【**Forum**】

Sonority Hierarchy in Warrongo (Australia)

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Abstract: This paper provides data on the intervocalic consonant clusters of Warrongo (Australia), and offers the following observations: (a) The liquids /ɾ, l/ should be considered more sonorous than the semivowel /w/; (b) The liquid /ɾ/ should be considered more sonorous than the semivowel /j/; (c) Among the nasals, the alveolar /n/ should be considered more sonorous than the bilabial /m/ and the velar /ŋ/; (d) Among the nasals, the palatal /ɲ/ should be considered more sonorous than the velar /ŋ/; (e) Among the stops, the alveolar /d/ should be considered more sonorous than the velar /g/; and (f) Among the nasals and stops, the alveolars may possibly be the most sonorous, and the velars possibly the least sonorous. In terms of (a) and (b), Warrongo diverges from most of the languages discussed in the literature, where semivowels are considered more sonorous than liquids.*

Key words: Warrongo, consonant cluster, sonority, syllable, phonological process

1. Introduction

The present paper provides data on the intervocalic consonant clusters of Warrongo (northeast Australia) and examines previously proposed sonority hierarchies on the basis of them. The Warrongo data suggests the following conclusions:

(a) The liquids /ɾ, l/ should be considered more sonorous than the semivowel /w/.
(b) The liquid /ɾ/ should be considered more sonorous than the semivowel /j/.
(c) Among the nasals, the alveolar /n/ should be considered more sonorous than the bilabial /m/ and the velar /ŋ/.
(d) Among the nasals, the palatal /ɲ/ should be considered more sonorous than the velar /ŋ/.

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*The Warrongo language used to be spoken in the upper Herbert River area of north Queensland, Australia. Fieldwork on it was conducted three times, from 1971 to 1974. Most of the data on Warrongo was obtained from the late Mr. Alf Palmer (Warrongo name: Jinbilnggay), the last fluent speaker of the language. The present paper is a tribute to his wisdom, foresight and efforts to have his language documented for posterity. I am grateful to (i) Haruo Kubozono for drawing Kiparsky (1979) and Suzuki (1989) to my attention, and (ii) two anonymous referees for very helpful comments.

(e) Among the stops, the alveolar /d/ should be considered more sonorous than the velar /g/.
(f) Among the nasals and stops, the alveolars may be considered the most sonorous, and the velars the least sonorous.

The consonant and semivowel phonemes of Warrongo are shown in Table 1.

Table 1. Consonant and semivowel phonemes

	bilabial	apico-alveolar	retroflex	lamino-palatal	dorso-velar
stop	b	d		ɟ	g
nasal	m	n		ɲ	ŋ
rhotic		ɾ	ɻ		
lateral		l			
semivowel				j	w

There are a stop phoneme and the corresponding nasal phoneme for each of the following points of articulation: bilabial, apico-alveolar, lamino-palatal, and dorso-velar. For stops, voicing is not distinctive. Phonetically, both voiced and voiceless allophones occur. There are also two rhotics (i.e. *r*-sounds): /r/ (generally an alveolar tap [ɾ], but possibly an alveolar trill [r] for emphasis) and /ɻ/ (generally a retroflex approximant [ɻ], and occasionally a retroflex tap [ɽ]); one lateral; and two semivowels. There is no fricative phoneme. Additionally, all the consonant clusters are inter-vocalic. There is no consonant cluster in a word-initial position or a word-final position.

The vowel system basically consists of three phonemes: /a, i, u/. The vowel length is significant for the pair of /a/ and /aː/ only and to a very limited degree.

The format of this paper is as follows. Section 2 examines consonant clusters within roots (i.e. intra-root clusters), and Section 3 those at a morpheme boundary (i.e. inter-morpheme clusters). Section 4 provides a summary of the paper.

2. Intra-root Clusters

2.1. Inventory of intra-root clusters

The intra-root clusters can be classified as shown in Table 2. Most of them are bi-consonantal, while others are tri-consonantal. For each group in the table, a generalization about its membership is given, together with a list of unattested combination(s), where relevant. We shall first look at bi-consonantal clusters (2.1.1), followed by tri-consonantal clusters (2.1.2).

Table 2. Intra-root clusters

The last member of the cluster is:	bilabial	apico-alveolar	lamino-palatal	dorso-velar
bi-consonantal clusters				
(a)	mb	nd	ɲɟ	ŋg
(b)	ɾb		ɾɟ	ɾg
	lb		lɟ	lg
	nb		nɟ	ng
(c)	ɾm			ɾŋ
	lm		lɲ	lŋ
(d)	ɾw			
	lw			
(e)	nm			nŋ
(f)	ɻb		ɻɟ	ɻg
	jb		jɟ	jg
(g)				ɻŋ
	jm			jŋ
tri-consonantal clusters				
(h)	ɾmb		ɾɲɟ	
			ɻɲɟ	ɻŋg
	lmb		lɲɟ	lŋg
	jmb		jɲɟ	jŋg
(i)	lnb			
	jnb			

2.1.1. Bi-consonantal clusters

Bi-consonantal clusters are as follows:

(a) Homorganic nasal-plus-stop clusters: /mb/, /nd/, /ɲɟ/, /ŋg/. All possibilities are attested, e.g. /ba**mb**aɻa/ 'white', /ba**nd**a/ 'to come out', /wa**ɲɟ**a/ 'where', /bala**ŋg**al/ 'dugong'. (The relevant phonemes are shown in bold face.)

(b) Apico-alveolar sonorant (/ɾ/, /l/ or /n/) plus non-apico-alveolar stop (/b/, /ɟ/ or /g/). All possibilities are attested, e.g. /ba**ɾb**iɻa/ 'echidna', /wa**ɾɟ**an/ 'raft', /bi**ɾg**il/ 'cold weather', /ba**lb**a/ 'to roll', /ba**lɟ**i/ 'empty', /ba**lg**a/ 'to hit', /ba**nb**a/ 'fig sp.', /wa**nɟ**a/ 'hole', /wa**ng**al/ 'little girl'.

(c) Apico-alveolar liquid (/ɾ/ or /l/) plus non-apico-alveolar nasal (/m/, /ɲ/ or /ŋ/). All possibilities are attested, except for /ɾɲ/. Examples: /bu**ɾm**u/ 'deaf', /ba**ɾŋ**a/ 'light (not dark)', /gu**lm**i/ 'back (adv)', /ŋa**lɲ**i/ 'kind, gentle', /ga**lŋ**a/ 'mother's brother'.

(d) Apico-alveolar liquid (/ɾ/ or /l/) plus semivowel (/j/ or /w/). /ɾj/ and /lj/ are not attested. Examples: /ɟi**ɾw**i/ 'namesake', /wa**lw**a/ 'bad'. Dixon (1972: 287)

states that in Dyirbal, immediately northeast of Warrongo, the clusters /lj/ and /nj/ are prohibited. Warrongo has the cluster /ɾ-j/ across a morpheme boundary; see Table 4. Nonetheless, /ɾj/ and /lj/ are possibly prohibited within a root.

(e) Apico-alveolar nasal (/n/) plus peripheral nasal (/m/ or /ŋ/). Both possibilities are attested, e.g. /gu**nm**a/'to break', /wa**nŋ**aɟa/ 'bony bream'. The latter is the only example of /nŋ/.

(f) Retroflex approximant (/ɻ/) or palatal semivowel (/j/) plus non-apico-alveolar stop (/b/, /ɟ/ or /g/). All possibilities are attested, e.g. /ba**ɻb**aj/ 'ice', /gu**ɻɟ**a/ 'native bee', /ba**ɻg**il/ 'bush rat', /bu**jb**un/ 'spring water', /gu**jɟ**aɾi/ 'scrub turkey', /ba**jg**aɻi/ 'fig sp.'.

(g) Retroflex approximant (/ɻ/) or palatal semivowel /j/ plus peripheral nasal (/m/ or /ŋ/). /ɻm/ is not attested. Examples: /ba**ɻŋ**an/ 'kangaroo rat', /ɟu**jm**a/ 'to crawl'.

There is not any good example of /jŋ/. One possible example is /gaɻu**jŋ**a/ 'to hide'. Etymologically it may contain the transitive-stem-forming suffix /ŋa/, but there is no evidence for this etymology, and tentatively /gaɻujŋa/ is treated as a root and it is listed in Table 2.

2.1.2. Tri-consonantal clusters

Tri-consonantal clusters are as follows:

(h) Liquid (/ɾ/, /ɻ/ or /l/) or palatal semivowel /j/ plus a non-apico-alveolar nasal-plus-stop homorganic cluster. /ɾŋg/ and /ɻmb/ are not attested. Examples: /bu**ɾmb**u/ 'to breath upon', /ma**ɾɲɟ**a/ 'a sore' (noun), /bu**ɻɲɟ**u/ 'elbow', /bi**ɻŋg**a/ 'grey hair', /ba**lmb**i/ 'to smell', /ba**lɲɟ**a/ 'to come out', /ba**lŋg**aɻa/ 'Stony Creek', /ɟa**jmb**aj/ 'hither', /bu**jɲɟ**al/ 'fish smell', /ba**jŋg**iɾa/ 'sweat'.

(i) /l/ or /j/ plus /nb/. These clusters are difficult to generalize about. Examples: /bi**lnb**iɻan/ 'crimson rosella (?)', /gu**jnb**un/ 'sorry'.

There are many gaps in Table 2. Some of the unattested patterns may be genuinely prohibited, while some others may simply be accidental 'gaps' in the language or they may be due to the incompleteness of the data.

2.2. Analysis of intra-root clusters

2.2.1. Relative orders of consonants and semivowels

Those features of the groups in Table 2 which are relevant to the ensuing discussions are as follows:

(1) Bi-consonantal clusters:
   a. nasal-plus-stop.
   b. sonorant (/ɾ, l, n /) + stop (/b, ɟ, g/).
   c. liquid (/ɾ, l/) + nasal (/m, ɲ, ŋ/).
   d. liquid (/ɾ, l/) + semivowel (/w/).
   e. apico-alveolar nasal (/n/) + peripheral nasal (/m, ŋ/).
   f. liquid /ɻ/ or semivowel /j/ + stop (/b, ɟ, g/).
   g. liquid /ɻ/ or semivowel /j/ + nasal (/m, ŋ/).

In each combination, the first member is a nasal, a liquid, or the semivowel /j/. They are all sonorants. (But /w/, which is a sonorant, does not occur here.) The second member is often, though not always, a stop. But the second member may be a peripheral nasal or semivowel (/m, ŋ, w/).

In tri-consonantal clusters, the first member is a liquid (/ɾ, ɻ, l/) or the semivowel /j/. They are all sonorants, but the other sonorants, i.e. nasals and /w/, do not occur here. The second member is a nasal (/m, n, ɲ, ŋ/). The last member is a stop (/b, ɟ, g/). This distribution can be summarized as in (2).

(2) Tri-consonantal clusters:
   liquid or /j/ + nasal + stop

2.2.2. Sonority hierarchies (I) and the Syllable Contact Law

Hierarchies of speech sounds in terms of their sonority, audibility or strength have been proposed by a number of researchers, notably Clements (1990: 285–286), Durand (1990: 210), Foley (1977: 145), Hooper (1976: 197–199), Kiparsky (1979: 432), Ladefoged (1975: 219–220, 281), Lass (1984: 183, 264), Murray and Vennemann (1983: 519), Selkirk (1984: 112), Trask (1996: 327–328), Vennemann (1972: 6), and Zwicky (1972: 277). They may be summarized as in (3).

(3) Sonority hierarchy:
   vowels > semivowels > liquids > nasals > fricatives > stops

   ⟵⟶

   most sonorous — least sonorous

A number of works have pointed out the cross-linguistic tendency for the sonority of a syllable-final consonant to exceed that of a following syllable-initial consonant. See, for instance, Clements (1990: 286, 1992: 67), Hooper (1972: 537, 1976: 196, 199), and Murray and Vennemann (1983: 520). Murray and Vennemann propose 'the Syllable Contact Law', which is paraphrased by Clements as follows.

(4) The Syllable Contact Law (Clements 1990: 287):
   In any sequence $C_a\$C_b$ there is a preference for C_a to C_b exceed in sonority.

('$' designates a syllable boundary.)

As mentioned in Section 1, Warrongo has no consonant cluster in a word-initial position or a word-final position. Consequently, the consonant clusters shown in (1) and (2) run astride a syllable boundary.

Most of the bi-consonantal clusters (-VC$_a$C$_b$V-) (see (1)) conform to the Syllable Contact Law; C$_a$ is more sonorous than C$_b$. (But there are exceptions, as seen below.)

In the case of tri-consonantal clusters -VC$_a$C$_b$C$_c$V- (see (2)) it is difficult to decide where the syllable boundary is. (Regarding intervocalic tri-consonantal clusters in Australian languages, Dixon (2002: 557) concludes as follows: "There appears to be no principled way to decide whether the middle consonant should relate to the first or second syllable." See also Dixon (2002: 656).) Nonetheless, at least C$_a$ (a liquid or /j/) is more sonorous than C$_c$ (a stop). Again, this conforms to the Syllable Contact Law.

The above indicates that Warrongo in the main conforms to the cross-linguistic tendency for the sonority of a syllable-final consonant to exceed that of a following syllable-initial consonant. However, there are two sets of exceptions: (1d) and (1e). This necessitates a revision of a sonority hierarchy such as that shown in (3). We shall examine each of the exceptions.

2.2.3. Exceptions in (1d)

In Table 2, /ɾw/ and /lw/ are exceptions. The first member (a liquid) is less sonorous than the second member (the semivowel /w/) in terms of the sonority hierarchy of (3), and consequently /ɾw/ and /lw/ are exceptions to this hierarchy. There is one way to accommodate them. If /w/ is placed below the liquids /ɾ, l/, as in (5), /ɾw/ and /lw/ will no longer be exceptions. In terms of the revised hierarchy, the liquids /ɾ, l/ should be considered more sonorous than the semivowel /w/.

(5) Revised sonority hierarchy—for Warrongo (I):
vowels > /ɾ, l/ > /w/ > nasals > stops

most sonorous least sonorous

The revised hierarchy in (5) accommodates all the other consonant clusters of Warrongo—except that the liquid /ɻ/ and the semivowel phoneme /j/ are absent in the hierarchy.

Regarding the liquid /ɻ/, there is no evidence for locating it relative to any semivowel. There is no example of /ɻw/ or /ɻj/. (Nor is there any example of /wɻ/ or /jɻ/. At least, according to the analysis adopted, /w/ cannot precede any consonant, and consequently /wɻ/ is prohibited.)

Concerning the semivowel phoneme /j/, as far as intra-roots are concerned, there is no evidence for locating it relative to any liquid. (However, the cluster /ɾ-j/ is attested at a morpheme boundary, and this suggests that /j/ can be placed lower than /ɾ/. See (11).)

The situation concerning /ɾ/, /ɻ/, /l/, /w/, and /j/ is shown in Table 3.

Table 3. /ɾ/, /ɻ/, /l/, /w/, and /j/

/ɾw/	attested within a root	/wɾ/	prohibited
/ɻw/	not attested	/wɻ/	prohibited
/lw/	attested within a root	/wl/	prohibited
/ɾj/	attested at a morpheme boundary	/jl/	not attested
/ɻj/	not attested	/jɻ/	not attested
/lj/	not attested	/jl/	not attested

2.2.4. Sonority hierarchies (II)

As noted in 2.2.2, a fair number of works assign semivowels a higher position than liquids in their respective sonority hierarchies; see (3). The revised hierarchy, shown in (5), diverges from them in that the liquids /r, l/ are placed higher than the semivowel /w/.

There are at least two previous works that propose a sonority hierarchy that diverges from that shown in (3): Hankamer and Aissen (1974) and Suzuki (1989).

Hankamer and Aissen (1974: 132) propose a hierarchy of (6) to account for assimilation in Pali.

(6) /r/ > /j/ > /v/ > /l/ > nasals > /s/ > stops

Note that the liquid /r/ (though not the liquid /l/) is placed higher than the semivowel /j/. (This hierarchy does not deal with /w/.) Also, Hankamer and Aissen (1974: 138) propose a hierarchy of (7) to account for assimilation in Hungarian.

(7) /l/ > /r/ > /j/ > nasals > fricatives > stops

Note that both /l/ and /r/ are placed higher than /j/. (Again, this hierarchy does not deal with /w/.)

Suzuki (1989) looks at early West Germanic and proposes that /w/ was less sonorous than /r/ and /l/. That is:

(8) /r, l/ > /w/

We have seen four cases (Warrongo, Pali, Hungarian, and early West Germanic) in which the proposed hierarchy diverges from that shown in (3). These divergences all concern the relative position of liquid(s) and a semivowel. (I owe this observation to Haruo Kubozono.)

It is important to enquire what may cause these divergences. One possibility is the type of phenomenon examined, i.e. the type of evidence employed. The works cited in 2.2.2, i.e. those works that propose (or endorse) the sonority hierarchy as shown in (3), in the main consider phenomena such as those listed below. (Some of the works cited in 2.2.2 do not refer to any specific phenomenon.) These works are referred to as Group A.

Group A:

(a) Clements (1990, 1992): syllable contact in English and many other languages.

(b) Foley (1977): phonological processes (synchronic and diachronic) (e.g. spirantization in German and Classical Greek, nasalization in Latin and French, denasalization in Old Norse, intervocalic obstruent deletion in French, and palatalization in Germanic).
(c) Hooper (1976): syllable contact (no language cited), and phonological processes (synchronic and diachronic) (e.g. strengthening in Spanish, and consonant deletion and assimilation from Latin to Spanish).
(d) Kiparsky (1979): stress assignment in English.
(e) Ladefoged (1975): the loudness of a sound relative to that of other sounds with the same length, stress and pitch in English.
(f) Lass (1991): deletion in English (evidence given by Zwicky 1972).
(g) Murray and Vennemann (1983): syllable contact.
(h) Vennemann (1972): phonological processes (e.g. vowel lengthening, aspiration, devoicing, and consonant deletion) in Icelandic, and stress assignment in Latin).
(i) Zwicky (1972): fast speech phenomena in English (e.g. gliding, nasal assimilation, schwa deletion, and consonant deletion).

The works that propose a sonority hierarchy that diverges from that of (3) consider phenomena such as those listed below. These works are referred to as Group B.

Group B:
(j) Hankamer and Aissen (1974): assimilation (synchronic and diachronic) in Pali, and assimilation (synchronic) in Hungarian.
(k) Suzuki (1989): onset clusters, alliteration, gemination, etc. (synchronic) in early West Germanic.
(l) The present work: syllable contact in Warrongo.

We have examined the kinds of evidence employed in order to see what lies behind the difference between Group A (which proposes the hierarchy of (3)) and Group B (which proposes deviations from (3)). However, it is difficult to see any clear difference. This indicates that the kind of evidence is not the factor that differentiates between Group A and Group B. We shall have to leave this question unsettled.

There seems little doubt that the proposed sonority hierarchies have some kind of phonetic basis. See Ladefoged's definition of sonority cited above. However, it is difficult to know exactly what this phonetic basis is. Clements (1990: 290) notes as follows.

> Given the remarkable similarity among sonority constraints found in different and widely separated languages, we might expect that sonority could be directly related to one or more invariant physical or psychoacoustic parameters. However, so far there exists no entirely satisfactory proposal of this sort.

Clements' remark suggests that the term 'sonority' may not be entirely suitable to

refer to the phenomenon in question. Indeed, Hooper (1976: 201) employs the term 'Consonantal Strength Hierarchies'. In her framework, 'more sonorous' segments in (3) are 'weaker', and 'less sonorous' ones are 'stronger'.

The above suggests that, while the previously proposed sonority hierarchies in the main have a phonetic basis, their precise determinants may differ and the differences may be language-specific and/or phenomenon-specific.

In the following, we shall continue to use the terms 'sonority' and 'sonority hierarchy'. We shall also continue to assume that intervocalic clusters of Warrongo conform to the Syllable Contact Law (see (4)).

In 2.2.3, we presented one pair of exceptions to the sonority hierarchy of (3) (i.e. /ɾw/ and /lw/ in (d) of Table 2), and in 2.2.4, we supplied detailed discussions thereof. We turn now to the other pair of exceptions.

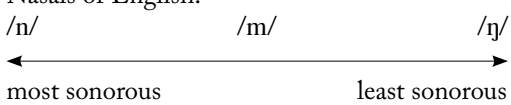
2.2.5. Exceptions in (1e)

In the clusters /nm/ and /nŋ/ in (e) of Table 2, both members are nasals, and consequently they exhibit no difference in terms of (3) or (5). However, the relative order of the nasals indicates that /n/ should be considered more sonorous than /m, ŋ/. That is:

(9) Nasals of Warrongo (I):
/n/ > /m, ŋ/

Zwicky (1972: 277) suggests the following hierarchy for the nasals of English:

(10) Nasals of English:



The relative order of the nasals in the Warrongo clusters /nm/ and /nŋ/ conforms to (10).

The evidence for (9) concerns intervocalic consonant clusters of Warrongo, while the evidence for (10) comes from nasal assimilation, schwa deletion, etc. in fast speech of English. It is interesting to note that these two different kinds of evidence from different languages point to the same hierarchy (or, at least very similar hierarchies).

3. Inter-morpheme Clusters

3.1. Inventory of inter-morpheme clusters

Consider Table 4. The classification of clusters follows that in Table 2.

Table 4. Inter-morpheme clusters

The last member of the cluster is:	bilabial	apico-alveolar	lamino-palatal	dorso-velar
bi-consonantal clusters				
(a)	mb	nd	ɲɟ	
(b)	nb		nɟ	ŋg
	ɾb		ɾɟ	ɾg
	lb	ld	lɟ	lg
(c)	ɾm			ɾŋ
	lm			lŋ
(d)			ɾj	
(e)	nm			nŋ
(f)	ɻb		ɻɟ	ɻg
	jb		jɟ	jg
(g)				ɻŋ
	jm		jɲ	jŋ
others			mɟ	mŋ
	ɲb			ɲŋ
				dg
			jj	
tri-consonantal clusters				
(h)	ɾmb			
	ɻmb			
	lmb			
	lnb			
	jmb			jŋg
	jnb			

3.2. Analysis of inter-morpheme clusters

In terms of sonority hierarchies, there are three important differences between intra-root and inter-morpheme clusters. Namely, /ɾ-j/, /ɲ-ŋ/ and /d-g/ are not attested in intra-root clusters, but they are attested in inter-morpheme clusters. We shall examine each of them.

3.2.1. /ɾ-j/

As an example of this cluster, consider:

/jamuɾi/ Vi 'hurry'
/jamu**ɾ**-**j**amuɾi/ Vi 'hurry'

Here we have the cluster /ɾ-j/ at a morpheme boundary. The existence of this cluster suggests that /ɾ/ should be considered more sonorous than /j/. That is:

(11) Revised sonority hierarchy—for Warrongo (II):
vowels > /r/ > /j/ > nasals > stops

most sonorous least sonorous

It is tempting to combine (11) and (5) ('Revised hierarchy for Warrongo (I)'), and to place /j/ together with /w/ in (5). Unfortunately, however, there is no evidence that concerns the relative ranking of /l/ and /j/, and we are unable to locate /j/ in (5).

3.2.2. /ɲ-ŋ/

Consider:

/julbiɻiɲ/ '[cooked animal etc.] with no skin'
/julbiɻiɲ-ŋa/ Vt 'skin [an animal]'

(/ŋa/ is a transitive-stem-forming suffix.) /julbiɻiɲ-ŋa/ is the only example of this cluster. The existence of this cluster indicates that /ɲ/ should be considered more sonorous than /ŋ/. That is:

(12) Nasals of Warrongo (II):
/ɲ/ > /ŋ/

It is tempting to combine (12) and (9) ('Nasals of Warrongo (I)'), and place /ɲ/ somewhere in (9). Unfortunately, however, there is no evidence that concerns the relative ranking of /ɲ/ in relation to /m/ and /n/, and we are unable to locate /ɲ/ in (9).

3.2.3. /d-g/

The only example of this cluster is:

/waɻa-ji-**d**-**g**u/ 'one's own-LINK-LINK-DAT'

(Phonetically, /d-g/ is voiceless: [tk].) This cluster is exceptional; it is the only stop-plus-stop cluster in the language. Also, the formation of this particular dative form is highly unusual. The dative form is generally:

/wu/ following a vowel
/gu/ following a consonant

In /waɻa-ji-**d**-**g**u/, the linking suffix /d/ intervenes. The linking suffix /d/ does not occur anywhere else in the language; it is in this respect that the formation of this particular dative form is unusual. Since /d/ is a consonant, the dative suffix is /gu/, and not /wu/.

The existence of this cluster indicates that /d/ should be considered more sonorous than /g/. That is:

(13) Stops of Warrongo:
/d/ > /g/

Recall that, regarding nasals, the velar /ŋ/ is less sonorous than the alveolar /n/ in (9) ('Nasals of Warrongo (I)'), and that it is less sonorous than the palatal /ɲ/ in (12). Note regarding (13) that the stop /g/ is velar, and that it is less sonorous than the alveolar /d/.

Note also that, in (9) regarding nasals, the alveolar /n/ is more sonorous than the bilabial /m/ and the velar /ŋ/. In (13), regarding stops, the alveolar /d/ is more sonorous than the velar /g/.

The above suggests the following possibility, although the evidence is not conclusive: Among stops and nasals, the alveolars are the most sonorous, while the velars are the least sonorous.

The following fact may be relevant. There is a word that contains the intermorpheme cluster /d-ŋ/: /ɻubiji**d-ŋ**umaj/ 'Rosevale-ABL'. /ɻubijid/ 'Rosevale' is a loan from English, and it is not a traditional Warrongo word. Traditional Warrongo roots/words do not end in a stop. In view of this, the cluster /d-ŋ/ was not listed in Table 4. Since the stop /d/ precedes the nasal /ŋ/, their relative order contradicts the sonority hierarchy of (3) or (5). Nonetheless, it is interesting to note that, in this cluster, the first member is the alveolar stop (probably the most sonorous among the stops), while the second member is the velar nasal (probably the least sonorous among the nasals).

There are works that discuss of the relative ranking of stops.

Vennemann (1972: 6) proposes a sonority hierarchy for Modern Icelandic, part of which is shown in (14).

(14) /f, b, d, g/ > /s/ > /p, k/ > /t/

(14) is the reverse of (13) in that the velar /k/ is considered more sonorous than the alveolar /t/. The evidence for the relative ranking of /p, k/ above /t/ comes from the voicing/unvoicing of /t/ that precedes.

Ladefoged (1975: 220) proposes a sonority hierarchy for English, part of which is shown in (15). (Ladefoged does not include /g/ in this hierarchy. Also, he does not give any specific evidence for this hierarchy.)

(15) /d/ > /t/ > /k/

(15) parallels (13) in that the alveolar /t/ is considered more sonorous than the velar /k/.

Foley (1977: 28) proposes the hierarchy of stops in North German, on the basis of evidence from spirantization.

(16) /b/ > /d/ > /g/

Again, different phenomena in different languages seem to suggest different hierarchies of stops. Nonetheless, it is worth noting that the velars are the least sonorous (Foley 1977: 94)—except in (14). Also, this in the main conforms to the tendency noted by Clements (1990: 296): "the apparently greater sonority of coronal [e.g. alveolar and palatal—TT] as opposed to noncoronal [e.g. labial and velar—TT] consonants in some languages".

Ladefoged (1975: 127) compares the pronunciation of the bilabial [b] and that of the velar [g] as follows.

> in [b] there is a fairly large space above the glottis. Air from the lungs can flow through the glottis for a relatively longer period of time before the pressure above the glottis begins to approach that of the air in the lung. … But in [g] there is only a small space above the glottis into which air can flow, …

This probably explains the low degree of sonority of the velar stops and also the velar nasal. See (10), (12), (13), (15), and (16). See also (9).

4. Summary

This paper has provided data on the intervocalic consonant clusters of Warrongo, offering the following observations.

(a) The liquids /ɾ, l/ should be considered more sonorous than the semivowel /w/.
(b) The liquid /ɾ/ should be considered more sonorous than the semivowel /j/.
(c) Among the nasals, the alveolar /n/ should be considered more sonorous than the bilabial /m/ and the velar /ŋ/.
(d) Among the nasals, the palatal /ɲ/ should be considered more sonorous than the velar /ŋ/.
(e) Among the stops, the alveolar /d/ should be considered more sonorous than the velar /g/.
(f) Among the nasals and stops, the alveolars may possibly be the most sonorous, and the velars possibly the least sonorous.

In terms of (a) and (b), Warrongo diverges from most of the languages discussed in the literature, where semivowels are considered more sonorous than liquids. Similar divergences are observed in Pali, Hungarian, and early West Germanic. The reason, if any, for these divergences is not known.

As for (c), the Warrongo data conforms to the nasal hierarchy proposed by Zwicky.

Regarding (d), no previous work has been found that concerns the relative degree of sonority of /ɲ/ and /ŋ/.

Concerning (e) and (f), there is a crosslinguistic variation regarding the relative degree of sonority of stops, but the velar stops seem to tend to be the least sonorous.

Abbreviations

DAT—dative; LINK—linking suffix; Vt—transitive verb

References

Clements, George N. (1990) The role of the sonority cycle in core syllabification. In: John Kingston and Mary Beckman (eds.) *Papers in laboratory phonology I: Between the grammar and physics of speech*, 283–333. Cambridge: Cambridge University Press.

Clements, George N. (1992) The sonority cycle and syllable organization. In: Wolfgang U. Dressler et al. (eds.) *Phonologia 1988: Proceedings of the 6th International Phonology Meeting, 63–76*. Cambridge: Cambridge University Press.

Dixon, R.M.W. (1972) *The Dyirbal language of North Queensland*. Cambridge: Cambridge University Press.

Dixon, R.M.W. (2002) *Australian languages*. Cambridge: Cambridge University Press.

Durand, Jacques (1990) *Generative and non-linear phonology*. London and New York: Longman.

Foley, James (1977) *Foundations of phonological theory*. Cambridge: Cambridge University Press.

Hankamer, Jorge and Judith Aissen (1974) The sonority hierarchy. In: Anthony Bruck et al. (eds.) *Papers from the parasession on natural phonology*, 131–145. Chicago: Chicago Linguistic Society.

Hooper, Joan B. (1972) The syllable in phonological theory. *Language* 48: 525–540.

Hooper, Joan B. (1976) *An introduction to natural generative phonology*. New York: Academic Press.

Kiparsky, Paul (1979) Metrical structure assignment is cyclic. *Linguistic Inquiry* 10: 421–441.

Ladefoged, Peter (1975) *A course in phonetics*. New York: Harcourt Brace Jovanovich.

Lass, Roger (1984) *Phonology*. Cambridge: Cambridge University Press.

Murray, Robert W. and Theo Vennemann (1983) Sound change and syllable structure in Germanic phonology. *Language* 59: 514–528.

Selkirk, Elisabeth (1984) On the major class features and syllable theory. In: Mark Aronoff and Richard T. Oehrle (eds.), *Language, sound, structure: Studies in phonology presented to Morris Halle by his teacher and students*, 107–136. Cambridge, MA: The MIT Press.

Suzuki, Seiichi (1989) On determining the sonority value of /w/ relative to /r/ and /l/ in Early West Germanic. *Folia Linguistica Historica* 10: 21–34.

Trask, R.L. (1996) *A dictionary of phonetics and phonology*. London: Routledge.

Vennemann, Theo (1972) On the theory of syllabic phonology. *Linguistische Berichte* 18: 1–18.

Zwicky, Arnold (1972) Note on a phonological hierarchy in English. In: Robert P. Stockwell and Ronald K.S. Macaulay (eds.) *Linguistic change and generative theory*, 275–301. Bloomington: Indiana University Press.

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[Received 20 December 2007;
Accepted 5 February 2008]

［要　旨］

ワロゴ語（オーストラリア）の「聞こえ度階層」

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本稿はワロゴ語（オーストラリア）の母音間の子音連続のデータを提示し，それをもとにして，音素の聞こえ度階層を提案する。この階層は，従来提案されている聞こえ度階層と異なる点がある。半母音と流音の相対的な位置などである。更に鼻音の階層と閉鎖音の階層も考察する。