990, and the references which they cite. See also Bures 1989, Rice 1992, and Lamontagne 1993. It is clear that the manner phonotactics in Australian Aboriginal languages are trans-syllabic in this and other respects. Under my assumptions, consonant phonotactics are string-wise constraints on the co-occurrence of consonants, in which case

syllable constituency is irrelevant. Therefore constraints are expected to show trans-syllabic properties, contrary to the assumption of locality present in some prosodic licensing approaches (Itô 1986).

§5.7 The marginal status of liquids in C_2.

The final issue to address in the phonotactics of son-son clusters is the following: liquids have an extremely marked status in C_2 in heterorganic clusters. This requires an account since glides, which have higher sonority, are comparatively common in C_2. I show that the glides (predominantly [w]) which occur in this position are well-formed with respect to place phonotactic constraints, since non-coronals are unmarked in C_2 (§4.2). Liquids, on the other hand, are predominantly apical. Since apical is the most marked place feature in C_2, the marked distribution of liquids in this position is accounted for.

Perhaps the language with the most liberal array of clusters with a liquid in C_2 is Nunggubuyu. Nunggubuyu has the following stem-internal clusters [ll̪], [rl̪], [ɻl̪]. In each cluster, the C_2 liquid segment is the lamino-dental lateral [l̪]. The relevant data are [ŋall̪a], *to be stuck in*; [wurl̪a], *to sink, drown*; [aɻl̪ak] *eucalypt sp.* (Heath 1984:28). The recent historical origin of [l̪] from *d̪ in Nunggubuyu (Heath 1978b:37-41) is undoubtedly the source of this marked distribution of the laminal lateral. These clusters in the reconstructed proto-language were [ld̪], [rd̪] and [ɻd̪], a much less marked state of affairs.

It is also possible that certain of these clusters are historically analysable. Several (except in the form for *eucalypt sp.* above) involve a root-final syllable [l̪a] in verbs of motion. This may indicate a frozen derivational suffix which is not synchronically analysable. The phonetic realisation of these clusters is also relevant to their markedness. Heath 1984:28 states that at least some instances of [ll̪] alternate freely with [l̪ː], and

/l+l̪/ (at morpheme juncture) is reduced to [l̪]. These facts indicate that the lamino-dental lateral is marked in C_2 in Nunggubuyu in spite of the fact that historical change has produced several morpheme-internal examples.

Aside from Nunggubuyu, clusters with a liquid C_2 are isolated, marked anomalies, typically only one or perhaps two examples occurring at low frequencies in a given language. For example, Warray has [ŋl] in one word, [giŋla], *feel sorry for (someone)* (Mark Harvey, pers. comm.). This is the only cluster with a liquid in C_2 in Warray.

I argue here that the marked status of liquids in C_2 derives largely from the place phonotactics. This being the case, the marked distribution of liquids in C_2 compared to the other sonorant manners of articulation is not anomalous with respect to the manner phonotactics. Coronals, especially apicals, are marked in C_2 (§4.2), and so liquids, which are predominantly apical, are marked in this position.

This proposal requires that oral sonorants are subject to the same patterns of place phonotactics as nasals and stops. In chapter 4, I discussed the place phonotactics mainly with reference to nasals and stops. Since these classes show the full range of place contrasts they demonstrate the place phonotactics most clearly. But the glides and liquids show the same patterns of markedness between the place features. For example, of the glides, the labial-dorsal [w] is the most highly valued in C_2. Many languages permit this segment in C_2 as the only glide in this position.[22] The laminal glide [j] occurs in C_2 in a subset of the languages which permit [w]: [j] implies [w] in this position. These facts are

[22] Languages which permit [w] but not [j] and [ɻ] in C_2: Anindilyakwa, Bandjalang, Bardi, Bularnu, Djabugay, Djaru, Djinang, Dyirbal, Garawa, Gumbaynggir, Gunin, Kukatj, Kurrtjar, Kuuku-Ya'u, Mantjiltjarra, Mbabarram, Nyangumarta, Nyawaygi, Nyigina, Panyjima, Pintupi, Umbugarla, Ungarinyin, Wambaya, Warlmanpa, Warlpiri, Warluwarra ([w] and [ɰ]), Warumungu, Wembawemba, Yaygir, Yidiny.

consistent with the place phonotactics for C_2: non-coronals are unmarked and coronals are marked (§4.2). The most marked place feature in C_2 is [apical]. The phonotactics of glides are consistent with this: the apical glide [ɻ] is the most marked member of this class in C_2, and its status in this position is marginal. The apical glide is doubly marked in C_2. First, since sonorants are preferred in C_1, clusters with a glide in C_2 violate ∗[son][son]. Second, the apical feature is marked in C_2. On both counts clusters with the apical glide in C_2 are marked.

Like the apical glide, liquids are extremely marked in C_2. The fact that liquids are predominantly apical is the primary cause of this pattern. Clusters with a liquid in C_2 are marked for the same reasons that clusters with an apical glide in C_2 are marked.

The sole class of non-apical liquids in Australian Aboriginal languages is the laminal laterals. There is no difference between apical and laminal laterals with respect to their distribution in C_2: both are extremely marked in this position (as discussed above, Nunggubuyu has a few clusters with its laminal lateral segment [l̪] in C_2). The laminal glide [j] is common in this position compared to the laminal lateral. The laminal laterals and glide have the same place features but have very divergent distributional patterns in C_2. This difference constitutes an apparent challenge to my proposal that the marked distribution of liquids in C_2 is accounted for primarily by place constraints. However, this cannot be taken as evidence that the markedness of liquids compared to glides in C_2 derives from manner phonotactics. The reason for this is that laminal laterals are independently motivated as marked on feature co-occurrence evidence. I argued in §2.2.3 that the articulatory precision required in maintaining lateral airflow around a lateral wedge means that laminal laterals are marked, expressed as the constraint ∗[laminal, lateral]. The context-independent markedness of laminal laterals predicts their restricted distribution both cross-linguistically and phonotactically within the word, including in C_2.

§5.8 Summary.

In this chapter I have proposed a formalism of the manner phonotactics which rests on constraints similar to those which were put forward to account for the place phonotactics in chapter 4. First, I have proposed OCP-type dissimilarity conditions against adjacent sonorants and adjacent approximants, *[son][son] and *[approx][approx]. Also, I have proposed three constraints against manner features in positions which lack release cues. Two of these constraints are in a fixed ordering relationship: *[obstruent]' ≫ *[sonorant]'; the third constraint is *[nasal]'. These constraints produce the effect that sonorants, particularly oral sonorants, are harmonic in C_1. The interaction of *[son][son] with the harmonic status of sonorants in C_1 means that obstruents have a preferential distribution in C_2. These two results require a proviso regarding the distribution of glides; glides are marked in C_1 in spite of their being oral sonorants. This pattern is accounted for on perceptual grounds, since the acoustic cues distinguishing glides from glide-vowel sequences in pre-consonantal position are not reliable.

Sequences of sonorants are licensed in languages where *[son][son] is relaxed. Four son-son cluster types are commonly found in Australian Aboriginal languages: N-N, liquid-N, liquid-G and N-G. N-G is the most marked, a fact accounted for on cummulative markedness grounds since it constitutes simultaneous violation of three constraints: *[son][son], *[nasal]' and Velum Uniformity, a constraint promoting uniformity of velum position in consonant clusters.

Two additional constraints play important roles in the manner phonotactics. I proposed a constraint, called Unassimilation, which promotes place assimilation of C_1

segments whenever possible under universal articulatory constraints governing association between the manner feature of the C_1 segment and the place feature of the C_2. This constraint has the remarkable property of accurately predicting that nasals are marked compared to liquids preceding noncoronals, and that vibrants are less marked than laterals preceding laminals.

The last constraint is the Velum Uniformity Constraint, which is motivated by the weakening of the acoustic cues of oral segments when adjacent to a nasal segment. In conclusion, the account presented in this chapter mirrors very closely the account of the place phonotactics: dissimilarity conditions and constraints on features contrastive among segments which lack release cues, all motivated on acoustic and articulatory grounds.

Chapter 6: Cumulative markedness effects.

§6.0 Introduction.

In chapters 4 and 5 I surveyed the place and manner phonotactics in consonant clusters. This chapter is a discussion of the interaction between place and manner features in cluster phonotactics. The generalisation made in this chapter is the following: marked place features condition the neutralisation of marked manner features, and *vice versa*. The empirical effect of this is that marked place and manner features often do not co-occur in C_1 and/or C_2. Therefore these patterns are cumulative markedness effects, or markedness ceilings, restricting the *degree* of markedness which is tolerated in clusters. For other discussion of markedness ceilings, see Rice & Avery 1991 where structural complexity constraints restrict feature co-occurrence in a feature geometry framework. I frame a constraints account of these patterns which follows from the theory of markedness and implication assumed in this thesis and discussed in chapter 1.

The organisation of this chapter is as follows: after introducing the empirical patterns and theoretical issues in cumulative markedness effects in §6.1, I discuss one well attested exemplary pattern in §6.2. This is followed by presentation of the formalism of the constraint interaction effects in §6.3. This is followed by three sections discussing additional interaction patterns, all of which are variations on the same general phenomenon which is the focus of this chapter. A summary is presented in §6.7.

§6.1 Formal description of cumulative markedness effects.

Let us assume a language L which licenses a place feature [P] and a manner feature [M] in phonological domain D. At the same time, these features do not co-occur in D. Let us also assume that the marked status of [P] and of [M] in D is accounted for by two

constraints *P/D and *M/D. Since both [P] and [M] are independently licensed in D in this example, L permits surface violations of *P/D and *M/D. At the same time, [P, M] is *Φ in D. This means that L does not permit simultaneous violation of both constraints. The facts are presented diagrammatically in (1). Four feature bundles are evaluated by the constraints *P/D and *M/D. Asterisks on the rows headed by the name of each constraint represent a violation of that constraint. "Total markedness" tallies the total number of constraint violations in the feature bundle across both constraints. In the pattern in question, violation of either constraint is acceptable, but forms which violate both are not permitted. Therefore under this evaluation the feature bundle [P, M] is *Φ in D while the other three are Φ.

(1) Constraints and cumulative markedness effectsconstraint violation.

	[-P, -M]/D	[P, -M]/D	[-P, M]/D	[P, M]/D
*P/D		*		*
*M/D			*	*
	=	=	=	=
Total markedness:		*	*	**
Evaluation:	Φ	Φ	Φ	*Φ

In this account I assume a theory of *domains* which constrains the evaluation of cumulative markedness. Here I follow assumptions in Smolensky 1995 (see also Prince & Smolensky 1993:180 who argue that constraints on tautosyllabic onsets and codas operate independently). The references to the constraint violations *in domain D* in the preceding discussion assumes that cumulative markedness is evaluated in a defined domain, not in different domains. For the purposes of discussion in this chapter, I assume that a consonant cluster is a domain. In the example case involving the features [P] and [M], if D=consonant cluster, then L does not permit simultaneous violation of both *P/D and

*M/D within a cluster. At the same time, L is free to permit simultaneous violation of these constraints in different clusters (i.e., different domains) within a form. Under these assumptions, in the grammar described above, violations of *P/D and *M/D are permitted in different positions, such as [−P, M] in one position and [P, −M] in another.

Because of the rich array of patterns of markedness of place and manner features discussed in chapters 4 and 5, the number of possible patterns of ceiling effects deriving from the interplay of place and manner markedness is exponentially larger: there is the theoretical possibility for each place constraint to interact with each of the manner constraints. I assume that all constraints potentially interact to produce cumulative markedness effects except those pairs of constraints which are intrinsically unable to interact. Constraints which apply to non-overlapping classes of segments do not interact. For example, *[approx][approx] cannot interact with *[nasal]ʳ since there are no nasal approximants in Australian Aboriginal languages. Therefore it is impossible for a consonant cluster to simultaneously violate both constraints. Also, pairs of constraints such as *[−sh][−sh] and *[+sharp]ʳ by definition cannot interact since they refer to mutually exclusive classes of coronal segments. Once again, no cluster can violate both constraints. Constraints are also precluded from showing cumulative markedness effects when the referent of one of the constraints is a subset of the other. *[approx][approx] cannot interact with *[son][son] since approximants are a strict subset of sonorants. Therefore a *[approx][approx] violation entails a *[son][son] violation as well. This precludes the possibility of a phonotactic pattern where the set of permitted clusters violate *either* *[son][son] *or* *[approx][approx] but not both. In summary, constraints may interact only where their referents are partially intersecting classes of segments.

Clusters which are marked necessarily occur at reduced frequencies. Therefore in

some patterns of interaction, the relevant attested clusters occur at such low frequencies that it is impossible to assume with any certainty that the unattested clusters are systematic rather than accidental gaps. For this reason I discuss a representative sample of the patterns which are the most robustly and unambiguously attested. By this I mean that the frequencies of the relevant attested clusters are such that the corresponding absent clusters are demonstrably systematic rather than accidental gaps; and/or the pattern is attested in a range of different languages. The treatment in this chapter is by no means exhaustive, but each case is a variation on a single underlying phenomenon: marked place features and marked manner features neutralise each other.

§6.2 *[cor][cor] and *[son][son] cumulative markedness effects.

I showed in §4.2 that coronal-coronal clusters are marked in Australian Aboriginal languages. This is the effect of the constraint *[cor][cor]. In the flow-chart diagram in (2), proceding from top (unmarked) to bottom (marked), I show the elaboration of the marked apical+laminal place contour (in the cluster [rc]) from an unmarked cor-noncor place contour (such as apical+labial, as in the cluster [rp]) in the left branch in the diagram. I showed in §5.1 that son+son clusters are marked (by the constraint *[son][son]). In (2) I show the elaboration of the marked son+son manner contour (in the cluster [rm]) from the unmarked son-obst manner contour (in the cluster [rp]) in the right branch in the diagram.

(2) Parallel elaboration of place and manner features in C_2.

Place contour			*Manner contour*
Unmarked (cor+non-cor)=	[rp]		=Unmarked (son+obst)
Marked (cor+cor)= (*[cor][cor] violation)	[rc]	[rm]	=Marked (son+son) (*[son][son] violation)

The first place/manner interaction effect is a restriction on combined markedness based on these two patterns. Many languages permit the marked place option by allowing coronal sequences. Also, many languages permit the marked manner option in allowing sequences of sonorants. However, in many languages, the marked place contour is restricted to occurring with the harmonic manner contour, and vice versa. In these cases coronal clusters are restricted to son-obst manner contours; son-son manner contours are necessarily cor+noncor. In other words, cor+cor clusters are Φ *just in case* the sonority profile is the unmarked son+obst; otherwise, clusters are necessarily cor+non-cor.

The augmented markedness of clusters which violate both *[cor][cor] and *[son][son] is represented diagrammatically in (3). Clusters which violate *either* *[cor][cor] (such as [rc]) *or* *[son][son] (such as [rm]) *but not both* are one degree more marked than a cluster such as [rp] which violates neither. Clusters which violate both constraints, such as [rɲ], are another degree more marked. This is presented in (3), where, once again, proceding from top to bottom on the diagram corresponds to the gradual elaboration of marked features.

(3) Parallel elaboration of place and manner features in C_2.

Place contour			*Manner contour*
Unmarked (cor+non-cor)=	[rp]		=Unmarked (son+obst)
Marked (cor+cor)= (*[cor][cor] violation)	[rc]	[rm]	=Marked (son+son) (*[son][son] violation)
	*[rɲ]		

(simultaneous violation of both *[cor][cor] and *[son][son])

Many Australian Aboriginal languages systematically lack sequences of two coronal sonorants, demonstrating the marked status of this cluster type. Walmatjarri is an

example. Walmatjarri allows cor-cor clusters and son-son clusters, both marked options, but fails to allow sequences of coronal sonorants. This can be seen by comparing the place contours attested in N-O and N-N clusters. Laminal stops occur in C_2 but laminal nasals do not. The figure and data in (4) illustrate this pattern.

(4) a. Walmatjarri: C_2 laminals in N-O and N-N clusters.[1]

	N-O	N-N
apical+labial	np ɳp	(nm) ɳm
apical+dorsal	nk ɳk	nŋ ɳŋ
apical+laminal	nc (ɳc)	*nɲ *ɳɲ

b. Walmatjarri data.

N-O clusters			N-N clusters		
[np]	ŋanpaji	*man*	([nm])	(not reported)	
[ɳp]	cuɳpul	*ashes*	[ɳm]	waɳmi	*friendly*
[nk]	ɲanka	*nape of neck*	[nŋ]	ɭinŋuru	*sweet taste*
[ɳk]	ŋaɳkur	*beard*	[ɳŋ]	caɳŋu	*bad smell*
[nc]	wanci	*alive*	(*[nɲ])		
([ɳc])	(not reported)		(*[ɳɲ])		

Laminal nasals are highly marked in C_2 in N-N clusters in Australian Aboriginal languages. The majority of languages which otherwise permit apical+laminal clusters and N-N manner contours are like Walmatjarri. Even in the languages which permit apical+laminal N-N clusters, they occur at vanishingly low frequencies. Nunggubuyu has [puɳɲurɲurwa-], *to sizzle*, and [aɳɲaliɲalika-], *to stir*, as its sole examples (both forms involve suspicious-looking frozen reduplications); Warndarrang has the suffix [-nɲaja],

[1]Languages which have apical+laminal N-O but not apical+laminal N-N clusters: Alawa, Djabugay, Djambarrpuyngu, Djamindjung, Djapu, Djaru, Djinang, Jingili, Gaagudju, Gaalpu, Gooniyandi, Gugada, Gumbaynggir, Gunin, Guugu-Yimidhirr, Jiwarli, Kayardild, Kitja, Kuku-Yalanji, Mangarrayi, Mantjiltjarra, Murinh-Patha, Ngalakan, Ngandi, Nyangumarta, Nyawaygi, Nyigina, Panyjima, Payungu, Pintupi, Ritharrngu, Umbugarla, Walmatjarri, Wambaya, Wardaman, Warlmanpa, Warndarrang, Warrgamay, Watjarri, Yankuntjatjara, Yawuru, Yaygir, Yidiny, Yindjibarndi, Yukulta.

there, as its sole example; Marra has [caŋɲin], *bloodwood tree sp., Eucalyptus polycarpa*, as its sole example.

Another demonstration of this pattern can be seen by comparing the place contours attested in L-O and L-N clusters. In languages which show this pattern laminal stops occur in C_2 following a lateral segment but laminal nasals do not. The table and data from Walmatjarri in (5) illustrate this pattern.

(5) a. Walmatjarri: C_2 laminals in L-O and L-N clusters.[2]

	L-O	L-N
apical+labial	lp ɭp	lm (ɭm)
apical+dorsal	lk ɭk	lŋ (ɭŋ)
apical+laminal	lc ɭc	*lɲ *ɭɲ

b. Walmatjarri data.

L-O clusters			L-N clusters		
[lp]	cilpiʈi	*intestine*	[lm]	palma	*creek*
[ɭp]	ʈuɭpu	*heart*	[ɭm]	(not reported)	
[lk]	kalkara	*widow, widower*	[lŋ]	calŋiri	*sharp*
[ɭk]	puɭka	*big*	[ɭŋ]	(not reported)	
[lc]	milcaɳ	*finger nail*	(*[lɲ])		
[ɭc]	piɭci	*red ochre*	(*[ɭɲ])		

This is another common pattern. Languages which license L-N clusters and which allow apical+laminal clusters divide roughly evenly between those which allow [lɲ] etc. and those which, like Walmatjarri, do not.

Another example of the same pattern comes from the distribution of the laminal

[2] Languages which have apical+laminal L-O clusters but not apical+laminal L-N clusters: Gaagudju, Gooniyandi, Gugada, Guugu-Yimidhirr, Kitja, Kuku-Yalanji, Kurrtjar, Mantjiltjarra, Mbabarram, Murrinh-patha, Ngalakan, Nyangumarta, Payungu, Ritharrngu, Ungarinyin, Walmatjarri, Wardaman, Warlmanpa, Watjarri. Languages which permit apical+laminal LN clusters are: Alawa, (Djabugay), Djambarrpuyngu, Djapu, Djaru, Djinang, Dyirbal, Gaalpu, (Gumbaynggir), Kayardild, Kukatj, Kuuku-Ya'u, Mangarrayi, Marra, Miriwung, Nunggubuyu, (Nyawaygi), Nyigina, Warndarrang, (Yidiny), Yukulta.

and nasal features in C_2 following a vibrant. In many languages laminal stops occur in C_2 following a vibrant but laminal nasals do not. Figure (6) illustrates the inventory of relevant clusters in a language which demonstrates this pattern, with data from Walmatjarri.

(6) a. Walmatjarri: C_2 laminals in r-O and r-N clusters.[3]

	r-C	r-N
apical+labial	rp	rm
apical+dorsal	rk	rŋ
apical+laminal	rc	*rɲ

b. Walmatjarri data.

r-C clusters			r-N clusters		
[rp]	ŋarpi	*finger*	[rm]	cirmiɭ	*sweat*
[rk]	karkin	*torso*	[rŋ]	warŋan	*still water*
[rc]	carcuɳ	*grasshopper*	(*[rɲ])		

One final phonotactic pattern which demonstrates the same cumulative markedness effect is the distribution of the laminal and glide features in C_2 in son+obst and son+son clusters. In many languages laminal stops and the labial-velar glide are licensed in C_2, but the laminal glide does not occur in this position. Figure (7) illustrates this pattern, with data from Mantjiltjarra.

[3]Languages which demonstrate this pattern: Alawa, Alyawarra, Anindilyakwa, Djaru, Djinang, Gaagudju, Gooniyandi, Gumbaynggir, Gunin, Kayardild, Kitja, Kurrtjar, Mantjiltjarra, Mbabarram, Murrinh-patha, Ngalakan, Ngawun, Nyangumarta, (Nyawaygi), Nyigina, Pintupi, Walmatjarri, Wardaman, Warlmanpa, Warlpiri, Warndarrang, Warumungu, Watjarri, Yandruwanhdha, Yukulta.

(7) a. Mantjiltjarra: C_2 laminals in r-O and r-G clusters.[4]

	r-C	r-G
apical+labial	rp	rw
apical+laminal	rc	*rj

b. Walmatjarri data.

r-C clusters			r-G clusters		
[rp]	karpu	*noonday*	[rw]	ɭirwanti	*black cockatoo*
[rc]	ɭarca	*snake sp.*	(*[rj])		

In each of the sets of data in this section, the laminal place feature and the sonorant manner feature, either nasal or glide, are independently licensed in C_2. However, these features do not co-occur in this position. I propose that these patterns are a markedness ceiling effect resulting from the interaction between *[cor][cor] and *[son][son].

§6.3 Theoretical discussion.

The cumulative markedness facts presented here play a central motivating role for the theory of markedness argued for in this thesis. The constraints formalism of the empirical phonotactic patterns of markedness is presented in (8), repeated from (11) in chapter 1 (see §1.3.3 and §1.3.4).

(8) Constraints and implicational markedness.
a. Markedness: F $\succ$ F' where F' violates constraint C and F does not, *ceteris paribus*.
b. Implication: F' is Φ only if F is Φ, where F $\succ$ F'.

[4]Languages which demonstrate this pattern: Alawa, Alyawarra, Anindilyakwa, Djaru, Djinang, Gaagudju, Gooniyandi, Gumbaynggir, Gunin, Kayardild, Kitja, Kurrtjar, Mantjiltjarra, Mbabarram, Murrinh-patha, Ngalakan, Ngawun, Nyangumarta, (Nyawaygi), Nyigina, Pintupi, Walmatjarri, Wardaman, Warlmanpa, Warlpiri, Warndarrang, Warumungu, Watjarri, Yandruwanhdha, Yukulta.

The cumulative markedness effects are consistent with the definition of implication given in (8). I illustrate this from the example of the interaction between *[son][son] and *[cor][cor]. I propose that the constraints build a path of elaboration of marked phonological structures.

Under the definition of markedness in (8.a), [rp] $\succ$ [rm] by *[son][son] and [rp] $\succ$ [rc] by *[cor][cor]. By the definition of implication in (8.b), since both [rm] and [rc] are Φ in this pattern, [rp] is predicted to be Φ as well. The cluster [rɲ] is the most marked of all four, since it violates both constraints. Therefore, [rc] $\succ$ [rɲ] by *[son][son] and [rm] $\succ$ [rɲ] by *[cor][cor]. The clusters [rc] and [rm] are not in a harmonic ordering under (8.a), since they violate different constraints. Because of the *ceteris paribus* condition in (8.a), markedness can only be evaluated between two forms where they differ minimally in whether they violate constraint C (or by transitivity: where F $\succ$ F', and F' $\succ$ F", by necessity F $\succ$ F"). Therefore [rc] and [rɲ] are parallel elaborations rather than in a harmonic order.

Following the principles in (8), constraints produce a harmonic scale of clusters, from least to most marked. The relevant scale for the purposes of the clusters under discussion here is shown in (9).

(9) Harmonic scale deriving from the interaction of *[son][son] and *[cor][cor].

	(b.i) [rc] $\succ$	
(a) [rp] $\succ$		(c) [rɲ]
	(b.ii) [rm] $\succ$	

The definition of implication in (8.b) means that the inventory of clusters attested in any language will always be a continuous portion of the scale beginning from the harmonic end (i.e., beginning from (9.a)). Any non-continuous portion of the scale (such as [rp] and [rɲ]), or any portion which is not aligned with the harmonic end of the scale (such as [rm] and [rɲ]), is an impossible subset under the definition of implication, and therefore cannot exist as a cluster inventory in a natural language.

Note that the definition of markedness and implication in no way forces the assumption that if a language permits violation of constraint C in one phonological context that it freely permits violation of C in any context. The cumulative markedness effects indicate that marked *place* features are elaborated asymmetrically in distinct *manner* environments, and *vice versa*. In Walmatjarri, the laminal place feature is elaborated as a feature of stops in C_2, but not as a feature of nasals in this position. Stop and nasal C_2 segments are distinct contexts with respect to the elaboration of [laminal].

The elaboration of marked features is formally the relaxing of constraints. Since obstruents are promoted as unmarked in C_2 by *[son][son] and *[obst]', the marked laminal feature is elaborated in forms which obey these constraints before forms which are marked under these constraints. This means that constraints are relaxed context-by-context, where *context* is determined by what other constraints are violated in the form in question. In a typical cumulative markedness effect, constraint C is relaxed in forms where C' is not violated, but constraint C is not relaxed in forms where C' is violated. Therefore C' is the crucial factor in determining the context where C is and is not violable, and *vice versa*.

The harmonic scales produced by the constraints, which I have referred to as elaboration paths of marked features, may also be thought of as learning paths in child language acquisition. I do not develop this notion here, but this follows similar proposals in the literature where learning paths have been assumed. Rice & Avery 1995 are an

example, with the path derived from segment structure complexity rather than from constraint violations.

§6.4 *[son][son] and *[hi][hi]

The manner constraint *[son][son] is also in a well attested pattern of interaction with the place constraint *[hi][hi]. The constraint *[hi][hi] reflects the marked status of sequences of an alveopalatal and a dorsal segment (§4.5). The result of the interaction between *[son][son] and *[hi][hi] is that the alveopalatal+dorsal place contour is elaborated in son+obst before son+son clusters. This can be seen by comparing the place features licensed in N-O and N-N clusters (10).

(10) Co-occurrence of [hi] articulations in N-O and N-N clusters.

	N-O	N-N[5]
alveopalatal+labial	ɲp	ɲm
alveopalatal+dorsal	ɲk	*ɲŋ

This pattern is attested in Bidyara-Gungabula. The data in (11) illustrate the set of permitted clusters where the C_1 segment is alveopalatal (data from Breen 1973:22).

(11) Bidyara-Gungabula cluster data.

[ɲp]	kuɲpit	*sweat*
[ɲk]	paɲkalu	*old man kangaroo*
[ɲm]	waɲma	*to make (e.g. a boomerang)*
*[ɲŋ]		

[5]Languages which allow [ɲk] and [ɲm] but not *[ɲŋ]: Bidyara, Garawa, Gumbaynggir, Jiwarli, Mantjiltjarra, Marrgany, Miriwung, Ngalakan, Ngandi, Nyangumarta, Nyungar, Panyjima, Ritharrngu, Walmatjarri, Wambaya, Warumungu, Watjarri, Yankuntjatjarra.

The cluster [ɲk] is marked under the constraint *[hi][hi] but it has the unmarked son-obst sonority contour. The cluster [ɲm] has a marked sonority contour since both segments are sonorants, but it is unmarked under *[hi][hi] since labials do not involve a gesture raising the tongue body. [ɲp] is unmarked on both parameters, but the cluster [ɲŋ] incurs violations of both *[son][son] and *[hi][hi]. I show the elaboration of the marked alveopalatal+dorsal place contour from the unmarked alveopalatal+labial place contour in the left branch in the diagram in (12) and the elaboration of the marked son-son place contour from the unmarked son-obst place contour in the right branch in the diagram in (12). Once again, the cluster which is marked under both constraints is one degree more marked. This accounts for the pattern attested in Bidyara and other languages where this cluster is *Φ.

(12) Parallel elaboration of place and manner features in C_2.

Place contour — *Manner contour*

Unmarked ([hi][-hi])= [ɲp] =Unmarked (son+obst)

Marked ([hi][hi])= [ɲk] [ɲm] =Marked (son+son)
(*[hi][hi] violation) (*[son][son] violation)

*[ɲŋ]
(simultaneous violation of both *[hi][hi] and *[son][son])

§6.5 *[−sh][−sh] in interaction with C_1 manner feature constraints.

In §4.8 I showed that many languages which have rich elaboration of cor-cor clusters have neutralisation of lamino-dentals in C_2. This is an effect of the constraint *[−sh][−sh]. The fourth place/manner cumulative markedness pattern which I discuss is the interaction between *[−sh][−sh] and the constraints on manner features in C_1.

The first example I will discuss derives from the marked status of dentals in C_2 in

apical+laminal clusters and the marked status of nasals relative to liquids in C_1. As proposed in §5.4, this difference between nasals and liquids with respect to their distribution in C_1 is partially the effect of the constraint *[nasal]˺. In this cumulative markedness pattern, the dental stop is licensed in C_2 when the C_1 segment is a liquid but is neutralised when the laminal segment is preceded by a nasal.

Yukulta demonstrates this pattern. Yukulta is a double-laminal language, and both laminal stops occur in contrast in C_2 in r-O and L-O clusters. However, in N-O clusters only the alveopalatal stop occurs in C_2 (13.a). Data showing the range of relevant clusters from Yukulta are presented in (13.b).

(13) Dentals in C_2 in r-O, L-O and N-O clusters: Yukulta.

	r-O	L-O	N-O
apical+labial	rp	lp ɭp	np ɳp
apical+dorsal	rk	lk ɭp	nk ɳk
apical+lamino-alveopalatal	rc	ɭc	ɳc
apical+lamino-dental	rt̪	ɭt̪	*ɳt̪

b. Yukulta data.

[rc]	ɭarcija	*wide*
[rt̪]	ʈurt̪aɻa	*rainbow*
[ɭc]	kaɭcirulu	*kin term*
[ɭt̪]	puɭt̪aŋara	*flying fox*
[ɳc]	kaɳcara	*silver bream (fish sp.)*
*[ɳt̪]		

As stated above, this place/manner interaction pattern derives from the interaction between the constraints *[nasal]˺ and *[−sh][−sh]. Dentals occur in C_2 (in violation of *[−sh][−sh]) only when the C_1 segment is a liquid. They are not permitted in C_2 in clusters with a nasal C_1. Nasals are marked in C_1, a fact which follows from the constraint *[nasal]˺. Clusters which violate both *[nasal]˺ and *[−sh][−sh] are *Φ. This pattern is presented in the diagram in (14).

(14) Elaboration of dentals in C_2 in L-O and N-O clusters: Yukulta.

Place contour		*Manner contour*
Unmarked ([-sharp][+sharp])=	[ɭc]	=Unmarked (liquid C_1)
Marked ([-sharp][-sharp])= (*[−sh][−sh] violation)	[ɭt̪] [ɳc]	=Marked (nasal C_1) (*[nasal]' violation)
	*[ɳt̪] (simultaneous violation of both *[−sh][−sh] and *[nasal]')	

A parallel pattern is found in languages which neutralise dentals in apical+laminal O-O clusters. In a variety of languages, including Djapu, the lamino-dental stop occurs in C_2 following a sonorant segment but not following a stop. In other words, the alveopalatal and dental stops are in contrast in son-obst clusters but not in obst-obst clusters. A representative set of the inventory of clusters in Djapu which illustrate this pattern is displayed in (15), based on Morphy 1983:22.[6]

(15) Asymmetrical distribution of the dental stop in N-O and O-O clusters: Djapu.

	N-O	O-O
apical+labial	np ɳp	tp ʈp
apical+dorsal	nk ɳk	
apical+lamino-alveopalatal	nc ɳc	tc ʈc
apical+lamino-dental	nt̪ ɳt̪	*tt̪, *ʈt̪

The fact that sonorants are less marked than obstruents in C_1 is the effect of the constraint ordering *[obst]' ≫ *[son]' (§5.1). The Djapu pattern is another example of dental neutralisation in C_2 following a marked manner feature in C_1. It results from the

[6]Languages which show this pattern: Djambarrpuyngu, Djapu, Gaalpu, Miriwung, Ngandi.

interaction of *[−sh][−sh] and *[obst]': Dentals are Φ just in case the C_1 segment apical segment is a sonorant. Therefore the account of this pattern follows very closely on the account of the Yukulta pattern.

§6.6 *[laminal] in interaction with manner constraints.

In §4.3 I showed that lamino-alveopalatals are marked in C_1 compared to apicals (lamino-dentals are marginal in C_1, and are ignored here). I proposed separate accounts of the harmonic distribution of apico-alveolars and apico-postalveolars with respect to alveopalatals in this position. I argued that alveopalatals have more gestural complexity than alveolars (expressed by the constraint ordering *[laminal] ≫ *[apical]) and that alveopalatals are perceptually more complex than retroflexes when lacking release cues (expressed by the constraint ranking *[+sharp]' ≫ *[+flat]). The marked status of alveopalatals in C_1 enters into cumulative markedness effects with manner constraints, and this is the subject of this section. I discuss its interaction with *[son][son], the constraint which is largely responsible for the harmonic status of son-obst clusters. Several languages which license lamino-alveopalatals in C_1 restrict it to unmarked son-obst clusters, although son-son clusters with an apical C_1 segment are permitted. In other words, alveopalatals are Φ in C_1 just in case the sonority profile of the cluster is son-obst.

This pattern can be seen by comparing the place features in N-O and N-N clusters (16.a). Yukulta illustrates this pattern; data from Yukulta are given in (16.b).

(16) Neutralisation of lamino-alveopalatals in C_1 preceding sonorants: Yukulta.[7]

a.

	N-O	N-N
apical+labial	np ɳp	(nm) ɳm
laminal+labial	ɲp	*ɲm

b. Yukulta data.

apical+labial	N-O	[np]	kunpa+kunpa	*freshwater crocodile*
laminal+labial	N-O	[ɲp]	paɲpaci	*big green parrot*
apical+labial	N-N	[ɳm]	paɳmara	*white headband*
laminal+labial	N-N	*[ɲm])		

This place/manner interaction pattern is the result of a cumulative markedness restriction on violations of *[son][son] and the constraints which produce the marked status of lamino-alveopalatal place in C_1: *[laminal] and *[+sharp]'. The cluster [np] is maximally unmarked since it incurs violation of none of these constraints. The cluster [ɲp] has the marked place features [laminal, +sharp] in C_1, but it is has the harmonic son-obst sonority profile. [ɳm] is marked since it is a sequence of two sonorants, in violation of *[son][son]. But its place contour is harmonic, with an apical segment in C_1. The cluster [ɲm], on the other hand, incurs violations of all three constraints, and therefore is the most marked option of the clusters discussed here. These facts are summarised in (17).

(17) Parallel elaboration of place and manner features.

Place contour | *Manner contour*

Unmarked (apical C_1)= [np] =Unmarked (son+obst)

Marked (alveopalatal C_1)= [ɲp] [nm] =Marked (son+son)

(*[laminal], *[+sharp]' violations) (*[son][son] violation)

*[ɲm]

(simultaneous violation of *[laminal], *[+sharp]' and *[son][son])

[7] Languages which allow [ɲ] in C_1 preceding a stop but not a nasal (i.e., in N-O but not N-N clusters): Baagandji, Bandjalang, Badimaya, (Bularnu), Gunin, Guugu-Yimidhirr, Kitja, Kuku-Yalanji, Warlpiri, Yawuru, Yidiny, Yindjibarndi, Yukulta.

The observation here is that a cluster which has marked place and manner features is the one which is systematically absent in a range of Australian Aboriginal languages.

§6.7 Summary.

In this chapter I have presented empirical evidence of a recurring pattern in the phonotactics of Australian Aboriginal languages: marked place features neutralise marked manner features in consonant clusters, and *vice versa*. The representative sample of phonotactic data reviewed here demonstrates that the simultaneous violation of two constraints is not tolerated in individual clusters, notably when both constraints are demonstrably relaxed independently in the language in question. I have shown that these facts follow in a straightforward way from the theoretical formalism of markedness and implication which I have assumed in this thesis.

Chapter 7: Conclusion.

§7.0 Conclusion.

In this final chapter I reiterate the principal elements of the constraints theory of markedness in morpheme-internal phonotactics I have argued for, highlighting its contribution to phonological theory.

§7.1 Narrow feature representations.

First, the phonological representations which I have assumed hug the phonetic ground closely. I have argued that they include both narrow articulatory and acoustic features.

A wide range of phonotactic data demonstrate that acoustic features as well as articulatory features play a crucial role in the formalism of place phonotactics of consonant clusters. This motivates a feature theory which includes acoustic information. An example is the evidence from the phonotactics of morpheme-internal clusters of heterorganic coronal consonants. I have expressed this pattern with constraints referring to the acoustic features [flat] and [sharp] (§4.7, §4.8). I also argued from the phonotactics of intervocalic consonants and homorganic sequences that the presence versus absence of V-C and C-V transition cues is an important determinant of phonotactic patterns.

The other potentially controversial stand I have made in my assumptions about representations is that redundant articulatory feature specifications are visible to the constraints. In §4.5, I discussed the marked status of sequences of lamino-alveopalatal and dorso-velar segments. I proposed to account for this pattern with a dissimilarity constraint governing the tongue body feature [high], which these articulations share. Assuming specification of this feature allows a felicitous account of this phonotactic pattern in spite of the fact that it is redundant from the place features.

§7.2 Markedness as an effect of phonetically grounded constraints.

The second defining attribute of this constraints theory is that constraints express the avoidance of gestural and perceptual complexity: *[F] where [F] is a phonetically complex feature. Therefore, markedness is expressed with reference to a particular constraint: form F is marked compared to F' if F' violates constraint C and F does not, all else being equal (1).

(1) A constraints theory of markedness.
Markedness: $F \succ F'$ if F' violates constraint C and F does not, *ceteris paribus*.

A constraint is motivated on an articulatory basis when the phonetic event it states requires gestural effort and/or precision. Articulatory constraints produce the general correlation: gesturally complex=marked, and gesturally simple=unmarked. Acoustic constraints are motivated when the feature or sequence of features described in the constraint is not robust and requires perceptual acuity on the part of the listener.

These two considerations--articulatory effort and perceptual saliency--often make different predictions regarding harmonic forms. The family of constraints which promote the minimisation of gestural complexity predicts that apico-alveolars are the least marked segments. But their vowel formant transition cues are inherently less robust than those of the other articulations when they lack release cues (see discussion in §4.3). Therefore, acoustically motivated constraints predict that alveolars are marked under co-articulation with an adjacent non-coronal. This is in conflict with the harmonic status of these segments from an articulatory perspective.

Languages follow different strategies in resolving examples of such conflict; they may elaborate structures which are marked in either articulatory or acoustic terms, or some of both. In Australian Aboriginal languages, the three least marked places of articulation in C_1 are apico-alveolars, apico-postalveolars and lamino-alveopalatals. In my account, presented in §4.2 and §4.3, I argued that both acoustic and articulatory considerations come into play. I argued that the perceptually salient cues of [+flat] and [+sharp] features in the V-C context license the retroflexes and alveopalatals in C_1; and that apico-alveolars are licensed in this position because of their gestural simplicity. Segments which possess neither gestural simplicity nor robust acoustic place cues are marked.

§7.3 Fixed constraint hierarchies.

The third defining attribute of the constraints theory which I have argued for is that certain constraints occur in universally fixed hierarchies, and that these hierarchies are grounded phonetically. This phonetic grounding follows from the articulatory and acoustic considerations discussed in the preceding section.

As discussed, perceptually robust features are more highly valued in linguistic speech acts than features which are perceptually weak, all else being equal: acoustically robust=unmarked, and acoustically weak=marked. Robustness is a continuum, with individual features occupying different positions relative to each other. Therefore, if feature [F] is more robust than [G], then [F] ≻ [G]. I express this formally by an ordering relationship between the filters referring to the two features: *[G] ≫ *[F] (Jun 1995, Steriade 1995b; see §1.1.2).

The difference between dorsals and labials with respect to their distribution in C_1 demonstrates this. Both in Australian Aboriginal languages and in other languages such

as Korean, dorsals are less marked in C_1 than labials. This follows from the feature [+compact] which dorsals possess and which acts as a salient place cue (see discussion and references in §4.10). Dorsals are [+compact] and labials are [−compact]. The fact that [+compact] is a robust place cue predicts the constraint ordering *[−compact] ≫ *[+compact]. This ordering predicts the attested asymmetry in the neutralisation of labial and dorsal segments in C_1 (Jun 1995).

The features [+flat], [+sharp] and [+compact] all refer to spectral prominences which are robust place cues relative to segments which lack these attributes. These three features occupy different positions on the continuum of relative saliency in C_1. The Australian C_1 phonotactics suggest the constraint ordering shown in (2).

(2) Acoustic constraint scale in unreleased contexts:

*[+grave, −compact]'	(i.e., labials) ≫
*[+grave, +compact]'	(i.e., dorsals) ≫
*[−grave, +sharp]'	(i.e., lamino-alveopalatals) ≫
*[−grave, +flat]'	(i.e., apico-postalveolars)

This ordering is consistent with the impressionistic observations of field researchers. The [+flat] and [+sharp] features are very salient cues in the V-C transition, since they typically trigger very robust allophonic alternations in the realisation of preceding vowels. Allophonic alternations of vowels adjacent to dorsals are not reported in language descriptions as consistently as with retroflexes and alveopalatals, and the conditioned mutation in the quality of the vowels is not as pronounced. These facts suggest that [+flat] and [+sharp] are more pronounced perceptually in C_1, and therefore are less marked in this position than [+compact] segments. This is partial motivation for the constraint ordering given in (2).

The facts discussed here demonstrate that certain scalar effects in markedness follow from universal scales of relative perceptual saliency and articulatory effort, formalised with universally fixed constraint ordering relationships. Therefore, markedness patterns follow from constraints as well as fixed orderings between constraints.

§7.4 Elaboration.

The final central point in this constraints theory of phonotactics is the incremental and idiosyncratic elaboration of markedness in natural languages. The definition of implication is repeated in (3).

(3) Implication: F' is Φ only if F is Φ, where F $\succ$ F'.

Crucial in this definition of implication is the assumption that languages elaborate marked features incrementally (Jakobson & Halle 1956, Jakobson 1962, Calabrese 1988, Rice & Avery 1993). In language acquisition, the child initially assumes a maximally harmonic phonotactic grammar, and elaborates complexity only on the basis of positive evidence consistent with a cue-based learner strategy (Dresher & Kaye 1990, Dresher 1994, 1995). Since constraints promote gesturally and perceptually optimal states, they exert constant pressure on language systems towards a more harmonic state (Lindblom 1983, Ohala 1983, 1990).

Within the constraints theory of markedness the incremental elaboration of complexity means that there can be no language in which a feature F' is Φ while F is $*\Phi$

if F is less marked than F'. This captures the implicational facts in markedness. The constraints interact to produce a complex harmonic scale of forms, from least marked to most marked. The scale is "complex" in that it contains forms which are not in a harmonic ordering, by violating different constraints, and therefore are represented as parallel branches in the scale.

The definition of implication requires that the inventory of forms attested in any language is a continuous portion of the scale beginning from the harmonic end. Therefore, the rich diversity in the phonotactic patterns attested in natural languages is a function partially of the size of the portion of the harmonic scale which they elaborate. In this way, languages differ in the *quantity* of markedness which they permit in their inventories of forms. The fact that the harmonic scale is complex allows languages to also differ in the *quality* of markedness which they tolerate. This latter pattern is expressed formally in the idiosyncratic variability which languages demonstrate in which constraints are relaxed and which are not.

§7.5 Conclusion.

In this thesis I have subjected the morpheme-internal phonotactics of consonants in Australian Aboriginal languages to a theoretical analysis within a constraints-based theory of markedness. The cross-linguistic comparison of phonotactic patterns provides a rich avenue of insight into markedness, insight which evades an analyst working on a formalism of patterns in one language in isolation. I have presented a theory which provides a formalism of individual phonotactic patterns, and at the same time reflects, in the formalism, the variability attested between languages. In this way, the formalism of each pattern informs the formalism of phonotactics as a whole. The heart of the account is that constraints promote the avoidance of articulatorily and perceptually difficult features. Therefore this framework is more substantive than formal since the constraints are motivated from physiology and acoustics rather than being axioms. Assuming the constraints which I have argued for, and that languages elaborate from unmarked to marked structures by relaxing constraints, the full range of phonotactic variability which I have described in this thesis is predicted.

Appendix A: Phonotactics of consonants at word edges.

§1.0 Introduction.

In this appendix I present a descriptive overview and discussion of the place and manner phonotactics of the consonantal positions at word edges. I demonstrate that the harmonic scales of place and manner features attested in the edge positions show a high degree of affinity with the scales attested in the counterpart positions in morpheme-internal clusters: C_{fin} corresponds to C_1; C_{init} corresponds to C_2. At the same time, features are not as severely neutralised in the edge positions as in clusters. In §1.1 and §1.2 I discuss the place and manner phonotactics of word-initial consonants, and in §1.3 I briefly discuss the theoretical importance of the fact that word-initial position is a position of neutralisation. In §1.4 and §1.5 I cover the phonotactics of place and manner features word-finally. In §1.6 I discuss the phonotactic asymmetries between edge and non-edge positions.

§1.1 Word-initial place phonotactics.

In this section I present a survey of the phonotactics of place features in C_{init}, based on both implicational and frequency evidence. I demonstrate the existence of the following harmonic ordering of places in C_{init}:

(1) Word-initial harmonic scale of place features:

Labial, Dorsal $\succ$ Laminal $\succ$ Apical

§1.1.1 Evidence from implications.

In Australian Aboriginal languages labial and dorsal stops and nasals are universally permitted in word-initial position, as are the labial-velar and laminal glides: [p], [m], [k], [ŋ], [w], [j]. The coronal series, however, are often impoverished in word-initial position relative to what is attested in other phonotactic positions in the word, particularly intervocalic position. In terms of their place phonotactics, Australian Aboriginal languages may be categorised according to how many and which coronal series are in contrast in C_{init}. I will continue to refer to place inventories by the number of laminal and apical coronal series which are in contrast: "1-laminal," etc. (as introduced in the survey of place contrasts in chapter 2). This may be used to refer to the coronal inventory in C_{init} as well as to the lexical coronal contrasts, so that a 2-laminal/2-apical language may have some other coronal inventory in C_{init}, such as 2-laminal/0-apical. In this discussion "0" means that no members of the class are permitted.

I begin by analysing the word-initial place phonotactics of four-coronal languages. The most restrictive pattern is 1-laminal/0-apical. In languages which have this pattern, no apicals are permitted initially, and the contrast between the two laminal series is neutralised (2.a). In these languages, although they contrast four coronal series in other phonotactic positions in the word, only one occurs in word-initial position. This initial coronal series is normally laminal and it is usually reported as being dental as well (Hercus 1986:20 reports that initial neutral laminals are "distinctly dental" in Baagandji). The next inventory of coronal series contrastive in word-initial position is pattern 2-laminal/0-apical (2.b). In other words, the two laminal series occur in contrast but apicals are *Φ. In other languages both laminal series occur and a neutralised apical series occurs in word-initial position, pattern 2-laminal/1-apical (2.c). Finally, in some languages, all four coronal series occur contrastively in word-initial position, showing pattern 2-laminal/2-apical (2.d). Here "TH" is a neutral laminal C_{init} segment, usually with dental

articulation; "T" is a neutral apical, often reported as either alveolar or postalveolar in language descriptions, but following Butcher 1995 is perhaps to be considered a *Mittelding* combining the articulatory attributes of both apical gestures in positions of contrast (see discussion in §2.1.3).

(2) Word-initial place phonotactics in place inventory 2-laminal/2-apical languages.

a.	Place inventory	2-laminal/2-apical	p	t̪	t	ʈ	c	k
	C_{init} place inventory	1-laminal/0-apical	p	*	*	*	TH	k[1]
b.	Place inventory	2-laminal/2-apical	p	t̪	t	ʈ	c	k
	C_{init} place inventory	2-laminal/0-apical	p	t̪	*	*	c	k[2]
c.	Place inventory	2-laminal/2-apical	p	t̪	t	ʈ	c	k
	C_{init} place inventory	2-laminal/1-apical	p	t̪	T	*	c	k[3]
d.	Place inventory	2-laminal/2-apical	p	t̪	t	ʈ	c	k
	C_{init} place inventory	2-laminal/2-apical	p	t̪	t	ʈ	c	k[4]

Similar observations regarding the distribution of apical and laminal segments word-initially present themselves in languages with other place inventories. In place inventory 1-laminal/2-apical languages, the single laminal series is always permitted initially. Some have a neutral apical series in C_{init} (3.a) while others contrast both apical series in this position (3.b). No known place inventory 1-laminal/2-apical languages disallow apicals

[1]Languages: Baagandji, Marrgany-Gunya.

[2]Languages: Arabana-Wangkangurru, Badimaya, Garlali, Jiwarli, Martuthunira, Nhukunu, Panyjima, Tharrgari, Yandruwanhdha, Yindjibarndi.

[3]Languages: Anindilyakwa, Arrernte, Bularnu, Dhuwaya, Diyari, Djambarrpuyngu, Gaalpu, Gooniyandi, Guugu-Yimidhirr, Kalkatungu, Kayardild, Kitja, Kukatj, Lardil, Miriwung, Muruwari, Ngawun, Pitta-Pitta, Ritharrngu, Yirr-Yorront.

[4]Languages: Alyawarra, Djapu, Nunggubuyu, Yanyuwa, Yindjibarndi.

altogether, but this pattern is predicted and its absence is likely not systematic.

(3) Word-initial place phonotactics in place inventory 1-laminal/2-apical.

a.	Place inventory	1-laminal/2-apical	p	t	ʈ	TH	k
	C_{init} place inventory	1-laminal/1-apical	p	T	*	TH	k[5]
b.	Place inventory	1-laminal/2-apical	p	t	ʈ	TH	k
	C_{init} place inventory	1-laminal/2-apical	p	t	ʈ	TH	k[6]

In place inventory 2-laminal/1-apical languages, some have a neutral laminal series in C_{init} and no apicals at all, pattern 1-laminal/0-apical (3.a). Others contrast both laminal series in this position, and all of the languages which show this pattern permit the single apical series initially as well (3.b). At present there are no examples of languages which permit both laminal series but do not permit apicals. I assume, once again, that this is an accidental gap.

(4) Word-initial place phonotactics in place inventory 2-laminal/1-apical languages.

a.	Place inventory	2-laminal/1-apical	p	t̪	T	c	k
	C_{init} place inventory	1-laminal/0-apical	p	*	*	TH	k[7]
b.	Place inventory	2-laminal/1-apical	p	t̪	T	c	k
	C_{init} place inventory	2-laminal/1-apical	p	t̪	T	c	k[8]

[5]Languages: Alawa, Djaru, Madhimadhi, Mangarrayi, Mantjiltjarra, Marra, Ngalakan, Ngandi, Nyigina, Nyungar, Tiwi, Walmatjarri, Wambaya, Warlmanpa, Warlpiri, Warluwarra, Warndarrang, Warumungu, Watjarri, Wergaia, Yankuntjatjarra.

[6]Languages: Djinang, Djinba, Gugada, Murrinh-patha, Ungarinyin.

[7]Languages: Ngiyambaa, Yuwaalaraay.

[8]Languages: Gog-Narr, Kuku-Thaypan, Kurrtjar, Kuuku-Ya'u, Mbabarram, Umpila, Wik-Ngathana.

In place inventory 1-laminal/1-apical languages, both the laminal and apical series occur in C_{init}. Therefore these languages do not show positive evidence of the implicational relationship between these two series in initial position.

(5) Word-initial place phonotactics in place inventory 1-laminal/1-apical languages.

a.	Place inventory	1-laminal/1-apical	p	T	TH	k
	C_{init} place inventory	1-laminal/1-apical	p	T	TH	k[9]

It is clear from this discussion of the word-initial place phonotactics that apicals imply laminals in this position when compared cross-linguistically. Therefore the laminal feature demonstrates in its preferential distribution that it is harmonic compared to the apical feature in C_{init}. A correlate to this fact is that apicals only occur initially when both laminal series are licensed in that position.

§1.1.2 Evidence from frequencies.

The fact that laminals are harmonic to apicals in initial position is also reflected in asymmetrical frequencies. In languages which allow both apicals and laminals, laminals always occur at higher frequencies than their apical counterparts.

The frequencies of word-initial stop and nasals and glides are given for six four-coronal languages in (6): Djapu (Morphy 1983:21), Gooniyandi (McGregor 1991:84), Guugu-Yimidhirr (Haviland 1979:38), Kalkatungu (Blake 1979a:13), Ngawun (Breen 1981:26) and Yirr-Yorront (Alpher 1994:162). Djapu has C_{init} place inventory 2-laminal/2-apical, but the others have pattern 2-laminal/1-apical and as a result have gaps (initial

[9]Languages: Bandjalang, Djabugay, Dyirrbal, Gidabal, Gugu-Yalanji, Gumbaynggir, MalakMalak, Nganyaywana, Waalubal, Warrgamay, Yaygir, Yidiny.

neutral apicals are reported as having default retroflex articulation in Kalkatungu; alveolar in Guugu-Yimidhirr, Ngawun and Yirr-Yorront; and are in free variation between alveolar and postalveolar articulation in Gooniyandi).[10]

(6) Word-initial frequencies for C_{init} stop and nasals and glides in place inventory 2-laminal/2-apical languages.

	Djapu	Gooniyandi	G-Yimidhirr	Kalkatungu	Ngawun	Yirr-Yorront
p	14.8%	14%	17.1%	15%	17%	17%
t̪	10.5	5	9.2	7	10	12
t	0.3	5	7.5	--	0.3	2
ʈ	4.5	--	--	1	--	--
c	6.8	11	11	6	5.5	1
k	14.8	15	17.4	14.5	25	15
m	14.6	10	12.2	14.5	10.5	12
n̪	1.1	0.4	2.6	3	1.3	>1
n	0.3	2	1.4	--	--	>1
ɳ	0.9	--	--	1	--	--
ɲ	1.6	3	0.5	1.5	1	>1
ŋ	7.8	9	9	5	9	6
w	10	9	12	7	9	13
y	4	7	6.9	6	9	7

There are several generalisations which are apparent from these data.[11] First, the peripherals always have higher frequencies than the coronals. This is apparent among the

[10]All of the frequencies here are expressed in percentage terms, calculated over the entire lexicon or of a representative lexical sample (see the references for specifics). The totals for any particular language do not necessarily total 100 since totals for initial vowels and liquids, if any, have been omitted.

[11]Word-initial frequencies from languages across Australia with all place contrast inventories demonstrate the same recurring patterns discussed in this section. Frequency data from languages with lexical place inventory 1-laminal/2-apical are Djinang and Djinba, Waters 1989:5; from languages with place inventory 2-laminal/1-apical: Kuuku-Ya'u, Thompson 1988:8; Yuwaalaraay, Williams 1980:22; from languages with place inventory 1-laminal/1-apical: Dyirrbal, Dixon 1972:279; Nyawaygi, Dixon 1979:446; Waalubal, Crowley 1978:446; Warrgamay, Dixon 1981:22; Yidiny, Dixon 1977:38.

stops ([p], [k] ≥ [c], [t]), nasals ([m], [ŋ] ≥ [ɲ], [n]), and glides ([w] ≥ [y]). Second, the laminals have higher frequencies than the apicals. The decline in frequencies from peripherals to laminals to apicals in initial position is a clear and recurring fact in Australian Aboriginal languages.

There is not, however, a consistent pattern of asymmetry in the frequencies of bilabial and dorsal segments. The labial stop sometimes occurs at a frequency marginally greater than the dorsal stop, and sometimes it is the other way around. But the frequency of the dorsal is higher than the labial more often than *vice versa*, and sometimes the plurality of [k] to [p] is considerable. On the other hand, the labial nasal [m] in almost every language occurs at higher frequencies than its dorsal counterpart [ŋ]. The disparity between the frequencies of these two segments is consistently rather substantial, with [m] sometimes reaching or surpassing double the frequency of [ŋ] (see the figures for Djapu, Kalkatungu and Yirr-Yorront in (6)). It must be admitted that word-initial frequencies are equivocal on the markedness relationship between [labial] and [dorsal], if any, in this position. Among stops [dorsal] appears to be less marked than [labial] from the frequency evidence but the pattern is not robust when compared cross-linguistically; among nasals, frequency data demonstrates a clear markedness asymmetry in favour of the labial in C_{init}. However, it is possible that the reduced frequency of the dorsal nasal is to be accounted for as an effect of a gesturally-motivated constraint against this segment, thus accounting for its marked status. This is not an unreasonable assumption, seeing as the task of dorso-velar and velum lowering gestures both tax the palatoglossus muscle.

These facts notwithstanding, the frequency data clearly illustrate the markedness relationships between non-coronals, laminals and apicals, in C_1, and corroborate the implicational facts discussed in the preceding section. In summary, I have shown in this section that noncoronals are unmarked in word-initial position. Among the coronals, laminals are less marked than apicals.

§1.2 Word-initial consonant manner phonotactics.

I turn in this section to a treatment of word-initial manner phonotactics. The following three descriptive generalisations are made in the survey of the relevant data: (i) Stops, nasals and glides occur word-initially in all Australian Aboriginal languages; (ii) The liquids (laterals and vibrants) are the most limited manner class in C_{init}, as demonstrated in patterns of implication and relative frequencies; (iii) The three manner classes pattern in the following frequency contour (*f*=frequency): $fO \geq fN, fG \geq fL$.

§1.2.1 Stops, nasals and glides.

In all Australian Aboriginal languages, stops, nasals and glides occur in word-initial position. Between these three manner classes there is a distinct frequency contour showing stops occurring at the highest frequencies. This pattern is straightforward to demonstrate between the stops and nasals. Since in most languages stops and nasals correspond at all the same places of articulation, it is possible to ascertain the relative frequencies of these two manner classes by comparing the frequencies of each homorganic nasal/stop pair. The word-initial frequency data for the six languages in (6) are repeated here, reorganised in such a way as to highlight the comparative frequencies of the nasals and stops at each place of articulation (7). The consistent pattern apparent in these data is that stops occur at higher frequencies than the corresponding nasals.

(7) Comparison of word-initial frequencies of homorganic of stop and nasals.

	Djapu	Gooniyandi	G-Yimidhirr	Kalkatungu	Ngawun	Yirr-Yorront
p/m	14.8/14.6	14/10	17.1/12.2	15/14.5	17%/10.5%	17/12
t̪/n̪	10.5/1.1	5/0.4	9.2/2.6	7/3	10/1.3	12/>1
t/n	0.3/0.3	5/2	7.5/1.4	--	7.3/0	2/>1
ʈ/ɳ	4.5/0.9	--	--	1/1	--	--
c/ɲ	6.8/1.6	11/3	11/0.5	6/1.5	5.5/1	1/>1
k/ŋ	14.8/7.8	15/9	17.4/9	14.5/5	25/9	15/6

It is not as straightforward a matter to compare the frequencies of the glides [w] and [j] with the other manner classes. This is because certain place contrasts among stops and nasals are neutralised in the glides. Therefore the glides do not correspond exactly to any one place series: [w] corresponds to both [p] and [k] and, in four-coronal languages, [j] corresponds to both [t̪] and [c]. However, what we can discern from a comparison of the frequencies of stops, nasals and glides in C_{init} indicates that stops are less marked than glides, and that there is no harmonic ordering between nasals and glides.

The labial-velar glide [w] occurs at frequencies significantly below both peripheral stops in C_{init} in (6). For example, in Djapu, the frequencies of [p] and [k] are both 14.8%, while the frequency of [w] is only 10%. However, there is no consistent contrast between the non-coronal nasals and [w]. In comparing the frequencies of [w] with the frequencies of the peripheral nasals, [w] usually falls in between the two. Sometimes *f*[w] is relatively high, approximating *f*[m] (see the figures for Guugu-Yimidhirr and Yirr-Yorront); in other cases *f*[w] is relatively low, in the range of *f*[ŋ] (see the figures for Kalkatungu). In some languages, [w] occurs at frequencies higher than both [m] and [ŋ] (see Patz 1991:257 on Djabugay). Therefore there is no clear pattern of markedness, as expressed in frequencies, between nasals and glides in C_{init}.

The laminal glide [j] has a consistent frequency in the range 4-9%. This is below the range of the laminal stops: in the data in (6), [t̪] occurs at frequencies ranging from 7-12% (with one language as low as 5%); and [c] ranges from 6-11% (with one language, Yirr-Yorront, with an unusually low figure of 1% for /[c]). Therefore there is overlap in the frequencies of the glide with its stop counterparts, but the median frequency of the stops is higher. [j] typically occurs at frequencies higher than both of the laminal nasals. The high frequency of [j] compared to its nasal counterparts is inconsistent with the frequency of [w] falling within the range of frequencies of the non-coronal nasals. Therefore it is safest to assume no harmonic ordering between nasals and glides in C_{init}.

Taken all together, the frequency facts indicate that stops are less marked in C_{init} than nasals and glides; there is no pattern of markedness asymmetry between nasals and stops.

§1.2.2 Liquids in C_{init}.

We saw in the preceding section that stops, nasals and glides are licensed in initial position in all Australian Aboriginal languages. The only manner features which are consistently neutralised in C_{init} are the liquid manners: laterals and vibrants.

There are four patterns of phonotactics of laterals in word-initial position. First, in certain languages the neutralisation of coronal place contrasts is so severe in initial position that there are no lateral segments which contrast at any of the places which are licensed initially. This is attested, for example, in languages which have only apical laterals, and which do not permit apicals in C_{init}. In these cases the laterals are unattested entirely as a function of place, rather than manner, restrictions. These languages do not demonstrate a systematic restriction against lateral manner. Such a pattern is apparent only in cases where stops are permitted but not their lateral counterparts.

Second, in many languages laterals are freely permitted initially. In these cases laterals are neutralised by the place constraints, but the lateral feature itself is licensed.[12]

The third pattern is attested in languages which do not permit laterals in initial position, but allow the stop counterparts to the laterals. For example, Diyari (8) permits its apico-postalveolar and laminal stops in C_{init} but not lateral segments. The phonemic inventory of stops and laterals in Diyari is presented in (8.a), and those which are permitted word-initially are presented in (8.b). Asterisks denote segments which are not licensed initially. The laminal and apico-postalveolar stops are missing their lateral counterparts in C_{init}. This indicates a restriction against lateral manner in this position.[13]

(8) Lateral phonotactics: exclusion of laterals in initial position: Diyari.

a. Inventory:	p	t̪	t	ʈ	c	k
		l̪	l	ɭ	ʎ	
a. C_{init}:	p	t̪	*	ʈ	c	k
		*	*	*	*	

Diyari and the other languages like it demonstrate an active prohibition of lateral manner of articulation in C_{init}. A second pattern of avoidance of laterals in initial position is attested. This pattern of lateral phonotactics is seen in languages which have both apical

[12] The languages which allow laterals in C_{init} subject only to the place phonotactics are: Anindilyakwa, Djambarrpuyngu, Djapu, Djinang, Djinba, Gaalpu, Kalkatungu, Kukatj, Kuku-Thaypan, Kuuku-Ya'u, Mbabarram, Ngalakan, Ngalkbun, Ngandi, Nganyaywana, Nunggubuyu, Ritharrngu, Tiwi, Umpila, Wardarrang, Wembawemba, Wergaia, Yukulta.

[13] Languages which show a restriction against laterals in word-initial position: Baagandji, Bandjalang, Diyari, Djabugay, Dyirrbal, Garlali, Gog-Narr, Gugada, Gugu-Yalanji, Gumbaynggir, Guugu-Yimidhirr, Muruwari, Nyungar, Panyjima, Warrgamay, Yaygir, Yidiny.

and laminal lateral phonemes but allow only the apical laterals in initial position. A signficant number of languages have this pattern, shown in (9). For example, in Alawa (9) there are both apical and laminal lateral phonemes. The laminal lateral does not occur in C_{init} in spite of the fact that the other members of the laminal series occur in that position. But this cannot be construed as a restriction against laterals *per se* since the apical lateral appears in C_{init}.

(9) Lateral phonotactics: Avoidance of laminal laterals in initial position.[14]

a. Inventory:	p	t	ʈ	c	k
		l	ɭ	ʎ	
b. C_{init}:	p	T	*	c	k
		L	*	*	

On the marked status of laminal laterals on articulatory grounds, which is likely the motivation for this pattern, see the discussion in §2.3.3. Note that the evidence reviewed in §1.1 indicates that laminal place is less marked than apical place in C_{init}. The avoidance of laminal laterals overrides this pattern which is otherwise a very uniform fact of Australian Aboriginal languages.

§1.2.3 Word-initial phonotactics of the vibrant phoneme [r].

Like the laterals, the vibrant phoneme ["r"] has a restricted status in word-initial position in Australian Aboriginal languages. However, vibrants are even more marginal in C_{init}

[14]Languages which disallow laminal laterals in initial position: Alawa, Bardi, Djaru, Djingili, Garawa, Gooniyandi, Kitja, Madhimadhi, MalakMalak, Mantjiltjarra, Marra, Ngarndji, Pintupi, Ungarinyin, Walmatjarri, Watjarri.

than laterals: only a small number of languages allow [r] initially.[15] In every language which permits initial [r] the apical laterals occur initially as well (in addition to the apico-postalveolar glide, [ɻ]). Also, it is worth noting that most of the languages which have initial [r] contrast both apical series in C_{init}. These facts indicate that the trill is normally attested in C_{init} only when apical places and associated manner contrasts have been fully elaborated in that position. Thus it is the most marked segment in C_{init}. This is further corroborated by its low frequency in initial position. The lexicon for Djambarrpuyngu given by Heath 1980, for example, gives only three forms with initial [r].

In this section, I have shown from both implicational and frequency evidence that the following harmonic scale of manner features is attested in word-initial position: Stop ≻ nasal, glide ≻ liquid. This is similar to the harmonic ordering between the manner classes attested in C_2, as discussed in chapter 5.

§1.3 Word-initial position as a position of neutralisation.

I have shown that Australian Aboriginal languages are relatively unusual in the larger context of natural languages in that C_{init} is a position of often very severe neutralisation of phonological contrasts. This is problematic within a prosodic licensing account of phonotactics. In a prosodic theory, C_{init} and C_{inter}, both syllable onsets, are expected to share similar phonotactic properties because of their common syllabic constituency. This, however, is not the case: C_{inter} is the position of maximal contrast while C_{init} is a position

[15]Languages: Anindilyakwa, Djambarrpuyngu, Djapu, Djinang, Gaalpu, Nunggubuyu, Warlpiri, Yanyuwa. Warlpiri contrasts apical trill/taps at alveolar and postalveolar places of articulation. The contrast between these two is not licensed in C_{init}, with the neutral segment varying allophonically between the two places of articulation. It contrasts in this position with the neutral apical lateral and [ɻ] (Jagst 1975:27-28).

of neutralisation.

Central in much of the work in prosodic licensing is an implicit or explicit assumption that onsets are phonotactically unconstrained (see, for example, Goldsmith 1990:125-126 and Blevins 1995:227). This putative observation regarding the phonotactics of onsets, "that single member onsets appear to be unrestricted cross-linguistically" (Blevins 1995:227), is incorrect with respect to word-initial onsets. In Australian Aboriginal languages, single intervocalic consonants are unconstrained, but the patterns of segments permitted word-initially show very clear and often highly restrictive phonotactics.[16] A rather severe example of this is Marrgany-Gunya. The consonantal phoneme inventory for this language is shown in (10), containing a total of twenty-five distinct segments.

(10) Marrgany-Gunya consonantal contrasts.

labial	lam-dental	apico-alv	apico-posta	lam-alvp	dorso-velar	
p	t̪	t	ʈ	c	k	fortis stop
b	d̪	d	ɖ	ɟ	g	lenis stop
m	n̪	n	ɳ	ɲ	ŋ	nasal
		l	ɭ	ʎ		sonorant lateral
		r				vibrant
w			ɻ	y		glide

Despite the rich inventory of place and manner contrasts in this language, only eight consonants are permitted in word-initial position. In terms of place contrasts, labial,

[16]In a footnote, Blevins (1995:227, fn 54) discusses the absence of flaps and glottal stops in initial position in some languages, and suggests that these patterns may be related to feature-linking between these segments and preceding vowels. The neutralisation of place and manner features in C_{init} discussed here goes well beyond such an account.

dorsal, and lamino-dental series occur in this position. In terms of manner, only stops, nasals and glides occur; liquids do not. Also, the fortis/lenis contrast for the stops is neutralised in this position. Near-minimal pair data showing phoneme contrasts permitted in word-initial position are given in (11).

(11) Marrgany-Gunya word-initial consonants.

p	pandi	*beeswax*	m	mandiɻi	*boot; shoe*
k	kandi	*to call*	ŋ	ŋan̪d̪i	*to speak*
t̪	t̪andi	*river wattle*	n̪	n̪aɻi	*name*
w	wandi	*to climb*			
y	yaɳɖi	*waist*			

Marrgany-Gunya is perhaps the most severe case among Australian Aboriginal languages of asymmetry between consonantal contrasts in C_{init} and those in other phonotactic positions. However, the number of Australian Aboriginal languages which allow all of their consonant phonemes in C_{init} is relatively small.

It is clear from these facts that onsets *per se* do not stand out as positions where consonantal contrasts are unconstrained. Therefore there is a significant asymmetry in the phonotactic patterns found in C_{init} and C_{inter}, in spite of their common syllabic constituency. These facts provide further support for the non-prosodic analysis of Australian phonotactics pursued in this thesis.

§1.4 Consonantal place phonotactics in word-final position.

I now address the place phonotactics of word-final consonants, and will show that, as with the word-initial phonotactics, there is a high degree of similarity in phonotactics attested at the word edge and those attested in consonantal positions in clusters.

To begin, it is important to note that a number of Australian Aboriginal languages do not permit consonant-final words.[17] Several of these languages have root-final consonants, with the vowel-final word template enforced by a very transparent surface alternation of paragogy (usually the phonological augment is the syllable [-pa]). In these languages, the phonotactics of the root-final consonants parallel word-final consonant phonotactics in other languages. This is undoubtedly to be accounted for on historical grounds: the vowel-final word template is a recent innovation in these languages, and therefore the root-final consonants reflect what were word-final segments in the recent history of these languages (see Dixon 1980:208-210). Because of the close historical parallel between the root-final consonants in these languages and the word-final consonants in their congeners, the languages for which root-final phonotactics have been reported are included in the word-final consonant survey in this chapter.

Among languages which permit word-final consonants, there is a clear pattern of markedness among the place features demonstrated in implication. In the implicational relationships between the place features in C_{fin}, a hierarchy of inclusiveness of place features is apparent. This is shown in (12.a). This hierarchy of inclusiveness translates into the harmonic scale shown in (12.b).

(12) Place markedness in C_{fin}.

a. Hierarchy of inclusiveness:	{Labial {Dorsal {Laminal {Apical}}}}
b. Harmonic scale:	Apical ≻ Laminal ≻ Dorsal ≻ Labial

[17]Languages: Alyawarra, Anguthimri, Anindilyakwa, Arabana-Wangkangurru, Arrernte, Baagandji, Bularnu, Diyari, Garlali, Jiwarli, Kayardild, Ngarndji, Panyjima, Pitta-Pitta, Tharrkari, Wambaya, Warlmanpa, Warluwarra, Yandruwanhdha, Yukulta.

In other words, [apical] is the least marked place feature in this position; the other place features imply [apical] in this position. Languages elaborate the additional place features in the order [laminal], [dorsal] and [labial], making [labial] the most marked place feature in C_{fin}.

The unmarked status of apicals in C_{fin} is shown from implicational evidence: a small number of languages exclude all non-apical segments in C_{fin}.[18] Additional evidence for the unmarked status of the apical feature word-finally comes from inventories of nasals or laterals permitted in this position. For example, in Kuuku-Ya'u, Ngiyambaa and Yuwaalaraay the apical nasal [n] is the only nasal permitted in C_{fin}, the other nasals in these languages, particularly the laminal nasals [n̪] and [ɲ], are $*\Phi$ in C_{fin}. These languages permit [j] finally and so the exclusion of the laminal nasals cannot be accounted for as a general avoidance of all non-apicals word-finally. Nonetheless, the pattern of exclusion of non-apical nasals is significant in its own right. Also, it is a widespread pattern that apical but not laminal laterals occur in C_{fin}, although non-apicals of other manners of articulation are permitted in this position.[19] Kalkatungu is an example of this: this language contrasts four lateral segments, but only the two apical laterals occur in C_{fin}.

[18]Languages: Garrawa, Lardil.

[19]Languages which permit apical but not laminal laterals in C_{fin}, while at the same time allowing laminals of other manners of articulation in this position: Amurdak, Djingili, Gaagudju, Gugada, Gunin, Kalkatungu, Jiwarli, Marrgany-Gunya, Miriwung, Murinh-Patha, Ngarigu, Payungu, Pintupi, Ungarinyin, Wambaya. In addition, the laminal lateral in Gooniyandi is marginal. The marked status of the laminal lateral word-finally could be related to the marked status of laminal articulation for laterals in general without appealing to the unmarked status of [apical] in C_{fin}. The laminal lateral segment in Nunggubuyu, which has dental articulation, is absent in C_{fin}, but this likely is primarily an effect of the restriction against lamino-dental segments in Australian in positions lacking release cues (see chapter 4).

A more common and robustly attested pattern of place phonotactics obtains in languages which restrict final consonants to apical and laminal articulation. This is most clearly demonstrated in the inventories of nasals permitted word-finally, since nasals typically are contrasted at all places of articulation and are generally permitted word-finally as well. In languages which show this pattern the non-coronal place features are not licensed in C_{fin} and only apical and laminal nasals occur.[20]

In the vast majority of double-laminal languages (i.e., languages which have both alveopalatal and dental laminal phonemes) which show this pattern, the dental series is not permitted finally. In chapter 4 I analysed this as acoustic neutralisation of the contrast between alveolars and dentals in positions lacking release cues. Word-final dental neutralisation is an almost completely uniform pattern of Australian Aboriginal languages: lamino-dentals are in contrast in word-final position in only a small number of languages.[21]

The next place feature which languages elaborate in C_{fin} is [dorsal]. Once again, in many languages this is especially demonstrated among the nasals, although some languages which permit final stops demonstrate the same pattern of place phonotactics among the stops as well. In these languages [ŋ] occurs in C_{fin} along with the coronals, but [m] is absent; similarly, in some languages which permit final stops, [k] occurs in C_{fin} but

[20]Languages which permit only apical and laminal nasal stops in C_{fin}: Djinggili, Gaagudju, Guugu-Yimidhirr, Jiwarli, Kalkatungu, Mantjiltjarra, Marrgany-Gunya, Martuthunira, Muruwari, Ngawun, Nyangumarda, Panyjima, Payungu, Pintupi, Uradhi, Warumungu, Watjarri, Yankuntjatjarra, Yindjibarndi.

[21]Languages which contrast two laminal series in C_{fin}: Gooniyandi, Kurrtjar, Miriwung, Muruwari, Olkol, Uradhi (Atampaya dialect only), Yaraldi, Yirr-Yorront. Both laminal series are in contrast root-finally in Kayardild and Yukulta, but root-final segments in these languages never occur in word-final position.

not [p].[22]

Finally, in a wide range of languages all four active articulators are licensed in C_{fin}.[23] It should be borne in mind, however, that in these languages labials often occur at very low frequencies in C_{fin}, further indicating their marked status in this position.

In summary, in the word-final place phonotactics in Australian Aboriginal languages, we see a harmonic ordering of the articulator place features: apical $\succ$ laminal $\succ$ dorsal $\succ$ labial. This scale is identical to the harmonic scale seen in C_1 in chapter 4.

§1.5 Word-final manner phonotactics.

I now discuss the manner of articulation phonotactics of word-final consonants in Australian Aboriginal languages. In the place phonotactics of final consonants a hierarchy of inclusiveness of manner features is apparent, as discussed in the preceding section. In particular, implicational evidence indicates that liquids and nasals are less marked than both obstruents and glides. There is no harmonic ordering between obstruents and glides: many languages license either one or the other class, but not both, in C_{fin}. There is no implicational evidence of a markedness asymmetry among the liquids and nasals, since all

[22]Languages which allow dorsal oral and nasal stops but not labials in C_{fin}: Badimaya, Gugada, Kayardild, Nunggubuyu, Ungarinyin, Wambaya. In Djambarrpuyngu, Djapu, Gaalpu and Gurr-Goni, [p], [m] occur at vanishingly low frequencies in C_{fin}, indicating their marked status; in Ndjebbana [p] is absent and [m] is marginal. In Ngarigu, Marra, Warndarrang and Walmatjarri [m] is the only nasal stop absent in C_{fin} but [p] is permitted. The opposite phenomenon is attested in Amurdak and Nakkara: [p] is absent and [m] is marginal. The fact that labial segments are vulnerable to be accidental gaps in C_{fin} is an effect of their low frequency and thus further corroborates their marked status in this position.

[23]Languages which license all four active articulator features in C_{fin}. Djambarrpuyngu, Djamindjung, Djapu, Gaalpu, Gooniyandi, Gnin, Kitja, Kukatj, Limilngan, Madhimadhi, Mangarrayi, Marra, Miriwung, Murinh-Patha, Nakkara, Ndjebbana, Ngarigu, Nyungar, Rembarrnga, Ritharrngu, Umbugarla, Walmatjarri, Warndarrang.

Australian Aboriginal languages license both manner features in C_{fin}. Frequency evidence hypothetically could be relevant on this question. However, the numbers of forms with a final consonant are often low, meaning that the chance of a statistically significant pattern emerging in the word-final consonant data is slim. Taken together, these facts produce the harmonic scale presented in (13).

(13) Harmonic ordering of manner classes in C_{fin}.
{Liquid, Nasal} $\succ$ {Obstruent, Glide}

Because the frequencies of word-final segments are not a reliable guide to markedness patterns since their frequencies are already very low by virtue of being word-final, the best evidence for markedness relations comes from implication: several languages permit only liquids and nasals in C_{fin}.[24]

The unmarked status of obstruents and glides with respect to each other in C_{fin} is also indicated in languages which license all of the manner classes except for either stops or glides in this position. Many languages permit liquids, nasals and stops in C_{fin} but exclude glides.[25] Several languages have the converse pattern, allowing all sonorant

[24]Languages which allow only liquids and nasals in C_{fin}: Jiwarli (root-final), Kalkatungu, Mantjiltjatjarra, Martuthunira, Ngawun, Nhanta, Panyjima (root-final), Pintupi, Warumungu, Yankuntjatjarra.

[25]Languages which allow liquids, nasals and oral stops but not glides in C_{fin}: Badimaya, Madhimadhi, Marrgany-Gunya, Ngarigu, Nyangumarta, Walmatjarri, Wambaya (root-final), Yindjibarndi. The word-final oral stops in Yindjibarndi descend from laterals via a recent historical change; if not for this, Yindjibarndi would fall among the languages cited in the preceding footnote.

manners of articulation in C_{fin}, including glides, but excluding stops in this position.[26] In spite of all of the languages which exclude stops or glides in C_{fin}, or both, we have no languages which exclude liquids and nasals in this position. These implicational facts indicate the markedness ordering {Liquid, Nasal} $\succ$ {Obstruent, Glide}.

In summary, the manner phonotactics of word-final consonants indicate a harmonic scale of the form {Liquid, Nasal} $\succ$ {Obstruent, Glide}. The implicational evidence shows this scale clearly, but does not allow for it to be any more finely tuned.

§1.5.1 Summary of word-final phonotactics.

Upon investigation of the place and manner phonotactics in C_{fin}, it immediately becomes clear that they bear close similarities with the phonotactics in C_l. Consonants in these two positions have in common the fact that they lack release and C-V vowel formant transition cues. Because of this, it is not surprising that they share similar phonotactic attributes. The markedness scales of place and manner features in C_{fin} are repeated in (14.a); the C_l place and manner feature scales discussed in chapters 4 and 5, respectively, are repeated in (14.b).

(14) Harmonic feature scales in positions lacking release and C-V vowel formant transition cues.

a.	Harmonic place scale (C_{fin}):	Apical $\succ$ Laminal $\succ$ Dorsal $\succ$ Labial
	Harmonic manner scale (C_{fin}):	{Liquid, Nasal} $\succ$ {Obstruent, Glide}
b.	Harmonic place scale (C_l):	Apical $\succ$ Laminal $\succ$ Dorsal $\succ$ Labial
	Harmonic manner scale (C_l):	Vibrant $\succ$ Lateral $\succ$ Nasal $\succ$ Obstruent, Glide

[26]Languages which allow liquids, nasals and glides but not oral stops in C_{fin}: Djabugay, Dyirrbal, Guugu-Yimidhirr, Kuku-Yalanji, Kuuku-Ya'u, Muruwari, Ngiyambaa, Yuwaalaraay. The languages which demonstrate this pattern are concentrated in the extreme eastern portion of Australia.

§1.6 The relationship between place phonotactics at word edges and in clusters.

In the preceding sections I have shown that the place and manner features at the word edge positions parallel very closely those attested in the corresponding positions in morpheme-internal clusters. There is one final empirical pattern in the word edge phonotactics to discuss. I will briefly demonstrate in this section that there is one systematic asymmetry in the phonotactics in the edge and non-edge positions. In both contexts, the same harmonic scales are attested; however, in the edge positions, neutralisation is not as severe as in the non-edge positions. I demonstrate this in reference to the place phonotactics by discussing three representative patterns.

First, apicals are marked in C_{init} but occur at low frequencies in the majority of languages (see (2.a, b) above). On the other hand, in only a handful of languages do apicals have even a marginal status in C_1. Therefore there is a clear disparity in the distribution of apicals in C_{init} versus their distribution in C_2.

Second, lamino-dentals are neutralised in C_1 and C_{fin} in most double-laminal languages. Lamino-dentals are contrastive in C_1 in a very small number of languages, and even then the contrast is distributionally restricted (see the discussion in §4.4). In contrast, a relatively substantial number of languages contast both laminal articulations in C_{fin} (see discussion above). Therefore there is a clear disparity in the distribution of lamino-dentals in C_1 and C_{fin}, with the wider distribution for this series attested in the word edge position.

Finally, labials have a considerably wider distribution in C_{fin} than in C_1, although it is the most marked place feature in both positions. The languages which license all four active articulator features are listed in footnote 22 above. In contrast, only a small number of languages license [labial] in C_1 (see discussion in §4.10).

The facts outlined here are a representative sample of patterns indicating the more liberal licensing of place features at word edges than in clusters. The same facts obtain in a comparison of the manner phonotactics in the edge and non-edge positions.

§1.7 Conclusion.

I have shown a clear parallel between the patterns of markedness found among the place and manner features at word edges and in clusters. The consonants which are most frequent in word-initial position are also least marked in C_2; the consonants which have a preferential distribution in word-final position are the least marked in C_1. One result of these facts is that the consonant clusters which occur at word-boundaries in connected speech are very similar to the least marked consonant clusters morpheme-internally.

I will not discuss the theoretical formalism of word edge phonotactics, beyond noting that they are consistent with the notion of phonetically grounded constraints argued for in this thesis. Word edge consonants in connected speech may benefit from more acoustic cues than segments in word-internal consonant clusters. For example, a word-initial consonant following a vowel-final word receives cues in the formant transitions in the preceding vowel. These facts merit further attention and theoretical investigation.

Appendix B: Phonotactic data

The following tables present the phonotactic data for the Australian Aboriginal languages which are referred to most frequently in this thesis. This will allow the reader to become more acquainted with the larger phonotactic picture of the languages which are referred to normally in a very brief fashion. For example, in discussing the phonotactics of the C_1 segments in some language, it may be useful to refer to the tables for that language to find the segments which occur word-finally.

The information is organised as follows:

Language name. (Region of Australian where the language is located; Language family it is a part of, followed by a sub-group name for those language which belong to the Pama-Nyungan family) Primary reference(s) for the language.

Consonant phonemes:

Consonantal segments which occur in contrast in intervocalic position. Segments in (parentheses) are marginal in the system, attested in a handful of forms or fewer.

Homorganic sequences:

Consonant clusters which have a common place of articulation. This includes primarily nasal+stop clusters, and often also lateral+stop clusters, but languages permit other types as well, such as glide+stop. In some cases the "homorganic" designation is approximate, meaning that they are both articulated by the same active articulator but the place of articulation may not be exactly the same, such as in [jt̪] or [ɻt].

Word-initial consonants:

Consonants which occur in initial position. I have used the symbol for the most common allophone of the segment in this position. If the language contrasts two series of stops, I have used voiceless symbols for neutralised oral stops. (all) means all consonants are permitted initially. (none) means no consonants are permitted initially. Segments in (parentheses) are marginal, attested in one or two forms, or only in borrowings, etc. Asterisks indicate segments which are not permitted word-initially.

Word-final consonants:

Consonants which occur in word-final position.

Attested morpheme-internal heterorganic clusters:

Clusters which are reported for the language within root morphemes. Clusters in (parentheses) are reported only once and/or are reported by the source to be marginal in the system.

Comments on the allophonic realisation of segments in various contexts, especially allophonic voicing of stops and the realisation of the vibrant segment(s) are given at the end of each language entry.

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Aghu-Tharrnggala. (Eastern Cape region; Pama-Nyungan, Pama-Maric) Jolly 1989.

Consonant phonemes:	p	t̪	t		c	k
	b	d̪	(d)		(ɟ)	g
	m	n̪	n		ɲ	ŋ
			l			
			"r"			
	w			ɻ	j	

Homorganic sequences:	mb	n̪d̪	nd		ɲɟ	ŋg (unit phonemes in source)
		n̪t̪			ɲc	ŋk (clusters in the source)

Word-initial consonants: (all)

Word-final consonants:	*	*	*		*	*
	*	*	*		*	*
	m	n̪	n		*	ŋ
			l			
			"r"			
	w			ɻ	j	

Attested morpheme-internal heterorganic clusters of two consonants (likely incomplete):

	N-O	L-O	L-O	L-N	r-O	r-O	r-N
ap+lab	nb	lp	lb	lm	rp	rb	rm
ap+dor	ng	lk	lg	lŋ	rk	rg	rŋ
ap+pal			lc		rc		

Homorganic sequences: The homorganic nasal plus voiced stop clusters are proposed as unit phonemes in the source on the basis of the following argument: Aghu-Tharrnggala permits three-consonant clusters composed of a liquid followed by a homorganic labial or dorsal N-O sequence: [lmb], [lŋg], [rmb], [rŋg]. The source states that assuming that the N-O sequence are unit phonemes simplifies the statement of the phonotactics, since this assumption allows the generalisation that all clusters are sequences of two consonants.

Clusters: Additional clusters composed of a consonant followed by one of the glides [w] or [j] are also attested in word-initial position: [tw], [kw], [mbw], [ŋgw], [gw], [rw], [lgw], [lkj], [bj]. In these cases, the glides descend from original vowels to the left of the consonant in the proto-language.

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Alawa. (Desert region; Maran) Sharpe 1972.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	

Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk	(units in the source)
		lt	ɭʈ			(clusters in the source)
				cɲ		

Word-initial consonants:	p	t	*	c	k
	m	n	*	ɲ	ŋ
		l	*	*	
		*			
	w		ɻ	j	

Word-final consonants:	*	t	*	*	*
	m	n	ɳ	ɲ	ŋ
		l	ɭ	*	
		"r"			
	*		ɻ	j	

Attested morpheme-internal heterorganic clusters of two consonants:

	N-O	O-O	O-N	N-N	N-G	L-O	L-N	L-G	r-O	r-N	r-G
ap+lab	np ɳp	tp ʈp	tm	nm	nw	lp ɭp	lm ɭm	lw	rp	rm	rw
ap+dor	nk ɳk	tk		nŋ		lk ɭk	lŋ ɭŋ		rk	rŋ	
ap+lam	nc	tc				lc ɭc	lɲ	lj ɭj	rc		
lam+lab				ɲm							
lam+dor	ɲk										
dor+lab			km								

	G-O	G-N	G-G
ap+lab	ɻp	ɻm	ɻw
lam+lab	jp		
lam+dor	jk		

Note: The word-final consonants exclude verbal particles, in which all consonants are found finally.

Homorganic N-O sequences: argued as pre-nasalised stop phonemes on the basis of phonotactics, since they can occur word-initially, in addition to the fact that "when dictating words slowly the informant usually makes the syllable boundary before the nasal segment." The prenasalised stops do not occur word-finally.

Consonant phonotactics: Various clusters of three consonants are present in the data: [rŋk], [rɲc] and certain others.

===

Anguthimri, Mpakwithi dialect. (West Cape region; Pama-Nyungan, Northern Pama) Crowley 1981.

Consonant phonemes:	p	t̪	t	ʈ^r	c	k
	m	n̪	n		ɲ	ŋ
	β	ð̪			ʒ	ɣ
			l			
				ɽ		
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ^r	ɲc	ŋk (units in the source)

Word-initial consonants: (all)

Word-final consonants: (none)

Attested morpheme-medial clusters (p.155): Labial or dorsal segment +[w]: [pw], [mpw], [βw], [mw], [kw]. Labial non-continuant +[ɻ]: [pɻ], [mpɻ], [mɻ]. Semi-vowel + consonant: [jɣ], [wc], [jm], [wn̪].

Stops: The stops vary freely between aspirated and unaspirated voiceless realisations. The labial stop generally lenites to [f] or [β] when followed by either [w] or [ɻ].

Retroflexes: The postalveolar stop is articulated slightly behind the alveolar ridge and with a sharp trilled release. The nasal portion of the pre-nasal stops is non-syllabic.

Fricatives: The fricatives and [ɽ] when word-initial optionally take a prothetic [ə]; for this reason the source treats [ɽ] phonologically as a fricative. Phonetically it is a single postalveolar flap, occasionally realised as a trill. [ɻ] conditions r-colouring in preceding vowels, even across another consonant.

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Anindilyakwa, Traditional. (Family isolate; Arnhem region) Leeding 1989.

Consonant phonemes:	p	t̪		ʈ	c	k	kp
	pʷ					kʷ	kpʷ
	m	n̪		ɳ	ɲ	ŋ	ŋm
	mʷ					ŋʷ	(ŋmʷ)
		l̪		ɭ	ʎ		
			"r"				
	w			ɻ	j		
Homorganic sequences:	mp	n̪t̪		ɳʈ	ɲc	ŋk	ŋp (units in the source)
	mpʷ					ŋkʷ	(ŋpʷ)

Word-initial consonants: (all except the labial-velars)

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	L-O	r-O	r-N	r-G	G-O	G-N
ap+lab		rp	rm	rw		
ap+labʷ	(lpʷ)	(rpʷ)	rmʷ		ɻpʷ	ɻmʷ
ap+dor	lk	rk	rŋ			
ap+dorʷ	lkʷ	rkʷ	(rŋʷ)			
ap+dent	(lt̪)	rt̪			ɻt̪	
ap+pal	(lc)	(rc)			ɻc	

Stops: Plain oral stops are normally voiceless unaspirated, but may be voiced for up to 40% of their duration following a vowel or a nasal. The oral portion of the pre-nasal series may be voiceless or have a voiced onset.

Homorganic N-O sequences: these are considered by the source as unit phonemes on the basis of tenuous evidence (which the source admits, p.26): they occur root-initially (as opposed to heterorganic clusters); the unit analysis simplifies the statement of certain rules; they occur word-initially in reduced forms of certain particles; no vocalic epenthesis ever breaks them up, but it does with heterorganic clusters; syllable breaks expressed by certain speakers.

Apico-alveolars: With the exception of the vibrant, there are no phonemic apico-alveolar segments in the traditional language. Most words with alveolars in the contemporary language are borrowings. In many native morphemes there is free variation between [n] and [ɳ], and the loss of retroflexion of apical nasals in the traditional language is a major source

of apico-alveolar nasals in the modern language. In the traditional language the lamino-dental lateral has apico-alveolar articulation in C_1, and in the modern language (which contrasts dental and alveolar laterals in intervocalic position) the contrast is neutralised in C_1 in favour of apico-alveolar articulation. Similar facts obtain for the lamino-dental and apico-alveolar nasals.

Dorsal+labial sequences: What I have presented as labial-dorsal complex segments [kp], [ŋm] and [ŋp] are assumed to be dorsal+labial clusters in the source. Several factors suggest that these are better analysed as complex segments. This includes their high frequencies.

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Arabana-Wangkangurru. (Eyre region; Pama-Nyungan, Karnic) Hercus 1994, Hercus 1979, Hercus 1972.

Consonant phonemes:	p	t̪	t	ʈ	c	k
			tr			
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			r			
			ɾ			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
			ntr			
		l̪t̪	lt	ɭʈ	ʎc	
			ltr			
Word-initial consonants:	p	t̪	*	*	c	k
	m	n̪	*	*	ɲ	ŋ
		(l̪)	*	*	*	
			*			
			*			
	w			*	j	

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-N	L-O	r-O
ap+lab	np	nm	(tm)	lp	rp
ap+dor	nk			lk	rk
ap+dent					rt̪
ap+pal					rc
lam+lab				ʎp	
lam+dor				ʎk	

Stops: The stops are normally voiceless except for the apico-postalveolar which is always voiced. Word-initial stops are voiced before their homorganic vowels: initial dorsal stops are voiced before [u] and an initial lamino-alveopalatal stop is voiced before [i]; before [i] the dorsal stop is articulated very far forward and as a result is voiced in this context since it is in effect homorganic with the vowel. Initial stops are also voiced when the following syllable in the word begins with an apical consonant.

Pre-stopping: Apico-alveolar, lamino-dental and bilabial nasals and laterals are pre-stopped in consonant-initial words following main stress, but only laterals are pre-stopped if the initial consonant is a nasal. The dorsal nasal occurs lengthened, [ŋː], in this context. The apico-postalveolar nasal is never either pre-stopped or lengthened.

Vibrants: The two vibrants are in free variation in C_1, with a preference for a trill articulation. The apico-postalveolar glide is strongly retroflex and as a result is never confused with [j], against the pattern attested in Pitta-Pitta, Wangkumara and other languages of the Ngura group.

Consonant phonotactics: The full four-way coronal contrast is only active intervocalically. In C_1 nasals are apico-alveolar and laterals in this position only contrast between apico-alveolar and lamino-alveopalatal articulation. The contrast between the alveolar trill and tap segments is maintained only in intervocalic position following a stressed vowel.

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Arrernte, Mparntwe dialect. (Desert region; Pama-Nyungan, Arandic) Wilkins 1989.

Consonant phonemes:	p pʷ	t̪ t̪ʷ	t tʷ	ʈ ʈʷ	c cʷ	k kʷ
	ᵖm	ᵗn̪	ᵗn	ᵗɳ	ᵗɲ	ᵏŋ
	ᵖmʷ		ᵗnʷ	ᵗɳʷ		ᵏŋʷ
	m mʷ	n̪	n nʷ	ɳ ɳʷ	ɲ ɲʷ	ŋ ŋʷ
		l̪ l̪ʷ	l lʷ	ɭ ɭʷ	ʎ ʎʷ	
			r rʷ			
	w			ɻ ɻʷ	j jʷ	ɰ
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
	mpʷ		ntʷ	ɳʈʷ	ɲcʷ	ŋkʷ
		l̪t̪	lt	(ɭʈ)	ʎc	
		l̪t̪ʷ		ɭʈʷ	ʎcʷ	
Word-initial consonants:	p pʷ	t̪	t tʷ	* *	c cʷ	k kʷ
	ᵖm		ᵗn	*	ᵗɲ	ᵏŋ
	ᵖmʷ		ᵗnʷ	*		ᵏŋʷ
	m mʷ	n̪	n nʷ	* *	ɲ ɲʷ	ŋ ŋʷ
		l̪ l̪ʷ	l lʷ	* *	ʎ ʎʷ	
				r rʷ		
	w			ɻ ɻʷ	j jʷ	*

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	N-Oʷ	N-N	L-O	L-Oʷ	L-ᶜN
ap+lab	np ɳp		nm ɳm	lp ɭp	lᵖm ɭᵖm	
ap+dor	nk ɳk	nkʷ ɳkʷ	nŋ ɳŋ	lk ɭk	lkʷ ɭkʷ	lᵏŋ ɭᵏŋ

	r-O	r-Oʷ	r-ᶜN
ap+lab	rp	rpʷ	rᵖm
ap+dor	rk	rkʷ	rᵏŋ
ap+dent	rt̪	rt̪ʷ	
ap+pal	rc		rᵗɲ

Stops: Initially and as the onset of stressed syllables stops are voiceless; otherwise there is variation except that the oral portion of word-initial N-O clusters is always voiced and lamino-dentals are always voiceless (including in initial N-O clusters). The oral onset of the pre-stopped nasals is voiceless, and this may extend into the nasal period.

Vibrants: The vibrant segments [r] and [rʷ] are only briefly trilled. They have an optional tap allophone in normal to fast speech, may be voiceless word-finally, and between low vowels they may be [ɹ].

Laminals: Both interdental and dental articulations for the lamino-dental series are common; the dental stop has associated friction at release but the nasals and laterals are hard to distinguish from their apico-alveolar counterparts.

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Baagandji. (Riverine region; Pama-Nyungan) Hercus 1982.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
		l̪t̪	lt	ɭʈ	ʎc	
Word-initial consonants:	p	t̪	*	*	*	k
	m	n̪	*	*	*	ŋ
		*	*	*	*	
			*			
	w			(ɻ)	j	

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters (certain marginal clusters attested in only one or two isolated forms are ignored, see pp. 26, 48):

	N-O	N-N	L-O	r-C	r-N
ap+lab	np ɳp	nm ɳm	lp ɭp	rp	rm
ap+dor	nk ɳk		lk ɭk	rk	
lam+lab	ɲp		ʎp		

Stops: The allophonic variation in the voicing of stops is very complicated, but intervocalically or in C_2 following a lateral or vibrant they are always voiceless.

Lengthening: There is very conspicuous lengthening of consonants following the stressed short vowel. This does not apply to glides, the apico-postalveolar stop or the vibrant. Nasals may not be fully lengthened following a word-initial nasal segment. Sometimes apico-alveolar nasals and laterals are lengthened and pre-stopped. Non-coronal stops show more pronounced lengthening.

Dorsal palatalisation: There is strong palatalisation and fronting of dorsals when preceding [i], particularly in word-initial position; the articulation may approach that of lamino-alveopalatals. Furthermore, word-initial dorsals are often dropped before [i].

Alveopalatals: In the articulation of alveopalatals in C_1 "the palatal articulation is very strongly anticipated and a palatal glide is always heard" (p.26).

Badimaya. (Northeast region; Pama-Nyungan, Kardu) Dunn 1988.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			r			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
Word-initial consonants:	p	t̪	*	*	c	k
	m	n̪	*	*	ɲ	ŋ
		*	*	*	*	
			*			
	w			*	j	
Word-final consonants:	*	*	t	*	*	k
	*	*	n	ɳ	ɲ	ŋ
		*	l	ɭ	ʎ	
			*			
	*			*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	G-O
ap+lab	ɳp	nm	lp ɭp	ɻp
ap+dor	nk ɳk		lk ɭk	ɻk
lam+lab	ɲp			
lam+dor			ʎk	

Stop voicing: In the speech of the last two (male) language speakers: stops are voiced word-initially and medially, but are voiceless and aspirated word-finally (at the same time, in recordings of a female speaker the stops are predominantly voiceless).

Laminal spirantisation: The laminal stops are frequently realised as voiced spirants, /t̪/ as [ð] and /c/ as [ʒ].

Retroflexes: The degree of retroflexion of the members of the apico-postalveolar series is most pronounced after the low vowel (p.33).

Vibrant: The flap is hard to distinguish from the alveolar stop.

Bandjalang. (Southeast region; Pama-Nyungan, Bandjalangic) Crowley 1978.

Consonant phonemes:	p	t	c	k
	m	n	ɲ	ŋ
		l		
		"r"		
	w		j	
Homorganic sequences:	mp	nt	ɲc	ŋk

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G	G-O	G-N
ap+lab	np	nm	lp		lw	rp	rm	rw	jp	
ap+dor	nk	nŋ	lk	lŋ		rk			jk	
ap+lam						rc				
lam+lab	ɲp									jm
lam+dor	ɲk									
dor+lab	ŋp	ŋm								
lab+dor	mk								wk	

Stops: The stops are very laxly articulated, typically as spirants. The non-coronals, especially the dorsal, are spirantised word-initially while the coronals are articulated tensely in this position. Only following a homorganic nasal are stops restricted to non-continuant articulation.

Coronal neutralisation: The contrast between the two coronal stops is neutralised intervocalically, with a laminal stop, spirant or affricated articulation in this position (the contrast is maintained among the coronal nasal stops). The apical/laminal stop contrast is maintained initially and in homorganic N-O clusters. The neutralised coronal series is phonetically apical in the Gidabal dialect, laminal in Waalubal.

Vibrant: "r" is a flap, or is very slightly trilled. Intervocally it can be [ɻ].

Clusters: There are two additional clusters, [ck], [rt], attested in only one word each.

Bardi. (Kimberley region; Nyulnyulan) Metcalfe 1971.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	
Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk (units in the source)
Word-initial consonants:	p	t	*	c	k
	m	n	*	ɲ	ŋ
		l	*	*	
		*			
	w		ɻ	j	

Word-final consonants:	*	*	ʈ	*	*
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	*		ɻ	*	

Attested morpheme-internal heterorganic clusters (likely incomplete, compiled from word-list in the source):

	N-O	N-N	L-O	L-N	r-O	r-N	r-G
ap+lab	np ɳp		lp ɭp	lm	rp	rm	rw
ap+dor	nk ɳk		lk ɭk		rk		
ap+lam	nc ɳc						
lam+lab	ɲp						
lam+dor	ɲk		ʎk				

Consonant allophony: Stops are normally voiceless when occurring at word-edges, except that the dorsal stop is aspirated in C_{init} preceding a low vowel. Stops are voiced word-medially. The vibrant segment is realised as a flap intervocally, a trill in C_1, and a voiceless trill in C_{fin}.

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Bidyara-Gungabula. (Northeast region; Pama-Nyungan, Pama-Maric) Breen 1973.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	n̪	n		ɲ	ŋ
			l			
			ɾ			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt		ɲc	ŋk
Word-initial consonants:	p	t̪	(t)	*	c	k
	m	n̪	n		*	ŋ
			*			
			*			
	w			*	j	
Word-final consonants:	*	*	*	ʈ	*	*
	*	*	n		ɲ	*
			l			
			ɾ			
	*			*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	N-N	L-O	r-O
ap+lab	np	tp ʈp	nm	lp	ɾp
ap+dor	nk		nŋ	lk	ɾk
lam+lab	ɲp		ɲm		
lam+dor	ɲk				

Consonant allophony: The dental stop is interdental with an affricated release; spirantised allophones are also common for this segment.

==

Bularnu. (Desert region) Breen 1978.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	b	d̪	d	ɖ	ɟ	g
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
	mb	n̪d̪	nd	ɳɖ	ɲɟ	ŋg
Word-initial consonants:	p	t̪	*	ʈ	c	k
	*	*	*	*	*	*
	m	n̪	*	ɳ	ɲ	ŋ
		*	*	ɭ	*	
			*			
	w			*	j	

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	N-O	N-N	O-O	L-O	L-O	r-O	r-O	r-G
ap+lab	np ɳp		nm ɳm	tp ʈp	ɭp	lb			rw
ap+dor	nk ɳk	ng	nŋ ɳŋ	tk ʈk		lg	rk	rg	
lam+lab	(ɲp)								

Stops: The two series of stops are neutralised word-initially. In this position, in this position they are lenes ranging from voiced to voiceless. In positions of contrast, the lenis stops are normally voiced intervocalically, and they may be spirantised following an unstressed vowel. The fortis stops are voiceless, and may be lengthened following a stressed vowel.

Pre-stopping: The apico-alveolar nasal may be lengthened or pre-stopped following a stressed vowel.

Vibrant: "r" is normally a tap but may be a trill following a stressed vowel.

Consonant phonotactics: The cluster [ɲp] is recorded in one form but it is considered as doubtful by the source, possibly actually [np]. Four words appear to have a phonemically geminate apico-alveolar lateral, probably all of which are loans from Warluwarra. Bularnu does not permit /lw/ clusters, and Warluwarra borrowings with this cluster are pronounced [lː] or [ᵈl] (see also comments on Warluwarra).

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Diyari. (Eyre region; Pama-Nyungan, Karnic) Austin 1981a.

Consonant phonemes:	p	t̪	t	ʈ	c	k
			d=[r]	ɖ=[ɽ]		
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			ɾ			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
			nd	ɳɖ		
		l̪t̪	lt	ɭʈ	ʎc	
			ld			
Word-initial consonants:	p	t̪	*	*	c	k
				ɖ		
	m	n̪	*	ɳ	ɲ	ŋ
		*	*	*	*	
			*			
	w			*	j	

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	r-O
ap+lab	np ɳp	nm	lp ɭp	ɾp
ap+dor	nk ɳk	nŋ	lk ɭk	ɾk
ap+dent				ɾt̪
ap+pal				ɾc

Stops: The stops, with the exception of /d/ and /ɖ/, are voiceless in all positions. The two laminal stops are sometimes heard as affricates. The voiced apical stops are vibrants in intervocalic position, and stops following a homorganic nasal or lateral. The cluster [nd] is optionally realised as [ndʳ] in the Dhirari dialect.

Pre-stopping: "The apico-alveolar and lamino-dental laterals may be optionally prestopped, as [dl] and [d̪l̪], when they occur immediately after the first (primary stressed) vowel of a word and are followed by a vowel. The corresponding nasals can be prestopped in this position as [dn] and [d̪n̪] provided that the word-initial consonant is NOT a nasal" (p.18).

Vibrant: The vibrant segment is phonetically a single tap, but in C_1, where it is not in contrast with the trilled segment /d/, it freely varies between trill and tap realisations.

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Djabugay. (Rainforest region; Pama-Nyungan, Pama-Maric) Patz 1991.

Consonant phonemes:	p	t		c	k
	m	n		ɲ	ŋ
		l			
		"r"			
	w		ɻ	j	
Homorganic sequences:	mp	nt		ɲc	ŋk
		rnt	ɻnt		
			ɻl		
Word-initial consonants:	p	t		c	k
	m	n		ɲ	ŋ
		*			
		*			
	w		*	j	
Word-final consonants:	*	*		*	*
	m	n		ɲ	*
		l			
		"r"			
	*		ɻ	j	

Attested morpheme-internal heterorganic clusters of two consonants:

	N-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G	G-O
ap+lab	np	(nm)	lp	lm	(lw)	rp	rm	(rw)	(ɻp)
ap+dor	nk		lk	(lŋ)		rk	(rŋ)		(ɻk)
ap+lam	nc		lc	(lɲ)		rc	(rɲ)		
lam+lab									jp
lam+dor									jk

Apical nasal: The apical nasal "becomes laminalised before a laminal stop. The difference between the laminal nasal phoneme and a laminalised [n] is only slight and could lead to misinterpretations. However, a difference can be clearly observed in the effect on preceding vowels. Before [ɲ] a vowel is slightly palatalised, but this does not happen before the laminalised allophone of [n]" (p.253). In other words, the clusters [nc] and [ɲc] are contrasted primarily by the palatal off glide of the preceding vowel in the case of [ɲc].

Consonant phonotactics: Various clusters of three consonants are attested.

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Djambarrpuyngu. (Arnhem region; Pama-Nyungan, Yuulngu) Wilkinson 1991.

Consonant phonemes:	p	t̪	t	ʈ	c	k	(ʔ)
	b	d̪	d	ɖ	ɟ	g	
	m	n̪	n	ɳ	ɲ	ŋ	
			l	ɭ			
			"r"				
	w			ɻ	j		

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
		jd̪				wg
		jn̪				

Word-initial consonants:	p	t̪	*	ʈ	c	k
	*	*	*	*	*	*
	m	n̪	*	ɳ	ɲ	ŋ
			*	ɭ		
			*			
	w			ɻ	j	

Word-final consonants:	p	*	t	ʈ	c	k
	*	*	*	*	*	*
	m	*	n	ɳ	ɲ	ŋ
			l	ɭ		
			"r"			
	w			ɻ	j	

Attested morpheme-internal heterorganic clusters of two consonants:

	N-O	O-O	N-N	L-O	L-O	L-N	L-G
ap+lab	np ɳp	tp ʈp	nm ɳm	lp ɭp		lm ɭm	lw ɭw
ap+dor	nk ɳk		nŋ ɳŋ	lk	lg	lŋ ɭŋ	
ap+dent	ɳt̪			lt̪ ɭt̪	ld̪	ln̪	
ap+pal	nc ɳc	tc ʈc		lc ɭc	lɟ	lɲ ɭɲ	
lam+lab	ɲp	cp	ɲm				
lam+dor	ɲk	ck	ɲŋ				
dor+lab	ŋp	kp	ŋm				

	r-O	r-O	r-N	r-G	G-O	G-O	G-N	G-G
ap+lab	rp		rm	rw	ɻp		ɻm	ɻw
ap+dor	rk	rg	rŋ		ɻk	ɻg	ɻŋ	
ap+dent	rt̪		rn̪		ɻt̪	ɻd̪		
ap+pal	rc		rɲ	rj	ɻc	ɻɟ	ɻɲ	ɻj
lam+lab	jp	jb	jm					jw
lam+dor	jk		jŋ					

Note: The glottal stop is restricted to occurring at the end of a syllable; as a result, it may be considered a contrastive prosodic feature of the syllable and not as a segmental phoneme. This is argued for Gaalpu by Wood 1978, following earlier work by Schebeck 1974 and McKay 1975.

==

Djapu. (Arnhem region; Pama-Nyungan, Yuulngu) Morphy 1983.

Consonant phonemes:	p	t̪	t	ʈ	c	k	(ʔ)
			(d)	ɖ=[ɽ]			
	m	n̪	n	ɳ	ɲ	ŋ	
			l	ɭ			
			"r"				
	w			ɻ	j		

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
		[l̪t̪]				
			ln			

Word-initial consonants:	p	t̪	t	ʈ	c	k
			*	*		
	m	n̪	n	ɳ	ɲ	ŋ
			l	ɭ		
			r			
	w			ɻ	j	

Word-final consonants:	p	*	t	ʈ	c	k
	*	*	*	*	*	*
	m	*	n	ɳ	ɲ	ŋ
			l	ɭ		
			"r"			
	w			ɻ	j	

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	N-N	L-O	L-N	L-G
ap+lab	np ɳp	tp ʈp	nm ɳm	lp ɭp	lm ɭm	lw ɭw
ap+dor	nk ɳk		nŋ ɳŋ	lk ɭk	lŋ ɭŋ	
ap+dent	nt̪ ɳt̪			lt̪ ɭt̪ (lt̪=[l̪t̪])	ln̪	
ap+pal	nc ɳc	tc ʈc		lc ɭc	lɲ ɭɲ	lj ɭj
lam+lab	ɲp	cp	ɲm			
lam+dor	ɲk	ck	ɲŋ			
dor+lab	ŋp	kp				

	r-O	r-N	r-G	G-O	G-N	G-G
ap+lab	rp	rm	rw	ɻp	ɻm	ɻw
ap+dor	rk	rŋ		ɻk	ɻŋ	
ap+dent	rt̪	rn̪		ɻt̪		
ap+pal	rc	rɲ	rj	ɻc	ɻɲ	ɻj
lam+lab				jp	jm	jw
lam+dor				jk	jŋ	

Inventory: The segment [d] is present in only one form, [guɻudut] *peaceful dove*.

Consonant phonotactics: There are some instances of O-N clusters but they occur at what were probably originally morpheme boundaries. There are also a variety of three-consonant clusters: [rŋk], [ɻŋk], ([lŋk]), ([ɭŋk]), ([rkm]), ([ɻkm]), ([ɻmp]), ([jmp]).

Note: The glottal stop is restricted to occurring at the end of a syllable; as a result, it may be considered a contrastive prosodic feature of the syllable and not as a segmental phoneme. This is argued for Gaalpu by Wood 1978, following earlier work by Schebeck 1974 and McKay 1975.

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Djaru. (Desert region; Pama-Nyungan, Nyungic) Tsunoda 1981.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	
Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk
				(ʎc)	
			tɻ		
		(tn)			
Word-initial consonants:	p	t	*	c	k
	m	n	*	ɲ	ŋ
		l	*	*	
		*			
	w		ɻ	j	
Word-final consonants:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	*		ɻ	*	

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	O-N	O-G	N-N
ap+lab	np ɳp	tp	(tm)	(tw)	nm
ap+dor	nk ɳk	tk			nŋ (ɳŋ)
ap+lam	nc (ɳc)	tc			
lam+lab	ɲp	cp			(ɲm)
lam+dor		(ck)	cŋ		
dor+lab					(ŋm)

	L-O	L-N	L-G	r-O	r-N	r-G	G-O
ap+lab	lp (ɭp)	lm ɭm	lw ɭw	rp	rm	rw	
ap+dor	(lk) ɭk	lŋ		rk	rŋ		
ap+lam	lc ɭc	(lɲ)		rc			ɻc
lam+lab	(ʎp)						
lam+dor	ʎk	ʎŋ					

Stops: As a rule stops are voiceless word-finally and in stop clusters, and are voiced following nasals. Word-finally they are also unreleased. In other positions there is non-contrastive alternation.

Vibrant: The vibrant is an alveolar flap or, in exaggerated speech, a trill, and occasionally for some speakers an approximant. [ɻ] is a "(semi-)retroflex frictionless continuant" but occasionally pronounced by speakers of one regional variety as a retroflex flap.

Retroflexes: "Apico-postalveolar consonants are pronounced with the tip of the tongue slightly behind the alveolar ridge, usually involving the r-colouring of the preceding vowels."

Laminals: The predominant allophones of the laminal series are all alveopalatal. There are only a handful of exceptions: in three words with [ʎ] the laminal shows free variation between alveopalatal and interdental articulation, and this is the case with [c] in one word. [c] has a fricative-like release, and when word-final occasionally has a voiceless alveopalatal fricative allophone.

Consonant phonotactics: Two additional clusters are present in the data, found in one form each: [ɳɲ] and [ŋɲ].

==

Djinang. (Arnhem region; Pama-Nyungan, Yuulngu) Waters 1989, Waters 1980a, Waters 1980b.

Consonant phonemes:	p	t	ʈ	c	k
	b	d	ɖ	ɟ	g
	m	n	ɳ	ɲ	ŋ
		l	ɭ		
		"r"			
	w		ɻ	j	
Homorganic sequences:	mp	nt		ɲc	ŋk
	mb	nd	ɳɖ	ɲɟ	ŋg
	pm		ʈn		kŋ
	pw				kw
		ld	ɭɖ		
		rt	rʈ		
			ɻʈ ɻɖ		wŋ
				jc	
Word-initial consonants:	p	(t)	*	(c)	k
	b	(d)	ɖ	ɟ	g
	m	(n)	ɳ	ɲ	ŋ
		l	ɭ		
		(r)			
	w		ɻ	j	

Word-final consonants: (all but the voiced stops)

Attested morpheme-internal heterorganic clusters of two consonants:

	N-O	N-O	O-O	O-N	N-N	L-O	L-O	L-N
ap+lab	np ɳp	nb ɳb	ʈp	ʈm	nm ɳm	lp ɭp	lb ɭb	lm ɭm
ap+dor	ɳk	ng ɳg			nŋ ɳŋ	lk ɭk	lg ɭg	lŋ ɭŋ
ap+lam	nc	nɟ ɳɟ	ʈc	ʈɲ		lc ɭc	lɟ ɭɟ	lɲ
lam+lab		ɲb	cp		ɲm			
lam+dor	ɲk	ɲg	ck		ɲŋ			
dor+lab		ŋb	kp	km				
lab+dor	mk	mg						

	L-G	r-O	r-O	r-N	r-G	G-O	G-O	G-N	G-G
ap+lab	lw ɭw	rp	rb	rm	rw	ɻp	ɻb	ɻm	ɻw
ap+dor		rk	rg	rŋ		ɻk	ɻg	ɻŋ	
ap+lam		rc	rɟ			ɻc	ɻɟ		
lam+lab						jp	jb	jm	jw
lam+dor						jk	jg	jŋ	

==

Dyirbal. (Rainforest region; Pama-Nyungan, Pama-Maric) Dixon 1972.

Consonant phonemes:	p	t		c	k
	m	n		ɲ	ŋ
		l			
		"r"			
	w		ɻ	j	

Homorganic sequences:	mp	nt		ɲc	ŋk
				jc	
				jɲ	

Word-initial consonants:	p	t		c	k
	m	n		ɲ	ŋ
		*			
		*			
	w		ɻ	j	

Word-final consonants:	*	*		*	*
	m	n		ɲ	*
		l			
		r			
	*		ɻ	j	

Attested morpheme-internal heterorganic clusters of two consonants:

	N-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G	G-O	G-N
ap+lab	np	nm	lp	lm	lw	rp	rm	rw	ɻp	ɻm
ap+dor	nk	nŋ	lk	lŋ		rk	rŋ		ɻk	ɻŋ
ap+lam	nc	nɲ	lc	lɲ		rc	rɲ		ɻc	ɻɲ
lam+lab									jp	jm
lam+dor									jk	jŋ

Consonant allophony: The laminal series involve contact between the blade of the tongue and the hard palate, alveolar ridge and teeth.

Consonant phonotactics: Two additional clusters, which are found in one form each and which the source treats as exceptional, are [ɲk] and [mt] (p.273).

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Gaagudju. (North region; Family isolate) Harvey 1992a.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ		
		"r"			
	w		ɻ	j	

Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk

Word-initial consonants:	p	t	*	c	k
	m	n	*	ɲ	ŋ
		l	*	*	
		*			
	w		ɻ	j	

Word-final consonants:	*	*	ʈ	c	*
	*	n	ɳ	ɲ	*
		l	ɭ		
		r			
	*		*	j	

Attested heterorganic morpheme-medial clusters:

	N-O	N-N	N-G	O-O	L-O	L-N	L-G	r-O	r-N	r-G	ɻ-O	ɻ-N
ap+lab	np ɳp	nm ɳm		tp ʈp	lp ɭp	lm	lw	rp	rm	rw		
ap+dor	nk ɳk	ɳŋ			lk ɭk	lŋ		rk	rŋ			
ap+lam	nc ɳc		nj ɳj		lc		lj	rc			ɻc	ɻɲ
lam+lab	ɲp	ɲm		cp								
lam+dor	ɲk	ɲŋ		ck								

==

Gaalpu. (Arnhem region; Pama-Nyungan, Pama-Maric) Wood 1978.

Consonant phonemes:	p	t̪	t	ʈ	c	k	(?)
			(d)	ɖ			
	m	n̪	n	ɳ	ɲ	ŋ	
			l	ɭ			
			"r"				
	w			ɻ	j		

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
		[l̪t̪]				

Word-initial consonants:						
	p	t̪	*	ʈ	c	k
			*	*		
	m	n̪	*	ɳ	ɲ	ŋ
			*	ɭ		
			*			
	w			ɻ	j	

Word-final consonants: (all, except the voiced stops)

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	N-N	L-O	L-N	L-G
ap+lab	np ɳp	tp ʈp	nm ɳm	lp ɭp	lm ɭm	lw ɭw
ap+dor	nk ɳk		nŋ ɳŋ	lk ɭk	lŋ ɭŋ	
ap+dent	nt̪ ɳt̪			lt̪ =[l̪t̪]	ln̪	
ap+pal	nc ɳc	tc ʈc		lc ɭc	lɲ ɭɲ	lj ɭj
lam+lab	ɲp	cp	ɲm			
lam+dor	ɲk	ck	ɲŋ			
dor+lab	ŋp					

	r-O	r-N	r-G	G-O	G-N	G-G
ap+lab	rp	rm	rw	ɻp	ɻm	ɻw
ap+dor	rk	rŋ		ɻk		
ap+dent	rt̪			ɻt̪		
ap+pal	rc	rɲ	rj	ɻc	ɻɲ	ɻj
lam+lab				jp	jm	jw
lam+dor				jk	jŋ	

Inventory: The segment [d] is present in only one form, [guɻudut] *peaceful dove.*

Stops: Stops have nontense, short and usually slightly voiced articulation word-initially and following a nasal while in word-final position they are tense, voiceless, short and unreleased. Between vowels or between a liquid or glide and a vowel, stops are tense, voiceless and unaspirated, with the exception of lenis [ɖ], which contrasts for tension with [ʈ]. In fast speech, [ɖ] can be a retroflex flap, [ɽ].

Laminals: For the lamino-alveopalatal series the blade of the tongue is "compressed against the alveo-palatal area, and the tip resting behind the lower teeth." For the dental series "the tongue blade is pressed lightly in the area from the back of the upper teeth to the peak of the alveolar ridge, with the tip touching or just outside the edge of the teeth" (p.63).

Lateral assimilation: /l/ optionally assimilates to lamino-dental articulation in the cluster /lt̪/.

Note: The glottal stop is restricted to occurring at the end of a syllable; as a result, it may be considered a contrastive prosodic feature of the syllable and not as a segmental phoneme. This is argued for Gaalpu by Wood 1978, following earlier work by Schebeck 1974 and McKay 1975.

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Garawa. (Gulf region; Karawan) Furby 1974.

Consonant phonemes:						
	p	t	ʈ	c	kʲ	k
	m	n	ɳ	ɲ	ŋʲ	ŋ
		l	ɭ	ʎ		
		"r"				
	w		ɻ	j		
Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋʲkʲ	ŋk
Word-initial consonants:	p	t	*	c	*	k
	m	n	*	ɲ	*	ŋ
		l	*	*		
		*				
	w		ɻ	j		
Word-final consonants:	*	*	*	*	*	*
	*	n	*	*	*	*
		l	ɭ	*		
		"r"				
	*		*	*		

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G
ap+lab	np ɳp	ʈp	ɳm	lp ɭp	lm	lw ɭw	rp	rm	rw
ap+dor	nk ɳk		nŋ ɳŋ	lk ɭk	lŋ		rk	rŋ	
ap+lam	ɳc	ʈc	ɳɲ						
lam+lab	ɲp	cp	ɲm						
lam+dor	ɲk								

Consonant allophony: The retroflex and alveopalatal stops are unreleased in C_1. The dorsal stop is optionally aspirated in C_{init}. The laminal segments have an optional palatalised release in pre-vocalic positions. The vibrant, phonetically a tap, is realised as a voiceless flap in C_{fin}.

==

Garlali. (Riverine region; Pama-Nyungan, Karnic) McDonald & Wurm 1979.

Consonant phonemes:						
	p	t̪	t	ʈ	c	k
	b	d̪	d	ɖ	ɟ	g
			dr			
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			"r"			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
	mb	n̪d̪	nd	ɳɖ	ɲɟ	ŋg
			ndr			
		l̪t̪	lt	ɭʈ	ʎc	
		l̪d̪	ld	ɭɖ	ʎɟ	
			ldr			
			rt			
			lr			

Word-initial consonants:	p	t̪	(t)	*	c	k
	*	*	*	*	*	*
			(dr)			
	m	n̪	(n)	*	ɲ	ŋ
		*	*	*	*	
			*			
	w			*	j	

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	N-O	N-N	L-O	L-O	r-O	r-O	G-O	G-O
ap+lab	np	nb	nm	lp	lb	rp			
ap+dor	nk ɳk	ng ɳg	ɳŋ	lk ɭk	lg ɭg	rk	rg	ɻk	ɻg
lam+lab					ʎb				

Stops: The relevant phonological contrast for the two series of plosives is one of voicing. "The contrastive value of voicing is limited to certain environments. There is no distinction initially ... and it may be demonstrated intervocalically only for laminals and peripherals. It can be shown for all the consonant series in homorganic clusters following nasals, but to only a limited extent following laterals and rhotics. Absence of a full set of distinctions after laterals and rhotics is probably a function of the limited material. It should be noted that voiced stops occur in only 20% of the vocabulary material" (p.7).

Spirantisation of stops: Voiced laminal stops optionally have spirant allophones following their homorganic lateral, i.e., [l̪ð] and [ʎʒ]. /b/ and /g/ are frequently spirantised intervocalically.

Retroflexes: "The tongue tip makes contact just behind the alveolar ridge. A preceding 'r-coloured' vowel is the chief perceptual correlate" (p.8).

Vibrant: The vibrant segment "is usually a strong trill, but intervocalically it is sometimes a strongly fricative sound" (p.8).

Word-initial coronals: "There are very few apico-alveolars in initial position. Those that are recorded may well be recorded in error" (p.10). The lamino-alveopalatal stop occurs in initial position in only three forms, each before /i/, but it is in contrast with the dental stop in this position.

Consonant phonotactics: Various additional clusters are attested: [jr], [jm], [jw], [jn]. There is a cluster [dr] where the stop does not contrast for voicing and which occurs word-initially and in C_2 and "sometimes sounds like a single segment" (p.10); this is perhaps the best analysis and has been incorporated into the segment chart above.

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Gog-Narr. (Gulf region; Pama-Nyungan) Breen 1976b.

Consonant phonemes:	p	t̪	t		c	k
	β					ɣ
	m	n̪	n		ɲ	ŋ
			l			
			r			
			ɾ			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt		ɲc	ŋk

Word-initial consonants:	p	t̪	t		c	k
	β					*
	m	n̪	n		ɲ	ŋ
			*			
			*			
			*			
	w			ɻ	j	

Word-final consonants: (all)

Attested morpheme-internal heterorganic clusters (possibly incomplete):

	N-O	O-O	N-N	L-O	r-O
ap+lab	np	tp	nm	lp	rp
ap+dor	nk		nŋ	lk	rk

Stops: "Stops are normally voiceless but tend to be voiced after a nasal; /p/ and /k/ tend to be voiced lenis word-initially and before a stressed vowel" (p.245).

"Rhotics": The source expresses reservation on whether the contrast between [ɾ] and [ɻ] is phonemic, based on a high degree of free variation. The contrast between the stops and fricatives is also blurred in the speech of some informants. The retroflex glide is often realised as a retroflex lateral [ɭ], especially in word-initial position.

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Gooniyandi. (Kimberley region; Bunaban) McGregor 1990.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ
			l	ɭ	ʎ	
			"r"			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
			(lt)		ʎc	
			rɻ			

Word-initial consonants:

	p	t̪	t	*	c	k
	m	n̪	n	*	ɲ	ŋ
			l	*	*	
			*			
	w			ɻ	j	

Word-final consonants: (none)

Root-final consonants:

	p	*	t	ʈ	c	k
	m	*	n	ɳ	ɲ	ŋ
			l	ɭ	(ʎ)	
			(r)			
	(w)			(ɻ)	(j)	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-O	L-O	L-N	L-G	r-O	r-N	r-G
ap+lab	np ɳp	ɳm	ʈp	lp ɭp	lm ɭm	lw ɭw	rp	rm	rw
ap+dor	nk ɳk	nŋ ɳŋ	ʈk	lk ɭk	lŋ ɭŋ		rk	rŋ	
ap+pal	nc ɳc		tc	lc ɭc		ɭj	rc		
lam+lab	ɲp	n̪m ɲm	cp	ʎp	ʎm	ʎw			
lam+dor	ɲk	n̪ŋ	ck	ʎk					
lab+dor		ŋm	kp						
lab+lam			pc						

Initial apicals: Apicals in initial position are in free variation between alveolar and postalveolar articulation, except that they assimilate to the place of articulation of an apical segment later in the word.

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Gugada. (Desert region; Pama-Nyungan, Nyungic) Platt 1972.

Consonant phonemes:

p	t	ʈ	TH=[t̪/c]	k
m	n	ɳ	NH=[n̪/ɲ]	ŋ
	l	ɭ	LH=[l̪/ʎ]	
	"r"			
w		ɻ	j	

Homorganic sequences:

mp	nt	ɳʈ	ɲc	ŋk
	lt		ʎc	

Word-initial consonants:

p	t	ʈ	TH	k
m	n	*	NH	ŋ
	*	*	*	
	*			
w		(ɻ)	j	

Word-final consonants:

*	*	*	*	*
*	n	ɳ	ɲ	ŋ
	l	ɭ	*	
	*			
*		ɻ	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-N	L-O	L-N	r-O	r-N	G-O
ap+lab	np ɳp	nm ɳm		lp ɭp	lm	rp	rm	ɻp
ap+dor	nk ɳk	ɳŋ		lk ɭk		rk		ɻk
ap+lam	nc ɳc		tɲ	lc				
lam+lab		ɲm		ʎp				
lam+dor				ʎk				
lab+dor		ŋm						

Stops: Stops are normally lenis, voiceless unaspirated, but may be voiced when preceded by a nasal and when in intervocalic position.

Laminal allophony: The laminal stop has alveolar articulation before [i] and a dental or interdental articulation before [a] and [u]. The laminal nasal has alveolar articulation before [i], in word-final position, and as part of a homorganic N-O cluster with alveolar articulation; interdental articulation initially before [a]; and free variation between the two articulations in other positions. The laminal lateral has alveolar articulation before [i] and dental articulation before [a]; free variation between the two articulations elsewhere.

==

Gumbaynggir. (Southeast region; Pama-Nyungan, Kumbainggaric) Eades 1979.

Consonant phonemes:

p	t		c	k
m	n		ɲ	ŋ
	l			
	"r"			
w		ɻ	j	

Homorganic sequences: mp nt ɲc ŋk

Attested morpheme-internal heterorganic clusters of two segments:

	N-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G	G-O	G-N	G-G
ap+lab	np	nm	lp	(lm)	(lw)	rp	rm	rw			
ap+dor	nk		lk	(lŋ)		rk					
ap+lam	nc		lc	(lɲ)		rc					
lam+lab	(ɲp)	(ɲm)							(jp)	(jm)	jw
lam+dor	(ɲk)								jk		
lab+dor	mk	(mŋ)							wk		

Consonant allophony: Stops are normally voiced, although they are sometimes voiceless in C_{inter}. Nasals and laterals vary freely between plain and prestopped realisations in all positions except word-initially. The vibrant segment is normally a trill. The vibrant and lateral segments are freqently neutralised phonetically in intervocalic position, both being realised as a retroflex flap. These flapped allophones of /r/ and /l/ occur in all vocalic environments except for between two high vowels. The retroflex glide does not occur in the i_i environment.

Consonant phonotactics: Clusters of three consonants are also attested, [wŋk] in one form and [jŋk] in two.

Gunin. (Kimberley region; Wororan) McGregor 1993.
The Gunin corpus in McGregor 1993 is based on a relatively small sample elicited from one speaker.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	
Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk
			rɻ		
Word-initial consonants:	p	t	*	c	k
	m	n	*	ŋ	
		l	*	*	
		*			
	w		ɻ	j	
Word-final consonants:	*	*	*	(c)	(k)
	m	n	ɳ	ɲ	ŋ
		l	ɭ	*	
		"r"			
	(w)		(ɻ)	(j)	

Attested heterorganic morpheme-medial clusters:

	N-O	N-N	O-O	L-O	L-N	L-G	r-C	r-N
ap+lab	np	ɳm		ɭp	lm	ɭw	rp	rm
ap+dor	nk ɳk			lk	lŋ ɭŋ		rk	rŋ
ap+lam	nc						rc	
lam+lab	ɲp		cp					
dor+lab	ŋp							

Stops: Stops are generally unaspirated and vary between voiced and voiceless. Word-initial coronal oral stops tend to be voiced and peripherals to be voiceless. In other environments voiced allophones predominate, but voiceless allophones are occasionally heard intervocalically.

Oral sonorants: "r" alternates between a tap and a trill, and /ɻ/ alternates between alveolar and postalveolar articulation. The glides /w/ and /j/ are frequently elided in the environment of their homorganic high vowel counterparts.

Consonant phonotactics: In addition to the clusters listed, a nasal+glide cluster [mɻ] is attested in a small number of roots.

Guugu-Yimidhirr. (Eastern Cape region; Pama-Nyungan, Pama-Maric) Haviland 1979.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ
			l			
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
					jc	
Word-initial consonants:	p	t̪	t	*	c	k
	m	n̪	n	*	ɲ	ŋ
			*			
			*			
	w			*	j	
Word-final consonants:	*	*	*	*	*	*
	*	n̪	n	*	*	*
			l			
			"r"			
	*			ɻ	j	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	L-N	r-O	r-N	G-O	G-N
ap+lab	np	nm	lp	lm	rp	rm	ɻp	ɻm
ap+dor	nk	nŋ	lk	lŋ	rk	rŋ	ɻk	ɻŋ
ap+pal	nc							
ap+dent	nt̪		lt̪					
lam+lab							jp	jm
lam+dor	n̪k						jk	

Stops: Stops are voiceless unaspirated initially and following short vowels, and voiced following a long vowel or in C_2.

Retroflexes: The source discusses that the status of the retroflex stop and nasal as distinct phonemes is somewhat problematic. These segments sometimes sound like single segments, [ʈ] and [ɳ] and sometimes like clusters of a retroflex glide plus a stop or nasal, [ɻt] and [ɻn]. It is possible that these should be analysed phonemically as clusters /ɻt/ and /ɻn/, as Dixon 1980:143 does. In this case Guugu-Yimidhirr is a single-apical language. This analysis would help explain the absence of the retroflexes in C_1 in the heterorganic clusters.

Vibrant: The vibrant is "nearly always" a front flap, occasionally a trill in intervocalic position. The vibrant segment is difficult to distinguish from [l] word-finally, especially following [u].

Clusters: Guugu-Yimidhirr also has three-consonant clusters, composed of a liquid or glide followed by a homorganic labial, dorsal or laminal N-O cluster.

==

Jingili. (Desert region; Tjingili-Wambayan) Chadwick 1975.

Consonant phonemes:	p	t	ʈ	c	kʲ	k
	m	n	ɳ	ɲ		ŋ
		l	ɭ	ʎ		
		"r"	ɽ			
	w			j		
Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋʲkʲ	ŋk
Word-initial consonants:	p	t	ʈ	c	*	k
	m	n	ɳ	ɲ		ŋ
		l	ɭ	*		
		*	([ɻ])			
	w			j		
Word-final consonants:	p	t	ʈ	c	*	k
	*	n	*	*		*
		l	*	*		
		*	([ɽ])			
	*			*		

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	N-N	L-O	L-N
ap+lab	np ɳp	tp ʈp	nm ɳm	(lp) ɭp	lm ɭm
ap+dor	(nk) ɳk	tk ʈk	(nŋ) ɳŋ	lk ɭk	lŋ (ɭŋ)
ap+lam	ɳc	ʈc			
lam+lab	ɲp	cp	ɲm		
lam+dor		ck			
dor+lab	ŋp		ŋm		
lab+lam		pc			
lab+dor	mk	pk			
dor+ap		kʈ			
lam+dorso-palatal		ɲkʲ			

	r-O	r-N	ɻ-C	ɻ-N	L-G
ap+lab	rp	rm	ɻp	ɻm	lw ɭw
ap+dor	rk	rŋ	ɻk		
ap+lam		rɲ		ɻɲ	ɭj
ap+dorso-palatal	rkʲ				

Stops: Stops are generally voiceless; they are forcefully released in initial position and laxly released word-finally. /p/ and /k/ are occasionally produced as fricatives by elderly speakers.

Retroflexes: Following the low vowels [a] and [aː] retroflexion is more pronounced than in other contexts. Retroflexion is detected in the preceding vowel.

Vibrants: The alveolar vibrant is a trill. /ɽ/ is a retroflex flap intervocalically (occasionally with some friction) and a retroflex glide [ɻ] in pre-consonantal position (and,

in one word, in initial position).

==

Jiwarli. (Northeast region; Pama-Nyungan, Nyungic) Austin 1992b, Austin 1981b.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ
			l	ɭ		
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk:
Word-initial consonants:	p	t̪	*	*	c	k
	m	n̪	*	*	ɲ	ŋ
		*	*	*	*	
			*			
	w			*	j	
Word-final consonants: (none)						
Root-final consonants:	*	*	*	*	*	*
	*	*	n	ɳ	ɲ	*
		*	l	ɭ	*	
			"r"			
	*			*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	r-O
ap+lab	np ɳp	nm	lp ɭp	rp
ap+dor	nk ɳk	(nŋ)	lk ɭk	rk
ap+lam	nc (ɳc)		(lc)	rc
lam+lab	ɲp	ɲm	ʎp	
lam+dor	ɲk		ʎk	

==

Kalkatungu. (Eyre region; Pama-Nyungan) Blake 1979a, Blake 1969.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk:
		l̪t̪		ɭʈ	ʎc	
Word-initial consonants:	p	t̪	*	ʈ	c	k
	m	n̪	*	ɳ	ɲ	ŋ
		l̪	*	ɭ	ʎ	
			*			
	w			ɻ	j	

Word-final consonants:

	*	*	*	*	*	*
	*	*	n	ɳ	ɲ	*
		*	l	ɭ	*	
			"r"			
	*			*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	L-N	r-O	r-N
ap+lab	np ɳp	nm	lp ɭp	lm ɭm	rp	rm
ap+dor	nk ɳk	nŋ ɳŋ	lk ɭk	lŋ	rk	rŋ

Stop voicing: The stops are basically voiceless lenes, but voiced allophones are attested, most commonly in intervocalic position and following a nasal segment; voicing is less common at a word edge or in a cluster following a non-nasal sonorant.

Laminals: The laminal stops are both somewhat affricated. The dental series is produced "with the tongue tip protruding between the teeth or with the tongue tip behind the lower teeth."

Vibrant: The vibrant segment "is a flap in slow pronunciation and in very clear, emphatic pronunciation a lingual trill. However, most typically it is a weak flap or a glide which makes it difficult to distinguish it from [ɻ], which is a glide produced with greater retroflection and/or bunching of the tongue." The alveolar stop has a flap allophone, thus overlapping phonetically with the vibrant segment.

==

Kayardild. (Gulf region; Tankic) Evans 1985.

Consonant phonemes:

	p	t̪	t	ʈ=[ɽ]	c	k
	m	n̪	n	ɳ	ɲ	ŋ
			l			
			"r"			
	w			ɻ	j	

Homorganic sequences:

	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
			lt			
			rt	ɻʈ =[ɭʈ]/[ɻʈ]		

Word-initial consonants:

	p	t̪	*	ʈ	c	k
	m	*	*	ɳ	ɲ	ŋ
			*			
			*			
	w			ɻ	j	

Word-final consonants: (none)

Root-final consonants:

	*	t̪	t	*	c	k
	*	*	n	ɳ	ɲ	ŋ
			l			
			"r"			
	*			ɻ	*	

Attested morpheme-internal heterorganic clusters of two consonants:

	N-O	O-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G	G-O	G-N	G
ap+lab	np ɳp			lp	lm	lw	rp	rm	rw	ɻp	ɻm	ɻw
ap+dor	nk ɳk			lk	lŋ		rk	rŋ		ɻk	ɻŋ	
ap+dent	ɳt̪			lt̪						ɻt̪		
ap+pal	ɳc			lc	lɲ		rc		rj	ɻc		ɻj
lam+lab	ɲp	cp	ɲm									

Stops: Voiceless allophones are found after sonorants and voiced allophones in other environments are standard, except that /t̪/ and /k/ tend to have voiceless realisations in all positions. In fast/casual speech, initial /p/ often has a labialised off-glide, [bʷ], or is lenited to [w]. Perceptual and spectrographic evidence indicates that length, and in the case of the stops voicing, are the main acoustic cues distinguishing dentals from alveolars.

"Rhotics": The vibrant is a trill in C_1 and C_{fin}, but is usually a tap in C_{inter} except in declamatory speech. /ɻ/ may be a fricative between high vowels; it is slightly palatalised before /i/ and between low vowels for some speakers it may be a retroflex tap, in which case the phonetic contrast between /ʈ/ and /ɻ/ is neutralised. For some older speakers it is [ɭ] in C_1. There has been a historical merger between proto-Tangkic *ɭ and *ɻ in Kayardild and Lardil, in which case the lateral allophones predominate.

Consonant phonotactics: There are certain three-consonant clusters in Kayardild, all composed of a liquid followed by a homorganic labial or dorsal N-O cluster: [lmp], [lŋk], [rŋk].

==

Kaytetye. (Desert region; Pama-Nyungan, Arandic) Koch ms.

Consonant phonemes:

	p pʷ	t̪ t̪ʷ	t tʷ	ʈ ʈʷ	ʲt ʲtʷ	c cʷ	k kʷ
	ᵖm	ᵗ̪n̪	ᵗn	ᵗɳ	ʲᵗn	ᵗɲ	ᵏŋ
	ᵖmʷ	ᵗ̪n̪ʷ	ᵗnʷ	ᵗɳʷ	ʲᵗnʷ	ᵗɲʷ	ᵏŋʷ
	m mʷ	n̪ n̪ʷ	n nʷ	ɳ ɳʷ	ʲn ʲnʷ	ɲ ɲʷ	ŋ ŋʷ
		l̪ l̪ʷ	l lʷ	ɭ ɭʷ	ʲl ʲlʷ	ʎ ʎʷ	
			r rʷ				
	w			ɻ ɻʷ		j jʷ	ɰ

Homorganic sequences:

	mp	n̪t̪	nt	ɳʈ	ʲnt	ɲc	ŋk
		ᵗ̪n̪t̪	ᵗnt	ᵗɳʈ	ʲᵗnt	ᵗɲc	ᵏŋk
	mpʷ			ɳʈʷ		ɲcʷ	ŋkʷ
		ᵗn̪t̪ʷ		ᵗɳʈʷ			ᵏŋkʷ
		l̪t̪	lt	ɭʈ	ʲlt	ʎc	
				ɭʈʷ		ʎcʷ	

Attested morpheme-internal heterorganic clusters:

	N-O	N-Oʷ	N-N	L-O	L-Oʷ
ap-alveolar+lab	np ᵗnp		nm	lp	
ap-postalveolar+lab	ɳp ᵗɳp		ɳm	ɭp	
pre-pal ap+lab	ʲnp ʲᵗnp				
ap-alveolar+dor	nk ᵗnk	nkʷ ᵗnkʷ	nŋ	lk	lkʷ
ap-postalveolar+dor	ɳk ᵗɳk	ɳkʷ	ɳŋ	ɭk	
pre-pal ap+lab	ʲnk ʲᵗnk				

	L-^{c}N	r-O	r-C^{w}	r-^{c}N
ap-alveolar+lab	l^{p}m	rp	rp^{w}	r^{p}m
ap-postalveolar+lab	ɭ^{p}m			
ap-alveolar+dor	l^{k}ŋ	rk	rk^{w}	r^{k}ŋ
ap-postalveolar+lab	ɭ^{k}ŋ			
ap+dent		rt̪	rt̪^{w}	
ap+pal		rc		r^{t}ɲ

==

Kitja. (Kimberley region; Djeragan) Taylor & Taylor 1971.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ
			l	ɭ	ʎ	
			"r"			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk

Word-initial consonants:	p	t̪	t	*	c	k
	m	n̪	n	*	ɲ	ŋ
			l	*	*	
			*			
	w			ɻ	j	

Word-final consonants:	p	*	t	ʈ	c	k
	m	*	n	ɳ	ɲ	ŋ
			l	ɭ	ʎ	
			"r"			
	*			ɻ	*	

Attested morpheme-internal heterorganic clusters (likely incomplete, drawn from the word-list in the source):

	N-O	O-O	N-N	L-O	L-N	r-O	r-N
ap+lab	np ɳp	tp	nm	lp	lm ɭm	rp	rm
ap+dor	nk ɳk	ʈk		lk	lŋ	rk	rŋ
ap+dent				lt̪			
ap+pal	nc			lc		rc	
lam+lab	ɲp	cp					

Stops: The peripheral stops are voiced and often spirantised in C_{inter}. In this position the dental stop is a spirant or an affricate, the alveopalatal is voiced and the apical stops are optionally flapped. The non-apical stops are voiceless and unreleased word-finally. Stops are voiced following a nasal, and are voiceless in C_1 and C_{init}.

Vibrant: The vibrant segment is realised as a flap in C_{inter}, a trill in C_1, and a voiceless trill in C_{fin}. The alveolar vibrant and stop segments are in contrast in C_1 and C_{fin}, but in intervocalic position the contrast is hard to perceive and may be neutralised.

==

Kukatj. (Gulf region; Pama-Nyungan) Breen 1992, Breen 1976a.

Consonant phonemes:	p	t̪	t		c	k
	m	n̪	n		ɲ	ŋ
			l			
			r			
			ɾ			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt		ɲc	ŋk
			lt			

Word-initial consonants: (all, except that /r/ is marginal)

Word-final consonants: (all)

Attested morpheme-internal heterorganic clusters of two consonants:

	N-O	L-O	L-N	r-O	r-N	r-G
ap+lab	np	lp	lm	rp	rm	rw
ap+dor	nk	lk	lŋ	rk	rŋ	
ap+dent		lt̪	ln̪	rt̪	rn̪	
ap+pal	nc	lc	lɲ	rc	rɲ	

Consonant phonotactics: N-N clusters appear to be absent underlyingly in Kukatj, but they are present on the surface: [nm] is a possible realisation of /rm/, and [nŋ] is attested in one root but it is possible that it is a variant of /rŋ/.

==

Kuku-Thaypan. (Eastern Cape region; Pama-Nyungan, Pama-Maric) Rigsby 1976.

Consonant phonemes:	p	t̪	t		c	k
	β	ð̪				γ
	m	n̪	n		ɲ	ŋ
			l			
			"r"			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt		ɲc	ŋk (units in the source)

Word-initial consonants: (all)

Word-final consonants:	*	*	*		*	*
	*	*				*
	m	n̪	n		*	ŋ
			l			
			"r"			
	w			ɻ	j	

Attested morpheme-internal heterorganic clusters (likely incomplete):

	N-O	N-F	L-O	L-O	L-G	r-O	r-O	r-N
ap+lab	np	nβ	lp	lβ	lw	rp	rβ	
ap+dor	nk	nγ	lk	lγ		rk	rγ	rŋ
ap+pal					lj	rc		

Stops: The stops are always voiceless and somewhat tense in articulation.

Fricatives: The fricatives are voiced and lenis in articulation, but may be voiced stops in clusters following [n]. The labial and dorsal fricatives both alternate with [w].

Vibrant: The vibrant is realised as both a tap and a trill. In word-final position it may vary as a voiceless trill.

Clusters: Additional clusters composed of a consonant followed by one of the glides [w] or [j] are also attested in word-initial position. In these cases, the glides descend from original vowels to the left of the consonant in the proto-language. Three-consonant clusters are attested, composed of a liquid followed by a homorganic N-O sequence.

==

Kuku-Yalanji. (Eastern Cape region; Pama-Nyungan, Pama-Maric) Patz 1982, Oates & Oates 1964.

Consonant phonemes:	p	t		c	k
	m	n		ɲ	ŋ
		l			
		"r"			
	w		ɻ	j	
Homorganic sequences:	mp	nt		ɲc	ŋk
			ɻn		
		ɻnt			
				jc, (jɲ)	
Word-initial consonants:	p	t		c	k
	m	n		ɲ	ŋ
		*			
		*			
	w		*	j	
Word-final consonants:	*	*		*	*
	*	n		ɲ	*
		l			
		"r"			
	*		ɻ	j	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	L-N	r-O	r-N	G-O	G-N
ap+lab	np	nm	lp	lm	rp	rm	ɻp	ɻm
ap+dor	nk	nŋ	lk	lŋ	rk	rŋ	ɻk	ɻŋ
ap+lam	nc		lc			(rɲ)		
lam+lab	(ɲp)						jp	jm
lam+dor	(ɲk)						jk	

Stops: The stops are generally voiceless, but voiced intervocalically and following a nasal, lateral or [ɻ]. The laminal stop is normally affricated.

Vibrant: "r" is a flap intervocalically, a trill word-finally and in C_1; both "r" and [ɻ] tend to be voiceless word-finally. There is some phonetic neutralisation between [t] and "r", both being pronouced as a tap intervocalically.

Lateral: The lateral is slightly velarised following [a] and [u].

Consonant phonotactics: The status of the contrast between [nc] and [ɲc] is uncertain: there are only a handful of instances of [ɲc] against many of [nc], a fact which is inconsistent with the otherwise preference for homorganic clusters. There are also three-consonant clusters in Kuku-Yalanji, all composed of a liquid or glide followed by a homorganic labial or dorsal N-O cluster.

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Kurrtjar. (Gulf region; Pama-Nyungan) Black 1980.

Consonant phonemes:	p	t̪	t	ʈ=[ɽ]	c	k
	β	ð̪				γ
	m	n̪	n		ɲ	ŋ
			l		ʎ	
			r			
			ɾ			
	w				j	
Homorganic sequences:	mp	n̪t̪	nt		ɲc	ŋk

Word-initial consonants: (all except that the contrast between the two vibrants is neutralised)

Word-final consonants: (all but [ð])

Attested morpheme-internal heterorganic clusters:

	N-O	L-O	L-F	L-N	r-O	r-F	r-N	r-G
ap+lab	np		lβ	lm		rβ		rw
ap+dor	nk	lk	lγ	lŋ	rk	rγ	rŋ	
ap+lam		lt̪			rt̪			
lab+lam	mc							

Fricatives: The oral stop/fricative contrast is not licensed after a nasal, either homorganic or heterorganic. The absence of [lp] and [rp] clusters relates to the historical lenition of *p to [β]; synchronically, in Kurrtjar [p] occurs almost only after nasals, the one non-leniting environment. [p] and [β] are in contrast on the basis of a few number of pairs such as [iːp], *father's mother*; [iːβ], *father*.

Vibrants: [r] and [ɾ] are not in contrast in C_1. The segment which appears in this position seems articulatorily ambiguous between the two.

Consonant phonotactics: There are certain three-consonant clusters in Kurrtjar, all composed of a liquid followed by a homorganic labial or dorsal N-O cluster: [lmp], [lŋk], [rmp], [rŋk].

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Kuuku-Ya'u and Umpila. (Eastern Cape region; Pama-Nyungan, Pama-Maric) Thompson 1988.

Consonant phonemes:	p	t̪	t	c	k	ʔ
	m	n̪	n	ɲ	ŋ	
			l			
			"r"			
	w			j		
Homorganic sequences:	mp	n̪t̪	nt	ɲc	ŋk	
			lt			

Word-initial consonants: (all, but "r" is marginal)

Word-final consonants: (only [n], [l], [j])

Attested morpheme-internal heterorganic clusters of two consonants (pp.47-8):

	N-O	O-O	N-N	L-O	L-N	L-G	r-O
ap+lab	np	tp		lp	lm	(lw)	rp
ap+dor	nk		nŋ	lk	lŋ		rk
ap+dent				l̪t̪	l̪n̪		
ap+pal				lc			

Consonant allophony: "With some speakers there is a tendency for the apico-alveolar stop and nasal to be slightly backed in articulation giving an impression of retroflexion" (p.221).

Consonant phonotactics: In addition to the clusters listed above, there are several where the C_1 segment is [j] and others where the C_2 segment is [ʔ].

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Limilngan. (North region; Isolate family) Harvey, ms.

Consonant phonemes:	p	t	(ʈ)	c	k
	b	d=[r]	ɖ=[ɽ]	ɟ	g
	m	n	ɳ'	ɲ	ŋ
		l	ɭ	ʎ	
		r			
	w		ɻ	j	
Homorganic sequences:	mp	(nt)		(ɲc)	(ŋk)

Word-initial consonants:	p	*	*	c	k
	*	*	*	*	*
	m	n	*	*	ŋ
		l	*	*	
		r			
	w		*	*	
Word-final consonants:	(p)	t	(ʈ)	c	k
	*	*	*	*	*
	m	n	(ɳ)	ɲ	ŋ
		l	ɭ	(ʎ)	
		r			
	*		*	j	

Attested heterorganic morpheme-medial clusters:

	N-O	N-N	O-O	L-O	L-N	r-O	r-N	r-G
ap+lab	np (ɳp)	nm ɳm	(ʈp)	(lp)	lm	(rp)	rm	
ap+dor		nŋ		lk (ɭk)	lŋ	(rk)	(rŋ)	
ap+lam								(rj)
lam+lab	ɲp	ɲm	cp					
lam+dor		ɲŋ	ck	ʎk				
dor+lab	ŋp	ŋm	kp					

	G-O	G-N	G-G
ap+lab			(ɻw)
ap+dor	jk	jŋ	
lam+lab			(jw)

Stops: Preliminary spectrographic investigation of the fortis/lenis contrast among the stops suggests that length is the relevant phonetic and phonological contrast. The source assumes a geminate analysis, in which case Limilngan has only a single stops series, and some phonotactic aspects of this language, such as the lack of contrast between the two series at word-edges, fall out automatically. The non-coronal lenis stops tend strongly towards spirantised realisation; the laminal lene does not tend towards weakened articulation.

Consonant phonotactics: Certain three-consonantal clusters are attested: [lkp], [rkp].

Homorganic clusters: Except for [mp], the homorganic N-O clusters are rare. The homorganic apico-alveolar cluster is attested only once, and in a widespread word, [nanta], *horse*, which is likely a borrowing; the laminal homorganic cluster [ɲc] is attested once in a place name used by Limilngan speakers for a location on Limilngan country.

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Mangarrayi. (Fitzmaurice region; Mangerian) Merlan 1982, Harvey ms.

Consonant phonemes:	p	t	ʈ	c	k	(ʔ)
	m	n	ɳ	ɲ	ŋ	
		l	ɭ			
		"r"				
	w		ɻ	j		

Homorganic sequences:

	mp	nt	ɳʈ	ɲc	ŋk
	pm			cɲ	
		lt	ɭʈ		

Word-initial consonants:

	p	*	ʈ	c	k
	m	*	ɳ	ɲ	ŋ
		*	ɭ		
		*			
	w		ɻ	j	

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-O	O-N	O-G	N-G	L-O	L-N	L-G
ap+lab	np ɳp	nm ɳm	tp ʈp	tm ʈm		nw	lp ɭp	lm ɭm	lw ɭw
ap+dor	nk ɳk	nŋ ɳŋ	tk				lk ɭk	lŋ ɭŋ	
ap+lam	nc ɳc		tc ʈc	ʈɲ	cw	ɲw	lc ɭc	lɲ ɭɲ	lj ɭj
lam+lab	ɲp	ɲm	cp	cm					
lam+dor	ɲk	ɲŋ	ck						
dor+lab	ŋp		kp	km	kw				
lab+ap	mt								
lab+lam	mc								
lab+dor	mk								

	r-O	r-N	r-G	G-O	G-N	G-G
ap+lab	rp	rm	rw	ɻp	ɻm	ɻw
ap+dor	rk	rŋ		ɻk	ɻŋ	
ap+lam	rc		rj			ɻj
lam+lab				jp	jm	jw
lam+dor				jk		

Stops: Stops have voiceless fortis, and sometimes unreleased, allophones syllable-finally; they are voiced lenes elsewhere. The postalveolars do not involve sublaminal contact and therefore are not as retroflex as in other languages.

Lateral velarisation: Laterals are clear before front and dark before back vowels.

Glides: [w] involves noticeable lip-rounding before the round vowels but elsewhere not as much. [j], [w] are easily perceptible in word-initial position before their corresponding high vowels.

Notes: The glottal stop is restricted to occurring at the end of a syllable; as a result, it may be considered a contrastive prosodic feature of the syllable and not a segmental phoneme. This is argued for Gaalpu by Wood 1978, following earlier work by Schebeck 1974 and McKay 1975. The glottal stop has a morphologically restricted distribution: "with few exceptions, it occurs only at the boundary between initial elements and auxiliary within the compound verb, and finally in verb particles." See Harvey 1991.

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Mantjiltjarra. (Desert region; Pama-Nyungan, Nyungic) Marsh 1969.

Consonant phonemes:

	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	

Homorganic sequences:

	mp	nt	ɳʈ	ɲc	ŋk
		lt	ɭʈ	ʎc	

Word-initial consonants:

	p	t	*	c	k
	m	n	*	ɲ	ŋ
		l	*	*	
		*			
	w		ɻ	j	

Word-final consonants:

	*	*	*	c	*
	*	n	ɳ	ɲ	*
		l	ɭ	ʎ	
		"r"			
	*		*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	L-G	r-O	r-N
ap+lab	np ɳp	nm ɳm	lp ɭp	lw	rp	rm
ap+dor	nk ɳk	(nŋ) ɳŋ	lk ɭk		rk	rŋ
ap+lam	ɳc		ɭc		rc	
lam+lab	ɲp	ɲm	ʎp			
lam+dor	ɲk		ʎk			

Note: Sporadic alternations between [ɻ]-[j] and [r]-[l] are attested.

Stops: Stops are voiceless word-initially; they are voiced following a nasal stop and alternate between voiced and voiceless following oral consonants; the non-apical stops alternate between voiced stop and voiced spirant allophones intervocalically, while the apical stops are voiced plosives.

Retroflexes: The retroflexion of apico-postalveolar segments is very clear following a low vowel, not as much so following a back-round vowel, and almost imperceptible following [i], [i:].

Clusters: The contrast between [nc] and [lc] and their homorganic counterparts [ɲc] and [ʎc] is neutralised. In fast speech the homorganic variants are attested, while in slow speech there is free variation.

Vibrant: The vibrant segment is a flap in intervocalic position and a trill elsewhere and in emphatic speech; it is often voiceless utterance-finally.

Marra. (Gulf region; Maran) Heath 1981a.

Consonant phonemes:

p	(t̪)	t	ʈ	c	k
				[c:]	
m	(n̪)	n	ɳ	ɲ	ŋ
	(l̪)	l	ɭ		
		r=[ɾ]			
w			ɻ	j	

The fortis lamino-alveopalatal stop [c:] is analysed as the cluster /tc/ underlyingly.

Homorganic sequences:

mp	(n̪t̪)	nt	ɳʈ	ɲc	ŋk:
					(kŋ)
		(lt)			
		(rt)			

Word-initial consonants:

p	(t̪)	*	ʈ	c	k
m	(n̪)	*	ɳ	ɲ	ŋ
	*	*	ɭ		
		*			
w			ɻ	j	

Word-final consonants: (all but [m])

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G
ap+lab	np ɳp	tp ʈp	nm ɳm	lp ɭp	lm ɭm	lw ɭw	rp	rm	rw
ap+dor	nk ɳk	ʈk	ɳŋ	lk ɭk	lŋ ɭŋ		rk	rŋ	
ap+lam	ɳc	tc ʈc	ɳɲ	lc ɭc	ɭɲ	lj ɭj	rc	rɲ	rj
lam+lab		cp	ɲm						
lam+dor	ɲk	ck							
dor+lab		kp							

	G-O	G-N
ap+lab	ɻp	ɻm
ap+dor	ɻk	
ap+lam	ɻc	ɻɲ
lam+lab		(jm)
lam+dor		(jŋ)

Dentals: The dentals are marginal in the system, occurring exclusively in flora-fauna vocabulary which is likely borrowed from Nunggubuyu or Yanyuwa.

Apicals: "Word-initial apicals are written as retroflexed since whenever they are preceded by words ending in vowels the retroflexion can be heard."

Consonant phonotactics: There are certain three-consonant clusters in Marra, all composed of a liquid or glide followed by a homorganic labial or dorsal N-O cluster: [lŋk], [rmp], [rŋk], [ɻmp]. There are two tri-consonantal clusters where the last two segments are heterorganic, [lgm] and [rgm] (one word with the former and two with the latter), both of which historically derive from compound forms.

Marrgany-Gunya. (Riverine region; Pama-Nyungan, Pama-Maric) Breen 1981a.

Consonant phonemes:

p	t̪	t	ʈ	c	k
b	d̪	d=[ɾ]	ɖ	ɟ	g
m	n̪	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		r=[r]			
w			ɻ	j	

Homorganic sequences:

	(n̪t̪)	(nt)		(ɲc)	(ŋk)
mb	n̪d̪	nd	ɳɖ	ɲɟ	ŋg
		(lt)			

Word-initial consonants:

p	t̪	*	*	(c)	k
*	*	*	*	*	*
m	n̪	*	*	*	ŋ
		*	*	*	
		*			
w			*	j	

Word-final consonants:

*	*	*	*	*	*
*	*	d	ɖ	*	*
*	*	n	ɳ	(ɲ)	*
		l	ɭ	(ʎ)	
		("r")			
(w)			*	(j)	

Attested morpheme-internal heterorganic clusters:

	N-O	N-O	N-N	L-O	L-O	r-O	r-O	r-N
ap+lab	nb ɳb		nm ɳm	lb	(lp ɭp)	(rp)	rb	(rm)
ap+dor	ng ɳg	(nk)	nŋ (ɳŋ)	lg (ɭg)	ɭk	rk	rg	
lam+lab	ɲb		(ɲm)					
lam+dor	(ɲg)				(ʎk)			

Stops: The two series of stops are long voiceless fortes and short voiced lenes. In intervocalic position the labial, dorsal and dental lenes are spirantised and /d/ is realised as a tap. The fortes occur at relatively low frequencies.

Nasals: Nasals are lengthened following the initial, stressed vowel.

Coronal nasals: The phones [n̪] and [n] are both attested word-initially, but there is no evidence of a contrast; they appear to be allophones of a neutral coronal nasal. The dental is more common preceding [u], the alveolar more common preceding [i].

Notes: The C_1 segment in the r-O clusters are phonemicised in the source as /d/ on the basis of the fact that normal realisation of the voiced, lenis alveolar stop in C_{inter} is [ɾ]. I assume that the C_1 segment in these clusters is to be aligned with the vibrant segment /r/, being realised as a trill in C_{inter} and a tap in C_1.

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Martuthunira. (Northeast region; Pama-Nyungan, Nyungic) Dench 1987.

Consonant phonemes:	p	t̪	t=[tː]	ʈ=[ʈ]	c	k
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
				ɻʈ		
Word-initial consonants:	p	t̪	*	*	c	k
	m	n̪	*	*	ɲ	ŋ
		*	*	*	*	
			*			
	w			*	j	
Word-final consonants:	*	*	*	*	*	*
	*	*	n	ɳ	ɲ	*
		*	l	ɭ	ʎ	
			r			
	*			*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	L-G	r-O	r-G
ap+lab	np ɳp	nm ɳm	lp ɭp	lw ɭw	rp	rw
ap+dor	nk ɳk	nŋ	lk ɭk		rk	
ap+lam				lj ɭj		rj
lam+lab			ʎp	ʎw		
lam+dor	ɲk		ʎk			

Stops: Stops are generally voiceless and unaspirated initially and following a nasal and voiced intervocalically; but there is persistent variation. The peripheral stops are most often voiceless. The lamino-dental stop tends to lenite to voiced stop, fricative or dental glide allophones. The apico-alveolar stop is always long and voiceless intervocalically, while the postalveolar is a retroflex tap.

Oral sonorants: Laterals are articulated with slight pre-stopping when syllable-final. /r/ is a tap intervocalically and a voiceless trill in C_I and C_{fin}. [w], [j] have some reduction in degree of occlusion intervocalically.

Apical stops: The /ɻt/ cluster occurs in only four words, but there is a compelling minimal set: /kuɻta/, *clever*; /kuʈa/, *brother*; /kuta/, *short*; /kuraŋa/, *black*; the source gives spectrographic evidence to support his claim for the contrast as well. /ɻt/ could be analysed as /ʈ/ and what has been considered /ʈ/ reanalysed as a third rhotic, a retroflex tap (which it is phonetically). The very low frequencies of both /t/ and /ʈt/ and the fact that they are both long and voiceless supports this, but the spectrographic evidence clearly shows a distinct [ɻ] portion in /ɻt/, which tends to support the original analysis assumed here.

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Mbabarram. (Rainforest region; Pama-Nyungan, Pama-Maric) Dixon 1991.

Consonant phonemes:	p	t̪	t		c	k
			t^w			k^w
	m	n̪	n		ɲ	ŋ
			n^w			
			l			
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt		ɲc	ŋk
			nt^w			$ŋk^w$

Word-initial consonants: (all except "r" and [ɻ])

Word-final consonants: (all except the labialised members; the contrast between the two laminal series *may* be neutralised word-finally)

Attested morpheme-internal heterorganic clusters of two consonants:

	N-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G	G-O
ap+lab	(np)	nm	lp	lm	lw	rp	rm	rw	
ap+dor	(nk)	(nŋ)	lk	lŋ		rk	rŋ		ɻk
ap+dent			lt̪			rt̪			
ap+pal			lc			rc			
lam+lab									jp
lam+dor									jk

Stops: Word-final stops have an audible release. Stops are normally voiceless in word-initial or -final position and in clusters following [j]; they are voiced after nasals; and they show free variation between vowels and in clusters following liquids, but tend towards being voiced when intervocalic and follow a word-initial vowel. Also, /p/ shows a stronger tendency towards a voiced allophone than oral stops of other places of articulation. "Articulation of the lamino-dental stop is sometimes accompanied by a little friction, as would be expected due to the long longitudinal channel between active and passive articulators (but I was corrected if I repeated it as a fricative or affricate)" (p.355).

"Rhotics": "r" is an alveolar tap or trill, /ɻ/ a postalveolar tap or trill or a retroflex glide. The source proposes that the distinction is primarily one of place rather than manner of articulation.

Consonant phonotactics: Clusters of three consonants are permitted. They are composed of a liquid followed by a homorganic labial, dorsal or lamino-dental N-O sequence.

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Miriwung. (Kimberley region; Djeragan) Kofod 1978.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m		n		ɲ	ŋ
			l		ʎ	
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt		ɲc	ŋk
			lt ln			
			rt rn			
Word-initial consonants:	p	t̪	t	*	c	k
	m		n		ɲ	ŋ
			l		*	
			*			
	w			ɻ	j	
Word-final consonants:	p	t̪	t	*	c	k
	m		n		ɲ	ŋ
			l		*	
			"r"			
	*			ɻ	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	N-G	O-O	L-O	L-N	L-G	r-O	r-N	r-G	ɻ-N
ap+lab	np	nm			lp	lm	lw	rp	rm	rw	ɻm
ap+dor	nk	nŋ		tk ʈk	lk	lŋ		rk	rŋ		
ap+dent	nt̪				lt̪			rt̪			
ap+pal	nc	nɲ		tc	lc	lɲ		rc	rɲ	rj	
lam+lab	ɲp	ɲm	ɲw	cp t̪p							
lam+dor	ɲk			ck							
dor+lab	ŋp			kp							
lab+dor	mk			pk							
lab+dent				pt̪							
lab+ap				pt							
lam+ap				ct							

Stops: Stops are uniformly voiced in intervocalic position and following a nasal or stop and are uniformly voiceless word-finally and preceding another stop. Word-initially and following a liquid there is variation but voiced allophones are more common.

Laminals: The lamino-dental stop alternates between continuant and non-continuant voiced realisations. There is sporadic alternation between dental and alveopalatal articulation of laminal stops syllable-finally, although some words are always pronounced one way or another.

Coronal nasals: The two neutral coronal nasals show contextually conditioned alternation between the two articulations of the corresponding stops. The laminal nasal, which is normally [ɲ], is [n̪] syllable-finally. The apical nasal is normally [n] but varies between [n] and [ɳ] following the vowel /ʌ/. Note the absence of a lamino-dental nasal phoneme but the presence of the contrast between [nt̪] and [n̪t̪].

Consonant phonotactics: Three-consonant clusters are also attested root-internally: [rkp], [rkm].

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Murinh-patha. (Fitzmaurice region; Garaman) Walsh 1976.

Consonant phonemes:	p	t	ʈ	c	k
	b	d	ɖ	ɟ	g
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w	ɹ	ɻ	j	
Homorganic sequences:	mp			ɲc	ŋk
	mb	nd	ɳɖ	ɲc	ŋg
		(lt)	(ɭʈ)	(ʎc)	
		(ld)	(ɭɖ)	(ʎɟ)	
		(ɹt) (rɹ)		(jc)	
	pm (pw)				
Word-initial consonants:	p	t	ʈ	c	k
	b	d	ɖ	ɟ	g
	m	n	ɳ	ɲ	ŋ
		l	*	*	
		*			
	w	ɹ	*	j	
Word-final consonants:	p	t	ʈ	c	k
	b	d	*	*	g
	*	n	ɳ	ɲ	*
		l	ɭ	*	
		r			
	*	ɹ	*	j	

Attested morpheme-internal heterorganic clusters:

	N-O	N-O	N-N	O-O	O-O	O-O	O-N
ap+lab	np (ɳp)	nb ɳb	nm	tp ʈp		(ɖb)	tm
ap+dor	nk ɳk	ng		tk (ʈk)		(tg)	
ap+lam	nc	nɟ		tc	tɟ		
lam+lab		ɲb	(ɲm)	cp			
dor+lab		(ŋb)		kp		gb	km (gm)
lab+ap		md (mɖ)	mn	pt			
lab+lam			mɲ				
lab+dor		mg	mŋ	pk			
dor+ap		ŋd			(kɖ)		
dor+lam			(ŋɲ)				
lam+ap	(ɲt)						(cn)

	L-O	L-O	L-N	L-G	r-O	r-O	r-N	r-G
ap+lab	lp ɭp	lb (ɭb)	lm ɭm	lw	rp	(rb)	rm	rw
ap+dor	lk (ɭk)	lg ɭg	lŋ ɭŋ		rk		(rŋ)	
ap+lam	lc			(lɟ ɭɟ)	(rc)			rj

	G-O	G-G
ap+lab		ɻw
ap+dor	ɻk	
lam+lab		(jw)
lam+dor	jk	

Stops: The contrast between the two series of stops is one of voicing. Members of the voiceless series alternates between aspirated and unaspirated. The labial stops have labio-dental or bilabial spirant allophones, and the apico-alveolar stops sporadically have dental spirant realisation. Both laminal stops are occasionally affricated at the alveolar or alveopalatal places of articulation.

Alveolars: The apico-alveolar series varies freely with lamino-dental articulation, but there is one minimal pair with [t] and [t̪] in contrast where native speakers insist they should be given distinct representations.

Consonant phonotactics: Certain geminate clusters are also attested: [nn], [tt], [kk], [jj]. Various three member consonant clusters are also attested: [ytp], ([lkm]), [lmb], [rkp], ([rŋk]), ([ɻŋk]).

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Muruwari. (Riverine region; Pama-Nyungan) Oates 1988.

Consonant phonemes:						
	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ
			l	ɭ		
			r			
			ɾ			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
				ɭʈ		
		jt̪				
Word-initial consonants:	p	t̪	t	*	c	k
	m	n̪	n	*	ɲ	ŋ
			*			
			*			
			*			
	w			*	j	
Word-final consonants:	*	*	*	(ʈ)	*	*
	*	n̪	n	ɳ	ɲ	*
			l	ɭ		
			ɾ			
			*			
	(w)			ɻ	j	

Attested morpheme-internal heterorganic clusters:

	N-O	L-O	r-O	G-O	G-N
ap+lab	np ɳp	lp ɭp	rp	ɻp	
ap+dor	nk ɳk	lk ɭk	rk	ɻk	
ap+pal		lc			
lam+lab	ɲp			jp	jm
lam+dor	ɲk			jk	
lam+ap				jt	jn

Stops: Stops are normally voiceless, but are voiced in a variety of contexts: in C_2, following a long vowel, word-initially preceding a long vowel or word-initially when the following consonant is apico-postalveolar. Word-initially all stops may show at least some voicing, but voicing is much more common before [a] than before either of the high vowels; these observations apply to all oral stops except /t̪/ which is always voiceless. Labial and dorsal stops have voiced fricative allophones sporadically in many words.

Lengthening: Stops, nasals and laterals often are lengthened following a stressed syllable, especially labial and dorsal segments. This tendency is not as strong in Muruwari as in some adjoining languages.

Glides: /ɻ/ is sometimes pronounced like [j] between vowels. Vibrants and apico-postalveolar segments commencing the second syllable of a word attract stress onto that syllable (pp.40-41).

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Ngalakan. (Arnhem region; Gunwinyguan) Merlan 1983.

Consonant phonemes:						
	p	t	ʈ	c	k	(ʔ)
	b	d	ɖ	ɟ	g	
	m	n	ɳ	ɲ	ŋ	
		l	ɭ			
		"r"				
	w		ɻ	j		

Homorganic sequences:	mp		nt	ɳʈ	ɲc	ŋk

Word-initial consonants:	p	*	ʈ	c	k
	*	*	*	*	*
	m	*	ɳ	ɲ	ŋ
		*	ɭ		
		*			
	w		ɻ	j	

Word-final consonants: (all except that the contrast between the two stop series is neutralised)

Attested morpheme-internal heterorganic clusters of two consonants (pp.12-18):

	N-O	O-O	N-N		L-O	L-O	L-N	L-G
ap+lab	np ɳp	tp ʈp	nm ɳm		lp ɭp	lb	lm ɭm	
ap+dor	nk ɳk	ʈk	ɳŋ		lk	lg	lŋ ɭŋ	
ap+lam	nc ɳc	ʈc			lc			lj ɭj
lam+lab	ɲp	cp	ɲm					
lam+dor	ɲk							
dor+lab	ŋp	kp	ŋm					

	r-O	r-O	r-N	r-G	G-O	G-O	G-N	G-G
ap+lab	rp	rb	rm	rw	ɻp		ɻm	
ap+dor	rk	rg	rŋ		ɻk		ɻŋ	
ap+lam	rc				ɻc	ɻɟ		ɻj
lam+lab					jp		jm	jw
lam+dor					jk		jŋ	

Vibrant: The vibrant "is an apico-alveolar tap, sometimes very lightly trilled when syllable final" (p.10). The laterals are clear in the environment of front vowels, but have some velarisation in the environment of back vowels.

Note: The glottal stop is restricted to occurring at the end of a syllable; as a result, it may be considered a contrastive prosodic feature of the syllable and not as a segmental phoneme. This is argued for Gaalpu by Wood 1978, following earlier work by Schebeck 1974 and McKay 1975.

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Ngandi. (Arnhem region; Gunwinyguan) Heath 1978a.

Consonant phonemes:	p	t̪	t	ʈ	c	k	(ʔ)
	b	d̪	d	ɖ	ɟ	g	
	m		n	ɳ	ɲ	ŋ	
			l	ɭ			
			"r"				
	w			ɻ	j		
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk	

Word-initial consonants:	p	t̪	*	ʈ	c	k
	*	*	*	*	*	*
	m		*	ɳ	ɲ	ŋ
			*	ɭ		
			("r")			
	w			ɻ	j	

Word-final consonants: (all except that the contrast between the two stop series is neutralised)

Attested morpheme-internal heterorganic clusters of two consonants:

	N-O	O-O	N-N		L-O	L-O	L-N	L-G
ap+lab	np ɳp	tp	nm ɳm		lp ɭp	lb	lm ɭm	lw
ap+dor	nk ɳk		nŋ ɳŋ		lk ɭk	lg ɭg	lŋ ɭŋ	
ap+dent	ɳt̪				lt̪	ld̪		
ap+pal	nc ɳc	ʈc			lc	lɟ ɭɟ	lɲ ɭɲ	
lam+lab	ɲp	cp	ɲm					
lam+dor	ɲk		ɲŋ					
dor+lab	ŋp	kp	ŋm					
dor+lam	(ŋt̪)							
lab+lam			(mɲ)					

	r-O	r-O	r-N	r-G	G-O	G-O	G-N	G-G
ap+lab	rp		rm	rw	ɻp		ɻm	ɻw
ap+dor	rk	rg	rŋ		ɻk		ɻŋ	
ap+dent	rt̪	rd̪				ɻd̪		
ap+pal	rc	rɟ	rɲ		ɻc	ɻc		
lam+lab					jp		(jm)	jw
lam+dor					jk		(jŋ)	

Dentals: The dental series is interdental, the tip of the tongue protruding between the teeth and the blade pressed against a broad area of the upper teeth and the alveolar ridge. Note that there is no contrast between [n̪t̪] and [nt̪].

Vibrant: The vibrant segment is a flap or a light trill.

Note: The glottal stop is restricted to occurring at the end of a syllable; as a result, it may be considered a contrastive prosodic feature of the syllable and not as a segmental phoneme. This is argued for Gaalpu by Wood 1978, following earlier work by Schebeck 1974 and McKay 1975.

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Nganyaywana. (Southeast region; Pama-Nyungan) Crowley 1976.

Consonant phonemes:	p	t		c	k
	m	n		ɲ	ŋ
		l		ʎ	
		"r"			
	w		ɻ	j	

Homorganic sequences:	mp		nt		ɲc	ŋk

Attested morpheme-internal heterorganic clusters:

	N-O	L-O	L-N	r-O	r-N
ap+lab	np	lp	lm	rp	rm
ap+dor	nk	lk		rk	

Ngawun. (Gulf region; Pama-Nyungan, Pama-Maric) Breen 1981b.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ
			l	ɭ		
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
					[ʎc]	
Word-initial consonants:	p	t̪	(t)	*	c	k
	m	n̪	*	*	ɲ	ŋ
			(l)	(ɭ)		
			*			
	w			(ɻ)	j	
Word-final consonants:	*	*	*	*	*	*
	*	*	n	ɳ	ɲ	*
			l	ɭ		
			"r"			
	*			*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	L-O	L-N	r-O	r-N
ap+lab	np	lp (ɭp)	lm	rp	rm
ap+dor	nk	lk	lŋ	rk	(rŋ)
ap+pal		lc=[ʎc]		rc	

Laminal lateral: There is a lamino-alveopalatal lateral allophone [ʎ] which occurs in a few words only in the cluster [ʎc]. It contrasts with neither of the lateral phonemes [l] nor [ɭ] in this environment.

Inventory: The consonant [t] is extremely marginal in contexts other than the [nt] cluster: it is attested initially in one word and intervocalically in one other.

Stops: Stops are normally lenis voiceless or lightly voiced, but voiced following a nasal in clusters. Stressed vowels are retroflex preceding apico-postalveolar segments.

Ngiyambaa. (Riverine region; Pama-Nyungan, Wiradjuric) Donaldson 1980.

Consonant phonemes:	p	t̪	t		c	k
	m	n̪	n		ɲ	ŋ
			l			
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt		ɲc	ŋk
			lt			
Word-initial consonants:	p	TH	*		*	k
	m	n̪	*		*	ŋ
			*			
			*			
	w			*	j	

Word-final consonants: (only [n], [l], [r], [j])

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	r-O	L-G	r-G
ap+lab	np	(nm)	lp	rp		(rw)
ap+dor	nk	(nŋ)	lk	rk		
ap+dent			lt̪			
ap+pal					lj	

Stops: Stops are voiceless fortes word-initially and are lenis and occasionally voiced word-medially. Dorsals (stop and nasal) have a palatal off-glide preceding the high front vowel.

Vibrant: The vibrant is normally a tap, but may be a trill when emphasised; word-finally it may be a tap or trill or a voiceless fricative.

Consonant phonotactics: In many environments the alveopalatal/dental contrast is not present, including word-initially, suffix-initially and in most intervocalic contexts, with the exception of a_a, and, in one dialect, u_a. In positions of neutralisation both alveopalatal and dental allophones are attested, but alveopalatal articulation is conditioned by the context.

Allophony: Word-initial "TH" is normally lamino-dental, but an alveopalatal allophone is conditioned by a following [i] or by an alveopalatal segment later in the word.

Nhukunu. (Spencer region; Pama-Nyungan, Parnkalla-Yura-Miru) Hercus 1992.

Consonant phonemes:	p	t̪	t	ʈ	c	k
				ɖ		
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			r			
			ɾ			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
		l̪t̪	lt	ɭʈ	ʎc	

Word-initial consonants:	p	t̪	*	*	c	k
				*		
	m	n̪	*	*	ɲ	ŋ
		*	*	*	*	
			*			
			*			
	w			*	j	

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	L-O	r-O
ap+lab	ɳp	tp	ɭp	rp
ap+dor	ɳk		ɭk	rk
lam+lab	ɲp			

Stops: Stops are normally voiceless (with the exception of contrastively voiced [d]) but are voiced following a long vowel.

Consonant phonotactics: Apicals in C_1 do not contrast between alveolar and postalveolar places of articulation. The default articulation of apicals in C_1 is primarily postalveolar, but there is some degree of variation. This pattern is shared with many other languages in the region.

==

Nunggubuyu. (Arnhem region; Family isolate) Heath 1984.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	(n̪)	n	ɳ	ɲ	ŋ
		l̪	l	ɭ		
			"r"			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
			rt	ɻʈ		
			rn			

Word-initial consonants: (all)

Word-final consonants:	*	*	t	ʈ	c	k
	*	*	n	ɳ	ɲ	ŋ
		*	l	ɭ		
			r			
	(w)			ɻ	j	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-O	L-O	L-N	r-O	r-N	r-G
ap+lab	np ɳp	nm ɳm	tp ʈp	lp ɭp	lm ɭm	rp	rm	rw
ap+dor	nk ɳk	nŋ ɳŋ	ʈk	lk ɭk	lŋ ɭŋ	rk	rŋ	
ap+dent	ɳt̪		ʈt̪	lt̪ ɭt̪		rt̪		
ap+pal	nc ɳc	ɳɲ	tc ʈc	lc ɭc	lɲ ɭɲ	rc	rɲ	rj
lam+lab	ɲp	ɲm	cp					
lam+dor	ɲk	ɲŋ	ck					
dor+lab		(ŋm)						

	G-O	G-N	G-G
ap+lab	ɻp	ɻm	ɻw
ap+dor	ɻk	ɻŋ	
ap+pal	ɻc	ɻɲ	ɻj
lam+lab			jw
lam+dor	jk	jŋ	

Dentals: The lamino-dental nasal has a marginal status, occurring only in a handful of nouns.

Phonotactics: There are three forms with a sequence /ll̪/ and one with /rl̪/; all four are verbs of movement with the final syllable [l̪a-], and therefore this may reflect a frozen verbal suffix. The /ll̪/ sequences are phonetically [l̪:]. There is one form with a cluster [ŋm]. Only some speakers pronounce the form with this cluster.

==

Nyangumarta. (Desert region; Nyungic) O'Grady 1964.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	

Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk
		(lt)	ɭʈ	ʎc	

Word-initial consonants:	p	*	ʈ	c	k
	m	*	ɳ	ɲ	ŋ
		*	ɭ	*	
		*			
	w		ɻ	j	

Word-final consonants:	p	*	ʈ	c	k
	*	n	ɳ	ɲ	*
		l	ɭ	ʎ	
		"r"			
	*		*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	N-N	L-O	L-N	r-O	r-N	O-G
ap+lab	np ɳp	ʈp	nm ɳm	lp ɭp	(lm) ɭm	rp	rm	ʈw
ap+dor	nk ɳk	ʈk	nŋ ɳŋ	lk ɭk	lŋ ɭŋ	rk	rŋ	
ap+lam	nc ɳc			lc ɭc		rc		
lam+lab	ɲp		ɲm	ʎp	(ʎm)			
lam+dor	ɲk			ʎk	ʎŋ			

Stops: Word-initially, /p/ has affricated and spirantised allophones before [u]; otherwise, stops have voiceless, unaspirated non-continuant allophones in C_{init}; they are unreleased in C_1 and C_{fin}, but are released, varying between voiced and voiceless, in utterance-final position; voiced following a homorganic nasal; elsewhere (intervocalically or in C_2), non-apical stops vary in voicing and apicals are uniformly voiced.

Vibrant: "r" varies between flap and trill realisations. The trill, nasals, glides and vowels are optionally voiceless in utterance-final position.

Consonant phonotactics: O'Grady 1964:25 gives a list of clusters attested at morpheme-boundaries beyond those attested morpheme-internally.

==

Nyawaygi. (Rainforest region; Pama-Nyungan, Pama-Maric) Dixon 1983.

Consonant phonemes:	p	t̪	t=[r]			k
	m	n̪	n			ŋ
			l			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt			ŋk
Word-initial consonants:	p	t̪	t=[r]			k
	m	n̪	*			ŋ
			*			
	w			ɻ	j	
Word-final consonants:	*	*	t=[r]			*
	m	n̪	*			*
			*			
	*			*	j	

Attested morpheme-internal heterorganic clusters of two segments:

	N-O	N-N	L-O	L-N	r-O	r-N	r-G	G-O	G-N
ap+lab	np		lp	lm	rp		(rw)	ɻp	(ɻm)
ap+dor	nk	nŋ	lk		rk	rŋ		(ɻk)	(ɻŋ)
ap+lam	nc		lc	(lɲ)	(rc)			ɻc	
lam+lab								jp	jm
lam+dor								jk	

Apicals: The contrast between the apico-alveolar stop and vibrant segments, present in Nyawaygi's congeners, has undergone a recent historical neutralisation in Nyawaygi. A single segment, /t/, is realised as a trill in intervocalic position, word-initially, word-finally and in clusters, and as a stop in homorganic N-O clusters.

Laminals: The single laminal series is interdental, with the blade making contact with the back of the teeth and the alveolar ridge. The release often involves frication. Alveopalatal allophones are attested sporadically before [i], but even in this environment they are outnumbered by dental allophones.

Consonant phonotactics: Clusters of three consonants are also attested, always involving a liquid or glide followed by a homorganic labial or dorsal N-O sequence. Additional clusters found in Nyawaygi are [wk] and [mk], each found in two forms.

==

Nyigina. (Kimberley region; Nyulnyulan) Stokes 1982.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	
Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk
				ʎc	
			ɭɻ		
Word-initial consonants:	p	t	*	c	k
	m	n	*	ɲ	ŋ
		l	*	*	
		*			
	w		ɻ	j	

Word-final consonants: (all, but the stops and non-coronal nasals are marginal)

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-O	L-O	L-N	L-G	r-O	r-N	r-G
ap+lab	np ɳp	nm ɳm	(ʈp)	lp ɭp	lm ɭm	lw ɭw	rp	rm	rw
ap+dor	nk ɳk	nŋ (ɳŋ)	(ʈk)	lk ɭk	lŋ		rk	rŋ	
ap+lam	nc ɳc			lc	lɲ		rc		
lam+lab	ɲp	ɲm	cp	ʎp					
lam+dor	ɲk	(ɲŋ)	(ck)	ʎk	ʎŋ				

	G-O	G-N	G-G
ap+lab	ɻp	ɻm	ɻw
lam+lab	jp	jm	
lam+dor	jk		

Stops: Stops may be voiceless word-finally and, to a lesser extent, word-initially, but elsewhere they are usually voiced.

Retroflexes: In the apico-postalveolars the tongue tip is not as retracted as in other Australian Aboriginal languages, "often only slightly further back than the apico-alveolar series" (p.14).

Consonant phonotactics: Nyigina is reported to contrast heterorganic apical N-O clusters: [nt], [ɳʈ], [ɳt] and [nʈ] (p.24, with minimal pair data). There are certain three-consonant clusters in Nyigina, all composed of a liquid followed by a homorganic labial or dorsal N-O cluster: [lmp], [lŋk], [rmp], [rŋk].

==

Nyungar. (Southwest region; Pama-Nyungan, Nyungic) Douglas 1968.

Consonant phonemes:	p	t	ʈ	TH	k
	m	n	ɳ	NH	ŋ
		l	ɭ	LH	
		"r"			
	w		ɻ	j	
Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk
Word-initial consonants:	p	t	*	TH	k
	m	n	*	NH	ŋ
		*	*	*	
		*			
	w		*	j	

Word-final consonants: (all)

Attested morpheme-internal heterorganic clusters of two consonants: (Bracketted clusters are predicted as possible from the statement on p.37, but are not attested in the word-list.)

	N-O	L-O	N-N	L-N	G-O
ap+lab	np (ɳp)	lp ɭp	nm ɳm	lm ɭm	ɻp
ap+dor	nk ɳk	lk ɭk			
lam+lab	(ɲp)	(ʎp)	(ɲm)	ʎm	
lam+dor	ɲk	ʎk			

Note: There are instances of initial [p^{w}], [k^{w}] and [t^{w}] which the author argues are separate phonemes. They are not clusters (no other clusters occur word-initially) but could be viewed as contracted CuwV sequences (there is alternation between [tuwuʈ] and [t^{w}uʈ] in one dialect).

Note: The source states (p.37) that homorganic L-O clusters are permitted, but none are found in the rather extensive word-list.

Stops: The stops are voiceless unaspirated, but are voiced following a nasal.

Vibrant: "r" is a flap or a trill in emphatic speech.

Laminals: The laminals are dental preceding a back vowel and "post-dental, alveolarised" when preceding a front vowel. All vowels have palatalised off-glides preceding laminal segments.

Consonant phonotactics: Some additional clusters are found in one word only and are somewhat anomalous: [cm], [cp], [kŋ], [pt], [nw]. The [ɻp] cluster may instead be [rp] (p.37).

==

Olkol. (West Cape region; Pama-Nyungan, Pama-Maric) Sommer 1969; Hamilton, unpublished field notes.

Consonant phonemes:	p	t̪	t		c	k
	β	(ð)				γ
	m	n̪	n		ɲ	ŋ
	^{b}m	^{d}n̪	^{d}n		^{d}ɲ	^{g}ŋ
		l̪	l		(ʎ)	
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt		ɲc	ŋk
	^{b}mp	^{d}n̪t̪	^{d}nt		^{d}ɲc	^{g}ŋk
			rt			

Word-initial consonants: (none)

Word-final consonants: (all)

Attested morpheme-internal heterorganic clusters:

	N-O	^{c}N-O	N-N	O-O	L-O	L-F	L-N	L-N	L-G	r-O	r-F
ap+lab	np	^{d}np	nm	tp	lp	lβ	lm	l^{b}m	lw	rp	rβ
ap+dor	nk	^{d}nk			lk	lγ	lŋ	l^{g}ŋ		rk	rγ
ap+pal										rc	

	r-N	r-N	r-G	G-O	G-N	G-N
ap+lab	rm	r^{b}m	rw	ɻp	ɻm	ɻ^{b}m
ap+dor	rŋ	r^{g}ŋ		ɻk	ɻŋ	ɻ^{g}ŋ
ap+pal	rɲ	r^{d}ɲ	rj	ɻc	ɻɲ	ɻ^{d}ɲ
lam+lab				jp	jm	j^{b}m
lam+dor				jk	jŋ	j^{g}ŋ

Dialectal variation: The Oykangand dialect has a voicing contrast among the stops which is not present in the Olgol dialect. The lamino-alveopalatal lateral is found in two words in Olgol, neither of which is used in Oykangand. The dental fricative is marginal, often occurring as an optional variant of the dental stop.

Clusters: There are also three-consonant clusters, most of which are oral sonorant +homorganic N-O sequence, although [rnp] and [j^{d}np] are also found.

==

Panyjima. (Northeast region; Pama-Nyungan, Nyungic) Dench 1991.

Consonant phonemes:	p	t̪	t=[tː]	ʈ=[ɽ]	c	k
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			"r"			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
					ʎc	

Word-initial consonants:	p	t̪	*	*	c	k
	m	n̪	*	*	ɲ	ŋ
		*	*	*	*	
			*			
	w			*	j	

Word-final consonants: (none)

Root-final consonants:	*	*	*	*	*	*
	*	*	n	ɳ	ɲ	*
		*	l	ɭ	ʎ	
			"r"			
	*			*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	L-G	r-O	r-G
ap+lab	np ɳp	nm ɳm	lp ɭp	lw	rp	rw
ap+dor	nk ɳk	nŋ ɳŋ	lk ɭk		rk	
ap+pal	ɳc		lc		rc	
lam+lab	ɲp	ɲm	ʎp			
lam+dor	ɲk		ʎk			

Stops: "Stops are voiceless and unaspirated with a tendency toward voicing in medial position." Dorsals are retracted, approaching uvular articulation.

Apicals: The apical contrast is not obvious in free speech and there is a degree of variation. The front vowel [i] tends to condition alveolar articulation of apicals (especially when preceding the apical segment) and the back vowel [u] conditions postalveolar articulation.

Vibrant: The vibrant is a trill in C_1 and a tap in C_{inter}.

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Payungu. (Northeast region; Pama-Nyungan, Nyungic) Austin 1992a, Austin 1981b.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			"r"			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk

Word-initial consonants:	p	t̪	*	*	c	k
	m	n̪	*	*	ɲ	ŋ
		*	*	*	*	
			*			
	w			*	j	

Word-final consonants:	*	*	*	*	*	*
	*	*	n	ɳ	ɲ	*
		*	l	*	ʎ	
			"r"			
	*			*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-O	L-O	L-N	r-O
ap+lab	np ɳp	nm		lp ɭp	(lm)	rp
ap+dor	nk ɳk	(nŋ)	(ʈk)	lk ɭk		rk
ap+lam	ɳc			ɭc		rc
lam+lab		(ɲm)		ʎp		
lam+dor	ɲk			ʎk		

==

Pintupi. (Desert region; Pama-Nyungan, Nyungic) Hansen & Hansen 1969, Hansen & Hansen 1978.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	

Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk
		lt	ɭʈ	ʎc	

Word-initial consonants:	p	*	ʈ	c	k
	m	*	ɳ	ɲ	ŋ
		*	ɭ	*	
		*			
	w		ɻ	j	

Word-final consonants:	*	*	*	*	*
	*	n	ɳ	ɲ	*
		l	ɭ	ʎ	
		"r"			
	*		*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	r-O	r-N	G-O	G-G
ap+lab	np ɳp	nm ɳm	lp ɭp	rp	rm	ɻp	ɻw
ap+dor	nk ɳk	(nŋ) ɳŋ	lk ɭk	rk		ɻk	
ap+lam	nc ɳc		lc ɭc	rc			
lam+lab	ɲp	ɲm	ʎp				
lam+dor	ɲk	ɲŋ	ʎk				

Phonotactics: Utterance-final words with a final consonant receive the dummy paragogic syllable [-pa] to enforce a vowel-final utterance phonotactic. This same syllable is used to break-up non-permitted clusters at morpheme junctures (1978:p.39; see Capell 1962:18 on Warlpiri).

"Rhotics": "r" is "usually a flap in normal unemotional speech. It varies to a trill however in slow or carefully articulated speech. It is usually a trill in emphatic or angry speech." There is inter-dialectal variation between /r/ and /ɳ/ in C_1 preceding a nasal segment. /ɻ/ varies freely from a retroflex glide to a retroflex flap.

Homorganic N-O sequences: "When learning to read, Aboriginal speakers of Pintupi have preferred to make a syllable break before the [homorganic] cluster, i.e., (pa mpa) and (wa ŋka) rather than (pam pa) and (waŋ ka). Although this analysis has been used in the Pintupi primer series for teaching purposes, the authors prefer to regard (mp) and (ngk) as a sequence of two consonants for the purpose of technical description" (1978:p.39).

==

Pitta-Pitta. (Eyre region; Pama-Nyungan, Karnic) Blake 1979b, Blake & Breen 1971.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			r			
			ɾ			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk:
		l̪t̪			ʎc	
Word-initial consonants:	p	t̪	*	ʈ	c	k
	m	n̪	*	ɳ	ɲ	ŋ
		(l̪)	*	(ɭ)	*	
			(r)			
			*			
	w			(ɻ)	j	

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	r-O
ap+lab	np	nm	lp ɭp	rp
ap+dor	nk	(nŋ)	lk ɭk	rk

Stops: Stops are typically fortis, voiceless, but voiced allophones occur between unstressed vowels.

Vibrant: The alveolar trill and tap segments are in free variation in C_1.

Retroflexes: The members of the apico-postalveolar series are distinguished mainly by the retroflexion they impart to the preceding vowel, which increases over the course of the vowel. There is also slight audible retroflexion in the onset of the following vowel. Word-initial apicals are noticeably retroflexed.

Consonant phonotactics: The sources imply that the absence of the apical homorganic

lateral+oral stop clusters is accidental (this cluster-type is normally very uncommon), but this pattern is not uncommon. The absense of the double-apical contrast for C_1 nasals may be systematic (Blake 1979:188).

==

Ritharrngu. (Arnhem region; Pama-Nyungan, Yuulngu) Heath 1980a.

Consonant phonemes:	p	t̪	t	ʈ	c	k	(ʔ)
	b	d̪	d	ɖ	ɟ	g	
	m	n̪	n	ɳ	ɲ	ŋ	
			l	ɭ			
			"r"				
	w			ɻ	j		
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk	
Word-initial consonants:	p	t̪	*	ʈ	c	k	
	*	*	*	*	*	*	
	m	n̪	*	ɳ	ɲ	ŋ	
			*	ɭ			
			*				
	w			ɻ	j		
Word-final consonants:	p	*	t	ʈ	c	k	
	*	*	*	*	*	*	
	m	*	n	ɳ	ɲ	ŋ	
			l	ɭ			
			"r"				
	w			ɻ	j		

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-O	L-O	L-O	L-N	L-G
ap+lab	np ɳp	nm ɳm	tb ʈb	lp ɭp	lb ɭb	lm ɭm	lw ɭw
ap+dor	nk ɳk	nŋ ɳŋ		lk ɭk	lg ɭg	lŋ ɭŋ	
ap+dent	ɳt̪		ʈt̪	lt̪			
ap+pal	nc ɳc		ʈc	ɭc	lɟ ɭɟ		ɭj
lam+lab	ɲp	ɲm	cp				
lam+dor	ɲk		ck				
dor+lab	ŋp	ŋm	kp				

	r-O	r-O	r-N	r-G	G-O	G-O	G-N	G-G
ap+lab	rp	rb	rm	rw	ɻp	ɻb	ɻm	ɻw
ap+dor	rk	rg	rŋ		ɻk	ɻg	ɻŋ	
ap+dent		rd̪			ɻt̪			
ap+pal	rc	rɟ	rɲ	rj	ɻc	ɻɟ		
lam+lab					jp	jb	jm	jw
lam+dor					jk	jg	jŋ	

Stops: "Stop oppositions of the fortis/lenis type are manifested phonetically by duration, tenseness, and often by voicing. Intervocalically after short vowel, duration is an important cue since the fortis stops are noticeably longer than the lenis ones. However, intervocalically after a long vowel, the fortis stops are not noticeably longer than the lenis ones, and the principal difference to my ears is voicing and general tenseness. Lenis stops in this position, while usually not reduced to fricatives, are rather weakly articulated.... Syllable-initially following a sonorant, voicing and tenseness rather than duration are again the principal cues for the opposition" (p.8). The two series of stops are in contrast only between a vowel or oral sonorant and a vowel.

Note: There is one word with an initial apico-alveolar: [lili], *this way*. The same form exists as exceptional in Gaalpu. Wood 1978:75 points out that this form is derived from the allative case marking suffix in the Dhuwala dialects, a fact which may account for its exceptional status.

Note: The glottal stop is restricted to occurring at the end of a syllable; as a result, it may be considered a contrastive prosodic feature of the syllable and not as a segmental phoneme. This is argued for Gaalpu by Wood 1978, following earlier work by Schebeck 1974 and McKay 1975.

==

Tharrgari. (Northeast region; Pama-Nyungan, Nyungic) Klokeid 1969.

Consonant phonemes:

p	t̪	t=[r]	ʈ	c	k
b	d̪	d	ɖ	ʎ	g
m	n̪	n	ɳ	ɲ	ŋ
		l	ɭ		
w	ð		ɻ	j	

Homorganic sequences: (none)

Word-initial consonants:

p	t̪	*	*	c	k
*	*	*	*	*	*
m	n̪	*	*	ɲ	ŋ
		*	*		
w			*	j	

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters (possibly incomplete):

	O-O	O-O	N-N	L-O	r-O	r-O
ap+lab	dp ɖb		nm ɳm			rb
ap+dor	dg			lg ɭg	rk	rg
ap+pal	dɟ ɖɟ				rc	
lam+lab	ɟb		ɲm			
lam+dor		ck				

Homorganic clusters: Homorganic N-O clusters have descended as voiced stops in the historical phonology of Tharrgari. Heterorganic N-O clusters have descended as stop clusters.

Stops: The voiceless stops are tense and aspirated. The voiceless laminal obstruents are affricates. The apico-alveolar voiceless stop is a tap or stop in regular speech and a trill

or stop in careful speech, in both cases the vibrant articulation being more common. The voiced apical stops are rather tense while the non-apicals are lax; in fact, /ɟ/ is easy to mishear as [j].

==

Tiwi. (North region; Isolate family) Lee 1987.

Consonant phonemes:

p	t	ʈ	TH	k
				γ
m	n	ɳ	NH	ŋ
	l	ɭ		
	"r"			
w		ɻ	j	

Homorganic sequences: mp nt ɳʈ ɲc ŋk (units in the source)

Word-initial consonants:

p	t	*	TH	k
				*
m	n	*	NH	ŋ
	l	*		
	*			
w		ɻ	j	

Word-final consonants: (none)

Laminals: There is variation between alveopalatal and dental articulation, with alveopalatals before [i] and dentals elsewhere.

Fricative: "The velar fricative is only lightly articulated although it is voiced. It is often hard to distinguish from [w]" (p.25). In the modern language, the velar fricative is often lost in the environment [a_a], and becomes a glide when adjacent to a high vowel ([j] when adjacent to [i], and [w] when adjacent to [u]).

Frequencies: The apico-postalveolar glide is attested initially in only 10-20 words, the laminal lateral in 12-15, /l/ is three or four.

==

Umbugarla. (North region; non-Pama-Nyungan) Davies 1989.

This Umbugarla source is not based on original field work but investigation of transcriptions and recordings made by earlier researchers.

Consonant phonemes:

p	t	ʈ	c	k
m	n	ɳ	ɲ	ŋ
	l	ɭ	(ʎ)	
	"r"			
w		ɻ	j	

Homorganic sequences: mp nt ɳʈ ɲc ŋk

Word-initial consonants:

p	t	*	c	k
m	n	*	ɲ	ŋ
	l	*	*	
	*			
w		ɻ	j	

Word-final consonants:	p	t	*	c	k
	m	n	(ɳ)	ɲ	ŋ
		l	*	*	
		"r"			
	*		ɻ	j	

Attested heterorganic morpheme-medial clusters:

	N-O	N-N	O-O	O-N	L-O	L-N	L-G	r-O	r-N	r-G
ap+lab	np		tp	tm	lp ɭp		lw		rm	rw
ap+dor	nk				lk ɭk	lŋ		rg		
ap+lam	nc									
lam+lab	ɲp		cp							
lam+dor	ɲk	ɲŋ	ck							
dor+lab	ŋp									
lab+lam	mc									

	G-C	G-N	G-G
ap+lab	ɻp	ɻm	ɻw
ap+dor	ɻk	ɻŋ	

Apicals: The contrast between the two apical series is extremely marginal and may not in fact be phonemic. The contrast is neutralised in intervocal contexts following /a/ and /u/, in which cases there is variation between alveolar and postalveolar articulations, with preference for the latter. There are forms showing the contrast following /i/. Apical laterals appear to contrast both articulations in C_1 in heterorganic clusters, but apical stops and nasals are so marginal in this position it is hard to determine whether the contrast is active for these segments or not.

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Ungarinyin. (Kimberley region; Wororan) Rumsey 1982, Rumsey 1978.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	

Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk
				ʎc	
		rɻ	ʈɻ		
		tn tl			

Word-initial consonants:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	*	
		*			
	w		ɻ	j	

Word-final consonants:	*	t	ʈ	c	k
	*	n	ɳ	ɲ	ŋ
		l	ɭ	*	
		"r"			
	w		*	j	

Attested heterorganic morpheme-medial di-clusters:

	N-O	N-N	O-O	O-N	L-O	L-N	L-G
ap+lab	np ɳp	nm ɳm	tp ʈp	tm ʈm	lp ɭp	lm ɭm	lw ɭw
ap+dor	nk ɳk	nŋ ɳŋ	tk ʈk	tŋ ʈŋ	lk ɭk	lŋ ɭŋ	
ap+lam			ʈc		ɭc		

	r-O	r-N	r-G	G-O
ap+lab		rm	rw	
ap+dor	rk	rŋ		
lam+lab				jp

Stops: Stops are voiceless and unaspirated except when following a nasal in a medial consonant cluster, but there is some variation and the laminal stop is the most consistently voiceless of all the stops. The labial stop and nasal are rounded before [u].

Retroflexes: Only the tip, not the underside of the blade, makes contact behind the alveolar ridge; the tip is "pointing straight up" rather than "bent back."

Laminals: The laminals are labeled lamino-prepalatal. "The tongue is literally quite widely spread, with the tip touching the back of the lower teeth. The blade contacts the alveolar ridge and a relatively small portion of the adjacent palatal region. Sometimes the blade also contacts the back of the upper teeth" (p.3). The lamino-prepalatal stop has a brief period of audible turbulence at the release. Of the dorsals, when preceding a front vowel the articulation approximates that of the laminals.

Liquids: Apical laterals are clear or dark depending on the tongue body position of the adjacent vowel(s); the laminal lateral is uniformly clear. The vibrant always involves contact between the two articulators but varies between alveolar and postalveolar places of articulation. Word-medially it alternates between trill and tap realisations; finally it is a devoiced trill which sometimes trails off into a fricative.

Glides: [w] is only rounded preceding round vowels; there is always a noticeable degree of velarisation.

Consonant phonotactics: In addition to the heterosyllabic clusters listed above, certain stop+glide clusters are attested: [pɻ], [ʈɻ], [kɻ].

Note: No data is actually given demonstrating the contrast between the two apical series in word-initial position.

==

Uradhi. (West Cape region; Pama-Nyungan, Pama-Maric) Crowley 1983.

Consonant phonemes:	p	t̪	t		c	k
	β	ð̪				ɣ
	m	n̪	n		ɲ	ŋ
			l			
			"r"			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt		ɲc	ŋk
	pw					kw
	mw					ŋw

Word-initial consonants:	p	(t̪)	(t)		(c)	(k)
	*	(ð)				(γ)
	m	(n̪)	(n)		*	(ŋ)
			l			
			("r")			
	w			ɻ	j	

Word-final consonants: (only [n], [ɲ], [l], ([j]) and, in Atampaya dialect only, [n̪])

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-O	L-O	L-O	r-O	r-O	G-O	G-N
ap+lab	np	nm	tp		lβ	rp	rβ		
ap+dor	nk	nŋ		lk	lγ	rk	rγ		
lam+lab								jp	jm
lam+dor								jk	

Obstruents: For the stops, voiceless allophones predominate word-initially. In the Angkamuthi and Yadhaykenu dialects, voiceless allophones predominate in all environments, but in Atampaya stops are uniformly voiced following a nasal. Preceding [j], the dorsal stop and nasal are fronted to an articulation approaching [c] and [ɲ]; lamino-alveopalatal and dorsal segments do not contrast in this context. In Angkamuthi the alveolar stop has a slightly trilled release, together with postalveolar articulation when preceding [u]. The fricatives are always fully voiced.

Liquids: In Yadhaykenu the lateral is realised as a apico-postalveolar flap [ɽ] when following a long back vowel; when following a short back vowel [l] and [ɽ] are in free variation. For the vibrant phoneme, in Atampaya it is predominantly [ɾ] and in Angkamuthi and Yadhaykenu it is [r].

Consonant phonotactics: In addition to the consonant clusters listed above: sequences of any consonant + [j]; and peripheral stop or nasal + [w]. Certain additional consonant clusters are attested in only one form each: [mt], [mt̪], [mk], [ɲm], [ŋm], [pm], [km].

==

Walmatjarri. (Desert region; Pama-Nyungan, Nyungic) Hudson & Richards 1969, Hudson 1978.

Consonant phonemes:	p		t	ʈ=[ɽ]	c	k
	m		n	ɳ	ɲ	ŋ
			l	ɭ	ʎ	
			"r"			
	w			ɻ	j	

Homorganic sequences:	mp		nt	ɳʈ	ɲc	ŋk
					ʎc	

Word-initial consonants:	p	*	ʈ	c	k
	m	*	ɳ	ɲ	ŋ
		*	ɭ	*	
		*			
	w		ɻ	j	

Word-final consonants:	p	*	ʈ	c	k
	*	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	*		*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-O	L-O	L-N	r-O	r-N	G-O
ap+lab	np ɳp	ɳm	ʈp	lp ɭp	lm	rp	rm	ɻp
ap+dor	nk ɳk	nŋ ɳŋ	tk	lk ɭk	lŋ	rk	rŋ	ɻk
ap+lam	nc			lc		rc		
lam+lab	ɲp	ɲm		ʎp				
lam+dor	ɲk			ʎk				

Stops: Stops are generally voiceless unaspirated at word edges and in a cluster of two stops and voiced following a nasal. Non-coronals alternate between voiced plosive and voiced spirant allophones intervocalically and following an oral sonorant. In these latter cases the coronal stops are fully voiced plosives.

Apicals: The double-apical contrast is neutralised following [i] or any consonant other than a member of the apico-postalveolar series or /r/ across morpheme boundaries within compound stems or across word boundaries (i.e., morpheme-initial apico-postalveolars occur only following the segments [a, u, r, ʈ, ɳ, ɭ]). (A word-initial apical following a word-final [i] is phonetically alveolar, and following [a] or [u] is phonetically postalveolar; apico-postalveolars are attested following [i] morpheme-internally). The apico-postalveolar stop is a retroflex tap intervocalically.

Vibrant: A flap intervocalically, a voiced trill pre-consonantally and word-finally, and a voiced trill utterance-finally.

==

Wambaya. (Desert region; Tjingili-Wambayan) Nordlinger 1993.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	

Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk

Word-initial consonants:	p	*	ʈ	c	k
	m	*	ɳ	ɲ	ŋ
		*	ɭ	*	
		*			
	w		*	j	

Word-final consonants: (none)

Root-final consonants:	*	*	ʈ	c	k
	*	n	*	ɲ	ŋ
		*	ɭ	*	
		"r"			
	*		*	*	

Attested heterorganic morpheme-medial clusters:

	N-O	N-N	O-O	L-O	L-G	r-O	r-N	r-G
ap+lab	np (ɳp)	nm ɳm	(tp) ʈp	(lp)	lw ɭw	rp	rm	rw
ap+dor	nk ɳk	nŋ (ɳŋ)	(tk) ʈk	(lk ɭk)		rk	(rŋ)	
ap+lam	(ɳc)		(ʈc)					
lam+lab	ɲp	ɲm	cp					
lam+dor	(ɲk)							
dor+lab	ŋp	ŋm	kp					

Stops: Voiced allophones occur word-medially. There is variation between voiced and voiceless unaspirated realisations word-initially, but the voiced realisation is more frequent in this position, especially in fast speech.

Retroflexes: Retroflexion is most easily perceptible following stressed low vowels and is not as clear following high and/or unstressed vowels. The source reports that language informants tended not to correct forms pronounced with an alveolar instead of a postalveolar apical unless there was a minimal pair.

Vibrant: The vibrant is trill pre-consonantally and a tap elsewhere.

Consonant phonotactics: There is one tri-consonantal cluster: [rkp].

==

Wardaman. (Arnhem region; Gunwinyguan) Merlan 1994.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	
Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk
	pm				
					ŋw

Word-initial consonants:	p	*	ʈ	c	k
	m	*	ɳ	ɲ	ŋ
		*	ɭ	*	
		*			
	w		(ɻ)	j	

Word-final consonants: (all)

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-O	L-O	L-N	L-G	r-G	r-N	r-G
ap+lab	np ɳp	ɳm	tp ʈp	lp ɭp	lm ɭm	lw ɭw	rp	rm	rw
ap+dor	nk	nŋ ɳŋ	tk ʈk	lk	lŋ ɭŋ		rk	rŋ	
ap+lam	nc		tc	lc ɭc		lj ɭj	rc		rj
lam+lab	ɲp		cp			ʎw			
lam+dor	ɲk	ɲŋ	ck	ʎk					
dor+lab	ŋp	ŋm	kp						
lab+dor	mk								
lab+lam	mc	mɲ							
lam+ap	ɲt								

Apicals: The two apical series are often hard to distinguish from each other. There is also a tendence towards harmonic phonetic "spread" of retroflexion to other apical consonants in the word following a retroflex one.

Note on initial apicals: "Where no vowel immediately precedes, in ordinary speech the word-initial realisation of initial apicals tends to be alveolar rather than retroflex. However, when a vowel (of another word, or of a vowel-final inflectional prefix) immediately precedes, the stem-initial norm tends to be quite strongly retroflex" (p.16).

==

Warlmanpa. (Desert region; Pama-Nyungan, Nyungic) Nash 1979.

Consonant phonemes:	p	t	ʈ	c	k
	b	d	ɖ	ɟ	g
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	
Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk
Word-initial consonants:	p	*	ʈ	c	k
	*	*	*	*	*
	m	*	ɳ	ɲ	ŋ
		*	ɭ	*	
		*			
	w		ɻ	j	

Word-final consonants: (none)

Words are uniformly vowel-final but many roots are consonant-final. Reduplicated nominals show the addition of a paragogic syllable [-pa]: winiɲ+winiɲ=pa, *plant sp.*

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G
ap+lab	np ɳp	tp ʈp	nm ɳm	lp ɭp	lm ɭm	lw ɭw	rp	rm	rw
ap+dor	nk ɳk		nŋ ɳŋ	lk ɭk	lŋ ɭŋ		rk	rŋ	
ap+lam	nc	tc		ɭc			rc		
lam+lab	ɲp	cp	ɲm	ʎp		ʎw			
lam+dor	ɲk		ɲŋ	ʎk					

Initial apicals: The phonologically retroflex quality of the initial apicals is clear in reduplicated forms: taʎpi+[ʈ]aʎpi, *grasshopper sp.*

==

Warlpiri. (Desert region; Pama-Nyungan, Nyungic) Jagst 1975, Nash 1980.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		r	ɽ		
	w		ɻ	j	
Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk (units in the source):
		lt	ɭʈ	ʎc	
Word-initial consonants:	p	*	ʈ	c	k
	m	*	ɳ	ɲ	ŋ
		*	ɭ	*	
		*	ɽ		
	w		ɻ	j	

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	L-G	r-O	r-N	G-N
ap+lab	np ɳp	nm	lp ɭp	lw ɭw	rp	rm	
ap+dor	nk ɳk	nŋ	lk ɭk		rk	rŋ	ɻŋ
ap+lam					rc		
lam+lab	ɲp		ʎp				
lam+dor	ɲk		ʎk				

Stops: The stops are generally voiceless, but some tend to be realised as voiced in certain contexts, particularly in C_2 and/or in C_{init}.

Retroflexes: Retroflexion of the apico-postalveolar segments is most pronounced following [a], not as strong following [u], and "almost imperceptible" following [i].

Laminal lateral: The neutralisation of the laminal lateral in initial position is shown in compounds: [luku+ʎuku], *emu bush* (Nash 1980:72).

Vibrants: For the alveolar vibrant, both flap and trill allophones are attested in C_{inter},

but the tap realisation is more common in C_1 in non-emphatic speech (trilled realisation in this position is characteristic of emotive speech styles). The retroflex vibrant is a flap. The contrast between these two segments is neutralised in C_{init}, where there is free variation.

==

Warluwarra. (Desert region; Pama-Nyungan, Wakaya-Warluwaric) Breen 1971.

Consonant phonemes:	p	t̪	t	ʈ	c	k	
	m	n̪	n	ɳ	ɲ	ŋ	
		l̪	l	ɭ	ʎ		
			"r"				
	w			ɻ	j	ɰ	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk	(clusters in the source)
	mb	n̪d̪	nd	ɳɖ	ɲɟ	ŋg	(units by the source)
		l̪t̪			ʎc		(clusters in the source)
Word-initial consonants:	p	t̪	*	ʈ	ȶ	k	
	m	n̪	*	ɳ	ɲ	ŋ	
		*	*	*	*		
			*				
	w			ɻ	j		

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	N-N	N-G	L-O	L-G	r-O	r-G	ɻ-G
ap+lab	np ɳp	tp	nm ɳm	ɳw	lp ɭp	lw ɭw		rw	
ap+dor	nk ɳk		nŋ ɳŋ		lk ɭk	lɰ ɭɰ	rk	rɰ	ɻɰ
ap+pal							rc		
lab+lam	mt̪								

Long laterals: There are surface forms with long apical laterals, which may be a phonemic geminate contrast; some forms show free variation in the length of apical laterals, while other forms show free variation between [l:] and [lw/lɰ]. Diachronic evidence indicates a historical process *lp, *lk → lw, lɰ → l, with [l:] intermediate between the last two stages. (For comparison, see the entry for Bularnu.)

Phonetic fricatives: There are surface palatal and retroflex fricatives which the source analyses as geminates glides: /jj/ surfacing as [ç, ʝ] and /ɻɻ/ surfacing as [ʂ, ʐ].

Note: The lamino-interdental nasal has a retracted (dental) allophone word-initially, and the apico-postalveolar nasal is not very retroflex in this position.

Stops: Stops are always unaspirated; they are lenis and voiceless or lightly voiced initially or medially following an unstressed vowel; fortis voiceless medially following a stressed vowel.

Laminals: Both dental and interdental allophones are common for the members of the lamino-dental series. Both laminal stops have fricated release. In the case of the lamino-alveopalatals, "the occlusion is made by pressing the blade of the tongue against the gum ridge, the tip of the tongue being behind and in contact with the lower teeth" (p.40).

Pre-stopping: The apical nasals occasionally have pre-stopped allophones, the oral occlusion being voiceless.

Consonant phonotactics: In a count of syllables in five texts containing 1687 syllables, well over 90% were CV. 76 of the 80 CVC syllables occurred as the initial syllable of a word, and accounted for 14.4% of syllables in this position. The remaining four were in English borrowings or in a reduplicated form, /yalku+[w]alku/. On the homorganic nasal plus voiced oral stop series and its relationship with long vowels, see Dixon 1980:215.

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Warndarrang. (Arnhem region; Maran) Heath 1980.

Consonant phonemes:	p	t̪	t	ʈ	c	k
					[c:]	
	m		n	ɳ	ɲ	ŋ
			l	ɭ		
			"r"			
	w			ɻ	j	

The fortis lamino-alveopalatal stop [c:] is analysed as the cluster /tc/ underlyingly.

Homorganic sequences:	mp		nt	ɳʈ	ɲc	ŋk
			lt	ɭʈ		

Word-initial consonants:	p	*	*	ʈ	c	k
	m		*	ɳ	ɲ	ŋ
			*	ɭ		
			r			
	w			ɻ	j	

Word-final consonants:	p	*	t	ʈ	c	k
	*		n	ɳ	ɲ	ŋ
			l	ɭ		
			"r"			
	w			ɻ	j	

Attested morpheme-internal heterorganic clusters (possibly incomplete):

	N-O	O-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G	G-O	G-N	G
ap+lab	np ɳp	tp ʈp	nm ɳm		lp ɭp	lm	lw	rp		rw	ɻp	ɻm
ap+dor	nk ɳk		nŋ	lk ɭk	lŋ ɭŋ		rk	rŋ		ɻk		
ap+pal	ɳc	tc ʈc		lc	ɭɲ	lj ɭj	rc		rj	ɻc		ɻj
lam+lab	ɲp	cp	ɲm								jm	
lam+dor	ɲk	ck	ɲŋ									
dor+lab		kp										

==

Warumungu. (Desert region; Pama-Nyungan) Simpson & Heath 1982, Evans 1982.

Consonant phonemes:	p	t	ʈ	c	k
	b	d	ɖ	ɟ	g
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	

Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk
	mb	nd	ɳɖ	ɲɟ	ŋg
				ʎc	
				ʎɟ	

Word-initial consonants:	p	*	ʈ	c	k
	*	*	*	*	*
	m	*	ɳ	ɲ	ŋ
		l	*	ʎ	
		*			
	w		ɻ	j	

Word-final consonants:	*	*	*	*	*
	*	*	*	*	*
	*	n	ɳ	ɲ	*
		l	ɭ	ʎ	
		"r"			
	*		*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-O	N-N	O-O	L-O	L-O	L-N	L-G
ap+lab	np ɳp	nb ɳb	nm ɳm	tp (ʈp)	lp ɭp	lb ɭb	(lm ɭm)	(ɭw)
ap+dor	nk ɳk	ng ɳg	nŋ ɳŋ		lk ɭk	lg ɭg		
lam+lab	ɲp	ɲb	ɲm	cp	ʎp	ʎb		
lam+dor	ɲk	ɲg			ʎk	ʎg		

	r-O	r-O	r-N
ap+lab	ɻp	rb	rm
ap+dor	rk	rg	rŋ
ap+lam	rc	rɟ	

Stops: The first series of stops is voiceless, aspirated, and long, depending on their position in the word. The second series is unaspirated and varies between voiced and voiceless. Stops do not contrast word-initially or adjacent to another stop. Initially, neutralised stops are short and the degree of voicing and aspiration depends on the place of articulation and the quality of the following vowel. Word-final and pre-consonantal stops, which are rare, are voiceless and short. The contrast between the two series of oral stops is attested only following the initial (stressed) syllable.

Apicals: Alveolars and postalveolars are distinguished by the r-colouring a postalveolar imparts to a preceding vowel, especially [a] or [i]. Allophonic prestopping occurs with alveolar nasals and laterals but not with the postalveolars. The laminal segments are occasionally heard as lamino-dental.

Consonant phonotactics: Lateral+nasal clusters appear to be avoided in Warumungu: they are phenomenally rare, and the Warumungu people refer to the Warlmanpa group as [waɳmanpa], with the lateral assimilated to the following nasal segment. There is evidence of rC and rN clusters being avoided by younger speakers: /lirpi/ → [lipi], *fingernail*; /kurkur/ → [kuʈkur], *owl*; /carban/ → [caban], *enter-PRES*; /kurma/ → [kunma], *bark*.

Phonotactic anomalies: Bird-names are often phonotactically anomalous; this probably reflects the use of onomatopoeia in forming bird-names, and the fact that many bird-names are shared with neighbouring languages with different syllable-structure constraints. Two words, both of which are onomatopoeic, have a final stop.

==

Watjarri. (Northeast region; Pama-Nyungan, Nyungic) Douglas 1981.

Consonant phonemes:	p	t̪	t	ʈ		k
	m	n̪	n	ɳ		ŋ
		l̪	l	ɭ		
			"r"			
	w			ɻ	j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ		ŋk
		l̪t̪				
Word-initial consonants:	p	t̪	t	*		k
	m	n̪	n	*		ŋ
		*	l	*		
			*			
	w			*	j	
Word-final consonants:	*	*	*	*		*
	*	n̪	n	ɳ		*
		l̪	l	ɭ		
			"r"			
	*			*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	L-N	r-O	r-N
ap+lab	np ɳp	nm ɳm	lp ɭp	lm	rp	
ap+dor	nk ɳk		lk ɭk		rk	rŋ
ap+lam	nc		lc		rc	
lam+lab	ɲp	ɲm	ʎp	ʎm		
lam+dor	ɲk		ʎk			

Stops: Stops are voiceless and unaspirated in all positions except following a nasal (homorganic or heterorganic), in which case they are lightly voiced. The members of the laminal series have interdental articulation preceding [a] and [u]. Some dialects have sporadic alveopalatal articulation, either as a plosive or as a light fricative, preceding the high front vowel. In consonant clusters laminals are always alveopalatal, except in the homorganic clusters.

"Rhotics": The vibrant is normally a tap, but is trilled in emphasised speech. Some speakers lightly voice medial [t] in which case it is hard to distinguish from the tap. There is some sporadic fluctuation between [ɻ] and [j]. There is no discussion of the exact place of articulation of the word-initial apicals.

==

Wembawemba. (Riverine region; Pama-Nyungan, Kulinic) Hercus 1986.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	m		n	ɳ	ɲ	ŋ
			l			
			"r"	ɻ		
	w				j	
Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
			rt			
			rn			
						ŋw

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	L-N	r-O	r-N	r-G	G-C	G-N
ap+lab	np	nm ɳm	lp	lm	rp	rm	rw	ɻp	ɻm
ap+dor			lk		rk	rŋ		ɻk	ɻŋ

Laminals: For the dentals, "the tongue is placed so that the tip touches the lower part of the inner surface of the upper teeth. Intervocalic and final stops are voiceless unaspirated, and have tense articulation. The dental stops is often spirantised. The "alveopalatal" series is slightly palatalised alveo-dental. "The tip of the tongue touches the back of the lower teeth, while the blade of the tongue forms an occlusion with the upper teeth-ridge and the palatal area immediately behind and above the teeth-ridge. As the occlusion is released a prepalatal form of the fricative becomes briefly audible". Wembawemba /t̪/ corresponds to /c/ intervocalically and finally in Wergaia cognates. There are some likely instances of long-distance laminal harmony in words with an initial lamino-palatal segment conditioning palatal articulation of a word-medial laminal segment (p.4). Before /i/ there is free variation between dental and alveopalatal articulation.

Stops: Initial stops are less tensely articulated, and when followed by a homorganic vowel (/c/ when followed by [i], [e]; /p/ and /k/ followed by [u]) tend to be partially voiced. Word- or phrase-final plosives are unreleased.

Vibrants: "r" is a very light alveolar trill or tap and /ɻ/ is an apico-postalveolar trill.

Consonant phonotactics: There are certain three-consonant clusters in Wembawemba, all composed of a vibrant or a glide followed by a homorganic labial or dorsal N-O sequence: [rmp], [rŋk], [ɻmp], [ɻŋk].

==

Yandruwanhdha. (Eyre region; Pama-Nyungan, Karnic) Breen 1975.

Consonant phonemes:	p	t̪	t	ʈ	c	k
	b	d̪	d=[ɾ]	ɖ	ɟ	g
	m	n̪	n	ɳ	ɲ	ŋ
		l̪	l	ɭ	ʎ	
			ᵈl	ᵈɭ		
			r			
			ᵈr	ᵈɽ		
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
	mb	n̪d̪	nd	ɳɖ	ɲɟ	ŋg
			n^{d}r	ɳ^{d}ɽ		
		l̪t̪	lt	(ɭʈ)	ʎc	
			l^{d}r	(ɭ^{d}ɽ)		

Word-initial consonants:	p	t̪	*	*	c	k
	*	*	*	ɖ	*	*
	m	n̪	*	*	ɲ	ŋ
		*	*	*	*	
			*	*		
			*			
			*	^{d}ɽ		
	w			*	j	

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	N-O	N-N	L-O	L-O	r-O	r-O	r-N
ap+lab	np ɳp	nb (ɳb)	nm ɳm	lp ɭp	lb (ɭb)	rp		rm
ap+dor	nk ɳk	ng ɳg	nŋ ɳŋ	lk ɭk	lg (ɭg)	rk	rg	
ap+pal						rc		

Stops: Initial /p/ is occasionally produced with less tension and voiced. The voiceless laminal stops have affricated allophones, and the voiced lamino-dental stop has a fricative allophone. The dental stops are often retracted to apico-dental or even apico-alveolar articulation, especially initially where apical stops do not occur.

Note: The pre-stopped trills are argued to be unit phonemes based on the basis of the following evidence: (1) [^{d}ɽ] occurs initially, (2) they can form clusters with preceding homorganic nasals or laterals, and (3) they correspond to voiced stops in cognates in related languages.

Apical stops: [t] and [d] are almost in complementary distribution, the former occurring only rarely intervocalically while the latter occurs in this position almost exclusively.

==

Yankunytjatjara. (Desert region; Pama-Nyungan, Nyungic) Goddard 1983.

Consonant phonemes:	p	t	ʈ	c	k
	m	n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
	w		ɻ	j	

Homorganic sequences:	mp	nt	ɳʈ	ɲc	ŋk
		lt	ɭʈ	ʎc	

Word-initial consonants:	p	*	ʈ	c	k
	m	*	ɳ	ɲ	ŋ
		*	ɭ	*	
		*			
	w		ɻ	j	

Word-final consonants:	*	*	*	c	*
	*	*	ɳ	ɲ	*
		*	ɭ	ʎ	
		*			
	*		*	j	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	r-O	r-N
ap+lab	np ɳp	nm ɳm	lp ɭp	rp	rm
ap+dor	nk ɳk	nŋ ɳŋ	lk ɭk	rk	rŋ
ap+lam	nc ɳc		lc ɭc	rc	rɲ
lam+lab		ɲm	ʎp		
lam+dor	ɲk		ʎk		

Stops: Stops are generally voiceless unaspirated, but are voiced following a nasal or lateral and may also be voiced intervocalically.

Laminals: The laminals are generally dental, but preceding [i] the tongue blade is slightly retracted. In consonant clusters laminals are (lamino-)alveolar following an apico-alveolar segment and (lamino-)postalveolar following an apico-postalveolar segment. In the cluster [rc], the tap may be optionally deleted, in which case the alveolar release of the laminal is the acoustic cue of the presence of the underlying apico-alveolar tap.

Vibrant: The vibrant is generally a tap, but may be realised as a trill in emphatic speech or as a marker of personal style.

Consonant phonotactics: The ergative marker /-Tu/ undergoes place assimiation to the stem-final consonant; a stem-final vibrant yields an apico-alveolar articulation of the initial segment of the suffix.

==

Yanyuwa. (Gulf region; Pama-Nyungan, Warluwaric) Kirton & Charlie 1979.

Consonant phonemes:	p	t̪	t	ʈ	c	k^{j}	k
	m	n̪	n	ɳ	ɲ	ŋ^{j}	ŋ
		l̪	l	ɭ	ʎ		
			"r"				
	w			ɻ	j		

Homorganic sequences:	mp	n̪t̪	nt	ɳʈ	ɲc	ŋ^{j}k^{j}	ŋk (units in the source)

Word-initial consonants: (not reported in the source)

Word-final consonants: (none)

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G
ap+lab	np ɳp		ɳm	lp ɭp	lm ɭm	lw ɭw	rp	rm	rw
ap+dor	nk ɳk		nŋ ɳŋ	lk ɭk	lŋ ɭŋ		rk	rŋ	
ap+lam	ɳc	ʈc	ɳɲ				rc	rɲ	rj
lam+lab	ɲp	cp	ɲm						
dor+lab			(ŋm)						

Note: The so-called "dorso-palatovelar" series fluctuates with alveopalatal plus dorsal clusters in the speech of some speakers (especially in the case of the oral stop segment, /kʲ/, which is often pronounced as a cluster [ck]. It is likely that this series has recently derived from such clusters.

Consonant phonotactics: There is one cluster of three consonants, [rŋk].

==

Yawuru. (Kimberley region; Nyulnyulan) Hosokawa 1991.

Consonant phonemes:

p		t	ʈ	c	k=[q/k/γ]
b		d	ɖ	ɟ	g=[g]
m		n	ɳ	ɲ	ŋ
		l	ɭ	ʎ	
		"r"			
w			ɻ	j	

Homorganic sequences:

mb		nd	ɳɖ	ɲɟ	ŋg
		ld	ɭɖ	ʎɟ	

Word-initial consonants:

p		*	ʈ	c	k
b		d	ɖ	ɟ	g
m		n	*	ɲ	ŋ
		l	ɭ	*	
		("r")			
w			ɻ	j	

Word-final consonants: (all but [ŋ], and [m] is marginal)

Attested morpheme-internal heterorganic clusters (possibly incomplete):

	N-O	N-N	L-O	L-G	r-O	r-G
ap+lab	np ɳp				rp	
ap+dor	nk ɳk	nŋ ɳŋ	lk ɭk		rk	
ap+lam	nc ɳc		lc ɭc	lj	rc	rj
lam+lab ·	ɲp					
lam+dor	ɲk		ʎk			

Laminals: The laminal series is reported as lamino-alveolopalatal rather than palatal or alveopalatal.

Apicals: Apico-alveolars tend to be more retracted than is the case in other Aboriginal languages, and as a result are often difficult to distinguish from apico-postalveolars, but there is a contrast.

Initial apicals: The allophonic retroflexion of the initial neutral apical nasal is most pronounced when there is a following apico-postalveolar in the word; otherwise there is free variation (compare with Gooniyandi). Apical stops and laterals contrast in C_{init}, and there is no allophonic retroflexion of these segments when initial in a word containing another retroflex segment.

==

Yaygir. (Southeast region; Pama-Nyungan, Kumbainggaric) Crowley 1979.

Consonant phonemes:

p	t		c	k
m	n		ɲ	ŋ
	l			
	r			
	r̥			
w		ɻ	j	

Homorganic sequences:

mp	nt	ɲc	ŋk
	rt		

Attested morpheme-internal heterorganic clusters of two segments:

	N-O	N-N	L-O	L-N	r-O	r-G	G-G
ap+lab		nm	lp	lm		rw	
ap+dor	nk		lk		rk		
ap+lam						rc	
lam+lab							jw

Stops: Stops are voiceless following a short vowel, but otherwise they are voiced (word-initial position, following a long vowel or a vowel+glide sequence, preceding a long vowel, following a nasal).

Pre-stopping: Nasals are occasionally prestopped, with no suggestion in the source that this is contextually conditioned. There is lengthening of all consonants following a stressed short vowel.

Lateral: The lateral segment is noticeably retroflexed when adjacent to [a] or [u].

Clusters: In addition to the clusters listed above, two clusters of a dorsal segment followed by the labial glide are attested: [kw] and [ŋw]. Clusters of three consonants are also attested: [lmp], [rmp], [wŋk], [jŋk] and [rŋk].

==

Yidiny. (Rainforest region; Pama-Nyungan, Pama-Maric) Dixon 1977.

Consonant phonemes:

p	t		c	k
m	n		ɲ	ŋ
	l			
	"r"			
w		ɻ	j	

Homorganic sequences:

mp	nt		ɲc	ŋk
	(ln)			
		(ɻn)		

Word-initial consonants:

	p	t		c	k
	m	n		ɲ	ŋ
		*			
		*			
	w		*	j	

Word-final consonants:

	*	*		*	*
	m	n		ɲ	*
		l			
		r			
	*		ɻ	j	

Attested morpheme-internal heterorganic clusters of two segments:

	N-O	N-N	L-O	L-N	L-G	r-O	r-N	r-G	G-O	G-N	G-G
ap+lab	np	(nm)	lp	lm	lw	rp	rm	rw	ɻp	ɻm	(ɻw)
ap+dor	nk	nŋ	lk	lŋ		rk	rŋ		ɻk	ɻŋ	
ap+lam	nc		lc	(lɲ)		rc	(rɲ)		ɻc		
lam+lab	(ɲp)								jp	jm	jw
lam+dor										jk	jŋ

Stops: Stops are almost always voiced; only in word-initial position are partially voiceless allophones attested, especially at the start of an intonational phrase. "It is, in fact, normal for the glottis to be vibrating throughout the articulation of a Yidiny word; thus, in one sense, 'voiced' is (for this language) the unmarked value of the phonetic opposition 'voiced/voiceless'" (p.32). The apical stop is often realised as a tap in intervocalic position.

Oral sonorants: The lateral segment tends to be velarised, especially following /u/, where it may be difficult to distinguish from /ɻ/. The retroflex glide is optionally realised as a trill, especially following a stressed syllable, and more in some dialects than others. In these cases, the contrast between /r/ and /ɻ/ is primarily one of place, rather than manner, of articulation.

Clusters: Clusters of three consonants are also attested, particularly sequences of a liquid or glide followed by a homorganic labial or dorsal N-O sequence; and [lnp], [lnc], [lnk].

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Yindjibarndi. (Northeast region; Pama-Nyungan, Nyungic) Wordick 1982.

Consonant phonemes:

p	t̪	t	ʈ=[ɽ]	c	k
m	n̪	n	ɳ	ɲ	ŋ
		l	ɭ		
		"r"			
w	ɹ̪		ɻ	j	

Homorganic sequences: mp n̪t̪ nt ɳʈ ɲc ŋk

Word-initial consonants:

p	t̪	*	*	c	k
m	n̪	*	*	ɲ	ŋ
	*	*	*	*	
		*			
w	*		*	j	

Word-final consonants:

*	*	t	ʈ	c	*
*	*	n	ɳ	ɲ	*
	*	*	*	*	
		"r"			
*			*	*	

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	O-O	L-G	r-O	r-N	r-G	G-O
ap+lab	np ɳp	ɳm	tp		(rp)	(rm)	rw	ɻp
ap+dor	nk ɳk	nŋ ɳŋ			rk			ɻk
ap+lam	nc		tc	lj			rj	
lam+lab			cp					
lam+dor	ɲk							jk

Stops: All consonants are lenis, and are geminated between vowels (except for [ʈ] and [r]).

Apicals: The apico-postalveolars are usually not very retracted; it is very hard for English speakers to hear the difference between the two apical series. The distinction between the apical stops is clearer in intervocalic position, because they differ in manner: the alveolar is a plosive and the postalveolar is a flap.

Laminal glides: "The unusual [ɹ̪] sound resembles a very fronted [j]. The edges of the tongue often rub the inner sides of the cheeks during its production" (p.12).

Vibrant: Speakers appear to vary freely between trill and tap articulations for the vibrant.

Clusters: The absence of the cluster *[jp] is accounted for historically: for reasons unknown, Proto-Ngayarda *ʎk descends as [jk] in Yindjibarndji but *ʎp descends as [cp].

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Yukulta. (Gulf region; Tangkic) Keen 1983.

Consonant phonemes:

p	t̪	t	ʈ	c	k
m	n̪	n	ɳ	ɲ	ŋ
		l	ɭ		
		"r"			
w			ɻ	j	

Homorganic sequences:

mp	n̪t̪	nt	ɳʈ	ɲc	ŋk
	[l̪t̪]	lt	ɭʈ	[ʎc]	

Word-initial consonants: (all but "r")

Word-final consonants: (none)
Root-final consonants: (all but [m], [ʈ], [ɻ])

Attested morpheme-internal heterorganic clusters:

	N-O	O-O	N-N	L-O		L-N	L-G
ap+lab	np ɳp		ɳm	lp ɭp		lm ɭm	lw
ap+dor	nk ɳk		nŋ ɳŋ	lk ɭk		lŋ ɭŋ	
ap+dent				lt̪ ɭt̪	(lt̪ =[l̪t̪])	ln̪	lj
ap+pal	nc ɳc			lc ɭc	(lc =[ʎc])		
lam+lab	ɲp	cp					

	r-O	r-N	r-G
ap+lab	rp	rm	rw
ap+dor	rk	rŋ	
ap+dent	rt̪		
ap+pal	rc		

Stops: Stops have primarily voiceless, lenis, unaspirated allophones, except that following a homorganic nasal they are fully voiced.

Note: The apico-alveolar lateral assimilates to a following laminal in clusters: /lt̪/ is normally [l̪t̪], and /lc/ is normally [ʎc].

Vibrant: In fast speech [t] and [r] are neutralised to an alveopalatal flap.

Clusters: There are certain three-consonant clusters in Yukulta, all composed of a liquid followed by a homorganic labial or dorsal N-O cluster: [lmp], [rmp], [rŋk]. The cluster [cp] is attested in only two forms and in both cases it appears to be at an old compound boundary.

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Yuwaalaraay. (Riverine region; Pama-Nyungan, Wiradjuric) Williams 1980.

Consonant phonemes:	p	t̪	t		c	k
	m	n̪	n		ɲ	ŋ
			l			
			"r"			
	w			ɻ	j	

Homorganic sequences:	mp	n̪t̪	nt		ɲc	ŋk
			nl			

Word-initial consonants:	p	t̪	*	*	*	k
	m	n̪	*	*	*	ŋ
			*			
			*			
	w			*	j	

Word-final consonants: (only [n], [l], [j], ["r"])

Attested morpheme-internal heterorganic clusters:

	N-O	N-N	L-O	r-O	r-N	G-O	G-N
ap+lab	np	nm	lp	rp	rm		
ap+dor	nk	nŋ	lk	rk	rŋ		
ap+dent			lt̪				
lam+lab						jp	jm
lam+dor						jk	

Stops: Stops are unaspirated and voiced.

Clusters: Two other, rather anomalous clusters are attested: [jr], [jl].

Appendix C: Genetic and Geographic Survey

1. Genetic organisation.

The first half of this appendix is a list of the Australian Aboriginal languages referred to in this thesis genetically organised. Languages are organised by family, with the name of the family in capitals. Languages in the Pama-Nyungan family are organised also by subgroups. Languages in the Nyungic and Pama-Maric subgroups of Pama-Nyungan also have their lower level affiliation listed (in parentheses) after the language name. I also give the geographical region following, in parentheses. This list allows the reader to compare the phonotactic patterns of closely related languages, by referring to Appendix B. The non-Pama-Nyungan groups are listed first, followed by the Pama-Nyungan groups. I have followed Voegelin & Voegelin 1966, with some modifications proposed by Blake 1990 and Breen 1971.

2. Geographical organisation.

The second half of this appendix presents the Australian Aboriginal languages organised by region. I use the seventeen regions of the mainland of Australia used in the Encyclopedia of Aboriginal Australia (Horton 1994). Following the name of each language is its genetic affiliation by family (with lower level groupings mentioned for the Pama-Nyungan languages). I also present a map showing the location of the languages.

Non-Pama-Nyungan families.

DALY	Maranungku (Fitzmaurice region) MalakMalak (Fitzmaurice region)
DJAMINDJUNGAN	Djamindjung (Fitzmaurice region)

DJERAGAN	Kitja (Kimberley region) Miriwung (Kimberley region)
GARAMAN	Murin-patha (Fitzmaurice region)
GUNWINYGUAN	Dalabon (Arnhem region) Gunwinygu (Arnhem region) Jawoyn (Fitzmaurice region) Ngalakan (Arnhem region) Ngandi (Arnhem region) Rembarrnga (Arnhem region) Wardaman (Arnhem region)
IWAIDJAN	Amurdak (Northern region)
KARAWAN	Garawa (Gulf region)
MANGERIAN	Mangarrayi (Fitzmaurice region)
MARAN	Alawa (Desert region) Marra (Gulf region) Warndarrang (Arnhem region)
NYULNYULAN	Nyigina (Kimberley region) Bardi (Kimberley region)
TANGKIC	Kayardild (Gulf region) Lardil (Gulf region) Yukulta (Gulf region)
TJINGILI-WAMBAYAN	Djinggili (Desert region) Ngarndji (Desert region) Wambaya (Desert region)
WORORAN	Gunin (Kimberley region) Ungarinyin (Kimberley region)
Family isolate	Anindilyakwa (Arnhem region)
Family isolate	Gaagudju (Northern region)
Family isolate	Limilngan (Northern region)
Family isolate	Nakkara (Arnhem region)
Family isolate	Nunggubuyu (Arnhem region)
Family isolate	Tiwi (Northern region)
Family isolate	Warray (Fitzmaurice region)

Pama-Nyungan family, organised by sub-groupings.

PAMA-NYUNGAN (Arandic)
- Alywarra (Desert region)
- Arrernte (Desert region)
- Kaytetye (Desert region)

PAMA-NYUNGAN (Bandjalangic)
- Bandjalang (Southeast region)

PAMA-NYUNGAN (Karnic, Breen 1971)
- Diyari (Eyre region)
- Garlali (Riverine region)
- Arabana-Wangkangurru (Eyre region)
- Pitta-Pitta (Eyre region)
- Yandruwanhdha (Eyre region)

PAMA-NYUNGAN (Kulinic)
- Madhimadhi (Riverine region)
- Wembawemba (Riverine region)
- Wergaia (Riverine region)

PAMA-NYUNGAN (Kumbainggaric)
- Gumbaynggir (Southeast region)
- Yaygir (Southeast region)

PAMA-NYUNGAN (Nyungic)
- Badimaya (Kardu) (Northeast region)
- Djaru (Ngumpin) (Desert region)
- Gugada (Wati) (Desert region)
- Gurindji (Ngumpin) (Fitzmaurice region)
- Jiwarli (Mantharta) (Northeast region)
- Mantjiltjarra (Wati) (Desert region)
- Martuthunira (Ngayarda) (Northeast region)
- Mudburra (Ngumpin) (Fitzmaurice region)
- Ngaanyatjarra (Wati) (Desert region)
- Nyangumarta (Ngayarda) (Desert region)
- Nyungar (Nyungar) (Southwest region)
- Palyku (Ngayarda) (Northeast region)
- Panyjima (Ngayarda) (Northeast region)
- Payungu (Kanyara) (Northeast region)
- Pintupi (Wati) (Desert region)
- Pitjantjatjarra (Wati) (Desert region)
- Tharrgari (Mantharta) (Northeast region)
- Walmatjarri (Ngumpin) (Desert region)
- Warlmanpa (Ngayarda) (Desert region)
- Warlpiri (Ngayarda) (Desert region)

- Watjarri (Kardu) (Northeast region)
- Yankuntjatjarra (Wati) (Desert region)
- Yindjibarndi (Ngayarda) (Northeast region)

PAMA-NYUNGAN (Pama-Maric)
- Aghu-Tharrnggala (Southern Pama) (East Cape York Peninsula region)
- Anguthimri (Northern Pama) (West Cape York Peninsula region)
- Bidyara-Gungabula (Mari) (Northeast region)
- Djabugay (Mari) (Rainforest region)
- Dyirbal (Yara) (Rainforest region)
- Gog-Narr (Norman Pama, Black 1980) (Gulf region)
- Gugu-Badhun (Mari) (Northeast region)
- Guugu-Yimidhirr (Eastern Pama) (East Cape York Peninsula region)
- Kukatj (Norman Pama, Black 1980) (Gulf region)
- Kuku-Thaypan (Southern Pama) (East Cape York Peninsula region)
- Kuku-Yalanji (Eastern Pama) (East Cape York Peninsula region)
- Kuuku-Ya'u and Umpila (Middle Pama) (East Cape York Peninsula region)
- Kurrtjar (Norman Pama, Black 1980) (Gulf region)
- Marrgany-Gunya (Mari) (Riverine region)
- Mbabarram (Rainforest region)
- Ngawun (Mayi) (Gulf region)
- Nyawaygi (Yara) (Rainforest region)
- Olkol (Western Pama) (West Cape York Peninsula region)
- Uradhi (Northern Pama) (West Cape York Peninsula region)
- Warrgamay (Yara) (Rainforest region)
- Wik-Mungkan (Middle Pama) (West Cape York Peninsula region)
- Wik-Ngatharra (Middle Pama) (West Cape York Peninsula region)
- Wik-Pakanh (Middle Pama) (West Cape York Peninsula region)
- Yidiny (Yara) (Rainforest region)
- Yirr-Yorront (Western Pama) (West Cape York Peninsula region)

PAMA-NYUNGAN (Parnkalla-Yura-Miru) (Breen 1971)
- Adnyamathanha (Spencer region)
- Nhukunu (Spencer region)

PAMA-NYUNGAN (Wakaya-Warluwaric)
- Bularnu (Desert region)
- Warluwarra (Desert region)
- Yanyuwa (Desert region)

PAMA-NYUNGAN (Wiradjuric)
- Ngiyambaa (Riverine region)
- Yuwaalaraay (Riverine region)

PAMA-NYUNGAN (Yuin-Kuric) Ngarigu (Southeast region)

PAMA-NYUNGAN (Yuulngu/Murngic)

Djambarrpuyngu (Arnhem region)
Djapu (Arnhem region)
Djinang (Arnhem region)
Gaalpu (Arnhem region)
Ritharrngu (Arnhem region)

PAMA-NYUNGAN (unclassified)
Kalkatungu (Eyre region)
Muruwari (Riverine region)
Nganyaywana (Southeast region)
Warumungu (Desert region)
Baagandji (Riverine region)

Part 2. Languages organised by geographic regions.

Arnhem region:
Anindilyakwa (Family isolate)
Burarra (Buraran)
Djambarrpuyngu (Pama-Nyungan, Yuulngu)
Djapu (Pama-Nyungan, Yuulngu)
Djinang (Pama-Nyungan, Yuulngu)
Djinba (Pama-Nyungan, Yuulngu)
Gaalpu (Pama-Nyungan, Yuulngu)
Nakkara (Buraran)
Ngalakan (Gunwinyguan)
Ngandi (Gunwinyguan)
Nunggubuyu (Gunwinyguan)
Rembarrnga (Gunwinyguan)
Ritharrngu (Pama-Nyungan, Yuulngu)
Warndarrang (Maran)

Desert region:
Alawa (Maran)
Alyawarra (Pama-Nyungan, Arandic)
Arrernte (Pama-Nyungan, Arandic)
Bularnu (Pama-Nyungan, Wakaya-Warluwaric)
Djaru (Pama-Nyungan, Nyungic, Ngumpin)
Djinggili (Tjingili-Wambayan)
Gugada (Pama-Nyungan, Nyungic, Wati)
Kaytetye (Pama-Nyungan, Arandic)
Kukatja (Pama-Nyungan, Nyungic, Wati)
Mantjiltjatjarra (Pama-Nyungan, Nyungic, Wati)
Ngaanyatjarra (Pama-Nyungan, Nyungic, Wati)
Ngarndji (Tjingili-Wambayan)
Nyangumarda (Pama-Nyungan, Nyungic, Marrngu)
Pintupi (Pama-Nyungan, Nyungic, Wati)
Pitjantjatjarra (Pama-Nyungan, Nyungic, Wati)

Walmatjarri (Pama-Nyungan, Nyungic, Ngumpin)
Wambaya (Tjingili-Wambayan)
Warlmanpa (Pama-Nyungan, Nyungic, Ngarga)
Warlpiri (Pama-Nyungan, Nyungic, Ngarga)
Warluwarra (Pama-Nyungan, Wakaya-Warluwaric)
Warumungu (Pama-Nyungan, unclassified)
Yankuntjatjarra (Pama-Nyungan, Nyungic, Wati)

East Cape region:
Aghu-Tharrnggala (Pama-Nyungan, Pama-Maric, Southern Pama)
Guugu-Yimidhirr (Pama-Nyungan, Pama-Maric, Eastern Pama)
Kuku-Yalanji (Pama-Nyungan, Pama-Maric, Eastern Pama)
Kuku-Thaypan (Pama-Nyungan, Pama-Maric, Southern Pama)
Kuuku-Ya'u and Umpila (Pama-Nyungan, Pama-Maric, Middle Pama)

Eyre region:
Arabana (Pama-Nyungan, Karnic)
Diyari (Pama-Nyungan, Karnic)
Kalkatungu (Pama-Nyungan, unclassified)
Pitta-Pitta (Pama-Nyungan, Karnic)
Yandruwanhdha (Pama-Nyungan, Karnic)

Fitzmaurice region:
Djamindjung (Djamindjungan)
Gurindji (Pama-Nyungan, Nyungic, Ngumpin)
Jawoyn (Gunwinyguan)
Malak-Malak (Daly)
Mangarrayi (Mangerian)
Maranungku (Daly)
Mudburra (Pama-Nyungan, Nyungic, Ngumpin)
Murrinh-patha (Garaman)
Warray (Family isolate)

Gulf region:
Garrawa (Karawan)
Kayardild (Tangkic)
Kok-Narr (Pama-Nyungan, Pama-Maric, Norman Pama)
Kukatj (Pama-Nyungan, Pama-Maric, Norman Pama)
Kurrtjar (Pama-Nyungan, Pama-Maric, Norman Pama)
Lardil (Tangkic)
Marra (Maran)
Ngawun (Pama-Nyungan, Pama-Maric, Mayi)
Yanyuwa (Pama-Nyungan, Wakaya-Warluwaric)
Yukulta (Tangkic)

Kimberley region:
Bardi (Nyulnyulan)

Gooniyandi (Bunaban)
Gunin (Wororan)
Kitja (Djeragan)
Miriwung (Djeragan)
Nyigina (Nyulnyulan)
Ungarinyin (Wororan)
Yawuru (Nyulnyulan)

Northeast region:
Bidyara-Gungabula (Pama-Nyungan, Pama-Maric, Mari)
Gugu-Badhun (Pama-Nyungan, Pama-Maric, Mari)

North region:
Amurdak (Iwaidjan)
Gaagudju (Family isolate)
Limilngan (Family isolate)
Tiwi (Family isolate)

Northeast region:
Badimaya (Pama-Nyungan, Nyungic, Kardu)
Jiwarli (Pama-Nyungan, Nyungic, Mantharda)
Martuthunira (Pama-Nyungan, Nyungic, Ngayarda)
Palyku (Pama-Nyungan, Nyungic, Ngayarda)
Panyjima (Pama-Nyungan, Nyungic, Ngayarda)
Payungu (Pama-Nyungan, Nyungic, Kanyara)
Tharrgari (Pama-Nyungan, Nyungic, Mantharda)
Watjarri (Pama-Nyungan, Nyungic, Kardu)
Yindjibarndi (Pama-Nyungan, Nyungic, Ngayarda)

Rainforest region:
Djabugay (Pama-Nyungan, Pama-Maric, Mari)
Dyirrbal (Pama-Nyungan, Pama-Maric, Yara)
Mbabarram (Pama-Nyungan, Pama-Maric)
Nyawaygi (Pama-Nyungan, Pama-Maric, Yara)
Warrgamay (Pama-Nyungan, Pama-Maric, Yara)
Yidiny (Pama-Nyungan, Pama-Maric, Yara)

Riverine region:
Baagandji (Pama-Nyungan)
Garlali (Pama-Nyungan, Karnic)
Madhimadhi (Pama-Nyungan, Kulinic)
Marrgany-Gunya (Pama-Nyungan, Pama-Maric, Mari)
Muruwari (Pama-Nyungan)
Ngiyambaa (Pama-Nyungan, Wiradjuric)
Wembawemba (Pama-Nyungan, Kulinic)
Wergaia (Pama-Nyungan, Kulinic)
Yuwaalaraay (Pama-Nyungan, Wiradjuric)

Southeast region:
Bandjalang (Pama-Nyungan, Bandjalanic)
Gumbaynggir (Pama-Nyungan, Kumbainggaric)
Nganyaywana (Pama-Nyungan)
Ngarigu (Pama-Nyungan, Yuin-Kuric)
Yaygir (Pama-Nyungan, Kumbainggaric)

Southwest region:
Nyungar (Pama-Nyungan, Nyungic, Nyungar)

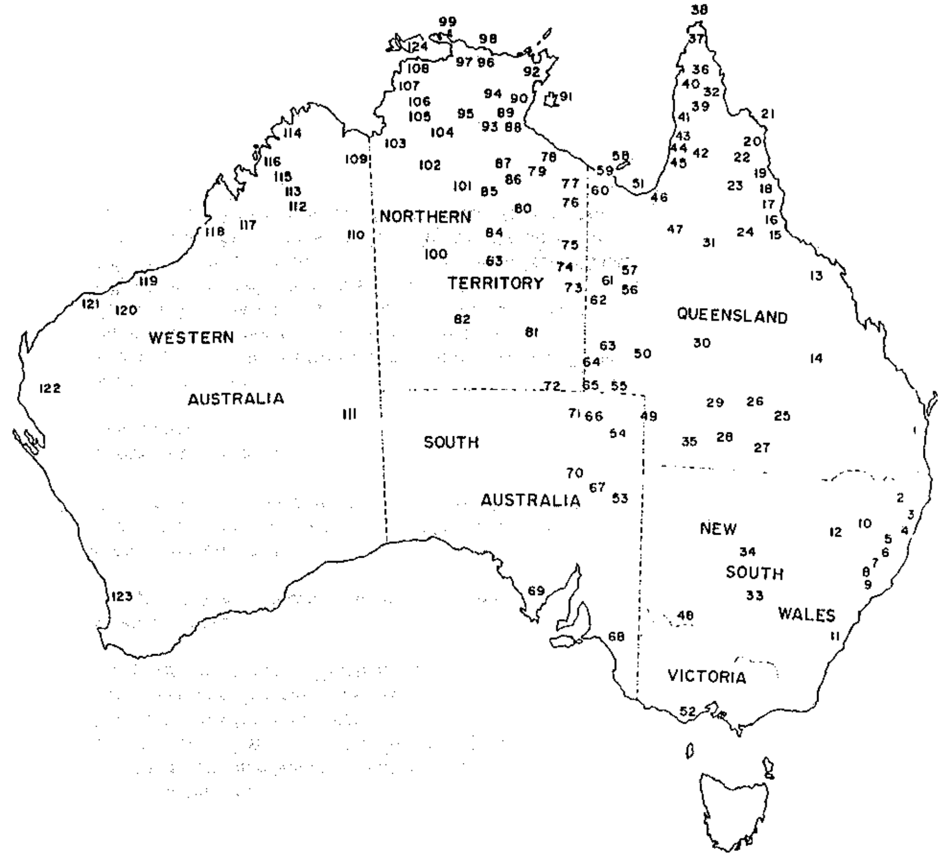
Spencer region (Spen):
Adnyamathanha (Pama-Nyungan, Parnkalla-Yura-Miru)
Nhukunu (Pama-Nyungan, Parnkalla-Yura-Miru)

Torres Strait region:
Kala Lagaw Ya

West Cape region:
Anguthimri (Pama-Nyungan, Pama-Maric, Northern Pama)
Olkol (Pama-Nyungan, Pama-Maric, Western Pama)
Uradhi (Pama-Nyungan, Pama-Maric, Northern Pama)
Wik-Mungkanh (Pama-Nyungan, Pama-Maric, Middle Pama)
Wik-Ngathana (Pama-Nyungan, Pama-Maric, Middle Pama)
Wik-Pakanh (Pama-Nyungan, Pama-Maric, Middle Pama)
Yirr-Yorront (Pama-Nyungan, Pama-Maric, Western Pama)

Map key to the Aboriginal languages of Australia

93 Alawa
74 Alyawarra
91 Anindilyakwa
72 Arabana-Wangganguru
81 Arrernte
35 Baagandji
02 Bandjalang
14 Bidyara
61 Bularnu
113 Bunaba
97 Dalabon
66 Diyari
19 Djabugay
92 Djambarrpuyngu
105 Djamindjung
17 Dyirrbal
77 Garawa
02 Gidabal, dialect of Bandjalang
45 Gog-Narr
86 Gudandji
111 Gugada, dialect of Pitjantjatjarra
22 Gugu-Yalanji
04 Gumbayngir
97 Gunwinygu
101 Gurindji
20 Guugu-Yimidhirr
85 Jingili
83 Kaytetye
57 Kalkatungu
51 Kayardilt
45 Koko-Bera
66 Kukatj
30 Kungkari
32 Kuuku-Ya'u
58 Lardil
48 MadhiMadhi
106 MalakMalak
95 Mangarrayi
88 Marra
29 Marrgany
23 Mbabarram
109 Miriwung
102 Mudbura
107 Murinh-patha
27 Muruwari
94 Ngandi
10 Nganyaywana
121 Ngarluma
87 Ngarndji
47 Ngawun
90 Nunggubuyu
119 Nyangumarda
15 Nyawaygi
123 Nyungar
42 Ogh-Undjan
42 Olkol
42 Oykangand
43 Pakanh
111 Pitjantjatjarra
62 Pitta-Pitta
97 Rembarrnga
92 Ritharrngu
122 Tharrkari
43 Thaayorre
124 Tiwi
115 Ungarinyin
37 Uradhi
75 Wagaya
110 Walmatjari
80 Wambaya
34 Wangaybuwan/Ngiyambaa
49 Wangkumara
100 Warlpiri
61 Warluwara
89 Warndarrang
84 Warramungu
16 Warrgamay
24 Warungu
48 Wembawemba
48 Wergaia
111 Western Desert
39 Wik-Mungkanh
54 Yandruwanhdha
78 Yanyuwa
03 Yaygir
18 Yidiny
120 Yindjibarndi
44 Yirrk-Thangedl
44 Yirr-Yorront
99 Yiwadja
60 Yukulta
92 Yuulngu



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