



## Research Article

# An ultrasound study of coronal places of articulation in Central Arrernte: Apicals, laminals and rhotics



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## ABSTRACT

This study presents ultrasound data from six female speakers of Arrernte, a language which has four coronal places of articulation: dental, alveolar, retroflex, and (alveo-)palatal. We present tongue contours for stop, nasal and lateral productions of each of these four coronal places – /t̪ t̪ c/, /n̪ n̪ ɲ ɲ/ and /ɬ ɬ l̪ l̪/ – as well as for the two contrastive rhotics of Arrernte, the alveolar trill /r/ and the retroflex glide /ɻ/. Results show that the palatal is characterized by a high and front tongue position, and the dental is characterized by a relatively low and flat tongue in the mid-to-front portion. Consistent with previous studies, the alveolar and the retroflex are difficult to discriminate, and potential differences are discussed. The rhotics are characterized by a low front portion of the tongue, and a retracted back portion of the tongue. The front portion of the tongue is lower for the alveolar trill than for the retroflex glide; and for most speakers, the back of the tongue is more retracted for the trill than for the glide. The back of the tongue is more retracted for the rhotics than for the corresponding stops and nasals, although there is evidence this part of the tongue patterns similarly for the laterals and the rhotics. It is suggested that this posterior constriction for the various liquid sounds arises from the interaction between bio-mechanical properties of the tongue and manner of articulation requirements.

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## 1. Introduction

In this study we present ultrasound data for the coronal stop, nasal, lateral and rhotic consonants of Central Arrernte, a Pama-Nyungan (Arandic) language of Central Australia spoken in and around the administrative township of Alice Springs (Breen & Dobson, 2005; Henderson, 2013). Arrernte is comparatively rare in having a very rich set of coronal contrasts, with four coronal places of articulation in each of the stop, nasal, and lateral series (c.f. Ladefoged & Maddieson, 1996; Maddieson, 1984). In this paper we examine these coronal consonants in order to achieve a better understanding of this relatively unusual set of phonological contrasts.

A particular characteristic of Arrernte (and of most Australian Aboriginal languages – c.f. Evans, 1995) is the division of the coronal consonants into an apical contrast, and a laminal contrast. The apical contrast is between an alveolar place of articulation and a retroflex. However, the contrast between the two apicals can be described as marginal – that is, there

are very few minimal pairs involving these sounds, and phonetic studies of the contrast (e.g. Tabain, 2009) show a good deal of phonetic overlap between the two phonological places of articulation (c.f. Nadeu & Renwick, 2016). Conversely, the laminal contrast, between a dental place of articulation and an (alveo-)palatal (henceforth simply palatal) place of articulation is very clear, both in articulatory and acoustic phonetic terms. However it may be noted that in perceptual terms, the palatal is more easily identifiable than either the dental, the alveolar, or the retroflex consonants (Bundgaard-Nielsen, Baker, Kroos, Harvey, & Best, 2015). More detail on these various articulations is provided further below.

We also examine the rhotic consonants of Arrernte in the present study. Arrernte is typologically unusual in having a rhotic contrast between a trill /r/ that is classed as apico-alveolar, and a glide /ɻ/ that is classed as apico-retroflex. The fact that Arrernte has a rhotic contrast within the set of apical contrasts allows us to explore what features of the alveolar and retroflex articulations may extend across the manner classes studied here – namely stop, nasal, lateral and rhotic. In addition, it allows us to explore the relationship between rhotics and

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laterals – the liquid consonants – by examining any similarities in articulatory patterns between these two manner classes, as opposed to the stop and nasal manner classes. We elaborate on the issue of rhotic and liquid articulations a little further below.

Table 1 shows the coronal consonants of Arrernte. Note that Arrernte has a palatal glide as well as a pre-stopped nasal series, neither of which we consider in the present study.

As mentioned above, the articulatory distinction between the two laminal sounds of Arrernte is quite clear. For the dental sounds, tongue-palate contact suggests a denti-alveolar articulation (Tabain, 2011). By contrast for the palatal sounds, data show an alveo-palatal articulation, with extensive contact along the entire front of the palate. In terms of overall tongue position, data show that the tongue tip is more forward for the two laminal consonants than it is for the apical consonants (Tabain, 2012). Other important differences emerge when the tongue body is considered. Although the tongue body is high for the palatals, it is noticeably low for the dentals (with intermediate values for the apicals).

For the apical sounds, the contrast is not so consistently clear. A prototypical retroflex articulation shows an initial thin band of contact in the pre-palatal or post-alveolar region (Tabain, 2009 – *Journal of Phonetics*). This is followed by a ballistic forward movement of the tongue during closure, leading to eventual release in the alveolar region. However, this sort of retroflex articulation is mainly found in un-stressed position (stress in Arrernte is located on the first vowel which follows a consonant – or as termed by Breen and Pensalfini (1999), on the second underlying VC syllable). By contrast, a prototypical alveolar articulation shows contact in the alveolar region for the entire duration of consonant closure – this may be termed a “plateau” articulation, since contact is both formed and released at the same point along the palate. Such a clearly alveolar articulation in Arrernte is typically found for a phonemically alveolar consonant before a stressed vowel. As is well-known in the literature on apical contrasts, these dynamic aspects of articulation result in both the retroflex consonant and the alveolar consonant being released at the alveolar region (Simonsen, Moen, & Cowen, 2008; Steriade, 2001).

It must be emphasized, however, that the majority of apical articulations in Arrernte do not align with one of these prototypical categories. Many articulations are intermediate – the closure is somewhat posterior to a typical alveolar closure, but does not usually show the ballistic forward movement of the tongue that is typical of a retroflex articulation. Even in the case of a clear minimal pair such as *ateke* /atək/ (“burst”) vs. *arteke* /aʔək/ (“built”), there is much variability between repetitions, with some repetitions of both words showing elements of an intermediate articulation. It should be noted that the contrast between alveolars and retroflexes is deemed to be neutralized in word-initial position. The apical contrast is therefore a notoriously difficult one for linguists who are studying the language, and in practice the contrast has an extremely low functional load (see Nadeu & Renwick, 2016 for a recent discussion of functional load and related issues in marginal phonemic contrasts).

Regarding the active articulator, linguogram studies by Butcher (1992) and Anderson (2000) of related Arrernte dialects have shown that the apical consonants are indeed artic-

ulated with a very small portion of the tongue tip. In the case of the retroflex, the articulation may be sub-apical. By contrast, a larger portion of the tongue is used for the laminal articulations, with the dental articulation using a longer portion of the tip-blade complex; and the palatal articulation using a very long portion of the tongue behind the tip, including the tongue body.

The above description of Arrernte articulations is largely in line with work on other languages, for instance Catalan, which has fewer coronal places of articulation than Arrernte. For instance, in their recent ultrasound studies of Catalan, Recasens and Rodriguez (2016, 2017) found more tongue body fronting for palatal consonants, and greater tongue body fronting for laminals than for apicals amongst the dentals and alveolars.

In addition, many Indian (especially Dravidian) languages contain retroflex articulations, which may in principle be similar to the retroflexes of Australian languages. In their single-speaker study of Malayalam, Scobbie, Punnoose, and Khattab (2013) found a retracted tongue root for the retroflex lateral, whereas for the alveolar lateral (and the tap /ɾ/) a more advanced tongue root was found, and also more dorsal raising. These results are similar to results from Narayanan, Byrd, and Kaun (1999) on the related language Tamil. Both sets of authors comment on a concaving of the middle portion of the tongue for retroflex sounds, behind the main retroflex constriction. Similar results are also found for Kannada (Kochetov, Sreedevi, Kasim, & Manjula, 2014). In addition, retroflexes in these Dravidian languages are accompanied by a lowering of the jaw – this is also the case for Arrernte (Tabain, 2012). It should be noted that these authors on Dravidian languages emphasize the fact that secondary resonances play a crucial role in the complex system of phonological oppositions in these languages: consequently, to suggest that there is a single “place of articulation” for retroflexes does not fully reflect the complexity of these articulatory configurations.

Turning now to the Arrernte rhotics, palatography data usually show central contact in the alveolar region for the trill /r/ (although as noted by Solé (2002), it is not always clear that full tongue-palate closure is achieved during trilling, much as full glottal closure is not always achieved during voicing). Lateral contact is also evident for the trill along the palate. By contrast, the glide /ɻ/ in Arrernte never shows central contact, while lateral contact is sporadic, and largely concentrated in the palatal region (see Tabain, 2009b for the glide data). Based on this contact pattern, it is not unreasonable to suggest that the glide may indeed have a post-alveolar approximant articulation. Although the rhotics of Australian Aboriginal languages have not been well studied in phonetic terms, and although there is much discussion in the literature on English as to whether the articulation of the glide /ɻ/ is tip-up (i.e. retroflexed) or bunched (e.g. Delattre & Freeman, 1968; Zhou et al., 2008), there is no reason to expect that the Arrernte rhotic glide is anything other than a tip-up articulation. However, it should be noted that the rhotic glide of English typically involves not just a constriction in the post-alveolar region, but also in the pharyngeal region, and at the lips.

Given the relative lack of articulatory or acoustic study on Arrernte rhotics, it is worth considering at this point some salient results from articulatory studies of rhotics in other languages. Recasens and Pallarès (1999), for Catalan, found

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